NSW GOVERNMENT

CONSULTATION PAPER

CLEAN AIR FOR NSW

Published by:

NSW Environment Protection Authority and Office of Environment and Heritage
on behalf of the State of NSW

59 Goulburn Street, Sydney NSW 2000

PO Box A290, Sydney South NSW 1232

Phone: +61 2 9995 5000 (switchboard)

Phone: 131 555 (environment information and publications requests)

Fax: +61 2 9995 5999

TTY users: phone 133 677, then ask for 131 555

Speak and listen users: phone 1300 555 727, then ask for 131 555

Email: info@environment.nsw.gov.au

Website: www.epa.nsw.gov.au

Report pollution and environmental incidents:

Environment Line: 131 555 (NSW only) or info@environment.nsw.gov.au

See also www.environment.nsw.gov.au

ISBN 978 1-76039-420-2

NSW 2016/0415

October 2016

Contents

HAVE YOUR SAY ON CLEAN AIR

This Clean Air for NSW Consultation Paper presents a proposed approach and actions for government to meet its goal of improving average air quality results across NSW.

Please have your say on whether you think we are proposing the right directions and the right actions. Make a submission and tell us:

- Are the actions proposed in this Clean Air for NSW Consultation Paper the right actions to improve air quality?
- Are there other issues and actions that Clean Air for NSW should cover?
- How do you want to be informed about and involved in improving air quality?
- Do you have any other comments or ideas on improving air quality in NSW?

Please email your written submissions to: Air.Policy@epa.nsw.gov.au by Friday, 20 January 2017.

Your submissions will lay the foundation for the NSW Clean Air Summit to be held in Sydney within six months.

Clean Air Summit attendees will include invited stakeholder representatives and the broader public via webcast. The Summit agenda will include an overview of the public and stakeholder feedback, themed workshops to discuss matters identified in submissions and a panel of air quality experts and decision makers to take up questions that submissions have raised.

Following the Summit, Clean Air for NSW will be finalised and released in 2017, setting the priority actions to be developed and longer term directions for NSW air quality management to 2027.

There will be further public and stakeholder consultation on the individual actions developed under Clean Air for NSW and Clean Air for NSW as a whole will be subject to a 4-yearly cycle of review and evaluation.

For more information, visit the Clean Air for NSW webpage at: www.epa.nsw.gov.au/consult/.

Clean Air for NSW at a glance

REDUCE EMISSIONS AND EXPOSURE
COMMIT TO CLEAN AIR ACROSS GOVERNMENT
EMPOWER AND ENGAGE STAKEHOLDERS
STRENGTHEN KNOWLEDGE
EVALUATE AND IMPROVE AIR QUALITY MANAGEMENT

Potential actions under development:

Industry

- Promote improved management of air emissions by industry by reviewing the EPA load-based licensing scheme
- Minimise emissions from coal-fired power stations
- Strengthen the mining rehabilitation framework
- Increase dust capture from coal mining and transport activities

Transport, engines and fuels

- Examine policies and incentives to increase uptake of electric vehicles
- Investigate vehicle emissions standards for NSW government contracts
- Further reduce diesel emissions from machines and locomotives
- Reduce toxic emissions from service stations in urban areas

Households

- Reduce wood smoke emissions
- Reduce emissions from domestic small petrol engines

Managing exposure and impacts

- Reduce health impacts of open burning, including hazard reduction, on metropolitan and regional NSW communities
- Review NSW air quality monitoring network to improve knowledge of air quality experienced in NSW regions
- Improve air quality forecasting and advice, to inform air quality responses and help people manage their exposure
- Improve responses to air quality incidents

Promote air "co-benefits"

- Achieve air quality co-benefits by implementing energy efficiency, advanced energy and climate change adaption actions.

MINISTER'S FOREWORD

Everyone who is born, lives, plays, learns, works, travels, makes their home, does business, or grows old in NSW deserves to breathe clean air.

NSW can be proud of its air quality and its record on clean air action. NSW has led Australia in improving air quality by, for example, leading the strengthening of national standards for harmful fine particle pollution.

Where people in NSW are concerned about the quality of the air they are breathing and the evidence demonstrates a need, the NSW Government is ready to act. Government is working towards improving average air quality results across NSW, so that adverse impacts and costs are progressively reduced and public health outcomes for NSW are continuously improved.

In that spirit, I am pleased to present this Clean Air for NSW Consultation Paper. It sets a proposed pathway to address pollution from industry, transport and households and to achieve significant and widespread gains for NSW air quality and public health. It sets, as well, the stage for developing future clean air actions and discussing those with our stakeholders.

The NSW Government will hold a Clean Air Summit, to enable stakeholders to share their concerns, knowledge and ideas and help shape future policy on improving air quality. As well, we will promote discussion and invite submissions on individual air quality initiatives as they are developed. Government will also rigorously evaluate and communicate our progress on achieving clean air to the people of NSW.

As clean air initiatives are developed and rolled out, I look forward to working and talking with those who play a role in cleaner air – in government, business and industry, expert and advocacy groups and communities across NSW.

Mark Speakman
Minister for the Environment

Towards cleaner air

The NSW Government is committed to improving average air quality results across NSW, in order to support public health and NSW's continued growth and prosperity. Our efforts are focused on pollutants that have measurable health impacts and are monitored according to national air quality standards (National Environment Protection [Ambient Air Quality] Measure).

Actions taken to protect air quality from the 1980s to the present day mean that NSW communities now generally experience good air quality. Clean air contributes to excellent quality of life for people living in NSW and also helps make NSW attractive for tourism and business.

Yet some urban and regional communities in NSW are exposed at times to elevated pollution levels, certain pollution sources need further controls and there are emerging pressures on NSW air quality that require new action.

Population growth in parts of NSW raises the risks of more people exposed to existing pollution levels and rising pollution as business, transport and household activities increase. Science is revealing more about the way emission sources pollute the air we breathe and predicting that climate change will result in more episodes of poor air quality. There is growing evidence of the serious health effects and costs of air pollution, and communities are increasing their calls for clean air.

Reducing the overall health impacts of air pollution is challenging. Measures that are low cost, easy and readily accepted by the community and industry are already in place. At the same time, it is important to recognise and capitalise on opportunities to protect air quality. These opportunities arise as business and household practices change and as we manage shifts in state and regional economies, plan for the growth of our cities and regions and build major infrastructure.

NSW cannot afford to wait on national action or market developments to support clean air. Achieving a "clean air" future for a growing NSW relies on government leadership in:

- innovative policy, regulatory and economic tools to accelerate adoption of clean air practices and technologies
- cooperation across tiers of government, among agencies and with communities and businesses to combine knowledge and efforts to achieve clean air
- continued knowledge-building to inform clean air policy and target actions to the greatest gains for air quality and public health
- effective implementation, enforcement and evaluation to ensure the benefits of clean air actions are fully realised.

The evidence tells us that the greatest public health gains will come from reducing long-term exposure of large populations to air pollution.

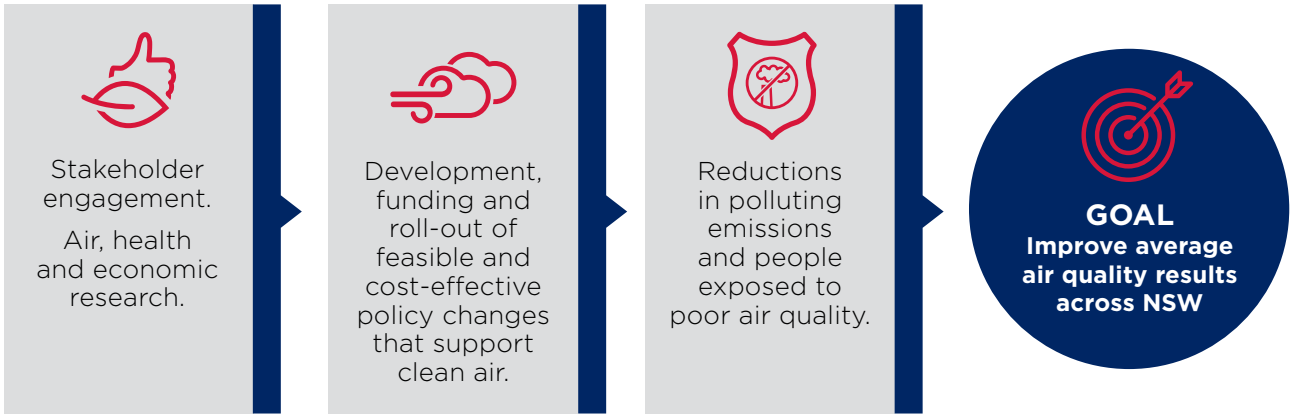
Clean Air for NSW will present options for improving air quality in NSW over a 10-year timeframe, 2017–27, as our cities and economy grow. It explains the goal of improving average air quality results across NSW and how that will be measured and tracked. It will describe air quality and trends and the major health and economic gains available from clean air.

Most importantly Clean Air for NSW will also present a framework and principles that could form the basis for developing the actions necessary to achieve gains for air and health over the next 10 years, and the actions that the NSW Government will deliver as immediate priorities.

NSW approach to improving air quality

The NSW Government's goal is to improve average air quality results across NSW. Our air quality management framework is designed to deliver effective, feasible actions targeted to ensure the greatest health gains for NSW. This approach will guide development of Clean Air for NSW and ensuing development of future clean air actions.

KEY STEPS IN IMPROVING AIR QUALITY



The public health impacts and costs of air pollution and, conversely, the benefits of reducing people's exposure to air pollution are substantial. Each year, air pollution leads to:

- 520 premature deaths and 6300 cumulative years of life lost in Sydney (Morgan et al. 2013)
- 1180 hospital admissions in Sydney (Broome et al. 2015), and
- an estimated $6.4 billion (2015 AUD) in health costs in the NSW Greater Metropolitan Region (GMR) (DEC 2005).

Factors that contribute to public health risk and which will inform our priorities for air quality management under Clean Air for NSW include:

- the type of pollutant and the harm caused at levels experienced in NSW
- regions and locations experiencing cumulative impacts and higher concentrations of harmful pollutants
- areas where population exposure is high and the risk is increasing as population and densities increase.

Actions that will be prioritised under Clean Air for NSW will reflect our understanding that the greatest health benefits will come from actions that achieve sustained reductions in long-term exposure of large populations to air pollution such as fine particles. Such actions will result in significant public benefit even with small improvements in air quality and even when air quality standards are being met.

As there is no safe threshold for exposure to fine particles, continued reductions in exposure can reduce adverse symptoms, need for medication, visits to doctors and emergency departments, hospital admissions and premature deaths across cities and communities.

Our knowledge of the factors for high public health risk from air pollution is informed and continues to evolve through a range of research tools, as presented in Figure 1.

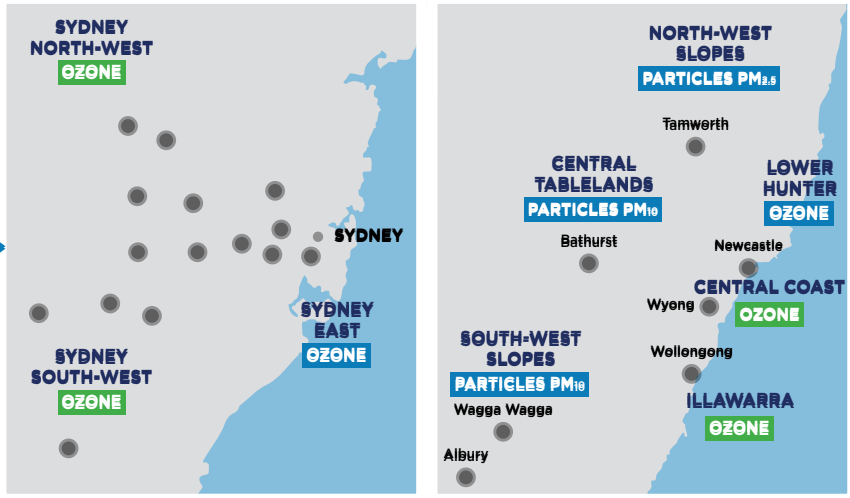
Proposals under Clean Air for NSW will be subject to rigorous cost–benefit analysis.

FIGURE 1: AIR QUALITY RESEARCH AND HOW WE USE IT

AIR QUALITY MONITORING

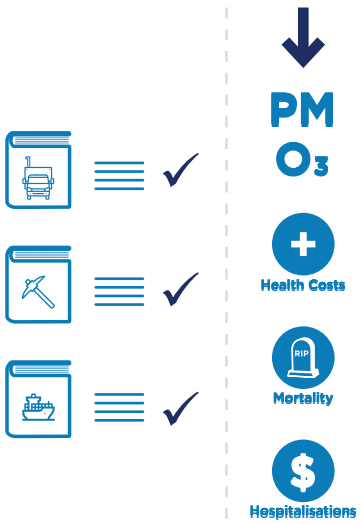
tells us the levels of pollutants across NSW regions, which can then be compared with national standards.

Major pollutants of concern include particulate matter (PM_{10}), especially fine particles ($PM_{2.5}$), and ozone (O_3).



BEST PRACTICE STUDIES

tell us what actions we can take to reduce emissions, and the linked health impacts and costs, and what overall gains we can make for the community.

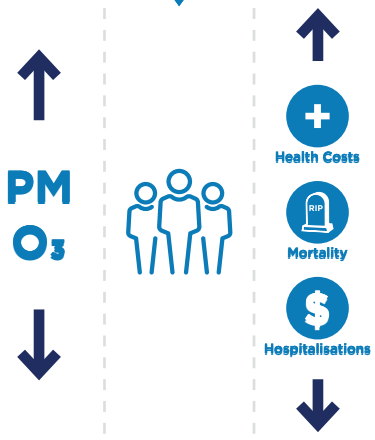


HEALTH STUDIES

tell us the health effects – such as increases or decreases in premature deaths and hospitalisations across a population – likely to result from changes in air quality.

ECONOMIC ANALYSIS

can tell us the cost or benefit of these changes.



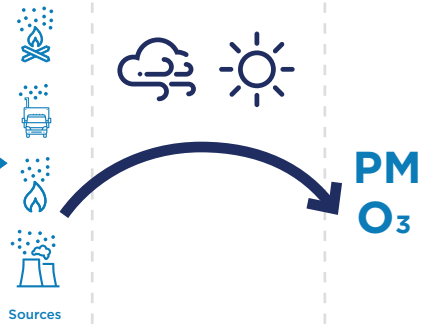
NSW AIR EMISSIONS INVENTORY

tells us which emission sources where are emitting how much of what pollutants.

CHARACTERISATION STUDIES

identify and quantify pollutants at a given location by their source type.

These and modelling help explain impacts on air quality when emissions are transported and transformed by weather and chemical reactions in the atmosphere.



AIR QUALITY MODELLING

predicts how air quality changes if emission levels change.

We depend as well on stakeholder consultation, to seek input into proposed initiatives to improve air quality in NSW and promote stakeholder awareness and support for clean air measures (see also the section on "Empowering and engaging stakeholders"). Within six months of the release of Clean Air for NSW, the NSW Government will hold a Clean Air Summit to involve stakeholders in setting the forward agenda for improving air quality in NSW.

Air quality management in NSW is dynamic, with new actions developed and implemented as new issues and opportunities emerge. Continued monitoring, modelling and evaluation of strategies, including further consultation, are used to assess and continue improving air quality management. (See also the sections on “Strengthening knowledge”, "Evaluating and improving air quality management" and “More information”).

Clean Air for NSW will be subject to annual reporting and a four-yearly cycle of review and consultation. Individual clean air initiatives will also be subject to consultation and evaluation.

Clean Air for NSW will present actions identified as potential priorities; new actions will continue to be brought forward over its 10-year timeframe, as new issues emerge and research, analysis and consultation progress.

Dr Geoff Morgan
Associate Professor, School of Public Health
University of Sydney

There is clear evidence that current levels of air pollution in NSW adversely affect the health of the population, resulting in substantial health costs.

Government agencies, including for health, environment, planning and transport, need to work together with researchers, communities and industry to reduce air pollution so that these adverse health effects and health costs don’t continue to rise, especially given the NSW population is predicted to increase by more than one million people within the next 15 years.

Air quality issues in NSW – current and future

HOW WILL WE MEASURE ACHIEVEMENT OF THE GOAL?

The goal of Clean Air for NSW will be to improve average air quality across NSW.

Calculating a single number to describe annual average air quality in NSW is challenging given the large variations in air pollutants we see from region to region, season to season and year to year. For hourly and daily air quality updates the Office of Environment and Heritage (OEH) uses the Air Quality Index (AQI) as an easy way to compare air quality across regions and pollutants. The AQI is a simple but effective way to communicate average air quality that has wide public support and acceptance.

However, in calculating the AQI, the population exposed to different levels of air pollution in a town or region is not considered. To ensure that population exposure is accounted for in tracking changes to average air quality in NSW, OEH will develop a population weighted annual clean air metric (CAM). The CAM will combine annual average, multi-pollutant assessments of air pollution levels across NSW similarly to the AQI, but will also weight the measured air pollution levels by population. This will help track our progress in ensuring that our management of air quality delivers the most positive health outcomes for the people of NSW.

We understand that our air quality can vary significantly from year to year due to "exceptional events" such as bushfires, dust storms and climatological events like El Niño. To smooth out this natural variability the metric will likely use 3-year rolling averages. This aligns with European Union and US Environmental Protection Agency exposure reporting approaches and allows us to focus on assessing our progress in tackling the human contributions to poor air quality.

The ultimate form of the metric and the assumptions that underpin its calculation will be finalised after the methodology has been interdependently peer-reviewed. Once finalised, the metric will be calculated and reported annually. To help us to better understand how average air quality has changed over the past 20 years, OEH will also use historical air quality and population data to calculate the metric back to 1996.

As with the AQI and to ensure transparency all of the data, assumptions and intermediate steps in calculating the metric will be available through the OEH website.

POLLUTANTS SUBJECT TO NATIONAL STANDARDS AND THEIR HEALTH IMPACTS

NSW is a signatory to the national standards and goals for criteria air pollutants set by the National Environment Protection (Ambient Air Quality) Measure (Air NEPM). The aim is outdoor air quality that protects human health and wellbeing. These standards underpin the metric for improving average air quality results across NSW.

We depend on monitoring of air quality against the national air quality standards to understand the air quality and associated health risks actually being experienced in different regions and their communities across NSW.

The pollutants of most concern under the Air NEPM are airborne particles 10 microns (µm) or less in diameter, referred to as PM_{10}, and most significantly, the subgroup of finer particles referred to as $PM_{2.5}$, which are less than 2.5 µm in diameter. Gaseous pollutants of concern include ozone (O_3), nitrogen dioxide (NO_2) and sulfur dioxide (SO_2). The Air NEPM also covers carbon monoxide (CO) and lead.

Particle pollution includes particles released directly from sources, and secondary particles produced by chemical reactions in the air, involving other particles or gases, including nitrogen dioxide, sulfur dioxide volatile organic compounds (VOCs) and ammonia.

Ground-level ozone is a secondary photochemical pollutant formed in the air when precursor pollutants, oxides of nitrogen (NO_x) and VOCs, react in sunlight.

Although air quality is relatively good in NSW by world standards, infrequent exceedances of the national standards for PM_{10}, $PM_{2.5}$ and ozone do occur. Levels of carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2) and lead meet national air quality standards in NSW. Reductions in CO and NO_2 appear to have tailed off however, due to growth in emission sources and increased emission contributions from unregulated sources.

The way air pollutants impact on communities and human health is complex. OEH monitors and models levels of pollutants across regions, the NSW Environment Protection Authority (EPA) inventories their sources and the EPA, OEH and NSW Health, in collaboration with other scientific bodies, study their impacts through a range of investigative tools.

KEY AIR POLLUTANTS, NATIONAL STANDARDS AND HEALTH EFFECTS

POLLUTANT AND HIGHEST CONCENTRATIONS STANDARDS ALLOW	DOES NSW MEET STANDARDS? HEALTH EFFECTS LINKED TO POLLUTANT
PARTICLES AS PM_{10} • 50 µg/m³ (micrograms per cubic metre) averaged over 24 hours • 25 µg/m³ averaged over one year **PARTICLES AS $PM_{2.5}$** • 25 µg/m³ averaged over 24 hours (target 20 µg/m³ from 2025) • 8 µg/m³ over one year (target 7 µg/m³ from 2025)	*Not always met: Sydney, Hunter, Illawarra and some rural regions* **Effects related to short-term exposure** • Lung inflammation • Respiratory symptoms • Adverse effects on cardiovascular system • Increased medication use • Increased hospitalisations • Increased mortality **Effects related to long-term exposure** • Increased lower respiratory symptoms • Reduced lung function in children and adults • Increased chronic obstructive pulmonary disease • Reduced life expectancy, mainly due to cardiopulmonary mortality and probably to lung cancer
OZONE • 0.10 ppm (parts per million) averaged over one hour • 0.08 ppm averaged over four hours	*Not always met: Sydney and Illawarra* **Effects related to short-term exposure** • Adverse effects on lung function • Lung inflammatory reactions • Adverse effects on the respiratory system • Increased medication use • Increased hospitalisations • Increased mortality **Effects related to long-term exposure** • Reduced lung function development
NITROGEN DIOXIDE • 0.12 ppm averaged over one hour • 0.03 ppm averaged over one year	*Met in all NSW regions but has local impacts; contributes to ozone and particles* **Effects related to short-term exposure** • Effects on lung function, especially in asthmatics • Increased airway allergic inflammatory reactions • Increased hospitalisations • Increased mortality **Effects related to long-term exposure** • Reduced lung function • Increased probability of respiratory symptoms
SULFUR DIOXIDE • 0.20 ppm averaged over one hour • 0.08 ppm averaged over 24 hours • 0.02 ppm averaged over one year	*Met in all NSW regions but has local impacts; contributes to ozone and particles* **Effects related to short-term exposure** • Effects on lung function, especially in asthmatics • Inflammatory reactions • Increased hospitalisations • Increased mortality **Effects related to long-term exposure** • Probable reduced life expectancy
CARBON MONOXIDE • 9.0 ppm averaged over eight hours	*Met throughout NSW*
LEAD • 0.50 µg/m³ averaged over one year	*Met throughout NSW*

Source: WHO 2004, Morgan et. al. 2013.

REVIEW OF NATIONAL AIR QUALITY STANDARDS

In 2011, the Council of Australian Governments declared air quality a "Priority Issue of National Significance" and agreed to develop a national approach to improve air quality and community health. NSW recommended and led a review of national particle standards as the first priority.

The Summary for Policy Makers of the Health Risk Assessment on Air Pollution in Australia (Morgan et al. 2013) for the review reported:

The health effects associated with exposure to these pollutants range from small, temporary changes in the respiratory tract and impaired lung function, to symptoms so serious they can lead to death. The consequences for people's health include restricted activity or reduced performance, hospital emergency department visits, or hospital admissions.

There is strong evidence for important air pollution effects on both the respiratory and cardiovascular systems from both short-term (24-hours) and long-term (annual) exposures. The most severe health effects include a significant reduction in life expectancy of the average population, linked to long-term exposure to particles.

There is no evidence of a threshold concentration below which adverse health effects of particulates are not observed.

It found that 520 premature deaths result in Sydney each year from long-term $PM_{2.5}$ exposure above background levels, and that decreasing air pollution exposures would lead to major health benefits. Short-term effects such as hospitalisations would reduce as air pollution reduced, while reducing deaths and other long-term effects would require sustained long-term reductions in pollution and benefits would take longer to accrue.

Following the review, in 2015 the NSW Government proposed and Australian environment ministers adopted the most health-protective fine particle standards in the world.

National standards for ozone, nitrogen dioxide and sulfur dioxide are under review.

A 2015 study (Broome et al. 2015) found air pollution to be the cause of about 2% of deaths and 1180 hospital admissions per annum in Sydney, based on 2007 data. It estimated that reducing $PM_{2.5}$ exposure by 10%, over 10 years, would result in about 650 fewer premature deaths and about 700 fewer respiratory and cardiovascular hospital visits. This indicates substantial health benefits are attainable in Sydney even with modest air quality improvements.

AIR QUALITY DATA

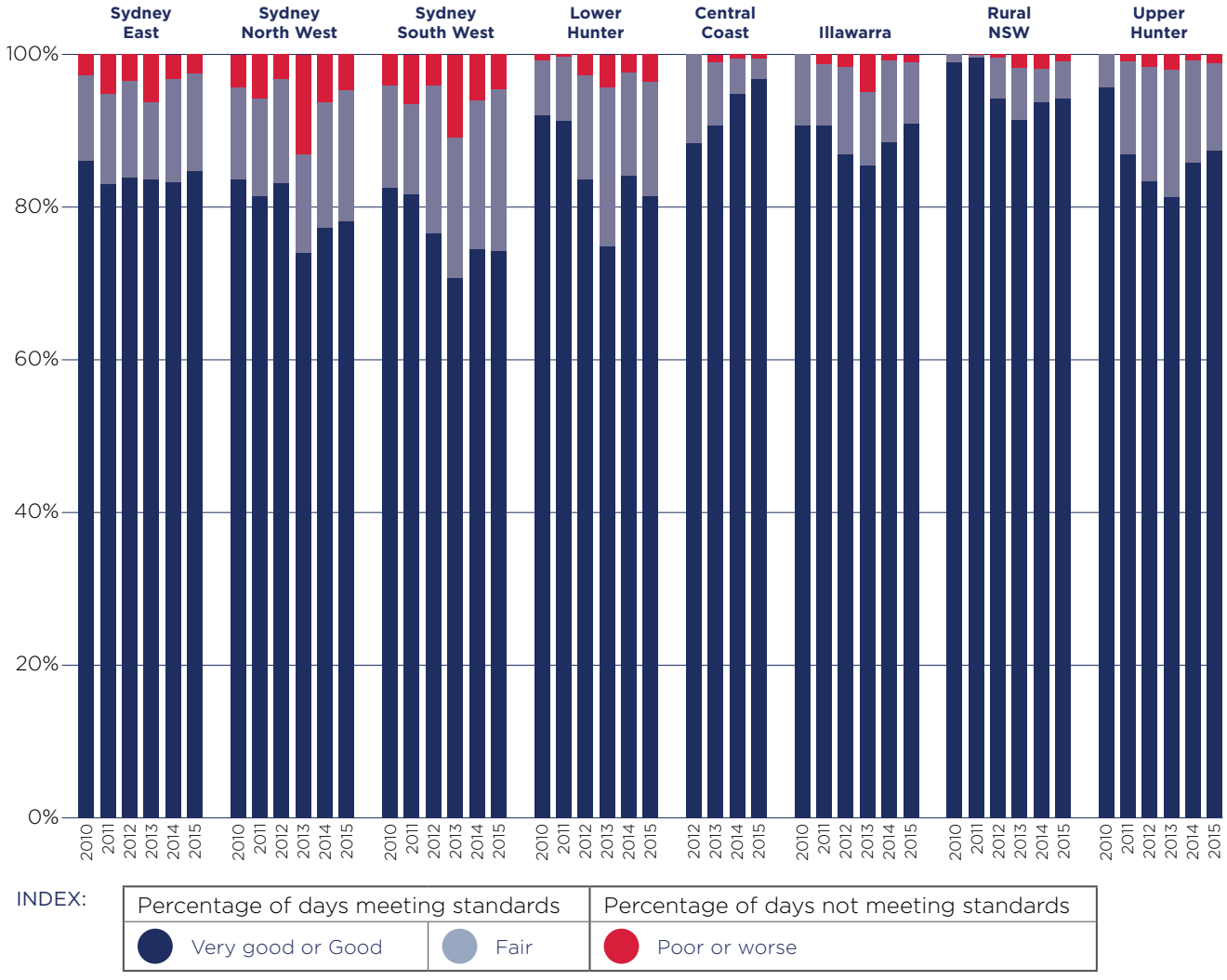
Air quality in NSW has improved since the 1980s and is generally comparable with other Australian jurisdictions and good by world standards. However, national air quality standards continue to be exceeded for ozone and particle pollution occasionally, and health effects are known to occur even at concentrations that are within national standards.

Air quality in NSW remains 'good' or 'very good' for around 75–85% of days in the Sydney and Hunter regions; 80–95% of days in the Illawarra; and 90% or more days on the Central Coast and in rural NSW (Figure 2). South-west and north-west Sydney experience more 'poor or worse' air quality days due both to ozone and particle pollution (Figure 3).

Poor air quality days across NSW are usually due to particle pollution. Major exceedances of particle standards generally coincide with dust storms, bushfire or open burning events. Sources contributing to fine particle concentrations across NSW are similar because these particles can travel a thousand or more kilometres from their source or the source of their precursor gases.

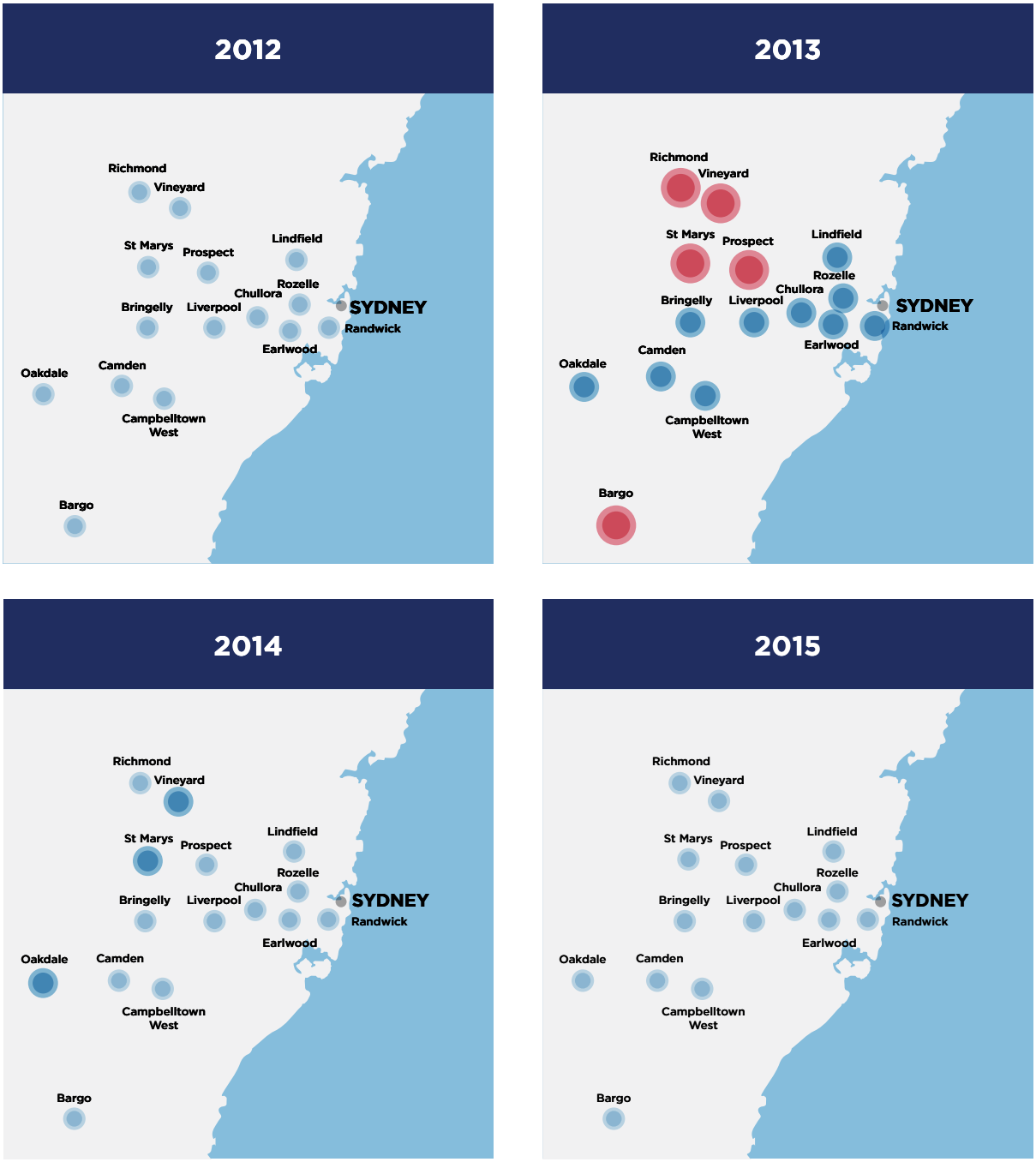
In Sydney regions and the Illawarra, poor air quality days are also caused by ozone. High ozone in the Sydney basin and Illawarra can result from local emissions, or smog or precursors transported from other regions. Exceedances of the ozone standards usually occur in the warmer months, peaking during high temperatures and during regional bushfires.

FIGURE 2: AIR QUALITY EXPERIENCED IN NSW SUBREGIONS, 2010–15 (AT SITES MONITORED AGAINST NEPM STANDARDS)



Note: *Compared with previous years, NSW experienced poorer air quality during 2013, due mainly to drier and hotter weather through the middle of the year and the impacts of bushfires in September, October and November.*

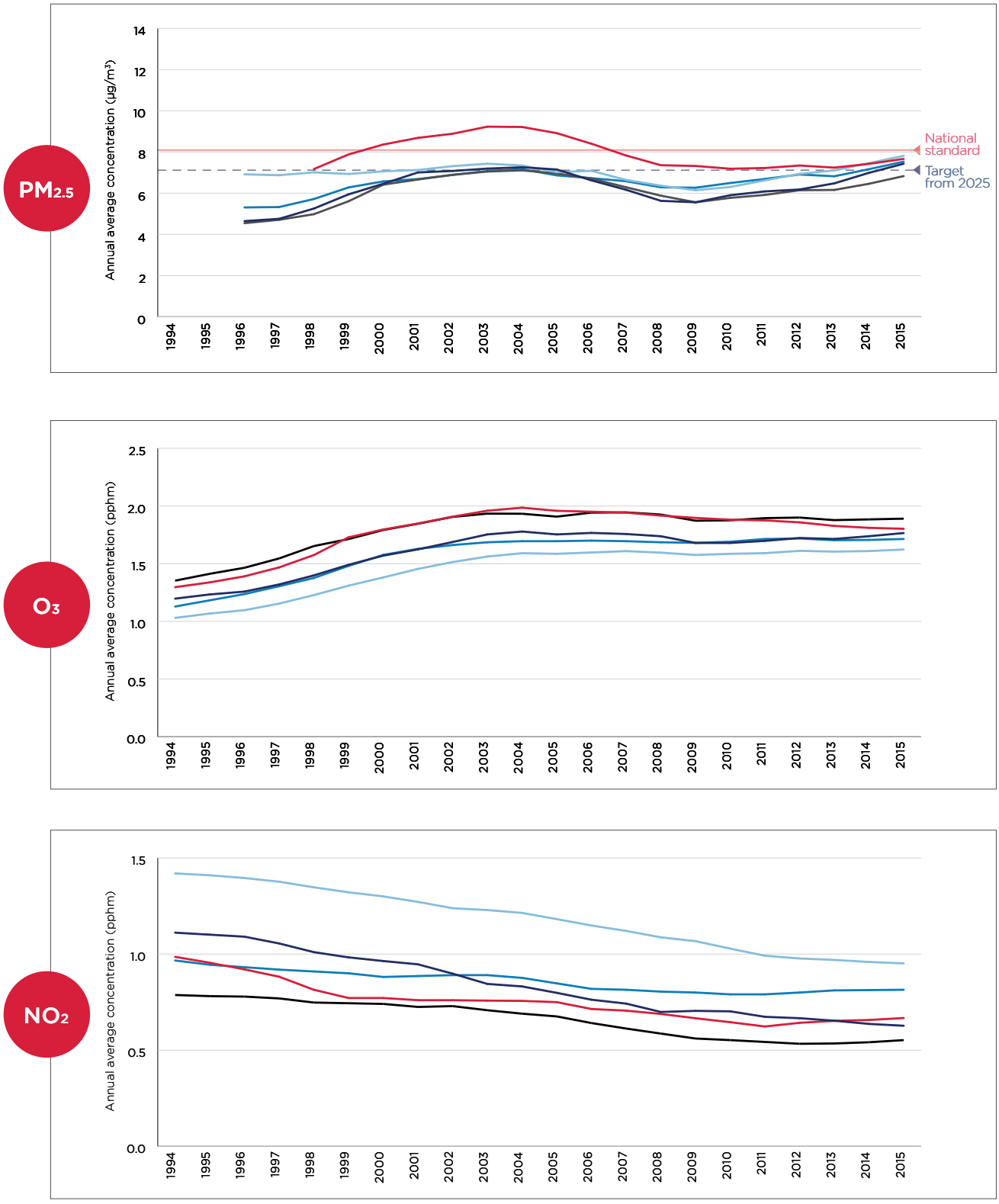
FIGURE 3: NUMBER OF 'POOR OR WORSE' AIR QUALITY DAYS IN RECENT YEARS FOR THE GREATER SYDNEY REGION



INDEX:
Number of 'poor or worse' air quality days — 20 – 30 days — 10 – 20 days — 1 – 10 days

Current trends in monitored air quality indicate that overall trends for average levels of fine particles and ozone have been stable in recent years but improvements for certain pollutants, such as nitrogen dioxide which has direct health impacts and is an important precursor pollutant, have tailed off (Figure 4). The growth of the population, urbanisation, energy and transport demands, and climate change would be expected to offset gains from past policies and lead to poorer air quality and increased exposure and health impacts, unless new measures are taken to reduce emissions and protect NSW air quality. Continuing and increasing measures that are positive for air quality, such as expansion of public transport systems, take-up of cleaner energy and technologies and planning that reduces air emissions from and impacts on communities, are also essential to future clean air in NSW.

FIGURE 4: TRENDS IN ANNUAL AVERAGE AIR POLLUTION LEVELS FOR 1994 TO 2015 BY REGION. THE DATA WERE SMOOTHED TO HIGHLIGHT THE LONG-TERM TENDENCY



AIR EMISSIONS DATA

Air quality in NSW is affected by human and natural sources, with the air quality in specific regions influenced by local sources and also by transport of pollutants and secondary pollutants. Emissions come from the following key sectors:

- **industry sources**, such as mining, power generation, manufacturing, waste management and agriculture
- **motor vehicles**, including heavy and light, commercial and private, diesel and petrol-powered vehicles; and including exhaust and evaporative emissions and particle emissions from brake and tyre wear
- **non-road mobile sources**, including shipping and locomotives and diesel equipment, used for example in mining, construction, waste management and port activities
- **commercial activities**, such as service stations, printing, dry cleaning and automotive repairs
- **domestic sources**, such as residential wood heating, lawn mowing and gardening equipment, aerosol and solvent use, and paints
- **natural sources**, such as vegetation emissions, bushfires and sea salt.

Action on air quality is targeted based on evidence of the sources of primary pollutants, fine particles being the most critical, and sources of precursor pollutants for particles and ozone, and how these sources contribute to observed air pollution levels.

The largest direct sources of human-made fine particle emissions in the Greater Metropolitan Region (GMR) are shown in Figure 5. Coal mining, residential wood heaters, power generation and non-road diesel equipment are key sources of particle emissions. Within the Sydney region, the major source is wood heating. Vehicles, shipping and fires also feature in the key sources (Figure 6).

FIGURE 5: TOP DIRECT HUMAN-MADE SOURCES OF $PM_{2.5}$ EMISSIONS (TONNES/YEAR) FOR GMR (EPA 2012)

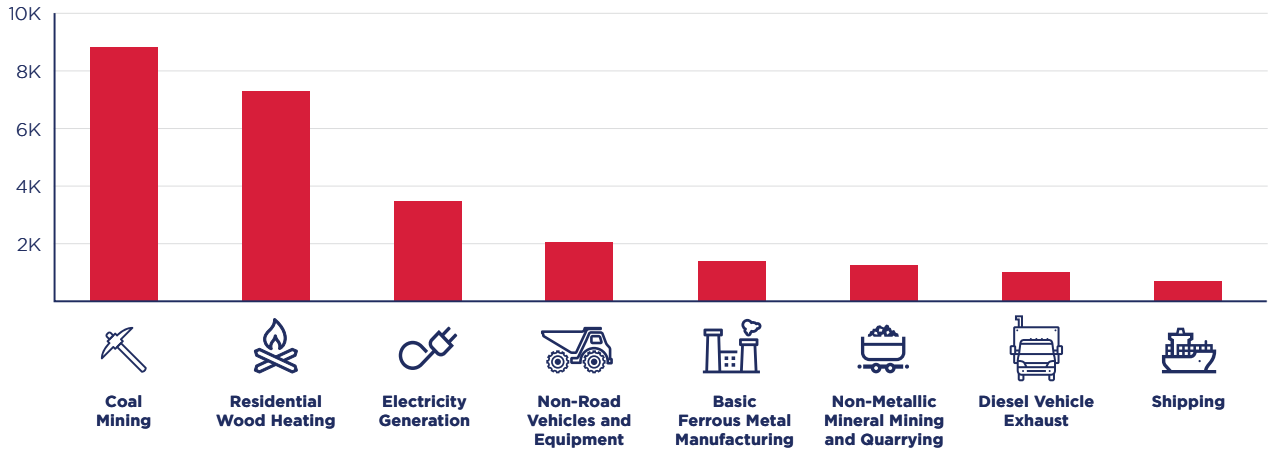
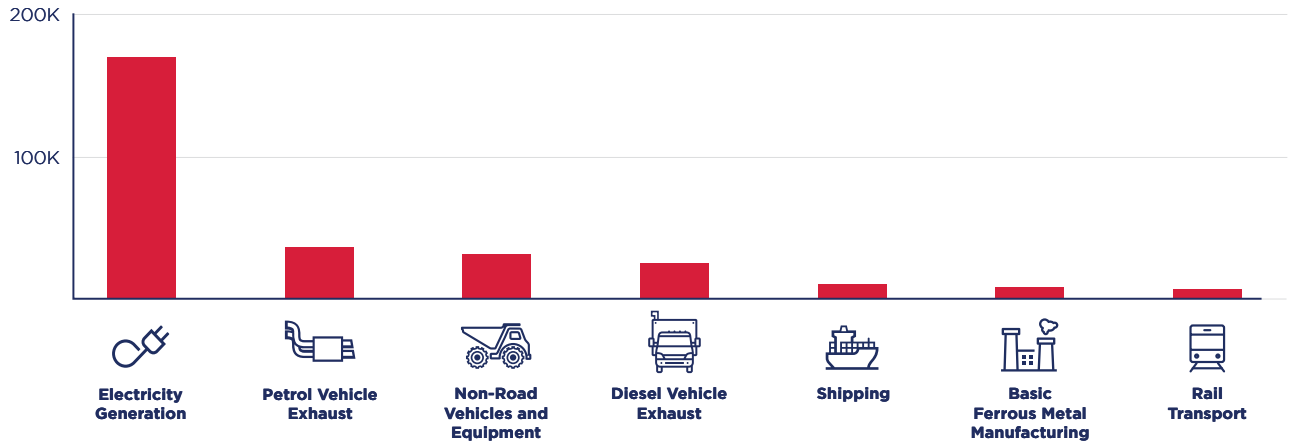


FIGURE 6: TOP DIRECT HUMAN-MADE AND NATURAL SOURCES OF $PM_{2.5}$ EMISSIONS (TONNES/YEAR) FOR SYDNEY REGION (EPA 2012)

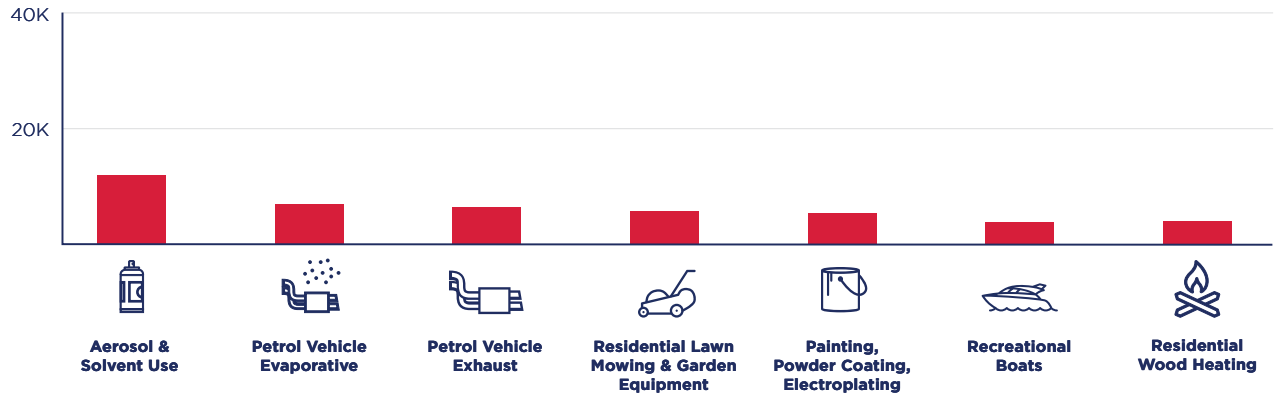
Sources of precursor pollutants are also critical to target in managing air quality. For example, secondary particles account for about half the fine particle concentrations in Sydney on an annual average basis. Effective air quality management depends on controlling precursor emissions of ozone (NO_2 and VOCs) and of particles (including SO_2, NO_2, VOCs and ammonia). Principal sources of precursor pollutants in the GMR are shown in Figure 7.

FIGURE 7: MAJOR HUMAN-MADE OZONE-FORMING AND FINE PARTICLE-FORMING POLLUTANTS IN THE GMR (EPA 2012)

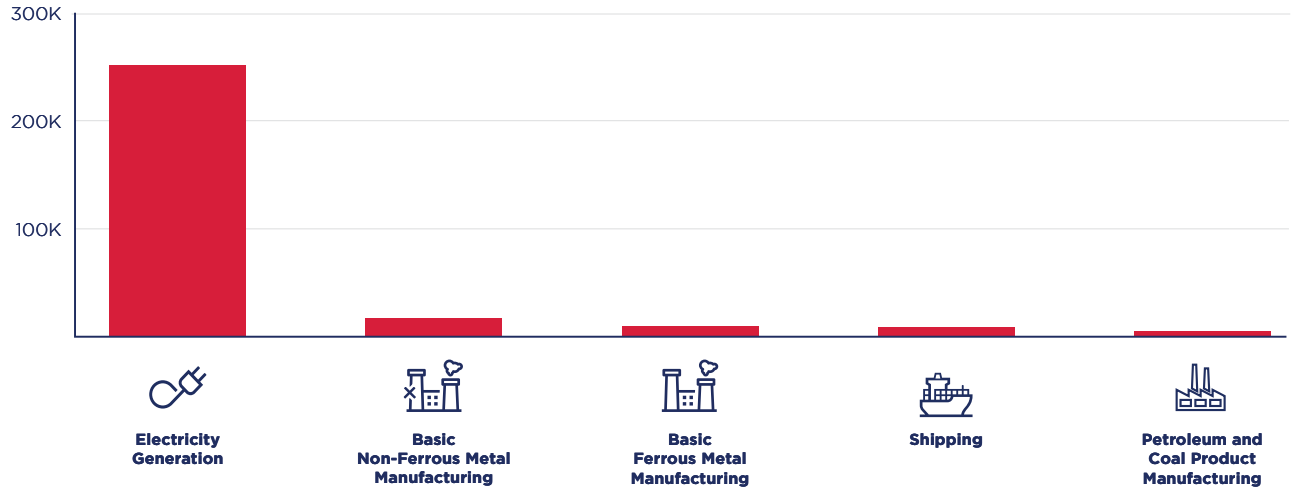
NO_x (tonnes/Year)



VOCs (tonnes/Year)

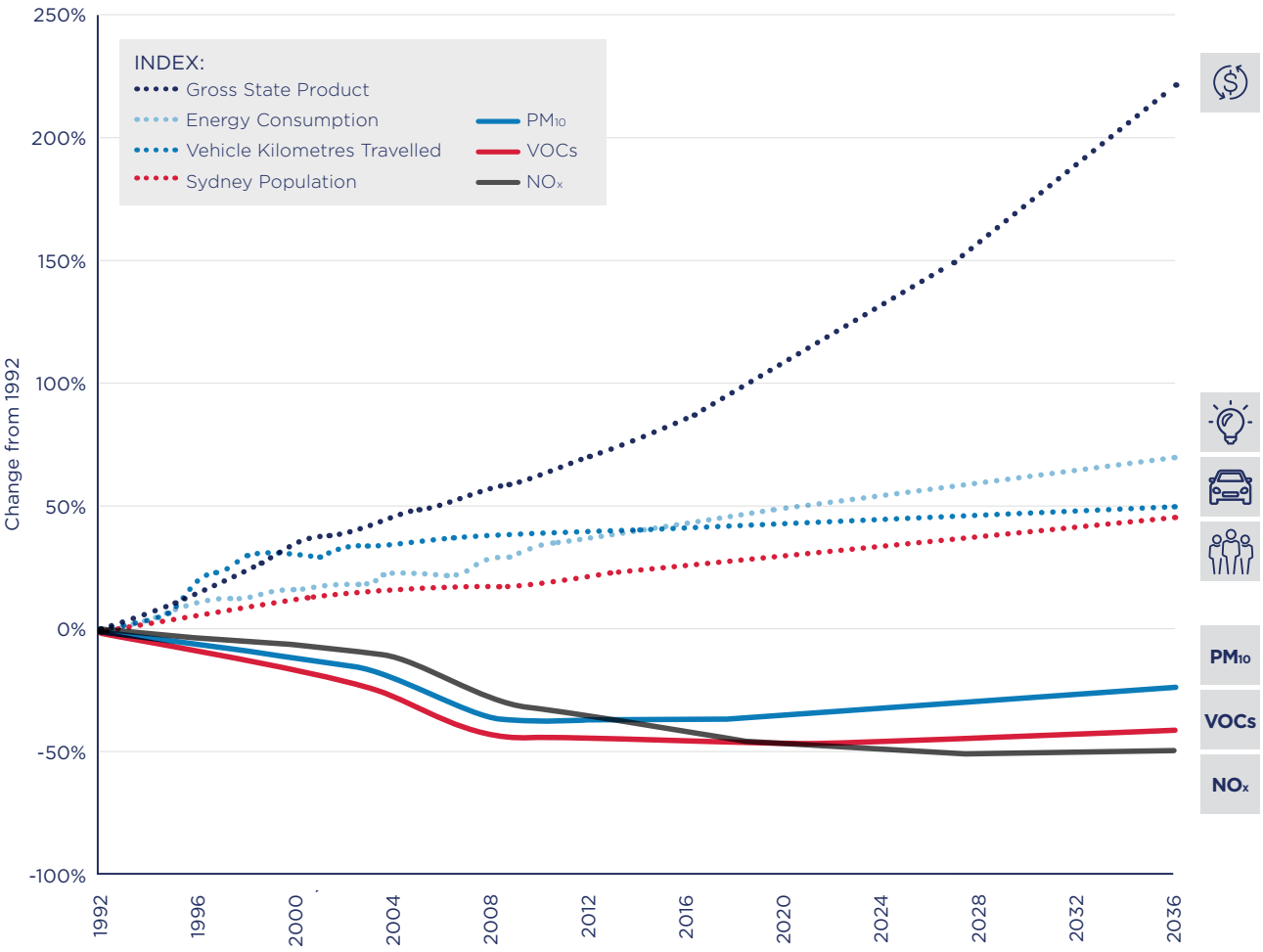


SO_2 (tonnes/Year)



Experience has shown that, with state and national regulation of major sources such as industry, motor vehicles and fuels, it is possible to reduce air emissions and air pollution impacts, even given growth in gross state product, traffic activity, energy consumption and population. However, current air quality trends and emission projections indicate that levels for target pollutants will plateau, and then gradually rise, without additional actions to protect air quality (Figure 8).

FIGURE 8: ACTUAL AND PROJECTED TRENDS IN TOTAL EMISSIONS IN SYDNEY COMPARED WITH KEY NSW STATISTICS. SOURCE: ADAPTED FROM EPA (2012)



Dr Mark Hibberd
Atmospheric Research Scientist, CSIRO
President CASANZ (Clean Air Society of Australia & New Zealand)

Development of effective and innovative solutions to improve our air quality requires detailed knowledge and understanding. For example, particulate pollution is a 'wicked' problem requiring complex measurement and modelling techniques to understand the many changes that can occur between the sources of particles and where people breathe them in.

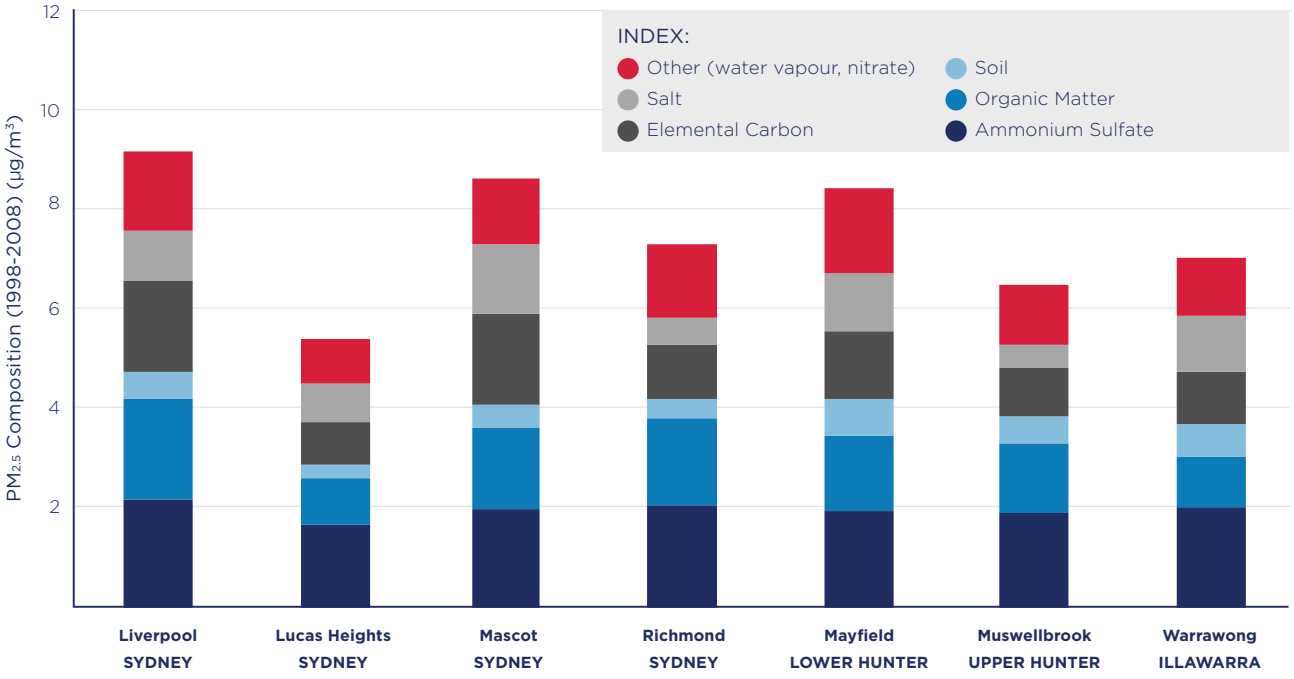
The required evidence is being delivered through high quality research, such as the recent collaboration of CSIRO and ANSTO with the EPA and OEH to deliver the Lower Hunter Particle Characterisation Project.

AIRBORNE PARTICLE COMPOSITION AND SOURCES

Except close to major particle sources, the composition of fine particles in the air does not vary greatly and is similar across regional and urban areas of NSW. This is because fine particles can travel long distances – a thousand or more kilometres from their original sources or the sources of their precursor emissions. Local, regional and even continental and global sources may contribute to the $PM_{2.5}$ particle concentrations measured at a specific site.

Figure 9 shows the long-term average $PM_{2.5}$ concentration and composition measured at several NSW sites by the Australian Nuclear Science and Technology Organisation (ANSTO). Particle composition was generally found to include ammonium sulfate, elemental carbon, organic matter, salt, soil and "other" components (likely water vapour and nitrates).

FIGURE 9: AVERAGE $PM_{2.5}$ MASS AND COMPOSITION FOR SEVERAL NSW SITES, JULY 1998 TO MAY 2008 (ANSTO 2008)



Ammonium sulfate forms in the atmosphere when sulfur dioxide (SO_2) emissions react with ammonia. SO_2 comes from coal-fired power generation, industrial sources, non-road sources such as industrial vehicles and shipping, on-road vehicles and residential fuel burning. The "salt" in fine particles originates from waves breaking in the open ocean and against the coast. Black carbon is emitted during incomplete combustion of fossil fuels used in transport, heating and industry, and from "biomass" or vegetation burning, for example during bushfires and hazard reduction burns. The soil component may be due to natural wind-blown dust or emissions from agriculture and industries such as mining and quarrying. Sources of the precursor NO_x emissions contributing to secondary nitrate may include power generation and industry, on-road and non-road transport, residential fuel burning and vegetation fires.

The organic component of $PM_{2.5}$ is likely to include primary particles from sources such as car exhaust and industries, and secondary organic particles formed from VOCs emitted by natural and human-made sources. The Sydney Particle Study identified VOCs from vegetation as a major source of secondary organic particles during summer, while wood heater emissions dominate fine particles in winter (Cope et al. 2014).

The composition of fine particles varies seasonally. Emissions from natural sources such as sea salt and biogenic emissions (VOCs from vegetation and bushfires) make a major contribution to background $PM_{2.5}$ concentrations, and human-made emissions are important in elevating those concentrations.

PARTICLE CHARACTERISATION IN THE HUNTER

Particle characterisation studies give us detailed information on key sources of $PM_{2.5}$ concentrations. Studies such as those undertaken in the Hunter region inform us on the contribution of source "factors": there may be one direct particle source (such as vehicles), a mixture of direct sources (such as shipping and industry) or multiple precursor pollutants that contribute to secondary particles (such as secondary nitrate and ammonium sulfate).

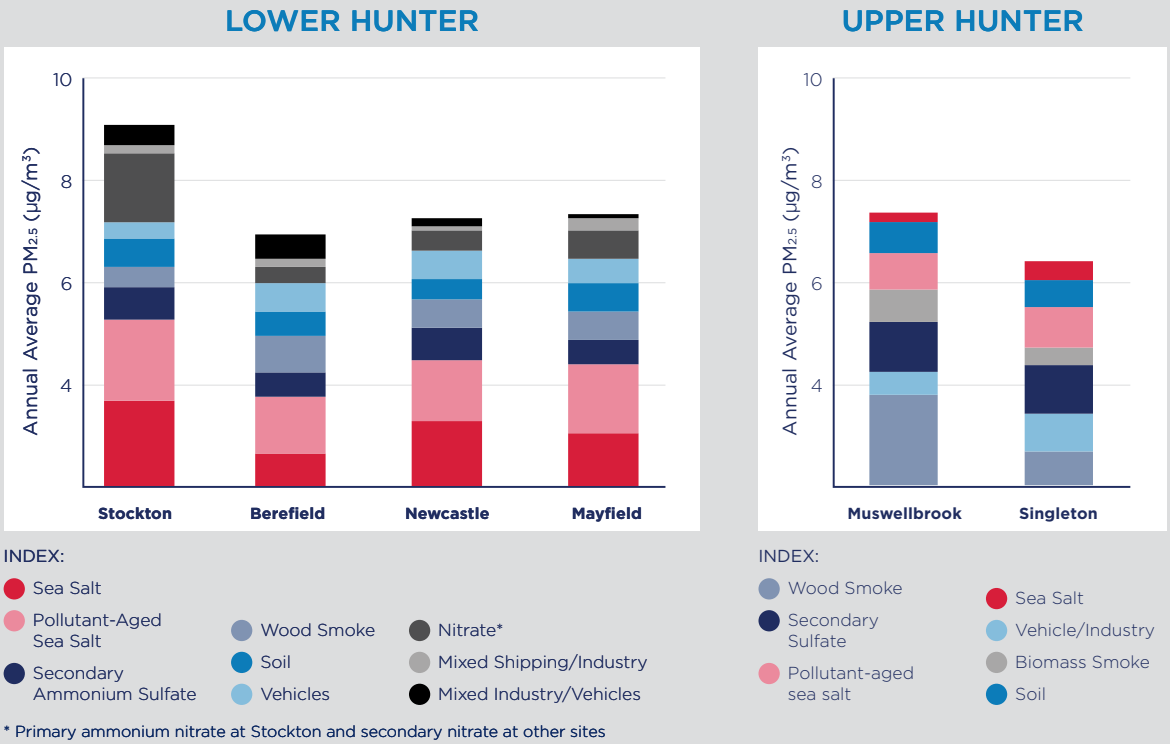
Source factors contributing to $PM_{2.5}$ concentrations in the Hunter were generally found to include sea salt, soil, wood smoke, vehicles, industry, shipping, secondary ammonium sulfate and nitrate.

Sea salt included fresh sea salt and "pollutant-aged" sea salt, formed when sea salt chemically reacts with air pollution from other sources. Wood smoke includes smoke from residential wood heaters and from vegetation fires. The contribution of shipping to $PM_{2.5}$ concentrations was evident in the Lower Hunter but not specifically identified in the Upper Hunter. Sea salt levels reduced with distance from the coast as expected but were still evident in the Upper Hunter. Nitrate was generally found to be secondary nitrate formed from NOx emissions, except for primary ammonium nitrate identified at Stockton in the Lower Hunter which was likely due to a local industry source.

According to the Lower Hunter study, about half the $PM_{2.5}$ concentrations are from primary particles emitted directly to the air, and the other half secondary particles formed in the air by chemical reactions of precursor pollutants.

Larger particles, with diameters of 2.5–10 microns, were also investigated at Lower Hunter sites, with source factors found to be fresh and pollutant-aged sea salt, industry, soil, bioaerosol (such as pollen and fungal spores) and potentially also coal.

FIGURE 10: SOURCE FACTORS CONTRIBUTING TO ANNUAL AVERAGE $PM_{2.5}$ CONCENTRATIONS IN THE HUNTER (OEH 2013, OEH 2016)



* Primary ammonium nitrate at Stockton and secondary nitrate at other sites

KEY POINTS

Key considerations for future air quality management in NSW include:

- Population growth will increase exposure to air pollution and resulting public health impacts and costs, even if air pollution concentrations stay the same. However air pollution concentrations are likely to increase as business, transport, and household activities increase, unless future intervention is undertaken. This is particularly relevant for proposed growth areas in Western Sydney in sensitive parts of the airshed.
- There is increasing need for new measures to address significant sources of pollutants, such as wood heaters, impacting on urban and regional populations.
- Increased development at the interface with natural bushland has potential to increase population exposure to the effects of smoke from bushfires and hazard reduction burns.
- Increased urban densities, including along urban transport corridors, has the potential to increase population exposure to traffic emissions.
- Changes in climate are likely to affect future air quality. Different patterns in rainfall, temperature and weather (including fire danger weather) may increase the frequency of dust storms and bushfire-related pollution events, leading to higher particle emissions. Higher air temperatures are also predicted to increase the number of high ozone episodes and the geographical extent of their effects.
- There are opportunities to realise air quality and health benefits as the population and economy grow, by integrating air quality considerations into transport, land-use and energy planning.

Professor Bin Jalaludin
Centre for Air quality & health Research and evaluation (CAR)

Each and every one of us is exposed to air pollution.

Air pollution affects some groups of people more than others. For example, the young, the elderly and people with chronic disease are more susceptible to the effects of air pollution, while others live in more polluted areas.

We must ensure that exposure to air pollution is minimised, especially for those who are most vulnerable.

Priorities to reduce emissions and exposure

The priority actions proposed for investigation fall into the broad categories of: industry; transport, engines and fuels; household emissions; actions to reduce impacts and exposure; and actions directed to other goals that have co-benefits for air quality.

The emission and exposure reduction actions identified in this Clean Air for NSW Consultation Paper have been prioritised for further investigation, generally on the basis that they:

- target emission sources that have large impacts on air quality and human health, based on the evidence, and
- have the potential to provide the most cost-effective responses to identified pollution and health issues and deliver the best net gains for the community, based on the findings from economic studies.

ACTIONS

Industry emissions

- Promote best practice air quality management by industry through reviewing the fee structure for environment protection licences
- Minimise emissions from coal-fired power stations
- Strengthen the mining rehabilitation framework
- Increase dust capture from coal mining and transport activities

Transport, engine and fuel emissions

- Examine policies and incentives that could be adopted by the NSW Government to increase the uptake of electric vehicles
- Investigate emission standards for vehicles under NSW Government contracts
- Further reduce diesel emissions from machines and locomotives
- Reduce toxic emissions from service stations in regional centres

Household emissions

- Reduce wood smoke emissions
- Reduce emissions from domestic small petrol engines

Exposure and impact reduction

- Reduce impacts of hazard reduction and open burning on metropolitan and regional NSW communities
- Review the NSW air quality monitoring network
- Improve air quality forecasting and advice, to inform air quality responses and help people manage their exposure
- Improve responses to air quality incidents

Co-benefit actions

- Achieve air quality co-benefits by implementing energy efficiency, advanced energy and climate change adaption actions.

Reducing industry emissions

PROMOTE IMPROVED MANAGEMENT OF AIR EMISSIONS BY INDUSTRY BY REVIEWING THE LOAD-BASED LICENSING SCHEME

Goal

Strengthen and better target the EPA's load-based licensing (LBL) scheme to extend and improve its effectiveness as a tool in managing air quality.

Action

Review the EPA load-based licensing scheme.

The EPA is currently reviewing the LBL scheme. The scheme has been in operation since 1999 and the purpose of the LBL review is to ensure the scheme is achieving pollutant load reductions effectively and efficiently. The review will consider all elements of the scheme, including the specific pollutants, industries and geographical priority areas covered by the scheme.

The review will include examination of existing and emerging trends in pollutant emissions and impacts to inform improvements to the scheme. The outcomes of the review will assist in better targeting the pollution reduction incentives for licensed facilities with high impacts.

The review will also consider providing additional incentives for licensed facilities with high impacts to reduce their emissions of a range of pollutants, especially in areas where high cumulative impacts are known to exist or are developing.

It is proposed that the release of an issues paper for stakeholder and public comment could be a component of the existing LBL review.

Why?

By applying fees to pollutant loads, the EPA's LBL scheme encourages licensees to improve their environmental performance beyond the levels required by regulation or licence conditions alone. The LBL scheme plays a complementary role within the EPA's wider regulatory and policy framework for managing pollutants, and is implemented under the *Protection of the Environment Operations Act 1997*, the Protection of the Environment Operations (General) Regulation 2009 and the Load Calculation Protocol.

Most major polluters in NSW are captured by the existing LBL scheme and indications are that LBL provides effective incentives to many licensees to improve environmental performance. However, there are still a number of significant and complex air quality (and other) issues in NSW that a strengthened and better targeted LBL scheme would help to address. LBL also addresses pollutants discharged to waters.

POWER PLANT EMISSION REDUCTIONS

Goal

Minimise emissions from power stations to reduce primary and secondary particle precursors.

Action

The EPA proposes an initial one-year project to:

- benchmark international best practice emission controls for coal-fired power stations
- model impacts of coal-fired power plants on air quality

- identify and research feasible control options and analyse their economic impacts
- analyse implications of potential control measures for the NSW energy sector
- consult with and engage stakeholders and experts in government, business and the community
- develop recommendations for government.

This action would be complemented by an initiative of Coal Innovation NSW, to undertake a detailed study on coal-fired electricity generation in order to better understand the role of coal in NSW's electricity mix to 2050 under various scenarios. The goal is to reduce greenhouse gas emissions from coal-fired power stations in line with international best practice methodologies.

The Coal Innovation NSW study will identify emerging technologies, incentive schemes, and best practice policy levers that may be applied in NSW to assist in greenhouse gas emissions reductions. It will be peer-reviewed before being presented to the Coal Innovation NSW Ministerial Advisory Council in late 2016.

Why?

There are currently five base-load power stations in NSW generating electricity from coal combustion. These power stations have a collective generating capacity of 10,240 megawatts (MW), representing 63% of the State's generating capacity. In the 2015 calendar year, coal accounted for 80% of actual electricity generated.

Particulate matter is emitted directly from power stations and also forms in the atmosphere from precursor power station emissions such as nitrogen oxides (NO_x) and sulfur dioxide (SO_2). The NSW Air Emissions Inventory estimates that generation of electrical power from coal contributes 87% of SO_2 emissions and 52% of NO_x emissions, as well as 9% of direct $PM_{2.5}$ emissions in the GMR.

Power stations in all three major generating regions – the Upper Hunter, Central Coast and Lithgow – contribute to sulfate particulate levels across the GMR. For example, power station SO_2 produces close to 20% of fine particle pollution at Richmond in Sydney's north-west on an annual basis.

Internationally, as environmental regulation is tightened to reduce exposure to air pollution, the United States, Europe and China have successfully introduced standards for power station SO_2 and NO_x emissions, based on currently available technology. Coal-fired power stations in NSW have controls to filter direct particle pollution under existing regulation but no comparable controls for NO_x or SO_2. Historically, SO_2 from power stations has been regulated by limiting sulfur content of the coal burnt, rather than by regulating emission standards.

STRENGTHENING THE MINING REHABILITATION FRAMEWORK

Goal

The NSW Government will strengthen the rigour of the rehabilitation framework for mining projects to ensure that outcomes better meet the expectations of government and the community.

Action

The NSW Government could develop a policy and updated rehabilitation framework which clearly sets out its expectations on post-mining final land-use (including voids). This policy would also provide upfront guidance to the consent authority and to the mine operator on the acceptability of final land-use proposals.

Standard conditions of a mining lease would be amended to require adherence to a rehabilitation code of practice. This would enforce progressive rehabilitation over the course of a mining project – that is, exploration, operation and closure.

Why?

The NSW Government has in place firm conditions designed to ensure that exploration and mining projects manage their emissions across a project's lifecycle and that land is rehabilitated.

More work is being done to address the temporal aspects of rehabilitation – so that improved outcomes can be achieved over the short term, medium term and long term. Different rehabilitation activities are required at each of these stages.

Having in place a rehabilitation code of practice and a final land-use policy will assist in ensuring better rehabilitation outcomes over the entire lifecycle of a mine.

MANAGE DUST EMISSIONS IN THE HUNTER RAIL CORRIDOR

Goal

Minimise exposure to dust emissions in the Hunter rail corridor.

Action

Consider and act on the findings of studies undertaken by the NSW Chief Scientist and Engineer, of coal dust emissions in the NSW coal chain.

Why?

The NSW Government has already implemented a wide package of measures to reduce air quality impacts from coal mining and mining related emissions, in particular via its Dust Stop program for coal mines.

Nearly all coal shipped through Newcastle is transported by rail; on average approximately 61 loaded coal trains use the rail corridor each day, travelling to and from the port, equivalent to approximately five coal trains per hour. The Newcastle port is one of the largest coal export ports in the world. 2013–14 coal exports from Newcastle were 155 million tonnes.

Communities within the rail corridor are concerned about health and amenity impacts of fugitive coal dust generated from transportation of coal in the rail corridor. Airborne particulate matter in elevated concentrations can have adverse impacts on human health, amenity and ecosystems.

Coal mines in NSW are relatively close to ports and other users. The most distant coal mining area is Gunnedah, approximately 320 kilometres north-west of Newcastle. Actions to reduce dust lift-off and coal loss from wagons are required by rail networks in Queensland and North America. The Protection of the Environment Operations Act obliges premises to manage activities in a manner that prevents or minimises air pollution.

At the request of the Minister for the Environment, the Chief Scientist and Engineer ~~has~~ conducted an extensive review of rail coal dust emissions in the NSW coal chain. The first stage of the review identified two key questions to be addressed in the second phase – whether air quality standards are exceeded in the Hunter rail corridor and whether effective management measures are available to ensure air quality is maintained within the standards.

The Final Report on the Independent Review of Rail Coal Dust Emissions Management Practices in the NSW Coal Chain (NSW Chief Scientist & Engineer, 2016) was released in August 2016. It stated that further targeted studies are needed to better understand the nature and distribution of particles along rail corridors and industry should continue existing dust mitigation measures.

The EPA and OEH in consultation with the Interagency Taskforce on Air Quality in NSW, will consider and act on the recommendations of the Chief Scientist and Engineer.

Reducing transport, engine and fuel emissions

DEVELOPMENT OF A NSW ELECTRIC VEHICLE STRATEGY

Goal

Examine policies and incentives that could be adopted by the NSW Government to increase the uptake of electric vehicles.

Action

The proposed electric vehicle (EV) strategy, led by the Department of Industry, will:

- analyse market developments and identify any barriers to expansion
- identify and evaluate potential solutions and new policy initiatives, including investigation, for example, of opportunities for:
  - potential measures that can be delivered by the NSW Government
  - infrastructure development to support the operational capability of EVs
  - linkages with renewable energy and
  - development of skills and capabilities in the EV supply chain.

Why?

With population growth expected to increase demand for vehicles, there is a need to investigate opportunities to reduce transport emissions, particularly in urban areas.

EVs and other low emission vehicles present significant opportunities to reduce the environmental impacts of road vehicle use. EVs do not cause air pollution when driven, and emit slightly less carbon dioxide than internal combustion engine vehicles, even when charged through the electricity grid.

Whilst maximum benefit would be obtained by powering EVs using renewable energy, research shows that even a relatively small increase in EV numbers can have a powerful impact on emissions reduction.

Albrecht et al. (2009) looked into the uptake of EVs in Australia and concluded that a five per cent uptake of EVs for daily commuting could lead to a 3.26 million kilometre reduction in travel by liquid fuelled vehicles in Sydney. Assuming these replace new petrol powered vehicles in Sydney and are powered by renewable energy, in 2016 this would result in an estimated reduction of over 68 tonnes of NOx emissions per year and 212 tonnes of VOC emissions (combustion and evaporative) per year, or emission reductions for the total petrol vehicle fleet of 0.2% and 1.4% for NOx and VOCs respectively.

Globally, the sale of EVs is growing exponentially. However in Australia in 2014, sales totalled just 0.009% of all new vehicles sold. The NSW Government's EV strategy will adopt initiatives that will ultimately increase the penetration of EVs. This will not only assist in lowering the State's transport emissions, but can also result in significant job creation.

INVESTIGATION OF VEHICLE EMISSION STANDARDS FOR NSW GOVERNMENT CONTRACTS

Goal

Investigate a mandatory emission performance standards policy for motor vehicles operated by or under NSW Government service contracts.

Action

The proposed action would involve:

1. researching current availability of, and lead times for, introduction to the Australian market of vehicles conforming to higher emissions standards and the resultant cost impacts
2. developing recommendations for an emissions performance standards policy for motor vehicles, to be implemented, when practicable, as a government-wide procurement policy. The standards, if adopted, would form a prerequisite for awarding all NSW Government procurement contracts, for government vehicle purchase and service contracts, and include phasing in of standards on existing service contracts.

Emissions performance standards proposed to be investigated are, for example:

- for all new NSW Government contracts (government vehicle purchase and service contracts):
  - motor vehicles first registered prior to [Year 1] must conform to Euro 5/V
  - motor vehicles first registered from [Year 1] must conform to Euro 6/VI or equivalent.
- for existing NSW Government service contracts:
  - from [Year 2] all vehicles must conform to Euro 5/V
  - from [Year 3] all vehicles must conform to Euro 6/VI or equivalent.

Why?

Around 12% of all new heavy vehicles registered in NSW in the first quarter of 2016 were registered to government and a greater proportion of the NSW heavy vehicle fleet is either engaged on government projects or owned by private companies that want government work. Vehicles are a major source of air pollution in major urban areas, with 62% of NO_x, 24% of VOCs and 14% of fine particle pollution ($PM_{2.5}$) in Sydney coming from vehicles. NO_x and VOCs are precursors to ozone formation and photochemical smog. $PM_{2.5}$ contributes directly to PM concentrations and population exposure. NSW experiences exceedances of the national ambient ozone and particle standards in most years.

Emissions from new motor vehicles have declined significantly in the past 20 years through progressive tightening of national motor vehicle standards and improvement in fuel quality. Australian Design Rules (ADRs) require Euro 5 for light duty vehicles and Euro V for heavy duty vehicles. Euro 6/VI vehicles are available internationally and have been adopted by the European Union, Japan and the United States. The Australian Government is reviewing the timeframe for implementing Euro 6/VI standards. NSW supports early adoption of Euro 6/VI (light vehicle/heavy vehicle standards) to reduce motor vehicle pollution (NSW 2015a) and low sulfur fuel (NSW 2015b).

Dr Caitlin Richards
Approvals, Environment and Sustainability Manager,
Sydney Metro Northwest Tunnels and Station Civil Works,
CPB John Holland Dragados

I am passionate about finding the best solutions to provide value for money, streamline management documentation and maximise environmental and community benefits. In working to reduce emissions, CPBJHD's focus is on worker safety, but the ancillary benefit is reducing the exposure of communities surrounding our worksites. Knowledge sharing amongst industry is integral to continual improvement. Showcasing the tools we used on the Sydney Metro Northwest tunnel project will help the construction industry to minimise non-road diesel emissions.

Emissions performance standards operated by, or under NSW Government service contracts would complement fuel efficiency standards for light vehicles and emission standards for non-road diesel plant and equipment required under the NSW Government Resource Efficiency Policy (GREP).

MINIMISE NON-ROAD DIESEL EMISSIONS

Goal

Further reduce diesel emissions from priority sources.

Action

Under its Diesel and Marine Emissions Management Strategy, the EPA is investigating and developing requirements for best practice emissions management measures for non-road diesel equipment and locomotives, including potential regulation of emission standards. Proposals on best practice diesel emissions management at coal mines have been developed and released following industry and stakeholder consultation. Similar investigations are proposed to develop targeted diesel emissions measures for the construction and infrastructure sector, extractive industry and waste management facilities.

Why?

There is mounting evidence of the adverse health impacts of diesel emissions and growing community concern. Diesel exhaust emissions contain harmful fine particles and have been declared a human carcinogen by the World Health Organization's International Agency for Research on Cancer.

While on-road vehicle emissions are declining through strict national engine and fuel standards, non-road diesel emissions continue to increase in the absence of national standards and regulation.

Feasible and cost-effective technologies and effective regulatory approaches to control these emissions are available, as demonstrated by approaches in the United States, European Union and many other countries.

In the absence of national standards in Australia, the EPA is developing state-level measures to reduce emissions from the non-road diesel sector. The EPA's *Diesel and Marine Emissions Management Strategy*, released in February 2015, maps out actions to address emissions from priority non-road diesel sources in NSW. Under the Strategy, the EPA will consider potential measures to require minimum performance standards aligned with international standards, for non-road diesel equipment used in priority sectors.

NSW GMR Air Emissions Inventory data shows that approximately 96% of all non-road diesel $PM_{2.5}$ emissions in the GMR come from industrial non-road vehicles and equipment, locomotives and shipping combined. Additionally many of these sources (e.g. construction activities, rail transport and cruise ships) are located in close proximity to communities.

PETROL VAPOUR RECOVERY REQUIREMENTS IN REGIONAL CENTRES

Goal

Reduce health impacts from air toxic emissions in petrol vapours, by extending vapour recovery requirements for new/upgraded petrol service stations and petrol depots to regional urban centres.

Action

It is proposed to investigate the fuel distribution network and to gather and analyse evidence on the benefits of extending requirements to install vapour recovery equipment at fuel depots and new or upgraded petrol stations to regional centres. Options for investigation to implement proposed requirements

include regulatory or planning instruments. Potential criteria for applying requirements would be developed to ensure fairness, such as population, proximity of service station to residences and proposed annual petrol throughput. The investigation will consider emissions when petrol is delivered to a service station or dispensed.

The investigation would inform potential recommendations on targeted requirements for new/upgraded petrol service stations in regional cities, requiring installation of vapour recovery equipment, to be accompanied by an auditing program to monitor industry's compliance.

Why?

Initial vapour recovery requirements in NSW have focused on metropolitan and surrounding areas (Central Coast, Lower Hunter, Illawarra and Sydney regions), where risk of exposure to ozone pollution is greatest. However, there is also potential for NSW regional communities to be exposed to harmful air emissions from petrol stations, particularly for people using bowsers or living close to petrol stations.

Air toxics are present in the air surrounding service stations as a result of emissions of vapours during dispensing, loading, unloading and transportation of petrol. Petrol contains benzene, toluene, ethylbenzene and xylene, the "BTEX" compounds. Benzene is the most hazardous of these, and though limited by volume in petrol to 1%, remains a concern as there is no safe exposure level.

The International Agency for Research on Cancer has classified benzene as a human carcinogen. Overseas and Australian studies have linked proximity to service stations with increased cancer risk from benzene exposure.

Reducing household emissions

WOOD SMOKE REDUCTION

Goal

Reduce exposure to fine particle pollution from domestic wood heaters.

Action

Update the Clean Air Regulation

It is proposed that changes to the wood heater regulatory framework will adopt the updated Australian/New Zealand Standards for new wood heaters, which set more stringent emission limits and new efficiency limits.

The EPA will undertake periodic compliance audits to ensure that heaters offered for sale in NSW are complying with the new national standards.

Investigate other measures to reduce wood smoke emissions

The EPA is undertaking further research into the impacts of wood heaters across the GMR and lower emission standards. This research is a collaboration with NSW Health, CSIRO and the Centre for Air quality & health Research and evaluation (CAR).

In consultation with stakeholders and the wider community, it is proposed that the EPA will investigate further improvements to the wood heater regulatory framework for consideration by Government, as well as education, training and replacement programs. It is not proposed to take action on the use of fire for cooking and recreational purposes, such as for camping or using outdoor pizza ovens and barbecues.

Why?

Local councils can implement controls on wood heaters. The EPA's role on the other hand is to develop policy and regulations and contribute to the development of national standards. The EPA provides councils with resources such as education materials, and provides training to help council officers identify and deal with wood smoke pollution. The EPA also conducts research and provides assistance to councils to run wood smoke reduction community education campaigns.

The use of fire for cooking and recreational purposes, for example camping or using outdoor pizza ovens and barbecues, is already regulated appropriately under environmental legislation; operators are required to use the correct fuel and take care to prevent or minimise air pollution.

An economic analysis by AECOM estimated the costs to health of wood smoke emissions across urban, regional and rural areas of NSW, without new government action, at $8.1 billion over 20 years (AECOM 2011).

In Sydney, wood smoke contributes 47% of annual $PM_{2.5}$ particle pollution and up to 75% of particle emissions in July each year. According to an Air Pollution Inventory forecast, 5835 tonnes of wood smoke was emitted in Sydney in 2015 and over 5770 tonnes will be emitted in 2026 if no action is taken.

The health effects of $PM_{2.5}$ are well researched and documented; pollutants found in wood smoke can cause breathing difficulties, respiratory disease and cardiac problems. Air pollution from wood heaters mostly affects young children, older people and people with existing respiratory conditions, such as asthma sufferers, however it also has impacts on healthy adults.

SMALL DOMESTIC PETROL-POWERED EQUIPMENT PROGRAM

Goal

Reduce emissions from garden equipment and fuel storage containers, and support uptake of national actions to improve emissions standards for new garden equipment.

Action

Investigate developing a program to promote replacement of 2-stroke garden equipment and old fuel cans. The project would involve identifying measures to reduce the number of high emission products in the community and partnering with local government, retailers of garden equipment and fuel cans and waste operators to develop and evaluate options that could be effective in NSW. Potential actions to be investigated for incorporating in the program could include, for example:

- a media campaign to raise awareness of the benefits and availability of low-emission products
- a summer-time garden equipment program that provides free scrappage of old equipment
- potential incentives to purchase low-emission or emission-free models, i.e. 4-stroke, electric or reel mowers.

The program would be coordinated with and complement national action, which NSW has supported, to adopt emission standards for garden equipment.

Why?

Petrol-powered garden equipment contributes significantly to urban air and noise pollution. An estimated 3.5 million pieces of powered garden equipment exist in the NSW GMR. Of these, an estimated 300,000 2-stroke lawn mowers in Sydney emit around 1620 tonnes of VOCs per year. By contrast, the 800,000 4-stroke mowers emit 60% less VOCs. Spillage, evaporation and permeation of fuel from over 1 million fuel cans emit around 3000 tonnes of VOC emissions per year.

Replacing a 2-stroke mower with a zero-emission model would eliminate around 5 kilograms of VOC emissions per mower per year. Replacement with a 4-stroke model would eliminate 3 kilograms of VOC emissions per mower per year.

Replacing old fuel cans with California Air Resources Board (CARB) compliant models would eliminate 2.2 kilograms of VOC emissions per can per year (equivalent to 8% of the can's contents).

Exposure and impact reduction

REDUCING HEALTH IMPACTS OF HAZARD REDUCTION BURNING AND OTHER OPEN BURNING

Goal

Improved health outcomes and reduction in all health impacts of smoke across populations by reducing exposure to particle pollution from hazard reduction and open burning in metropolitan and regional NSW.

Action

It is proposed that NSW Government agencies will work collaboratively with research organisations, industry groups and local government to improve air quality and reduce population exposure to smoke from hazard reduction and open burning in metropolitan and regional communities.

Actions to minimise community exposure to particle pollution include:

- improving collaboration – across government agencies, including EPA, OEH, NSW Health, Bureau of Meteorology, local government and Rural Fire Service (RFS), and with local communities and industry – in managing particle pollution impacts from hazard reduction and open burning. This will include a cross-agency protocol to identify circumstances where carrying out or continuing hazard reduction burning would be harmful to public health, to reduce the potential for hazardous air pollution episodes and to minimise smoke impacts on local communities
- supporting research into health impacts of smoke and management measures to reduce health impacts of smoke from controlled burning and bushfires
- expanding the scope and enhancing the accuracy of air quality forecasting capabilities in New South Wales over the next five years by the OEH Air Quality Forecasting Program, through collaboration and the development of advanced tools and analysis
- fully utilising Rural Fire Service smoke plume modelling to forecast the impact of hazard reduction burns or bushfires on communities
- improving communication and awareness of air quality and health impacts from smoke and fine particle pollution across government, the private sector and the community
- promoting conservation farming to reduce impacts of agricultural burning
- increasing community understanding of appropriate meteorological conditions for hazard reduction and agricultural burning that is provided by the Bureau of Meteorology and improved pollution forecasting.

Why?

There are a number of potential contributors to particle pollution that impact on urban and regional communities. These include dust, which is increased during drought, bushfires, wood smoke and hazard reduction burning. Agricultural burning also impacts periodically on rural communities.

A number of regions in NSW experience high particle pollution associated with hazard reduction and open burning. Episodes of high smoke pollution from hazard reduction burning also occur in the Sydney region that result in exceedances of air quality national standards. These can have adverse health impacts, potentially affecting millions of people, ranging from eye and throat irritation and asthma symptoms to hospitalisations and premature deaths.

While committed to carrying out hazard reduction burning as a public safety tool, the NSW Government also recognises the need to minimise the associated air quality impacts on NSW communities.

AIR QUALITY MONITORING REVIEW

Goal

Ensure NSW air quality monitoring networks meet government and community information needs.

Action

OEH will undertake a review of the principles and requirements of air quality monitoring in New South Wales. The review will focus initially on the government's ambient air quality network and on the industry-funded, government-operated air quality monitoring networks in the Upper Hunter and Newcastle areas. This stage of the review will address the requirements for monitoring under the Air NEPM and community information needs. It will be followed by a review of industry self-monitoring required under the Protection of the Environment Operations (General) Regulation. Findings from each stage of the review will be made publicly available.

OEH is also participating in a national expert working group reviewing monitoring requirements and protocols for the Air NEPM and assessing monitoring requirements that may support improved assessment of population exposure to air pollution.

Why?

The review will ensure that NSW Government-operated air quality monitoring networks are meeting the needs and priorities of the government and the community, as well as requirements of the Air NEPM. Stage 2 of the review will assess if monitoring requirements placed on industry are efficient and effective and are providing the government with the information needed to ensure that industry complies with operating requirements and inform future air pollution control programs.

AIR QUALITY FORECASTING

Goal

Expand the scope and enhance the accuracy of air quality forecasting capabilities in NSW.

Action

It is proposed that the the OEH Air Quality Forecasting Program will progressively expand the scope and enhance the accuracy of air quality forecasting capabilities in New South Wales over the next five years, through collaboration and the development of advanced tools and analysis.

Components include:

- OEH to continue to develop air quality forecasting tools to deliver accurate, locality-specific short-term forecasts for major population centres on an ongoing basis
- OEH and EPA collaborate to develop an air quality forecasting system for the Upper Hunter to support actions by mines to reduce dust from operations in adverse weather conditions
- air quality forecasting systems and tools to be integrated into an easy-to-access interface
- longer term, OEH to further enhance capabilities to forecast air quality impacts associated with incidental emissions due to wildfires, hazard reduction burns, industrial accidents and other incidents.

Further engagement will be undertaken to better understand user needs, build inter-agency collaborations, increase awareness of the benefits of robust air quality forecasting, and ensure forecasting skills being developed are fit for purpose.

Why?

Improved air quality forecasting will reduce health impacts by:

- enabling people who are sensitive to air pollution to better manage personal exposure
- informing the NSW Government's response to air pollution incidents
- supporting proactive management to reduce the potential for air pollution episodes.

AIR POLLUTION INCIDENT RESPONSE

Goal

Provide the best available information on air pollution and possible health impacts from major incidents, to inform emergency management responses and to reduce health impacts in communities affected by major incidents.

Action

It is proposed that OEH will develop its air pollution incident monitoring and associated air quality modelling and health risk assessment capabilities. Existing air pollution incident monitoring capabilities will be further expanded, refined and tested.

Tools and procedures would be developed and staff trained to:

- deliver robust air pollution plume modelling for major incidents, including short-term forecasts
- undertake timely assessments of health risks associated with such incidents, based on measured, modelled and forecast air pollution levels
- communicate air pollution and health risk information rapidly to inform emergency management responses
- interpret and use air pollution and health risk information to improve responses to major incidents.

Why?

Air pollution from major incidents such as large bushfires and industrial accidents poses a significant risk to the health and wellbeing of NSW communities. Timely access to the best available information on air pollution and associated health risks is needed to inform emergency management responses to reduce health impacts within communities affected by major incidents.

The NSW Government has established pollution incident response monitoring for incidents where air quality impacts may be experienced in the community for a period of several days or longer. The core components of this monitoring capability developed by OEH are portable monitoring pods fitted with telemetry and communications systems. Web reporting capabilities enable rapid transfer of information to a publicly accessible website. Air pollution incident monitoring supplements the information from OEH's network of 43 air quality monitoring stations located across NSW.

Co-benefit actions

ENERGY PRODUCTIVITY

Goal

Promote more productive use of energy in the transport sector which could also lead to local air quality benefits, via for example:

- cleaner vehicles, such as electric and hybrid vehicles
- reduced road congestion
- increased use of public and active transport.

Action

It is proposed that the NSW Government will:

- identify opportunities for increased energy productivity in the transport sector
- examine whether there are market barriers which require government action
- identify international best practice policies
- assess the costs and benefits for NSW of potential government actions, including the benefits from reduced air pollution.

The government is coordinating this work with agreements made under the National Energy Productivity Plan (NEPP), which sets a national, economy-wide target to deliver a 40% improvement in Australia's energy productivity by 2030.

The NSW Government continues to develop and drive improvements in the energy efficiency of households, businesses and government under the NSW Energy Efficiency Action Plan. Reducing demand for energy through increased energy efficiency also reduces air pollution.

Why?

Many of the key sources of air pollution are also the key sources of carbon emissions. Policies to reduce carbon emissions can therefore provide a significant opportunity to reduce air pollution, and vice versa. For example, policies to improve energy efficiency can deliver carbon emission and air pollution savings, whilst also providing energy bill savings and deferring costly energy infrastructure upgrades.

Shared responsibility

Clean air is dependent on the successful implementation of many government policies directed to goals such as greater efficiency and productivity across transport and industry, improved workplace and community health, and more liveable cities and neighbourhoods. Policies relating to air pollution sources and receptors can also impact negatively on air quality. Protecting and improving air quality is thus a responsibility shared by multiple partners, including State, Commonwealth and local government, industry, community organisations and the general public.

CO-BENEFITS OF CROSS-AGENCY ACTIONS

The Interagency Taskforce on Air Quality in NSW will oversee whole-of-government development and delivery of, and communication on, Clean Air for NSW, and ensure coordination with other relevant government programs, such as those on climate change.

The Taskforce includes the EPA, as chair, OEH, NSW Health, Transport for NSW, the Department of Planning and Environment, the Department of Industry and the Department of Premier and Cabinet. They will set, discuss and collaborate on the NSW whole-of-government clean air agenda to ensure clean air is at the heart of policies for sustainable growth and development in NSW cities and regions. The Taskforce may also involve other relevant experts or agencies, for example the Chief Scientist and Engineer or the Rural Fire Service, in discussion of specific issues.

ENVIRONMENT AND HEALTH ACTION FOR CLEAN AIR

As NSW's independent environmental regulator, the EPA protects air quality using its regulatory powers, education, economic mechanisms and partnerships with business and the community. Its remit includes researching and implementing innovative approaches to minimising air impacts and ensuring air quality is improved using all reasonable and practicable measures. Its current clean air actions are presented in *Implementing Managing Particles and Improving Air Quality in NSW* and the Diesel and Marine Emissions Management Strategy.

OEH has a lead role in providing scientific evidence and expert knowledge to support environmental decision-making, including the science to support government policies and programs on air quality and climate change. NSW Health undertakes health research on air quality and contributes expert scientific knowledge and advice on health aspects of state and national government decisions that affect air quality. Under a memorandum of understanding, the EPA, OEH and NSW Health work with Centre for Air quality & health Research and evaluation (CAR) to initiate new research on the health impacts, risks and costs of air pollution in New South Wales (See also the chapter on "Strengthening knowledge").

OEH also provides community, business and government with robust air quality information, including near-real time measurements from the NSW air quality monitoring network. Its air quality forecast information provides the basis for NSW Health to issue health alerts for high pollution episodes, to help people manage their exposure to air pollution.

The NSW environmental regulation framework that supports clean air actions:

- The *Protection of the Environment Operations Act 1997* – sets the statutory framework for managing air quality in NSW
- The Protection of the Environment Operations (Clean Air) Regulation 2010 – provides measures to control emissions from industry, motor vehicles and fuels, domestic solid fuel heaters and open burning, and cruise ships
- The Protection of the Environment Operations (General) Regulation 2009 – establishes the licensing scheme for major industrial premises and economic incentives for licensed businesses and industry to reduce pollution, including emissions to air
- "Risk-based licensing" – aims to ensure that all licensees receive an appropriate level of regulation based on the level of environmental risk they pose. Environmental risk for each EPA-licensed industry is assessed based on: the types and nature of emissions from the industry, its pollution control measures and its proximity to sensitive environments and receivers. Risk assessments are undertaken at a minimum of five year intervals and may be more frequent if circumstances at the licensed premises change.

SUPPORTING CLEAN AIR THROUGH CLEAN ENERGY AND ENERGY EFFICIENCY

The Division of Resources and Energy (DRE) of the NSW Department of Industry, Skills and Regional Development delivers policy, programs and compliance across the minerals and energy sector. DRE leads a number of industry initiatives which will contribute to cleaner air across NSW, including implementing the Renewable Energy Action Plan (REAP), investigating low-emission coal technologies and considering ways to support the uptake of electric vehicles.

OEH develops policy and initiatives on energy efficiency, taking into account potential co-benefits for air quality. It implements the NSW Energy Efficiency Action Plan (EEAP) to deliver clean and affordable energy for households and businesses in NSW.

The EEAP contains actions to strengthen the energy efficiency market and support efficient energy use by households, business and government, including through rebates for households and businesses. The REAP positions NSW to increase energy from renewable sources at least cost to the energy customer and with maximum benefits to NSW. The NSW Government works closely with communities and the renewable energy industry to grow renewable energy generation in NSW. Actions include exploring opportunities for using emerging renewable sources such as bioenergy, geothermal, wave and tidal, and smart-grid technology.

PLANNING FOR CLEAN AIR AS SYDNEY GROWS

The EPA and OEH are working with the Department of Planning and Environment and the Greater Sydney Commission (GSC) to plan for clean air as Sydney continues to grow.

This collaboration aims to ensure that principles to protect air quality and public health are implemented through the strategic land-use policies and planning instruments that govern Sydney's growth. A priority is to support the GSC in identifying links between Clean Air for NSW and preparation of District Plans for Sydney. These will require measurement of strategic and cumulative issues and effects, and the GSC will look to OEH and the EPA for data and support on air quality issues.

Principles the EPA is promoting in planning for urban growth focus on the adoption of best practice urban planning and design to minimise emissions from new development and minimise people's exposure to air pollution. Delivering actions that address these principles is consistent with best practice planning for sustainable and liveable cities.

Well considered urban layouts that address air quality and exposure issues will be increasingly important as the density of people living in and around compact strategic centres continues to increase. Examples of planning opportunities to reduce air pollution impacts include avoiding land-use conflict and improving energy production and the use of clean energy. Incorporating greenery and tree cover into urban layouts also has air quality and amenity benefits. Parks, street trees and vegetation can keep urban areas cooler, reducing the effects of heatwaves and improving the air we breathe, nurturing local biodiversity and providing better places for healthy living.

CLEAN TRANSPORT FOR CLEAN AIR

Government transport actions, led by Transport for NSW, support clean air by:

Providing opportunities to use cleaner public transport instead of private vehicles, through major public transport infrastructure projects

Sydney Metro is Australia's largest public transport infrastructure program. Sydney Metro Northwest, the first stage of the program, will deliver eight new railway stations and 4000 commuter car parking spaces to Sydney's growing North West. Trains will operate every four minutes in peak hours with at least 15 trains an hour.

Sydney Metro Northwest will deliver, for the first time, a reliable public transport service to a region that has the highest car ownership per household in Australia. By 2021 Sydney Metro Northwest will cut 6.2 million vehicle kilometres travelled by car, resulting in improved air quality by cutting 15 tonnes of PM_{10} and 70 tonnes of NO_x emissions.

Sydney Metro North West has committed to using renewable energy sources for operational needs. In January 2016 Transport for NSW released a request for Expressions of Interest to supply a demand of 137 gigawatt hours of electricity from a renewable energy project in NSW. This is enough energy demand to support a large scale renewable energy project, driving new investment and jobs in a regional part of the State.

Expansion of the Sydney light rail network will promote a more sustainable future for Sydney by creating more sustainable transport choices and development opportunities.

CBD and South East Light Rail (CSELR) when completed in 2019 will connect Circular Quay to Central Station, the Moore Park sporting and entertainment precinct, Randwick Race Course, the University of NSW and Prince of Wales Hospital at Randwick. There will be a reduction in bus and car vehicle kilometres travelled as people switch to the new light rail network.

CSELR will reduce emissions from the transport system in the CBD and inner Sydney, thereby increasing its overall sustainability. The project will reduce greenhouse gas emissions by 663,000 tonnes of CO_2 over 30 years. Around 77% of this reduction will be attributable to a decrease in car use, and around 23% will be due to a reduction in bus use.

The CSELR project is currently investigating purchasing 100% renewable energy to offset carbon emissions generated by the operation of the project.

The public transport fleet of trains, buses, light rail and ferries is at the heart of our public transport system. Tougher emissions standards and a greater need for energy efficiency will drive fleet modernisation across all modes.

The bus fleet is progressively being replaced. The emissions profile of State Transit's Bus Fleet continues to improve with the acquisition of new buses and the retirement of its older fleet. As of June 2016 some 43% of State Transit's buses meet the latest Euro 5 or Enhanced Environmentally Friendly Vehicle (EEV) standard. New double-decker buses to be added to the fleet have improved fuel consumption and lowered emissions on a per passenger basis.

Addressing traffic congestion, which causes higher emissions

Traffic congestion causes air quality impacts as vehicles stopping and starting burn fuel at a higher rate. Transport for NSW manages the urban road network in real-time through the Transport Management Centre by detecting and responding to incidents, traffic signal timing, and providing real-time traveller information to motorists. Key initiatives include:

WestConnex is Australia's largest transport project, linking Sydney's west and south-west with the CBD, Sydney Airport and Port Botany. The 33-kilometre motorway will remove through traffic from local roads, easing congestion and reducing vehicle emissions across Sydney. WestConnex's tunnel ventilation systems will also be designed to best practice standards and operate to achieve stringent air quality criteria.

NorthConnex a new tolled motorway linking the M1 Motorway to the M2 Motorway is important infrastructure for freight traffic and wider connectivity within NSW. NorthConnex will reduce congestion and improve traffic flow by redirecting around 5000 heavy vehicles each day off Pennant Hills Road. This will lead to improved local air quality.

The Northern Sydney Freight Corridor (NSFC) Program is a joint Australian and NSW Government initiative to improve capacity and reliability for passenger and freight trains between Sydney and Newcastle. By 2031, the freight task in NSW is projected to nearly double to 794 million tonnes. Putting freight on trains is recognised as being good for our economy, good for our environment and good for road users.

Each freight train is equivalent to approximately 150 semi-trailers, and transporting freight by rail generates only one third of the greenhouse gases produced by road transport. Enhancing the capacity of the rail freight network through the NSFC Program will allow rail to be more competitive with road transport for certain types of freight and cut more than 200,000 heavy vehicle road trips per year within 15 years. It will also reduce diesel use by almost 40 million litres and greenhouse gas emissions by more than 100,000 tonnes each year.

The Sydney Road Congestion Management Program sets the direction for minimising congestion within the metropolitan area. Initiatives include bus priority measures, kerbside management, addressing pinch points at rail level crossings, incident management and actions to address congestion hot spots.

Reducing vehicle emissions

Despite an expected increase in the number of cars in Sydney over the next 20 years as the population grows, total emissions from motor vehicles are set to fall between now and 2031 due to the continued phasing out of older vehicles. To encourage this process, the NSW Government provides a lower rate of motor vehicle tax for hybrid and electric vehicles with CO_2 emission levels up to 150 grams/kilometre.

Another initiative to improve air quality is the NSW Government's smoky vehicle camera system that identifies polluting vehicles in the M5 East tunnel. Operators of detected smoky vehicles are issued penalty infringement notices (PIN) for their first two offences and have automatic three-month suspensions of vehicle registration imposed for third offences.

Heavy vehicles, despite accounting for just 4% of the Australian vehicle fleet, contribute 22% of total transport emissions. To achieve better environmental outcomes, Roads and Maritime Services works with industry to implement the Green Truck Partnership and the Clean Fleet Program, and information on these programs can be found at: http://www.rms.nsw.gov.au/about/environment/air/green-truck-partnership/index.html and http://www.rms.nsw.gov.au/about/environment/air/clean-fleet.html.

Supporting active transport

Increased walking and cycling, particularly for short, local trips also contributes to improved environmental outcomes and is critical to a successful integrated transport system.

Transport for NSW is improving pedestrian facilities in partnership with local councils and improving pedestrian priority in the CBD to support and encourage walking, through initiatives such as the Wynyard Walk pedestrian link between Wynyard and Barangaroo.

Transport for NSW is also investing in initiatives to support and grow cycling across Sydney, including through establishing a connected cycling network within a five kilometre catchment of local centres and providing bike parking at transport interchanges.

COLLABORATION WITH COMMONWEALTH AND LOCAL GOVERNMENT

New South Wales works with **the Commonwealth and other States and Territories** to deliver clean air actions and address emerging air quality issues under the National Clean Air Agreement. This covers reviewing and strengthening air quality standards, developing measures addressing air pollution sources common to all jurisdictions, improving access to air information and fostering partnerships with industry.

NSW also advocates to influence national policy on air quality, including Commonwealth policy and legislation on motor vehicles and fuel emissions. NSW supports the Commonwealth policy of harmonising Australian vehicle and fuel standards with European standards designed to protect air quality and human health.

In particular, NSW is advocating for early adoption of tighter vehicle emission standards, for trucks and buses, through adoption of Euro VI heavy vehicle standards (NSW 2015a).

OEH is also working collaboratively with the Commonwealth Clean Air and Urban Landscapes Hub (CAUL) consortium on the Western Air-Shed and Particulate Study for Sydney. The project will contribute to the understanding of poor air quality events within Western Sydney by addressing knowledge gaps, and provide evidence and tools for policy makers to estimate the benefits of different strategies to improve future air quality in the region. More information about the Western Sydney air quality project can be found at: http://www.nespurban.edu.au/research-projects/project-one/.

Local councils have a major role in managing local air quality, including through regulatory responsibilities for activities where they are designated as the appropriate regulatory authority. They also manage air emissions and exposure through local level land-use and transport planning. The EPA supports local councils by providing training, management frameworks and tools, information, guidance and funding for local clean air initiatives. The EPA offers councils a broad range of courses on environmental regulation through the Australasian Environmental Law Enforcement and Regulators network (AELERT).

Councils work with their communities to promote and support individual responsibility for improving air quality. Ways **individuals and households** can reduce their emissions include:

- ensure domestic wood-fired heaters operate efficiently e.g. use only small logs of seasoned dry wood, maintain a bright flame and never let the fire smoulder (i.e. overnight), increase air supply to your chimney if smoking, and make sure your chimney is cleaned at least every two years

- be considerate to neighbours, particularly those individuals that are highly susceptible, when undertaking activities that may increase local air pollution (such as operating domestic wood-fired heaters, barbecues, lawn mowers or other activities that may cause pollution)
- choose alternatives to car transport e.g. cycling, walking, or catching public transport whenever possible.
- buy cleaner, more efficient 4-stroke petrol and diesel-powered machinery and equipment. Regularly service and maintain vehicles, and other petrol and diesel-powered machinery
- implement measures to save energy and consider installing renewable energy or purchasing accredited GreenPower
- choose low-volatility surface coatings and alternatives to aerosols. These are better for outdoor air quality and also protect air quality and health in the home.

Councils' close relationships with their communities, together with the increasing availability of new monitoring technologies, mean that councils have greater opportunity to engage their communities in monitoring and managing air quality at the local level (see also the section on "Empowering and engaging stakeholders").

Mr Jon Bannister
Manager – Plant & Equipment, Blacktown City Council

The partnership between Blacktown City Council and the NSW Government to reduce diesel exhaust emissions has always been extremely positive. My initial focus was on minimising health impacts on council workers and the community in western Sydney, and also having an audited maintenance system ensuring we are incorporating best practice, in line with the NSW Government's Clean Fleet Initiative.

We did quite a bit of work, some of which took time to implement, but we achieved the goal of reducing our diesel emissions. Blacktown City Council's commitment to cleaner air for the western suburbs will continue.

KEY POINTS

Establish an Interagency Taskforce on Air Quality in NSW to deliver and oversee the implementation of Clean Air for NSW.

Collaborate across NSW agencies to:

- Support improved knowledge, communication and consultation on air quality management in NSW
- Promote actions to directly improve air quality in NSW
- Maximise air quality benefits and mitigate or prevent adverse air outcomes from decisions that can impact on air, such as decisions on land-use and transport planning and climate change and energy policy
- Maximise potential co-benefits from clean air efforts,such as reduced greenhouse gas emissions and improved energy efficiency.

Work with the Commonwealth and across jurisdictions to champion national initiatives to improve air quality and public health in NSW and Australia-wide.

Support local government and community actions to improve air quality at a local and regional level.

Empowering and engaging stakeholders

A wide array of groups and individuals are critical to protecting the air we breathe. Managing air quality and minimising health risks involves engaging with multiple stakeholders, within and outside government, including industry and business groups, environment and health experts and advocates and the broader community.

Engaging and communicating with all clean air stakeholders and achieving genuine and meaningful participation and balance requires a flexible, responsive and agile approach. With innovations in engagement approaches and new technologies, various methods are available to work together to improve air quality across the State.

Under Clean Air for NSW, the NSW Government will explore new ways to build stakeholder and community networks, share and receive information, and involve the community in air quality improvement projects.

NSW CLEAN AIR SUMMIT

Within six months of release of the Clean Air for NSW consultation paper, the EPA on behalf of the NSW Government will host the NSW Clean Air Summit – a major event to bring together government, industry and the community to present and discuss current and future air quality challenges. This event will also lay the foundations for future engagement by the NSW Government across clean air issues, policy and regulatory changes and specific clean air initiatives. It will facilitate connections and networking, and promote clean air actions by all stakeholders across the State.

To deliver clean air initiatives, the government will also:

CONTINUE TO ENGAGE EARLY AND COMMUNICATE RESULTS

- Identify and engage stakeholders and the community early on clean air projects, including via consultation committees with community representatives.
- Gather feedback, report results of our engagement processes and explain how we have used the results of our engagement.
- Evaluate how we are doing and identify ways we can do better in engaging stakeholders.

ENHANCE AND EXPAND ENGAGEMENT TOOLS

- Use social media channels where appropriate.
- Enhance and increase stakeholder use of community information, survey and web tools.
- Develop and enhance networks to share information and expertise amongst groups and individuals interested in air quality.
- Coordinate cross-government engagement activities, including via formal and informal working groups, to inform and improve engagement on clean air projects.

EXPLORE INNOVATIVE, ADAPTABLE, TRANSPARENT AND BEST PRACTICE ENGAGEMENT APPROACHES

- Develop and pilot citizen science as an engagement approach. Citizen science is increasingly used worldwide to involve members of the public in scientific research. While not new, the approach has developed rapidly with advances in technology. It offers particular opportunities in the areas of air quality monitoring and data collection. Communities have a legitimate interest in being informed about air quality and involved in its management, especially in their own local areas.

NSW industry is leading and implementing initiatives that, while delivering on their regulatory obligations to control air emissions, also contribute to healthier communities and environments and benefit their own businesses.

The EPA works with peak industry bodies to engage with, consult on and share best practice amongst industry stakeholders. One example of this is the set of best practice case studies for emissions from non-road diesel equipment, developed jointly by the EPA and the Infrastructure Sustainability Council of Australia and available on the EPA's website at: http://www.epa.nsw.gov.au/air/nonroaddiesel-case-studies.htm.

WESTERN SYDNEY COMMUNITY AIR PROJECT

Western Sydney can experience higher levels of pollution than other parts of Sydney and NSW, due to weather patterns and topography.

Government and communities recognise the risk of increased pollution impacts in Western Sydney, as Sydney's population grows (by more than a million people in the next 15 years) and major State and Commonwealth infrastructure projects proceed, including the planned airport at Badgery's Creek.

The EPA and OEH propose to work with a Western Sydney council and community to co-design a pilot community air monitoring project.

The monitoring component would support involvement of the community in local air quality management initiatives, as well as helping to communicate and promote the importance of managing individual exposure to health impacts from air pollution. It would also collect useful air pollution data for analysis, interpretation and action by the community, researchers and government.

The project would be developed in consultation with the Commonwealth, to complement innovative monitoring work being undertaken in Western Sydney as part of its Clean Air and Urban Landscapes Hub program.

Following a pilot, the EPA would evaluate the project outcomes and consider opportunities for further community air projects to address local air quality concerns in urban and regional NSW.

KEY POINTS

Hold a NSW Clean Air Summit for government, stakeholders and the community to review air quality issues and set the basis for future engagement.

Set in place a Clean Air stakeholder and community engagement plan that provides for:

- integration of engagement in all NSW clean air policy and actions
- early engagement, communication of engagement outcomes, enhancement and expansion of engagement tools, and commitment to best practice engagement approaches.

Undertake a community engagement project in Western Sydney, to pilot citizen science and participation approaches for air quality, and provide a pilot for potential projects elsewhere in NSW.

Strengthening knowledge

The NSW Government continually builds and reviews the knowledge base to support priority air actions and policy decisions and to inform stakeholders and the community. We strive to understand air quality and its impacts, incorporate and learn from world best-practice air management approaches and improve health and economic outcomes for NSW and its citizens. Key tools for air quality management under Clean Air for NSW will be the NSW air quality monitoring network and the air emissions inventory for the GMR.

NSW AIR QUALITY MONITORING NETWORK

The NSW network has 43 monitoring stations, more than any other state:

- Greater Sydney (15 sites)
- Lower Hunter (3 sites)
- Illawarra (3 sites)
- Central coast (Wyong)
- Regional NSW – Albury, Bathurst, Tamworth and Wagga Wagga
- Industry funded, OEH-operated networks:
  - Upper Hunter (14 sites)
  - Newcastle local network (3 sites).

Pollutants measured are particles (PM_{10}, $PM_{2.5}$), sulfur dioxide (SO_2), carbon monoxide (CO), ozone (O_3) and nitrogen dioxide (NO_2). Air quality is continuously measured and information in this regard is available to the public in near real-time: www.environment.nsw.gov.au/AQMS/hourlydata.htm.

Information from the air quality monitoring network is used to:

- contribute to public information and understanding of air quality
- describe air quality trends over time
- inform policy and program development to improve air quality
- track the effectiveness of air quality improvement programs
- provide a baseline for assessing impacts of new development scenarios
- provide input to health studies and other research
- characterise regional air quality levels for statutory and other reporting.

NSW AIR EMISSIONS INVENTORY

The Air Emissions Inventory for the Greater Metropolitan Region in NSW presents emissions and their sources for hundreds of different air pollutants in the GMR, where about 75% of the NSW population lives. It is updated by the EPA every five years.

The pollutants covered include primary emissions of total suspended particles, PM_{10} and $PM_{2.5}$, and emissions of precursors of ground-level ozone and secondary particles, as well as other common pollutants, organic compounds, metals and greenhouse gases.

The inventory covers emissions from natural sources, businesses, domestic activities, industrial premises, non-road vehicles and equipment and on-road transport.

The Air Emissions in My Community tool provides data at a glance from the inventory for different geographical areas, ranging from the GMR down to single postcodes, presented in an interactive and readily accessible format for the general community.

The EPA is updating the Air Emissions Inventory for the 2013 calendar year to improve the evidence about current contributions from all sources and past and future trends in emissions. This work will enhance the EPA's ability to communicate accurate, up-to-date information to community, environmental and industry stakeholders; evaluate the effectiveness of existing programs; and develop new cost-effective programs aimed at improving air quality. Source and emissions data from the Air Emissions Inventory represents a critical input to regional airshed modelling for the GMR.

Updated inventory data, projections and analysis will be released for the Clean Air Summit.

SYDNEY AIR QUALITY STUDY

This multi-year study commissioned in 2016 by OEH and the EPA will improve our understanding of air quality and the impacts of air pollution on human health and the environment within the Greater Sydney region. The study will meet the information needs of decision-makers and communities, with the evidence base being expanded to address critical knowledge needs related to air quality and its impacts in the region.

The study will provide information on past, current and future air quality and its impacts on public health and the environment. It will support evidence-based air policies and programs by identifying emerging issues, and highlight opportunities for improving air quality and realising public health benefits through innovative whole-of-government actions. Such opportunities may include achieving air quality and health benefits through integrating air quality considerations within development planning and energy and resource efficiency programs.

Under the **Pollution Knowledge Strategy**, OEH and the EPA harness existing knowledge and develop new knowledge to reduce the risks of harm from air pollution to human health and the environment. A flagship project is the Sydney Air Quality Study.

Other projects to build knowledge for air quality management are focused on:

- **Regional airshed modelling**, to assess the impact of future development and planned mitigation measures on regional air quality. Regional airshed modelling is being used within the Sydney Air Quality Study to improve our understanding of air quality impacts on health and the environment in the Greater Sydney region, and support the identification of feasible options to reduce such impacts.
- **Particle characterisation studies** – OEH, EPA and NSW Health have collaborated with ANSTO and CSIRO to undertake particle speciation and source apportionment studies in New South Wales. To date, particle speciation studies have been undertaken for Sydney (OEH 2014), the Upper Hunter (OEH 2013) and the Lower Hunter (OEH 2016), with further source apportionment studies underway for Sydney.
- **Climate change impacts on air quality** – Projections of climate change and related impacts on regional air quality are being undertaken as part of the NSW and ACT Regional Climate Modelling (NARCliM) project, a multi-agency research partnership between the NSW and ACT governments and the Climate Change Research Centre at the University of New South Wales. This research will address future trends in both ozone and particle pollution.
- **Health effects of air pollution** – The EPA, OEH and NSW Health will continue to collaborate with the independent Centre for Air quality & health Research and evaluation (CAR) and other expert groups and stakeholders on new research to increase understanding of the health impacts, risks and costs of air pollution in New South Wales. The EPA and OEH are supporting the University of Tasmania on a multi-year interstate study on the relative health effects of smoke pollution from bushfire events and planned hazard reduction burns.

KEY POINTS

Maintain and enhance key knowledge tools for air quality management and communication with stakeholders:

- Review the NSW air quality monitoring network, to ensure it meets air quality management and community information needs across NSW
- Release a comprehensive NSW Air Quality Report for the Clean Air Summit
- Finalise and release updated air emissions inventory data, projections and analysis for the Clean Air Summit.

Complete the Sydney Air Quality Study to support air quality management for major new areas of growth and the Sydney region as a whole.

Continue to develop a comprehensive, robust, current and relevant body of research to inform air quality management in NSW and meet stakeholder needs, through the OEH/EPA Pollution Knowledge Strategy and specific air science, health and economic studies.

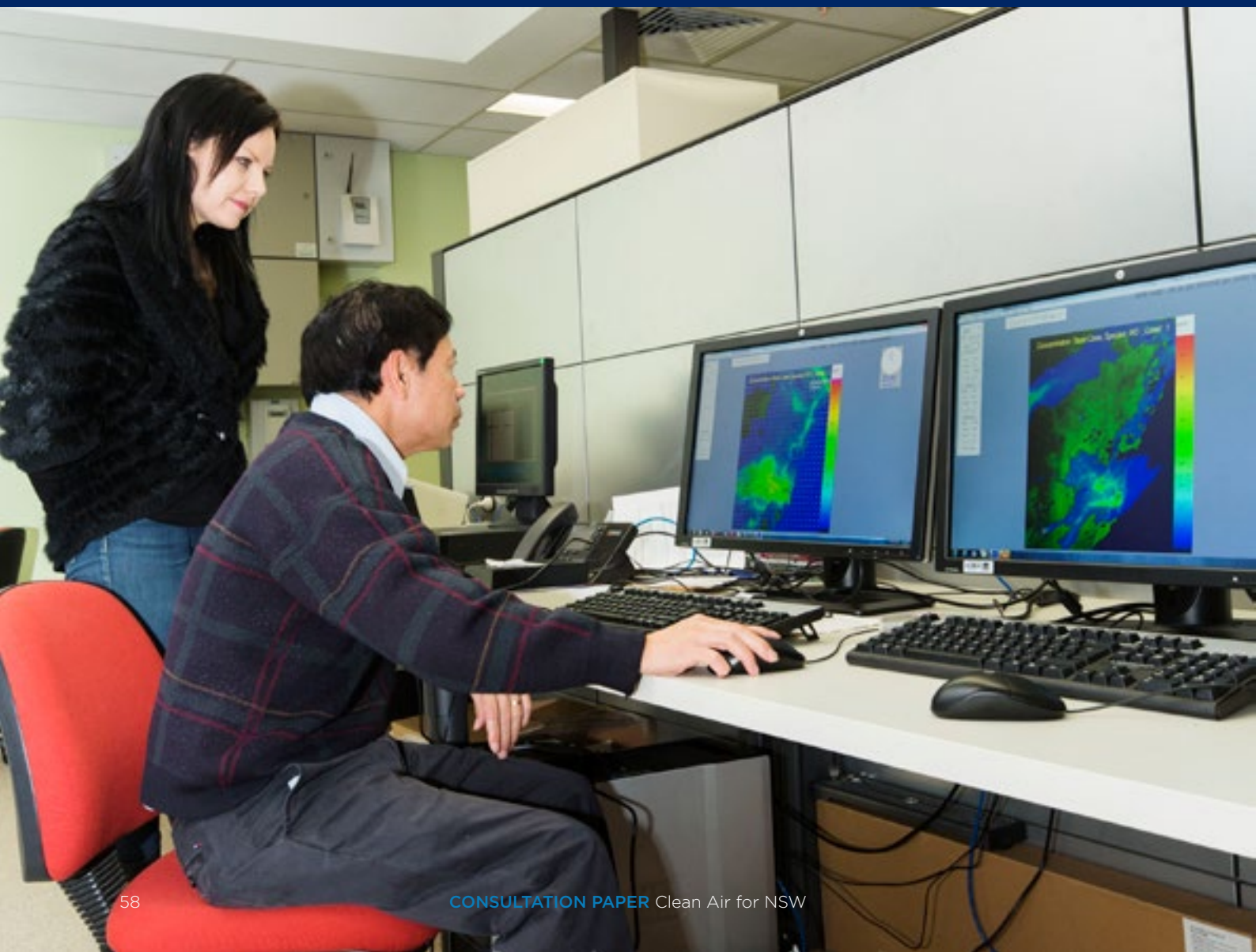
Mr John Tate
Chair Newcastle Community Consultative Committee on the Environment

The EPA has worked closely with its local advisory committees in Newcastle and the Hunter. Together we've found ways of helping the wider community to understand local air quality issues.

The EPA included community representatives on the management teams for two major air quality research studies in the Lower Hunter during 2013 to 2016. The Lower Hunter particle characterisation and dust deposition studies demonstrated the genuine effort to seek out the real facts that provide a solid basis for future air quality decisions.

The community representatives became aware of the depth of scientific rigour in the investigations and that built community confidence in the validity of the studies' findings. This augurs well for our future.

Evaluating and improving air quality management



A system of integrated monitoring, evaluation and reporting will be developed to ensure that the NSW Government collects the right information to assist decision-making and track progress to deliver improved air quality for NSW. This will support evidence-based policy and decision-making.

MEASURING PROGRESS

MEASUREMENT	WHEN	HOW REPORTED	OUTCOME
Indicator for measuring the impacts of average air quality on the population	Annually	Report in the NSW Air Quality Statement	Targeted improvement of air quality in the most populated areas, and where actions will have the greatest health benefits
Performance of air quality in NSW against the Ambient Air Quality NEPM	Annually	Include in the Air NEPM compliance reporting	Targeted action for specific pollutants impacting public health in NSW
Long-term emission source trends in the Greater Metropolitan Area	5-yearly	NSW Air Emissions Inventory – data released on EPA's website and via sector reports	Targeted action and programs addressing major sources of primary and precursor pollutants impacting public health

EVALUATION

The NSW Government is committed to continuous improvement of its air quality management framework. Progress on Clean Air for NSW initiatives will be evaluated against the above measures to ensure that the goal of "clean air for NSW" is delivered, and delivered efficiently and effectively to maximise overall benefit for the community. To support the overall goal, ongoing and rigorous evaluation requirements will also be built into the design of each priority action.

REPORTING

The EPA will lead and coordinate reporting to government and the community on progress of Clean Air for NSW initiatives towards achieving their goals and priority actions, and their performance against performance measures. A consolidated report will be issued annually, bringing together evaluation data, tracking progress on each of the priority actions, and reporting on the performance measures.

Reporting will be accessible through a number of channels, including Annual NSW Air Quality Statements, the EPA Annual Report and the Clean Air for NSW webpage.

ONGOING REVIEW

The reporting system will include a built-in cycle of review every four years, to ensure Clean Air for NSW adapts to new and emerging trends, research and issues. This could include developing new indicators if required. The last cycle of review in 2025 will inform planning and scoping of longer term strategic actions beyond the proposed life of Clean Air for NSW.

KEY POINTS

Set in place an integrated monitoring, evaluation and reporting system for Clean Air for NSW initiatives that includes:

- A population-weighted air quality metric for measuring progress towards the goal of improving average air quality across NSW
- Integration of evaluation into the development of all initiatives under Clean Air for NSW
- Annual reporting requirements against Clean Air for NSW goal and actions
- Development of a dedicated Clean Air for NSW webpage, where all relevant reports and links are available.

More information

NSW AND NATIONAL AIR STRATEGIES AND POLICIES

Diesel and marine emissions management strategy (EPA, 2015):
http://www.epa.nsw.gov.au/air/150038DieselStrategy.htm

Impact statement and Draft varied Ambient Air Quality NEPM (Australian Government 2015):
http://www.environment.gov.au/protection/nepc/nepms/ambient-air-quality/variation-2014/impact-statement

Load-based licensing:
http://www.epa.nsw.gov.au/licensing/lbl/lblicences.htm

Managing particles and improving air quality in NSW (EPA, 2013):
http://www.epa.nsw.gov.au/air/20130784ManPartStr.htm

National Clean Air Agreement (Australian Government 2015):
http://www.environment.gov.au/protection/air-quality/national-clean-air-agreement

Pollution – Knowledge Strategy 2013-2017 (OEH, 2013)
http://www.environment.nsw.gov.au/knowledgestrategy/Pollution.htm

Risk-based licensing:
http://www.epa.nsw.gov.au/licensing/licenceintro.htm

Upper Hunter air particles action plan (EPA 2013):
http://www.epa.nsw.gov.au/aqms/130158uphuntap.htm

AIR QUALITY AND EMISSIONS STUDIES AND REPORTS

Air emissions inventory for the Greater Metropolitan Region (EPA):
http://www.epa.nsw.gov.au/air/airinventory2008.htm, and Air emissions in my community web tool (EPA):
http://www.epa.nsw.gov.au/air/airemissionsinmycommunity.htm

Air quality monitoring reports, and Annual air quality statements (OEH):
http://www.environment.nsw.gov.au/aqms/datareports.htm

Air quality trends in Sydney (OEH 2104)
http://www.environment.nsw.gov.au/AQMS/aqi.htm

Air quality trends in Sydney (prepared by OEH for Advisory Committee on Tunnel Air Quality, 2014):
http://www.chiefscientist.nsw.gov.au/__data/assets/pdf_file/0003/52986/Road-Tunnels_TP02_Air_Quality_Trends_in_Sydney.pdf

Current and forecast air quality (OEH):
http://www.environment.nsw.gov.au/aqms/aqi.htm

Lower Hunter particle characterisation study, by Hibberd et al., (OEH, 2016):
http://www.environment.nsw.gov.au/aqms/lowhunterparticle.htm

NSW State of the Environment 2015 (EPA):
http://www.epa.nsw.gov.au/soe/20150817soe-2015.htm

Sydney particle study – Stage II, by Cope et al., (OEH, 2014):
http://www.environment.nsw.gov.au/aqms/sydparticlestudy.htm

Upper Hunter fine particle characterisation study, by Hibberd et al., (OEH, 2013).
http://www.environment.nsw.gov.au/aqms/uhaqmnfpcs.htm

AIR POLLUTION AND HEALTH

Exposure assessment and risk characterisation to inform recommendations for updating ambient air quality standards for $PM_{2.5}$, PM_{10}, O_3, NO_2, SO_2, by Frangos, J and DiMarco, P, (prepared by Golders for NEPC, 2013): https://www.environment.gov.au/system/files/pages/dfe7ed5d-1eaf-4ff2-bfe7-dbb7ebaf21a9/files/exposure-assessment-risk-characterisation.pdf

Health Impacts of Transport Emissions in Australia: Economic costs, (Bureau of Transport and Regional Economics, Department of Transport and Regional Services, Canberra 2005): www.bitre.gov.au/publications/2005/wp_063.aspx

Review of the health impacts of emission sources, types and levels of particulate matter air pollution in ambient air in NSW, (Woolcock Institute of Medical Research, Centre for Air Quality and Health Research and Evaluation, produced for NSW EPA and NSW Ministry of Health, 2016): http://www.car-cre.org.au/images/content/Health%20impacts%20of%20PM%20report_final%20for%20web.pdf

Summary for policy makers of the health risk assessment on air pollution in Australia, by Morgan, G, Broome, R and Jalaludin, B, (NEPC, 2013), https://www.environment.gov.au/system/files/pages/dfe7ed5d-1eaf-4ff2-bfe7-dbb7ebaf21a9/files/summary-policy-makers-hra-air-pollution-australia.pdf

The health benefits of reducing air pollution in Sydney, Australia, by Broome, RA; Fann, N, Navin Cristina, TJ; Fulcher, C; Duc and Morgan, GG, (2015): http://dx.doi.org/10.1016/j.envres.2015.09.007

The mortality effect of ship-related fine particulate matter in the Sydney greater metropolitan region of NSW, Australia, by Broome, et al (2016): http://www.sciencedirect.com/science/article/pii/S0160412015300969

AIR ECONOMICS

Air pollution economics – health costs of air pollution in the Greater Sydney Metropolitan Region, (DEC, 2005): www.environment.nsw.gov.au/resources/air/airpollution05623.pdf

Cost abatement curves for air emissions reduction actions (prepared by SKM for DECCW, 2010): http://www.epa.nsw.gov.au/resources/air/CostCurveAirEmissionRedn.pdf

Economic analysis to inform the National plan for clean air (Particles), by Boulter, P, and Kulkarni, K, (prepared by Pacific Environment for NEPC, 2013): http://www.environment.gov.au/system/files/pages/dfe7ed5d-1eaf-4ff2-bfe7-dbb7ebaf21a9/files/nepc-economic-analysis-final-report.pdf

Methodology for valuing the health impacts of changes in particle emissions – Final Report, by Aust, N, Watkiss, P, Boulter, P and Bawden, K, (prepared by PAEHolmes for EPA, 2013): http://www.epa.nsw.gov.au/resources/air/HealthPartEmiss.pdf

EVALUATION OF POTENTIAL MEASURES TO REDUCE EMISSIONS

Cleaner Non-road Diesel Engine Project – Identification and Recommendation of Measures to Support the Uptake of Cleaner Non-road Diesel Engines in Australia Final Report, (prepared by ENVIRON for DECCW 2010): http://www.epa.nsw.gov.au/resources/air/nonroaddieselrpt.pdf

Diesel locomotive emissions upgrade kit demonstration project: fuel efficiency, emissions and noise testing (prepared by ABMARC for EPA, 2016):
http://www.epa.nsw.gov.au/resources/air/diesel-locomotive-emissions-report.pdf

Literature Review of Coal Train Dust Management Practices, (prepared by Katestone for NSW EPA 2014):
http://www.epa.nsw.gov.au/resources/epa/coaltrain-litreview.pdf

Locomotive emissions project: scoping study of potential measures to reduce emissions from new and in-service locomotives in NSW and Australia, (prepared by ENVIRON for EPA, 2013).
http://www.epa.nsw.gov.au/resources/air/locoemissrep.pdf

Non-road spark ignition engines and equipment (Australian Government):
https://www.environment.gov.au/protection/air-quality/non-road-spark-ignition-engines-and-equipment

NSW coal mining benchmarking study: best-practice measures for reducing non-road diesel exhaust emissions, (EPA, 2014):
http://www.epa.nsw.gov.au/resources/epa/140075coalminestudy.pdf

NSW coal mining benchmarking study: measures to prevent and/or minimise emissions of particulate matter from coal mining, (prepared by Katestone Environmental for OEH, 2011):
http://www.epa.nsw.gov.au/resources/air/ke1006953volumei.pdf

NSW ship emissions study: emissions from ships operating in the Greater Metropolitan Area (prepared by DNV for EPA, 2015). http://www.epa.nsw.gov.au/resources/air/gma-ship-emissions.pdf

Protection of the Environment Operations (Clean Air) Amendment (Cruise Ships) Regulation 2015: better regulation statement (EPA, 2015): http://www.epa.nsw.gov.au/resources/air/150604-regulation-statement.pdf

Reducing emissions from non-road diesel engines, (prepared by ENVIRON for EPA, 2014): Sydney, NSW.
http://www.epa.nsw.gov.au/resources/air/140586NonrdDiesInfoRpt.pdf

Wood smoke control measures: cost benefit analysis, (prepared by AECOM for the EPA, 2014):
http://www.epa.nsw.gov.au/resources/woodsmoke/wood-smoke-control-measures.pdf

SOCIAL RESEARCH

Who cares about the environment? (OEH):
http://www.environment.nsw.gov.au/communities/who-cares.htm

Upper Hunter Wood Smoke Community Research Project (prepared by Databuild for the EPA, 2016):
http://www.epa.nsw.gov.au/resources/woodsmoke/UHWSCR-consultant-report.pdf

STATUTORY DOCUMENTS

The Protection of the Environment Operations Act 1997 (POEO Act):
http://www.epa.nsw.gov.au/legislation/actsummaries.htm

The Protection of the Environment Operations (Clean Air) Regulation 2010:
http://www.epa.nsw.gov.au/air/poeocleanair.htm

The Protection of the Environment Operations (General) Regulation 2009:
http://www.legislation.nsw.gov.au/#/view/regulation/2009/211

National Environment Protection (Ambient Air Quality) Measure 1994 (as amended):
https://www.legislation.gov.au/Details/F2016C00215

ABBREVIATIONS

ANSTO	Australian Nuclear Science and Technology Organisation
AQI	Air quality index
BTEX	Benzene, toluene, ethyl benzene and xylene – a group of air toxics found in petrol vapour
CAM	Clean Air Metric (to be developed by OEH)
CSELR	CBD and South East Light Rail project
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEC	Department of Environment and Conservation (NSW)
DECCW	Department of Environment, Climate Change and Water (NSW)
DIT	Australian Government Department of Infrastructure and Transport
DNV	Det Norske Veritas (Australia) Pty Ltd – DNV GL Maritime Regional Representative Australia
DoE	Australian Government Department of the Environment
EPA	NSW Environment Protection Authority
EEAP	NSW Energy Efficiency Action Plan
EV	Electric vehicle
GMA	NSW Greater Metropolitan Area, defined in the Protection of the Environment Operations (Clean Air) Regulation 2011, and includes local government areas from Port Stevens to the Shoalhaven and west to the Blue Mountains
GMR	NSW Greater Metropolitan Region, defined in the Air Emissions Inventory and used for air modelling and air inventory estimates
LBL	Load-based-licensing, a licensing scheme that provides incentives for reduction in emissions by charging higher licence fees when higher levels of pollution are emitted
Micrograms (symbol: µm)	$1x10^{-6}$ of a gram (a unit of measure for particle weight)
Micrograms per cubic metre (symbol: μm^3)	Unit of measure for particle concentration in air
Micron	Micrometre (one thousandth of a millimetre)
NARCliM	NSW and ACT Regional Climate Modelling project
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure – a set of national environmental objectives agreed to by governments of states, territories and the Commonwealth to assist in protecting or managing particular aspects of the environment
NEPP	National Energy Productivity Plan
OEH	NSW Office of Environment and Heritage
POEO	Protection of the Environment Operations – the NSW name for Acts and Regulations related to pollution
PPHM	Parts per hundred million - a unit of measurement of concentration
PPM	Parts per million
REAP	NSW Renewable Energy Action Plan
US Tier	A series of emission standards adopted in the United States of America to limit emissions from non-road diesel equipment
Vapour recovery	A system to capture vapoury that would otherwise be lost from industrial and commercial processes
VR1	Stage 1 Vapour Recovery – the capture of vapour displaced when underground petroleum storage tanks are refilled
VR2	Stage 2 Vapour Recovery – the capture of vapour from vehicle fuel tanks when vehicles are refuelled
WHO	World Health Organization

CHEMICAL SYMBOLS

CO	Carbon monoxide
NO_2	Nitrogen dioxide
NO_x	A range of oxides of nitrogen
PM_{10}	Particulate matter with diameter 10 microns or less (includes $PM_{2.5}$)
$PM_{2.5}$	Particulate matter with diameter 2.5 microns or less
SO_2	Sulfur dioxide
VOC	Volatile organic compound

REFERENCES

AECOM (2011), "Wood smoke control measures: cost benefit analysis." Prepared for the NSW Environment Protection Authority. Sydney, NSW.
www.epa.nsw.gov.au/resources/air/WoodsmokeControlReport.pdf

Albrecht, A; Holyoak, N; Pudney, P; Raicu, R; Taylor, M; Zito, R and Groves, J. (2009), "The uptake and use of electric vehicles in Australia." Adelaide, South Australia,
http://scg.ml.unisa.edu.au/autocrc/ev_planning/final_reports/uptake.pdf

ANSTO (2008). Newsletter Number 38 July 2009, A Long Term Fine Particle Database Along the Australian East Coast, Australian Nuclear Science and Technology Organisation.
http://www.ansto.gov.au/cs/groups/corporate/documents/webcontent/mdaw/mday/~edisp/acstest_040330.pdf

Broome, RA; Fann, N, Navin Cristina, TJ; Fulcher, C; Duc and Morgan, G., (2015), "The health benefits of reducing air pollution in Sydney, Australia."
http://dx.doi.org/10.1016/j.envres.2015.09.007

DEC (2005) "Air pollution economics - health costs of air pollution in the Greater Sydney Metropolitan Region." Department of Environment and Conservation. Sydney, NSW.
www.environment.nsw.gov.au/resources/air/airpollution05623.pdf

EPA (2012), "2008 Calendar Year Air Emissions Inventory for the Greater Metropolitan Region in NSW, NSW Environment Protection Authority."
www.epa.nsw.gov.au/air/airinventory2008.htm

EPA (2015), "Review of Fuel Quality Standards Act 2000 NSW SUBMISSION", accessed 9 May 2016 at
http://duqm0dwvyjbvv.cloudfront.net/wp-content/uploads/2015/08/NSW-EPA.pdf
Available through http://www.marsdenjacob.com.au/fuel-quality-review-submissions/

NSW, (2015a), "Advisory Committee on Tunnel Air Quality comment on Australian Government Vehicle Emissions Discussion Paper":
http://www.chiefscientist.nsw.gov.au/__data/assets/pdf_file/0010/87589/160610-NSW_Advisory_Committee_on_Tunnel_Air_Quality_amended.pdf

NSW, (2015b), "Review of Fuel Quality Standards Act 2000: NSW Submission":
http://duqm0dwvyjbvv.cloudfront.net/wp-content/uploads/2015/08/NSW-EPA.pdf

Morgan, G, Broome, R and Jalaludin, B (2013), "Summary for policy makers of the health risk assessment on air pollution in Australia." Prepared for the National Environment Protection Council. Canberra, ACT.
https://www.environment.gov.au/system/files/pages/dfe7ed5d-1eaf-4ff2-bfe7-dbb7ebaf21a9/files/summary-policy-makers-hra-air-pollution-australia.pdf

NSW Chief Scientist & Engineer (2016), Final Report on the Independent Review of Rail Coal Dust Emissions Management Practices in the NSW Coal Chain,
http://www.chiefscientist.nsw.gov.au/reports/review-of-rail-coal-dust-emissions

OEH (2013), "Upper Hunter Fine Particle Characterisation Study" by Hibberd et al., Sydney NSW.
http://www.environment.nsw.gov.au/aqms/uhaqmnfpcs.htm

OEH (2014), "Sydney Particle Study – Stage II" by Cope et al., Sydney NSW.
http://www.environment.nsw.gov.au/aqms/sydparticlestudy.htm

OEH (2016), "Lower Hunter Particle Characterisation Study" by Hibberd et al.; Sydney NSW.
http://www.environment.nsw.gov.au/aqms/lowhunterparticle.htm

PHOTOGRAPHY ACKNOWLEDGEMENTS

Cover image	D Finnegan/OEH
Page 7	Bob Peters/OEH
Page 9	Bob Peters/OEH
Page 13	John Spencer/OEH
Page 16	Botanic Gardens Trust/Simone Cottrell
Page 26	John Spencer/OEH
Page 41	OEH
Page 49	Rosie Nicolai
Page 51	Bob Peters/OEH
Page 53	Simone Pieta Vivers/OEH
Page 55	John Spencer/OEH
Page 58	Simone Pieta Vivers/OEH
Page 61	Simone Pieta Vivers/OEH

Published by:

NSW Environment Protection Authority and Office of Environment and Heritage
on behalf of the State of NSW

59 Goulburn Street, Sydney NSW 2000

PO Box A290, Sydney South NSW 1232

Phone: +61 2 9995 5000 (switchboard)

Phone: 131 555 (environment information and publications requests)

Fax: +61 2 9995 5999

TTY users: phone 133 677, then ask for 131 555

Speak and listen users: phone 1300 555 727, then ask for 131 555

Email: info@environment.nsw.gov.au

Website: www.epa.nsw.gov.au

Report pollution and environmental incidents:

Environment Line: 131 555 (NSW only) or info@environment.nsw.gov.au

See also www.environment.nsw.gov.au

ISBN 978 1-76039-420-2

NSW 2016/0415

October 2016