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Application number - SSI 13_6136
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NorthConnex Application Number: SSI 13_6136

To Whom It May Concern,

Please find below Asthma Foundation NSW's submission in response to the exhibition of the Environmental Impact Statement for NorthConnex.

The Asthma Foundation is a community-based organisation committed to eliminating asthma as a major cause of illness and disruption to the community.

Australia has one of the highest prevalence rates of asthma in the world with 1 in 10 children and adults diagnosed with asthma. Asthma currently affects 2.2 million Australians. While the overall asthma mortality rate is declining, people continue to die unnecessarily from the disease. Around 400 Australians die each year from asthma.

Air pollution is a major contributor to asthma related hospitalisations and mortalities. Our role as the representative voice for asthma consumers is to advocate for cleaner air and educate the general public about the risks of air pollution and how to best minimise its impacts on their asthma.

Consumer information is provided through a range of channels including community programs, a telephone information line, website, brochures and newsletters.

The Foundation has run many high-profile campaigns on the need to reduce various kinds of air pollution including; unflued gas heaters, road tunnels, coal-fired and gas power stations, wood-fired heaters, traffic and bushfire emissions.

One of our focuses in recent years relates to vehicle emissions and their impact on air quality both at the road side and in road tunnels. It has been conclusively established that exposure to high traffic roads, and high concentrations of vehicle emissions is harmful to health, with specific adverse impacts identified on pulmonary and cardiac health. The Foundation has sought to respond to community's concerns around air quality in M5, which has been labelled one of the dirtiest tunnels in the world. Even Minister Gay suggested it is 'pretty ordinary in many respects'.

Our involvement in NorthConnex is to ensure mistakes made with the M5 tunnel are not repeated, namely:

1. **Inaccurate assumptions regarding traffic levels.**
   The ventilation system was designed on the assumption that traffic volumes in the tunnel would grow slowly

and that improvements in vehicle design and reductions in vehicle emissions would compensate for increases in traffic volumes. Actual levels were traffic growth was much greater than predicted, thereby creating higher concentrations of pollutants than predicted. This was beyond the capacity of the tunnel ventilation system to maintain acceptable conditions and consequently, had greater health impacts for motorists using the tunnel.

2. **Inappropriate response to community pressure**
   The Government responded to community pressure around the planned location of the stacks. This led to replacing the planned three stacks mainly in elevated locations with a single stack located in a valley which exposed motorists and residents to greater amounts of air pollution.

3. **Filtration was not considered in the planning**
   Filtration needed to be retrofitted which was expensive and ineffective.

4. **Lack of independent audit of monitoring system**
   Although there is an extensive and well maintained system of pollution monitoring around the tunnel, there is no publicly accessible monitoring of in-tunnel conditions. Also there is a lack adequate quality control of the in-stack monitoring system.

Asthma Foundation NSW's main concerns with NorthConnex relate to the in tunnel air quality including:

- **Exposure levels of ultrafine particles**
  Whilst car engines and fuels are becoming cleaner, the increase in diesel engines and diesel fuel means an increase in ultrafine particles. These are invisible to the naked eye – unlike the larger particulates which are visible as haze when they are found in high concentrations. These ultrafine particles are also of much greater concern to health as they travel deep into their airways, and cross into the bloodstream, contributing to a range of respiratory and cardiovascular disease.

- **Appropriate monitoring and reporting of in tunnel air quality**
  Another concern is that monitoring equipment has not kept pace with the decrease in particle sizes or the increased understanding of the mechanisms by which adverse health impacts occur. Some of the current pollutants monitored include: NO2, CO, PM10 and PM2.5 particulates (PM2.5 only more recently). None of the current tunnel monitoring systems that we are aware of measure and report specifically on ultrafine particles which can be 1 micron in diameter and smaller.

- **Lack of guidelines for in tunnel air quality**
  National Environment Protection Measures (NEPM) provide guidelines for ambient air quality. There are currently no guidelines for in tunnel air quality. The NHMRC Report published in 2008 clearly identifies that new tunnel regulations are needed. Some of the recommendations include;
  - The need for guideline values or health based exposure limits for priority pollutants. These need to be based on realistic estimates of transit times to capture both normal and congested conditions. They should also take into consideration the total trip of the motorist to assess the total daily exposure to various pollutants.
  - The revision of standards to take into account the interaction of various pollutants.
  - The monitoring of particulate matter levels should be monitored with a view to reduction, as current levels of PM in some tunnels in Australia are in excess of $1000gm^3$ which is clearly dangerous to health.

- **Lack of data on health impacts of in tunnel air quality**
  The NHMRC report also highlighted that further studies are needed on the in tunnel impacts including:
  - Experimental studies needed to determine the health effects from exposure to tunnel air and its components at relevant timescales (minutes).
  - The relative importance of different indicators of in-tunnel air quality (e.g. NO_2, particulates) in predicting patho-physiological or health effects should be explored.

- A practical and reliable method needs to be developed for monitoring NO2 concentrations in road tunnels.
- A practical method needs to be developed for predicting tunnel users' exposure to NO_2.

Due to a lack of guidelines and health impact data, the true long term impacts are unknown an there is nothing to hold the tunnel operators accountable to.

It is necessary that in-tunnel conditions be appropriately regulated. Not only is it necessary to specify that the tunnel ventilation and operational systems shall cause no harm but the regulations must specify maximum peak pollutant levels and also the maximum time weighted exposures which are permitted.

Tunnels provide critical infrastructure for a growing population and a healthy economy, and if designed well will actually decrease ground concentration of pollutants by effectively dispersing these pollutants into the atmosphere. However there are important considerations in assessing potential health impacts which the Foundation would like further information on including:

- What assumptions underpin the forecasts for traffic volumes?
- What actions will be taken to control the level of pollution and exposure for motorists and residents?
- What is the predicted mix of vehicles, particularly the percentage of freight?
- What happens if forecasts and assumptions are incorrect?
- What are the standards by which the operator contractor will be held accountable for and are these stringent enough?
- What pollutants will the proposed monitoring report on and will the monitoring be independently audited on a regularly basis to ensure:
  - Real-time data is easily accessible
  - Monitors are placed in the right locations
  - Monitors are working correctly and are regularly calibrated
  - Monitors are measuring relevant air quality data, specifically ultrafine particles, and this is updated as required when new research or technology becomes available
  - Air quality exceedances are accurately and transparently reported.

The Foundation has detailed the following information below for consideration:

1. Manufactured pollutants and health effects
2. Health impact of air pollution
3. Health impacts of underground road tunnels
   3.1 Case Study: Sydney's M5 East tunnel
4. Recommendations for NorthConnex

Please do not hesitate to contact me if you wish to discuss this submission in further details.

Kind regards,

Michele Goldman
Chief Executive Officer
Asthma Foundation NSW

1. Manufactured pollutants and health effects

Air pollution is made up of a range of pollutants including; particles, sulphur dioxide, nitrogen oxides, ozone, carbon monoxide and lead. Of these pollutants a number have been shown to have direct health effects on people with asthma.

The following table[1] outlines the pollutants with known health effects and their primary source.

Pollutant group (primary source)	Known health effects
Airborne particles (primarily from combustion sources such as power stations, petrol and diesel – powered motor vehicles, wood heaters, fireplaces and incinerators)	– Respiratory tract irritation and – infection, allergies – Bronchitis, eye irritation – Exacerbation of respiratory and cardiopulmonary diseases – Asthma requiring hospital admission – Lung cancer
Sulphur dioxide (combustion of sulphur containing fossil fuels)	– Respiratory tract irritation, bronchitis, bronchoconstriction – Provocation of asthmatic episodes – Exacerbation of cardiopulmonary diseases
Nitrogen Oxides (measured as nitrogen dioxide) (biomass and fossil fuel consumption, tobacco smoke and exhaust fumes)	– Eye irritation – Respiratory tract infection (especially in children) – Exacerbation of asthma, irritation of bronchi – Asthma requiring hospital admission
Ozone (reaction product of sunlight and vehicle pollutants; hydrocarbons and oxides of nitrogen)	– Eye and respiratory tract irritation – Reduced exercise capacity – Exacerbation of asthma – Asthma requiring hospital admission

High levels of particulate matter and ozone in the environment remain a concern for people with asthma and we believe it is vital that strategies are employed to reduce these levels to meet the National Environment Protection Measure (NEPM) standards.

1.1 The health impacts of exhaust emissions

The link between air pollution and a worsening prevalence of asthma and death has been established by many recent international and Australian studies. While pollution levels in Australian cities may not be high by international standards, the same patterns of ill health, high health costs and fatalities are already evident and will continue to rise, unless urgent remedial action is taken.

A large proportion of the air pollution is due to exhaust emissions from cars, which release nitrogen oxides and ozones into the air - the major pollutants in what is known as smog. Studies suggest these pollutants both worsen asthma symptoms and trigger asthma attacks. Exposure to nitrogen oxides causes infection in the airways, especially in children. A 2005 WHO[2] report stated:

> "…there is evidence sufficient to infer causality: air pollution contributes to asthma aggravation, leading to an increase in symptoms, greater use of relief medication and a transient decline in lung function. Such worsening of the disease leads to an increased demand for medical care."

A 2002 study by the University of Southern California[3] went further and suggested that air pollution causes asthma and other diseases in children. The study followed 3,500 children in 12 communities over five years to determine potential health damage caused by growing up in polluted air. Six communities had higher than

average ozone concentrations; whilst the other six were lower than average. Children in the higher ozone communities who played up to three team sports developed asthma at a rate three times higher than children living in the lower ozone communities. The study concluded that smog can trigger attacks in people with asthma, but that ozone, another constituent of smog, can cause asthma.

Several studies have demonstrated a higher prevalence of chronic cough among children living close to main roads. Sydney researchers revealed that they had detected a link between higher pollution levels and reduced birth weight in babies in the metropolitan area, suggesting the noxious effects of traffic fumes may cross the placenta to the developing foetus[4].

Researchers from Taiwan have shown that chemicals in vehicle exhausts lead to an increased risk of respiratory disorders in children living in heavy traffic areas and support the increasingly popular hypothesis that exposure to traffic pollution modifies children's susceptibility to allergens. Boys exposed to high levels of traffic pollution had a 16 per cent higher risk of hay fever, which is linked to the development of asthma, while girls had a 17 per cent increase[5]. Children may be more vulnerable than adults because they spend more time outdoors, breathe in more air pound for pound than adults and their airways are more efficient in trapping pollutants. Because of this, air pollution can affect children up to nine times more harshly than adults[6].

The emissions from car exhausts are responsible for more deaths than road accidents, according to World Health Organisation (WHO) research. A study in France, Austria and Switzerland found that the number of people dying from respiratory or cardiovascular problems which could be attributed to car fumes far outweighed the death toll from crashes.[4]

This rather alarming conclusion is supported by recent statistical data from Australia. In the first study of its kind, the Bureau of Transport and Regional Economics found that in 2000, air pollution from cars caused between 900 and 2,000[7] early deaths and contributed to between 700 and 2,050[7] asthma attacks in Australia. About 4,500 people are thought to be treated in hospital each year as a result of car-related pollution. The Federal Government estimates the health impact costs at around $2.7 billion a year.[7]

The Foundation believes a long term strategy should be adopted where air pollution is tackled at the source. This may include increased investment in public transport and fitting vehicles with pollution traps

While sulphur dioxide, lead and carbon monoxide levels have been dramatically reduced in Australia and other developed countries in recent years, ozone and particles, two ingredients of photochemical smog with strong links to asthma, are still present in high quantities. Better motor engines haven't reduced the number of particles, but have just made them smaller and more harmful.

Air particles are of particular concern because they cause breathing problems, exacerbate respiratory diseases such as asthma and are not detected by current pollution monitoring. What is really doing the harm are the smaller particles, those which are PM2.5 [2.5 microns or less]. Almost all diesel exhausts are PM1 or less.[5] They enter the lungs, and the finest particles penetrate the cells of the lungs.

An estimated 70 per cent of vehicle emissions are of this smaller particulate matter and the number is increasing with new motor technology development. We believe the EPA should urgently develop standards for these small and highly dangerous particulates so that pollution information is meaningful.[8]

The main harmful constituents of pollution generated by cars are carbon monoxide, nitrogen dioxide and particulate matter.

Carbon Monoxide

Carbon Monoxide (CO) is a highly toxic, colourless and odourless air contaminant that is produced when fossil

fuels such as diesel and petrol are burned. The recommended limit for carbon monoxide is given by WHO Guidelines for Indoor Air Quality: Selected Pollutants 2010[9] as 10 mg/m^3 or 9 parts-per-million (ppm) for an eight hour time weighted average.

In 1999 the WHO set guidelines for 15-minute average exposure of 87 ppm and 30-minute average exposure of 50 ppm[10]. These guidelines are designed to offer protection in situations where more intense exposure can occur, for example in heavy traffic in urban canyons, enclosed car parks or tunnels.[10]

Nitrogen Dioxide

Nitrogen oxides (NOx) refer to a collection of highly reactive gases containing nitrogen and oxygen, most of which are colourless and odourless. NOx gases form when fuel is burned; automobiles, along with industrial, commercial and residential sources, are primary producers of nitrogen oxides. In Sydney, motor vehicles account for about 70 per cent of emissions of nitrogen oxides, industrial facilities account for 24 per cent and other mobile sources account for about 6 per cent.

In terms of health effects, nitrogen dioxide (NO_2) is the only oxide of nitrogen of concern. NO_2 can cause inflammation of the respiratory system and increase susceptibility to respiratory infection. Exposure to elevated levels of NO_2 has also been associated with increased mortality, particularly related to respiratory disease, and increased hospital admissions for asthma and heart disease patients.

Chamber studies, where people were exposed to varying concentrations of NO_2 for 30 minutes to several hours, have demonstrated adverse impacts on asthmatics at levels over 200ppbv. The National Environment Protection Council (NEPC) adopted a NO_2 standard of 120ppbv or 245 µg/m3 for a one-hour average by applying a safety factor to the 200ppbv level found in the chamber studies. In recent years, peak levels in metropolitan Sydney have ranged from 90 -130ppbv, and it has been uncommon for the daily Air NEPM standard to be exceeded.[11]

Particulate Matter

Acute health effects of particulates include increased daily mortality, increased rates of hospital admissions for exacerbation of respiratory and heart diseases, fluctuations in the prevalence of bronchodilator use and cough and peak flow reductions. Particulate air pollution is especially harmful to people with lung disease such as asthma and chronic obstructive pulmonary disease (COPD), which includes chronic bronchitis and emphysema, as well as people with heart disease.[12]

Exposure to particulate air pollution can trigger asthma attacks and cause wheezing, coughing, and respiratory irritation in individuals with sensitive airways. Recent research has also linked exposure to relatively low concentrations of particulate matter with premature death. Those at greatest risk are the elderly and those with pre-existing respiratory or heart disease.

Australian studies have shown adverse health effects associated with exposure to particulate matter. Current studies have been unable to define a threshold below which no health effects occur. Recent studies suggest that even low levels of fine particle exposure are associated with health effects. There are limited standards available against which to judge the potential effects of short term (less than 24-hour) exposure to high levels of fine particles.

In addition, recent studies have also found potentially harmful interactions between particulates and NO_2 in relatively high concentrations.[5] Consequently, there are concerns about the effect that these gases and particulate matter are having on motorists in the tunnel and on residents in the surrounding residential areas.

2. Summary of health impacts of air pollution

The health impacts from air pollution may have both short and long term effects. The short-term effects caused by variations to pollution exposure may result in exacerbations of pre-existing illness, admission to hospital and in some cases death. It is speculated that ongoing exposure to certain air pollutants could result in a decline in lung function.

A review study by the American Thoracic Society[13] showed that the respiratory health effects from air pollution include more than just the clinical outcomes (such as hospital admissions, loss of lung function and mortality); they also include diminished quality of life and are the cause of symptoms which interfere with daily activities.

The following list outlines the adverse respiratory effects of air pollution as reported in the review paper:

- Increased mortality.
- Increased incidence of lung cancer.
- Increased frequency of symptomatic asthma attacks.
- Increased incidence of lower respiratory tract infections.
- Increased exacerbation of chronic cardiopulmonary or other diseases, reflected in various ways, including reduced ability to cope with daily activities, increased hospitalisation, increased physician visits and medication, and decreased pulmonary function.
- Reduction of forced expiratory volume in one second (FEV1) or forced vital capacity (FVC)
- Increased prevalence of wheezing
- Increased incidence of chest tightness
- Increased cough/ phlegm production requiring medical attention
- Increased upper respiratory tract infections
- Eye, nose and throat irritations that may interfere with normal activities.

Local studies are consistent with overseas studies showing both an increase in hospitalisations and mortality due to air pollution in Sydney[14] [15].

3. Health impacts of underground road tunnels

In the 1990's road tunnels were hailed as a modern, innovative solution to the old problem of traffic congestion. Tunnels can move traffic under previously gridlocked streets and in some cases cut travel times considerably. However, as evidenced by many recent Australian and overseas scientific studies, road tunnels also pose many serious potential health risks from death from lung cancer and cardiopulmonary diseases,[16] to cardiovascular,[17] asthma and other respiratory diseases.[18]

Although not all Australian cities have road tunnels - the increase in road vehicles, which has grown from almost 15,674,436 in 2009 to almost 17,633,493 in 2014 means that they will become more prevalent in times to come.[19]

The main cause of pollution in road tunnels is tailpipe emissions, which can become trapped in high concentrations inside the tunnels and settle on the surrounding suburbs once expelled through a ventilation stack. They contain a cocktail of toxic gases such as Carbon Monoxide (CO) and Nitrogen Dioxide (NO_2) and particulate matter (PM) of various sizes (coarse, fine and ultrafine) as well as Volatile Organic Compounds (VOCs) such as BTEX (benzene, toluene, ethyl benzene, and xylenes) and Sulphur Dioxides. Most of these studies observed that air pollution has an association with both short-term and long-term mortality as well as morbidity effects on the exposed population. [7]

3.1 Case study: Sydney's M5 East tunnel

Concerns about potential health risks have dogged Sydney's M5 East tunnel since its conception. It is a 4km twin tunnel connecting the city's airport/ Port Botany with the south-western suburbs. It opened to traffic in December 2001.

The M5 was an example of a good idea and bad policies, which has left Sydney with one of the dirtiest tunnels in the world. There was much public controversy before the tunnel was even built. The three proposed ventilation stacks to be sited near residential areas was cut to one following a public campaign – a decision which was described by a 1999 Parliamentary Inquiry [20] as:

> "….made both hastily and with no public consultation. There were no published environmental studies or a supplementary environmental impact statement undertaken to support the decision to build a single stack.
>
> It is apparent that the original three stack option was the more scientifically valid option, though unacceptable to the community. It is equally apparent that the single stack option is also unacceptable to the community. The current stack, located in a valley, is likely to be 25 metres high, yet has ridges of the valley surrounding it 40 metres high. It is clearly an inappropriate location to site for the ventilation exhaust stack."

This design fault is also responsible for the reduced air flow in the tunnel resulting in high concentrations of pollutants. It should be noted that this mistake was not repeated in the design of the Cross City or Lane Cove tunnels, both of whom appear to be functioning safely at current traffic volumes.

This crucial design flaw was compounded by the fact that the M5 reached its projected capacity for its first decade of operation of 80,000 cars almost as soon as it opened.[15] As a result it has faced constant questions about the quality of air both in the tunnel and the levels of pollution in the surrounding suburbs.

There have been numerous studies completed on the M5 some of the most relevant papers include:

- National Health and Medical Research Council (NHMRC), 2008, Systematic Literature Review, Air Quality in and around Traffic Tunnels, Final Report[22]
- Knibbs et al., 2009, On-road ultrafine particle concentration in the M5 East road tunnel, Sydney, Australia[21]

The Foundation has summarised the key points that have a direct relation to the NorthConnex development.

3.1.a NHMRC Report, 2008

The National Health and Medical Research Council (NHMRC) published a study on 'Air Quality in and Around Traffic Tunnels' in 2008 with support from the Department of Health & Ageing.[22] The report addressed the health of tunnel users and those living or working near portals or ventilation stacks by developing evidence-based approaches to the management of air quality in and around road tunnels in Australia.

Findings regarding tunnel regulations

- Guideline values or health-based exposure limits should be developed for the priority pollutants—including particulates and nitrogen dioxide—based on transit times through tunnels, and realistic estimates of total trip and daily exposure.
- Future tunnel design should not be based on carbon monoxide levels and exposures alone.
- Revised standards should take into account the fact that all components interact in determining the safety of in-tunnel conditions and the comfort of users.
- Tunnels can cause adverse health impacts:
    - There is evidence that airborne pollutants in tunnels will affect the health of users of these tunnels.
    - The evidence for health effects on people living close to tunnel portals or stacks is more equivocal.

Recommendations for further research

- The health effects of exposure to tunnel air and its components at the relevant timescales (minutes) need to be determined from experimental studies.
- The relative importance of different indicators of in-tunnel air quality (e.g. NO_2, particulates) in predicting patho-physiological or health effects should be explored.
- A practical and reliable method for monitoring NO_2 concentrations in road tunnels needs to be developed.
- A practical method needs to be developed for predicting tunnel users' exposure to NO_2.

Recommendations for air monitoring

- Air quality monitoring is an essential component of environmental management of a road tunnel in the early stages after opening.
- Monitors should be sited, where possible and practical, in locations relevant for exposure (including plume impact).
- Further studies should investigate the impacts of tunnels on the indoor air quality of residences near portals or stacks. This should include a study of the health effects resulting from any increased exposure to pollutants.

3.1.a Knibbs et al, 2009

Within a year of the NHMRC paper Queensland University of Technology (UTQ) released a study entitled *On-road ultrafine particle concentration in the M5 East road tunnel, Sydney, Australia*. It provided much-needed information on the concentration and potential health effects of particulate matter – as outlined in the NHMRC report.

In terms of the health effects the official UTQ media release summarised the study's findings as follows[23].

- The human health effects of exposure to ultrafine particles produced by fuel combustion are generally regarded as detrimental.
- Effects can range from minor respiratory problems in healthy people, to acute myocardial infraction (heart attack) in people with existing heart complaints.
- In subsequent media interviews[24] Professor Morowska was quoted as saying:
  "If healthy people travel in these conditions regularly they are subjected to a more chronic exposure….On a longer term it can lead to chronic respiratory problems or cardiovascular problems."

4. Recommendations for North Connex

4.1 Air quality monitoring and reporting

A passage from the Precis to the 2008 NHMRC study neatly summarised the largest single issue with the M5 – the lack of real time air pollution data on key pollutants that have the potential to harm human health.

> "Future plans for tunnel design should move away from standards based on carbon monoxide levels and exposures alone, to standards based on carbon monoxide, nitrogen dioxide and particulate matter. These revised standards should take into account the fact that all components interact in determining the safety of in-tunnel conditions and the comfort of users. There is evidence that airborne pollutants in tunnels will affect the health of users of these tunnels."[22]

The advantage of "real time" monitoring is that hourly reports tend to average out the dangerous peaks that can occur when the traffic slows in the tunnel during rush hours or following a traffic incident thereby not giving a true picture of the health risks. As motorists exposure to tunnel pollutants is only short term this is important information.

Another concern is that monitoring equipment has not kept pace with the decreasing particle size. Some of the current pollutants monitored include: NO_2, CO, PM10 and PM2.5 particulates (PM2.5 only more recently). None of the current tunnel monitoring systems that we are aware of provide data on ultrafine particles which can be 1 micron and smaller.

We note that equipment which may be suitable for the assessment of particulate matter in ambient air is not necessarily suitable for use inside a tunnel with its much higher mass and number concentrations and markedly higher proportions of ultra-fine and 'nano' particles. Additionally we question whether mass based measurements, as opposed to size sorted number measurements, are suitable for the assessment of in-tunnel conditions.

In considering the second report on the Cross City tunnel in 2006, the Joint Select Committee agreed that it was not enough for the NSW government to say to people with asthma "…wind up your windows and close your air vents." They concluded that warning notices advising people with respiratory conditions to take adequate precautions should be prominently displayed outside the tunnel.[25]

Air Quality monitoring and reporting recommendations

1. Air quality monitoring in the NorthConnex tunnel should monitor Nitrogen Dioxide, PM10, PM2.5 and ultrafine particles, as well as Carbon Monoxide.
2. Air quality data should be reported in real-time and be easily accessible to the public.
3. A thorough independent audit should be conducted to ensure the best placement for air quality monitors both inside and outside the tunnel.
4. Air quality monitors should be routinely checked and calibrated to ensure they are working correctly.
5. Air quality monitors should be upgraded as required by new research or as more advanced air quality technology becomes available.
6. Physical warning signs should be placed so motorists can be informed of poor air quality and precautions they can take to minimise their exposure. Signs should be placed to allow motorists adequate opportunity to change route if the notice gives them cause for alarm.

4.2 Air quality standards

Monitoring the levels of air pollutants in the tunnel is just the first step in improving air quality in the NorthConnex. As recommended by the 2008 NHMRC report:

> "Development of an exposure limit for nitrogen dioxide (NO_2), set in the context of co-exposure with

particulate matter (PM), and numerous other toxins and irritants from road vehicle emissions, is justified."

Currently, there are no air quality standards for road tunnels. The often quoted NEPM standards are to do with ambient air quality and were specifically not designed for road tunnels. NEPM is referred to as it is the only benchmark that exists for air quality and is used inappropriately to provide goal levels up to which it is permissible to pollute.

Although NEPM has set standards for NO_2 and PM it is not an enforceable standard. Without enforceable standards there is no obligation for government, tunnel operators or tunnel users to do anything about the problem and no consequences if they don't.

In the absence of enforceable Australian standards or any legislated international standards the solution may be to adopt WHO guidelines. Despite gaps in our understanding of the health effects of particles in tunnel air, including the crucial issues of dose duration and repetition, WHO established guideline values for PM10 and PM2.5 in 2006. The guidelines values are 50.g m–3 24-hour mean and 20.g m–3 annual mean for PM10, and 25.g m–3 24-hour mean and 10 .g m–3 annual mean for PM2.5.

There is, however, an essential flaw in the WHO guidelines in that they do not consider the possibility of interactions between pollutants such as particulate matter and ozone in ambient air and particulate matter and nitrogen dioxide in tunnels.

The NHMRC 2008 report notes:

> "No clear evidence exists to show that monitoring such as that carried out to assess compliance with air-quality goals, especially for PM10, can reliably predict the size, nature and course of adverse health impacts."

Air quality standards recommendations

1. Introduce enforceable guideline values or health based exposure limits for priority pollutants based on realistic estimates of transit times to capture both normal and congested conditions.
2. Guidelines should also take into consideration the total trip of the motorist to assess the total daily exposure to various pollutants as most, if not all priority pollutants produce effects which are cumulative over periods in excess of 24 hours.
3. As recommended in the 2008 NHMRC Report standards should be revised to take into account the interaction of various pollutants.
4. Particulate matter levels should be monitored with a view to reduction, as current levels of PM in some tunnels in Australia are in excess of $1000gm^3$ which is clearly dangerous to health.
5. In the absence of enforceable Australian standards or any legislated international standards it is recommended to adopt WHO guidelines.

4.3 Data collection on health impacts of air quality

There is still a lot that is unknown about the long term health effects of exposure to air pollution especially in regards to untrafine particles. The Foundation would like to see comprehensive studies to be conducted to gain a greater understanding of the short and long term health impacts of motorists and residents.

One area of particular concern is the accumulative effect of travelling through road tunnels several times within a 24 hour period.

As stated earlier the 2008 NHMRC report also highlighted that further studies are needed on the in tunnel impacts which inform the following recommendations.

Data collection on health impacts of air quality recommendations

1. Experimental studies should be conducted to determine the health effects from exposure to tunnel air and its components at relevant timescales (minutes) such as in vehicle monitoring.
2. Research should be conducted to explore the relative importance of different indicators of in-tunnel air quality in predicting patho-physiological or health effects.
3. Research should conducted to develop a practical and reliable method for monitoring NO_2 concentrations in road tunnels.
4. Studies should be conducted to determine long and short term health impacts on local residents.

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[1] Australian Government Department of Health and Ageing, 2004, Asthma and Air Pollution - A guide for health professionals [accessed online: https://www.google.com.au/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&ved=0CCQQFjAB&url=http%3A%2F%2Fwww.parliament.nsw.gov.au%2Fprod%2Fparlment%2Fcommittee.nsf%2F0%2F209a14eb53da8907ca2571cd0022b69a%2F%24FILE%2Fsub%252029.pdf&ei=zDMNVMupIYaeugSCtYGIAw&usg=AFQjCNHZIMo8C7toEpwffL6KeobPi9mssA&sig2=w_zniUR0ZloA0LRcWL_40g]

[2] World Health Organization, 2005, Effects of Air Pollution On Children's Health And Development A Review of The Evidence, World Health Organization, Special Programme on Health and Environment, European Centre For Environment and Health, Bonn Office

[3] Californian Environmental Protection Agency, 2002 "The Children's Health Study- Factsheet"

[4] Smith A and Robotham J, 2005, Car fumes driving us to early grave, 30/7/2005, Sydney Morning Herald [accessed online: http://www.smh.com.au/news/national/car-fumes-driving-us-to-early grave/2005/07/29/1122144024506.html]

[5] Reuters News Service, 2003, Traffic fumes shown to raise asthma risk in children, May 28, 2003 [accessed online: http://www.planetark.org/dailynewsstory.cfm/newsid/20951/story.htm]

[6] Today@UCI, 2006, Air Pollution from Fires May Affect Children More Harshly, July 2006 [accessed online: http://today.uci.edu/news/tipsheet_detail.asp?key=163#large]

[7] Bureau of Transport and Regional Economics, 2005, Health Impacts of Transport Emissions In Australia: Economic Costs [accessed online: http://www.bitre.gov.au/publications/2005/files/wp_063.pdf]

[8] Moore, C, 2001, NSW Legislative Assembly Hansard. 2001, Cross-city tunnel air filtration, Page: 17655, 2006 [accessed online: http://www.parliament.nsw.gov.au/prod/parlment/hansart.nsf/V3Key/LA20011018053?open&refNavID=HA8_1]

[9] The WHO European Centre for Environment and Health, 2010, WHO guidelines for indoor air quality: selected pollutants, [accessed online: http://www.euro.who.int/__data/assets/pdf_file/0009/128169/e94535.pdf]

[10] World Health Organisation, Air quality guidelines. 1999, WHO, Geneva.

[11] NSW Health, 2004, Comparison of personal exposures to air pollutants by commuting mode in Sydney – BTEX & NO2

[12] NSW Health – Air Pollution [accessed online: http://www.health.nsw.gov.au/environment/air/Pages/particulate-matter.aspx]

[13] American Thoracic Society, 2000, What constitutes an adverse health effect of air pollution?Am J Respir Crit Care Med 2000;161:665–673

[14] Morgan G, Corbett S, Wlodarczyk J, 1998, Air pollution and hospital admissions in Sydney, Australia 1990 to 1994, American Journal Public Health 1998 Dec; 88(12):1761-64

[15] Morgan G, Corbett S, Wlodarczyk J, Lewis P, 1998, Air pollution and daily mortality in Sydney, Australia, 1989 through 1993, American Journal Public Health 1998 May; 88(5):759-64

[16] Dockery, DW, Arden Pope, C, Xu, X, Spengler, JD, Ware, J H, Fay, ME, Ferris,BG Jr., and Speizer, FE, 1993, An Association between Air Pollution and Mortality in Six U.S. Cities, The New England Journal of Medicine, 9 December 1993 http://www.nejm.org/doi/full/10.1056/NEJM199312093292401

[17] Fung KY, Luginaah I, Gorey KM, Webster G., 2005,Air pollution and daily hospital admissions for cardiovascular diseases in Windsor, Ontario. Can J Public Health. 2005; 96:29–33. [PubMed: 15682690]

[18] Jerrett M, Shankardass K, Berhane K, Gauderman WJ, Künzli N, Avol E, Gilliland F, Lurmann F, Molitor JN, Molitor JT, Thomas DC, Peters J, McConnell R. Traffic-related air pollution and asthma onset in children: a prospective cohort study with individual exposure measurement. Environ Health Perspect. 2008;13:1433–1438. doi: 10.1289/ehp.10968. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2569108/

[19] The Australian Bureau of Statistics, 2014, 9309.0 - Motor Vehicle Census, Australia [accessed online: http://www.abs.gov.au/ausstats/abs@.nsf/mf/9309.0/ viewed 21/2/2013]

[20] Parliament of New South Wales Legislative Council, General Purpose Standing Committee No 5, 1999, Report on Inquiry into the M5 East Ventilation Stack December 1999 http://www.parliament.nsw.gov.au/Prod/parlment/committee.nsf/0/58908a6040c5dfd0ca256cf4002108c7/$FILE/m5report.PDF

[21] Knibbs, L., Dear, R., Morawska, L. and Mengersen, K., 2009, On-road ultrafine Particle concentration in the M5 East road tunnel, Sydney, Australia.Atmospheric Environment 43,3510–3519 [Accessed online:: http://eprints.qut.edu.au/27536/1/27536.pdf]

[22] National Health and Medical Research Council, 2008, A Systematic Review: Air Quality in and Around Road Tunnels http://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/eh42.pdf

[23] University of Queensland, 2009, Tunnels concentrate air pollution by up to 1000 times. UTQ media release 27/8/2009 [accessed online: http://www.news.qut.edu.au/cgi-bin/WebObjects/News.woa/wa/goNewsPage?newsEventID=29820 Viewed 3/9/2012]

[24] ABC News, 2009, M5 tunnel regulars 'risk chronic health problems' 28/08/2009 [accessed online: http://www.abc.net.au/news/2009-08-28/m5-tunnel-regulars-risk-chronic-health-problems/1407728 Viewed 3/9/2012]

[25] Joint select committee on the Cross City tunnel, 2006, Second Report – The cross city tunnel and public private partnerships. 08/05/2006 http://www.parliament.nsw.gov.au/prod/parlment/committee.nsf/0/f412e826bc3dfd5bca2571720010fc97/$FILE/Final%20Second%20Report.pdf