# APPENDIX S

# CROSS CITY TUNNEL IMPACTS: QUALITATIVE AIR QUALITY ASSESSMENT - AECOM

Mirvac Group
27-Oct-2014
Doc No. 60334043_1.1_22102014

# Cross City Tunnel Impacts on 505-523 George Street Sydney

Qualitative Air Quality Assessment

# Cross City Tunnel Impacts on 505-523 George Street Sydney

Qualitative Air Quality Assessment

Client: Mirvac Group

ABN: 92 003 280 699

Prepared by

**AECOM Australia Pty Ltd**
17 Warabrook Boulevard, Warabrook NSW 2304, PO Box 73, Hunter Region MC NSW 2310, Australia
T +61 2 4911 4900 F +61 2 4911 4999 www.aecom.com
ABN 20 093 846 925

27-Oct-2014

Job No.: 60334043

AECOM in Australia and New Zealand is certified to the latest version of ISO9001, ISO14001, AS/NZS4801 and OHSAS18001.

# Quality Information

Document Cross City Tunnel Impacts on 505-523 George Street Sydney

Ref 60334043_1.1_22102014

Date 27-Oct-2014

Prepared by Colin Clarke

Reviewed by David Rollings

Revision History

| Revision | Revision Date | Details | Authorised | |
|---|---|---|---|---|
| | | | Name/Position | Signature |
| 1 | 24-Oct-2014 | Draft Client Review | David Rollings Principal Air Quality Engineer | |
| 2.0 | 27-Oct-2014 | Final Report for Client | David Rollings Principal Air Quality Engineer | [signature] |
| | | | | |
| | | | | |
| | | | | |

This page has been left blank intentionally.

# Table of Contents

This page has been left blank intentionally.

# 1.0 Introduction

## 1.1 Proposed Development

This report supports a Planning Proposal submitted to the City of Sydney Council on behalf of Coombes Property Ground and Mirvac. The planning proposal amendment includes two distinct elements:

- Amendment to maximum height control; and
- Amendment to the Development Control Plan (DCP).

The Planning Proposal will establish a clearly defined framework against which to assess the subsequent detailed 'Stage 2 DA' for the detailed design and construction of the proposed development.

It is proposed to increase the maximum height control from 150m to 260m. In conjunction with amending the maximum height control, it is proposed that the development will provide a range of public benefits such as childcare centre(s) and other community facilities for Council.

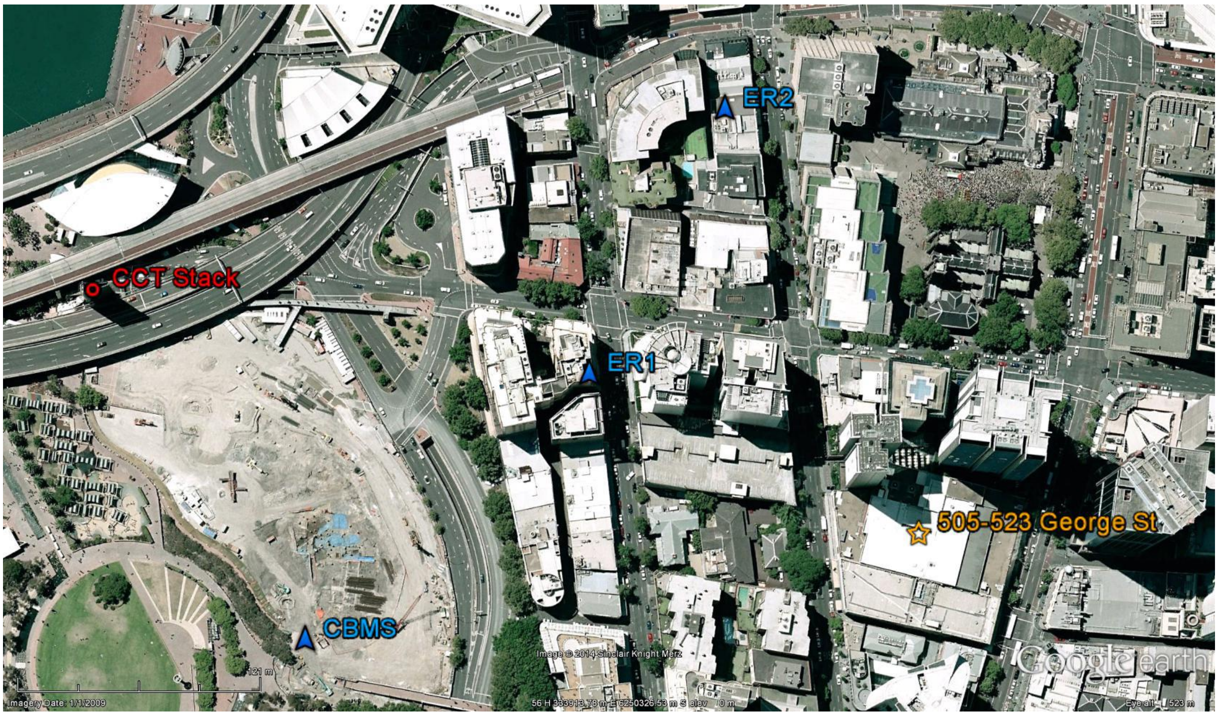
## 1.2 Purpose of Report

AECOM has been commissioned by Mirvac and Coombes Property Group to undertake a qualitative air quality assessment on the potential air quality impacts on the proposed mixed use, multi-level residential tower (here in 'residential tower') from the cross city tunnel (CCT) vent located approximately 400m to the west of the proposed residential tower between the Western Distributor viaducts near the north-western corner of the existing Harbour and Bathurst Street intersection (see **Figure 1**). This assessment was requested by the City of Sydney as an addendum to the Planning Proposal prepared by JBA on behalf of Coombes Property Group and Mirvac for the '*Amendment to maximum height control and concurrent DCP amendments*'. This assessment will address Part 7 clause 7.24 of the *Sydney Local Environmental Plan 2012* (LEP) which requires assessment of air quality impacts from the CCT ventilation stack on the proposed residential tower.

In summary the report provides information on the following:

- A discussion on the factors affecting air quality near road tunnels and impacts of road tunnel pollutants on human health;
- Identification of relevant NSW Environmental Protection Agency (EPA) air quality criteria including nitrogen dioxide, carbon monoxide and particulates;
- Review of relevant meteorology and air quality data in accordance with the NSW EPA criteria;
- A review of available literature relating to air quality assessments and monitoring data for the CCT;
- Qualitative assessment of air quality impact assessment of cross city tunnel vent stack on the mixed use tower at 505-523 George Street with regard to ambient nitrogen dioxide, carbon monoxide and particulate concentrations; and
- Recommendations and conclusions.

**Figure 1 Location of Cross City Tunnel and Project Location**




Source: Satellite Imagery Google Earth 2014, Sinclair Knight Merz

# 2.0 Air quality Criteria

Air quality criteria are used to assess the potential for ambient air quality to give rise to adverse health or nuisance effects. Emissions from tunnel ventilation systems have the potential to impact on local amenity. The most significant emissions produced from road tunnel ventilation stacks include:

- Particulate matter with equivalent aerodynamic diameter ≤10 microns ($PM_{10}$);
- Particulate matter with equivalent aerodynamic diameter ≤ 2.5 microns ($PM_{2.5}$);
- Carbon monoxide (CO); and
- Nitrogen Dioxides ($NO_2$).

The NSW EPA has set air quality assessment criteria as part of their *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC 2005). **Table 1** summarises the NSW EPA's impact assessment criteria for the pollutants included in the assessment. In general, these criteria relate to the total burden of air pollutants in the air and not just the air pollutants from project-specific sources. A discussion of existing air quality levels in the study area is provided in **Section 4.2.**

**Table 1 NSW EPA Air Quality Impact Assessment Criteria (DEC 2005)**

| Pollutant | Averaging Period | Criteria |
|---|---|---|
| Particulate matter ($PM_{10}$) | Maximum 24-hour average | 50 $\mu g/m^3$ |
| | Annual average | 30 $\mu g/m^3$ |
| Particulate matter ($PM_{2.5}$)* | Maximum 24-hour average | 25 $\mu g/m^3$ |
| | Annual average | 8 $\mu g/m^3$ |
| Carbon monoxide (CO) | Maximum 15 min average | 100 $mg/m^3$ |
| | Maximum 1-hour average | 30 $mg/m^3$ |
| | Maximum 8-hour average | 10 $mg/m^3$ |
| Nitrogen dioxide ($NO_2$) | Maximum 1-hour average | 246 $\mu g/m^3$ |
| | Annual average | 62 $\mu g/m^3$ |

$\mu g/m^3$ = micrograms per cubic metre
$mg/m^3$ = milligrams per cubic metre
*NEPM Advisory reporting standards only

The NSW EPA's criteria for $PM_{10}$, CO and $NO_2$ criteria were set to protect against adverse health effects. There is an increasing body of evidence to suggest that criteria for finer particulate matter (for example, $PM_{2.5}$) may be more important than $PM_{10}$ for protecting against adverse health impacts; at this stage, however, the NSW EPA has not set criteria for $PM_{2.5}$ that are applied on a project-specific basis, and the criteria specified above represent the NEPM advisory reporting standards. Potential health effects of particulate matter, CO and $NO_x$ are presented in **Section 3.2**.

# 3.0 Factors Affecting Air Quality near Road Tunnels

## 3.1 Factors Affecting Ambient Air Quality

Road tunnels restrict the normal dispersion of airborne pollution from traffic. This occurs due to the concentration of a line-emission source of pollution (ie. the road) into a few potentially intense point-sources (such as ventilation stacks and tunnel portals), so pollutants are more concentrated near the points where tunnel air is released into the atmosphere. The concentrations of air pollutants that occur within road tunnels, and the consequent emissions from stacks and portals into the external atmosphere, depend on factors including; traffic volume, speed, fleet composition, road gradient, tunnel length and the rate of dilution (NHMRC 2008).

Tunnel ventilation stacks in addition to tunnel openings are a key focus of any tunnel air quality assessment. It is at ventilation stacks that the pollutants, which have been released inside the tunnel and have accumulated rather than been dispersed as in the case of open roads, are finally released into the ambient environment at high concentrations (NHMRC 2008). Vehicle emissions from within the CCT are collected via a parallel ventilation tunnel and vented via a singular stack at one end of the tunnel approximately 400m to the west of the proposed residential tower.

Key features of the ventilation system for the Cross City Tunnel are (CCT Motorway Group Holding 2010):

- Jet fans along the ceiling of the tunnels and access ramps to control air flow;
- A main underground ventilation station at the western end near Druitt Street;
- A ventilation tunnel connecting the main ventilation station to a single ventilation stack near the Western Distributor in Darling Harbour;
- Ventilation of cross passage egress tunnels for pressurisation;
- A ventilation cross-over passage and ventilation station at the eastern end of the main tunnels;
- A bypass ventilation tunnel that runs beneath the main road tunnels connecting the eastern crossover and western ventilation stations; and
- A bypass fan station at the western end that will generate airflow in the bypass ventilation tunnel.

According to the 2008 *Air Quality in and around Traffic Tunnels Report* written by the National Health and Medical Research Council (NHMRC 2008) the effects of road tunnels on ambient air quality can generally be broken up into a number of zones. Ambient air quality is most greatly affected within 100m of tunnel portals where pollutant concentrations at portal exits can approach the maximum values found within tunnels; falling almost to background levels within 100m from the tunnel, thus affecting only a small population. Between 100m and 1 km from tunnel portals and ventilation stacks (such as in the case of 505-523 George Street, Sydney) the increase in concentrations are generally negligible.

## 3.2 Health Impacts of Road Tunnel Pollutants

Potential health effects of road tunnel pollutants including particulate matter, carbon monoxide and nitrous oxides are presented in the following subsections.

### 3.2.1 Particulate Matter

Particles within the $PM_{10}$ and $PM_{2.5}$ fractions generally enter the body via inhalation. In the lungs particles can have a direct physical effect and/or be absorbed into the blood. Total suspended particulates may also may be deposited in the mouth, throat or nose and can be ingested. Airborne particulate matter can be generated by vehicles from direct emissions from the burning of fuels (especially diesel powered vehicles) and from wear of tyres or vehicle-generated air turbulence on roadways. Particles may also be generated from earthworks, wind erosion, and construction activities.

The factors that may influence the health effects of exposure to particles include:

- The chemical composition and physical properties of the particles.
- The mass concentration of the airborne particles.

- The size of the particles (smaller particles may be associated with more adverse effects due to increased likelihood of deep inhalation into the lungs).
- The duration of exposure (acute and long term).

Recent epidemiological research suggests that there is no threshold at which health effects do not occur. The health effects include irritation of mucous membranes, toxic effects by absorption of the toxic material into the blood and increased respiratory symptoms, aggravation of asthma and premature death.

### 3.2.2 Carbon Monoxide

Carbon monoxide can enter the body by inhalation and be rapidly absorbed by the bloodstream from the lungs. Typical levels in urban areas are however, unlikely to cause ill effects. People can be exposed to CO through using malfunctioning equipment and using poorly vented vehicles.

Acute exposure to levels of 200 parts per million (ppm) or more for 2 to 3 hours can lead to headache, dizziness, light-headedness and fatigue. Exposure to higher concentrations (say, 400 ppm or more) of CO can cause sleepiness, hallucinations, convulsions, collapse, loss of consciousness and even death. It can also cause personality and memory changes, mental confusion and loss of vision.

Extremely high exposures to carbon monoxide can cause the formation of carboxyhaemoglobin and decrease the body's ability to transport oxygen. This can cause a bright red colour to the skin and mucous membranes causing trouble breathing, collapse, convulsions, coma and possibly death.

Long term (chronic) health effects can occur from exposure to low levels of carbon monoxide. These effects may produce heart disease and damage to the nervous system. Exposure of pregnant women to carbon monoxide may result in low birth weights and other defects in the offspring.

### 3.2.3 Oxides of Nitrogen

Nitrogen oxides ($NO_X$) emitted from combustion sources are comprised mainly of nitric oxide (NO, approximately 95% at the point of emission) and nitrogen dioxide ($NO_2$, approximately 5% at the point of emission). Nitric oxide is much less harmful to humans than $NO_2$ and is not generally considered a pollutant with health impacts.

$NO_x$ may be inhaled or absorbed through the skin. People who live in areas of high motor vehicle usage may be exposed to higher levels of nitrogen oxides. Acute exposure to low levels of $NO_2$ can irritate eyes, nose, throat and lungs, possibly leading to coughing, shortness of breath, tiredness and nausea. Exposure can also result in a build-up of fluid in the lungs for 1-2 days after exposure. Breathing high levels of $NO_2$ can cause rapid burning, spasms and swelling of tissues in the throat and upper respiratory tract, reduced oxygenation of tissues, a build-up of fluid in the lungs, and in extreme cases death.

# 4.0 Existing Environment

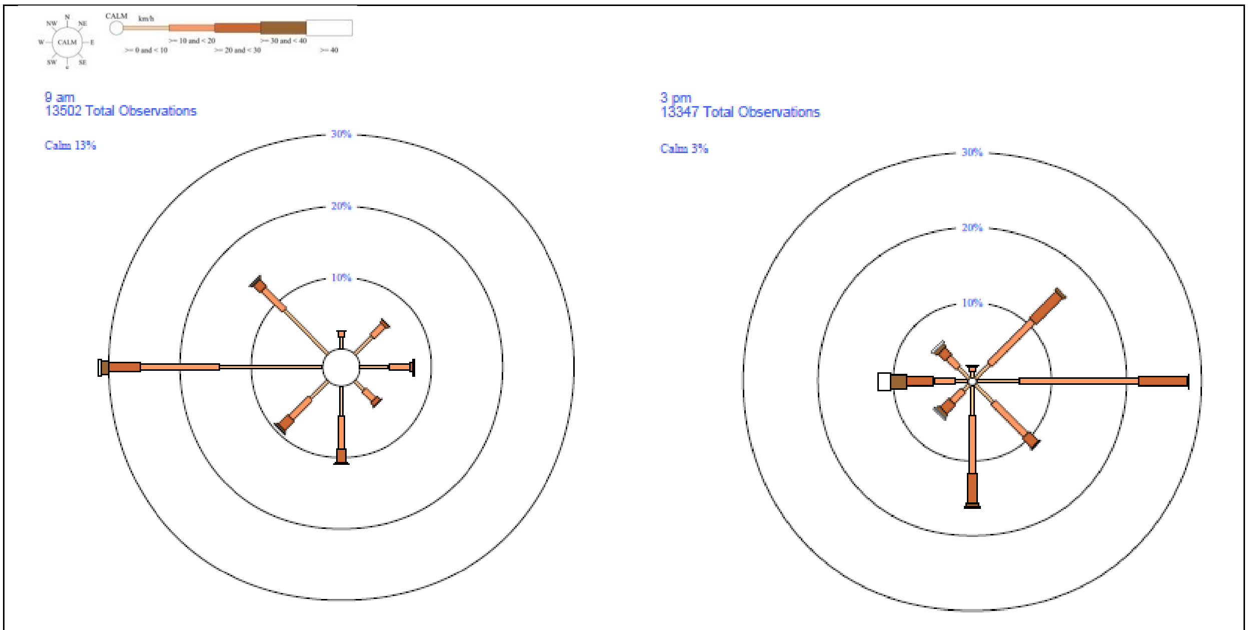
## 4.1 Local Meteorology

Meteorology in the area surrounding the project location is affected by several factors such as terrain and land use. Wind speed and direction are largely affected by topography at the small scale, while factors such as synoptic scale winds affect wind speed and direction on the larger scale.

On a relatively small scale, local winds are largely affected by the topography. At larger scales, winds are affected by synoptic scale winds, which are modified by convective processes in the daytime and also by a complex pattern of regional drainage flows, caused by sloping terrain that can develop overnight. Metrological data has been obtained from the Bureau of Meteorology (BoM) automatic weather station at Observatory Hill approximately 2 km to the north of the development.

Long term wind data from the BoM at Observatory Hill recorded between 1858 and 1992, and presented in **Figure 2** indicates that the predominant wind direction in the morning is from the west and winds most commonly occurring from the north east to east during the afternoons. Calm conditions are most frequent during the morning hours with 13% compared to 3 % in the afternoon.

Wind speeds are generally higher in the afternoon compared to the morning, with an average of 10.6km/h recorded at 9am and 16.6km/h recorded at 3pm. The highest average wind speeds occur during the month of November (19.5 km/h).




**BoM Observatory Hill 9am (1955 – 1992)** **BoM Observatory Hill 3pm (1955 – 1992)**

**Figure 2 9 am and 3 pm wind roses from Observatory Hill (BoM, 1955 - 1992)**

## 4.2 Existing Air Quality

The EPA operates a network of monitoring stations around the state, which measures various ambient pollutant levels. The closest station to the site is located at Rozelle (approximately 4.4 km northwest of the site). The Rozelle monitoring station records hourly $NO_2$ and $PM_{10}$, and CO as an 8-hour rolling average. The site does not record 1-hour and 15 minute CO concentrations or $PM_{2.5}$ data.

Ambient air quality concentrations for CO, $NO_2$ and $PM_{10}$ recorded at Rozelle for 2013 are presented in **Table 2.** It can be seen from **Table 2** that all pollutant concentrations were within the relevant EPA criterion, with exception to the $PM_{10}$ maximum 24-hour average, with a pollutant concentration of 59 µg/m$^3$ compared to the limit of 50 µg/m$^3$.

According to the 2013 *New South Wales Air Quality Statement* written by the Office of Environment & Heritage (OEH 2013) higher levels of fine particulates were observed across most of NSW during 2013. This was a result of warmer and drier conditions across the state, coupled with severe bushfires. Whilst the maximum recorded 24-hour average for $PM_{10}$ was above the EPA criteria, the Standards allow for up to 5 exceedences in a year to account for random natural events. At the Rozelle station, the 6$^{th}$ highest maximum 24-hour average for $PM_{10}$ was 41.2 µg/m$^3$, which is compliant with the Standards.

**Table 2 Ambient Pollutant Concentrations at Rozelle (EPA 2013)**

| Pollutant | Averaging Period | Pollutant Concentration | EPA Criteria |
|---|---|---|---|
| Carbon monoxide (CO) [mg/m$^3$] | Maximum 8-hour average | 1.8 | 10 |
| Nitrogen dioxide ($NO_2$) [µg/m$^3$] | Maximum 1-hour average | 144 | 246 |
| | Annual average | 23 | 62 |
| Particulate matter ($PM_{10}$) [µg/m$^3$] | Maximum 24-hour average | **59** (41.2*) | 50 |
| | Annual average | 18 | 30 |

*The 6$^{th}$ highest value it reported for compliance with the Standards

In addition to the ambient air quality monitoring data at Rozelle, ambient air quality monitoring was undertaken at Tumbalong Park Community Based Monitoring Station (CBMS) as part of conditions of consent for the cross city tunnel development both prior to commissioning of the tunnel and following operation. A comparison of these data sets is provided in **Section 5.0** and the location of the Monitoring station is shown in **Figure 1**.

# 5.0 Impact Assessment

This qualitative assessment looks at the potential air quality impacts at sensitive receptors at the proposed residential tower to be located at 505-523 George Street from the CCT ventilation stack. Sensitive receivers refer to locations where people are likely to work or reside including dwellings, schools, hospitals, offices and public recreational areas, The proposed development includes mixed use, multi-level tower comprised of residential, retail and community uses, situated 400m east of the CCT ventilation stack.

In 2001 the environmental impact statement (EIS) prepared for the for the construction of the CCT; air quality and in particular the health impacts associated with the emissions from the ventilation stack was the most notable issue raised as part of the development (DUAP 2001).

Assessment of air quality emissions from the ventilation stack undertaken for the EIS indicated emissions of pollutants from the stack were not expected to be an issue for existing nearby local residents including at Ultimo/Pyrmont and Darling Harbour at ground level. Contributions from the stack were predicted to be negligible at these locations; however elevated receivers at rooftop level at Darling Park (DoP 2002) and other nearby high-rise apartments including the Millennium Towers were predicted to experience an increase in pollutant concentrations including an exceedence of $NO_2$ concentrations (DUAP 2001).

As part of the Minister for Planning's Approval (MPA) Conditions for the CCT development, ambient air quality monitoring of CO, $NO_2$ and $PM_{10}$ were required at four monitoring stations to assess the predicted air quality concentrations against monitoring data. The monitoring program included; two elevated monitoring stations (ER1 and ER2) located at Millennium Towers and 51 Druitt Street operational both prior to and for 12 months from opening the CCT to traffic and two ground level monitoring stations, located at Tumbalong Park (CBMS) and Mary Anne Street Park both prior to and for three years following the tunnel opening (DUAP 2001).

## 5.1 Elevated Monitoring

The elevated monitoring stations were located approximately 240m east (ER1) and 320m northeast (ER2) of the CCT ventilation stack; in between the CCT and the proposed development (refer to **Figure 1**). According to BoM data (refer to **Section 4.1**) morning winds are predominantly from the west, blowing towards ER1 and ER2 from the CCT ventilation stack. In spite of unfavourable wind conditions, monitoring data from the elevated monitoring stations between September 2005 and August 2006 revealed no exceedence of the EPA criteria for CO, $NO_2$ and $PM_{10}$. Based on the CCT monitoring data, it is unlikely that high rise buildings such as the proposed residential tower would experience an exceedence of the EPA criterion for CO, $NO_2$ and $PM_{10}$. Furthermore, given that the proposed residential tower is situated further east than the monitoring points; approximately 400m east of the CCT ventilation stack it is unlikely to experience notable elevated concentrations of pollutants attributed to the ventilation stack.

## 5.2 Ground Level Monitoring

The ground level monitoring station at Tumbalong Park (CBMS) is located approximately 450 south west of the proposed residential tower (approximately 250m south of the CCT ventilation stack), and would be considered representative of the Project area. **Table 3** and **Table 4** show a copy of the monthly average and maximum pollutant concentrations for CO, $NO_2$ and $PM_{10}$ for the pre and post CCT commissioning monitoring respectively at Tumbalong Park. Exceedances of the relevant ambient air quality criterion are shown in bold type. A summary of the two data sets is also presented in **Table 5**.

The location of the ground level monitoring station CBMS is shown in **Figure 1**.

**Table 3 Pre-Commissioning of the Cross City Tunnel Ambient Air Monitoring Results at Tumbalong Park (Jan 2004 to Jun 2005) (BHBB 2004a, 2004b and 2005)**

| Year | Month | Monthly Average | | | Monthly Maximum | | |
|---|---|---|---|---|---|---|---|
| | | 8-hour CO (mg/m³) | 1-hour $NO_2$ (µg/m³) | 24-hour $PM_{10}$ (µg/m³) | 8-hour CO (mg/m³) | 1-hour $NO_2$ (µg/m³) | 24-hour $PM_{10}$ (µg/m³) |
| 2004 | January | 0.5 | 57.4 | 25.7 | 1.8 | 104.6 | **50.3** |
| | February | 0.6 | 59.5 | 27.9 | 2.8 | 147.6 | **51.1** |
| | March | 0.6 | 57.4 | 25.7 | 1.6 | 139.4 | 49.7 |
| | April | 0.8 | 67.7 | 22.8 | 1.8 | 118.9 | 37.5 |
| | May | 1.4 | 67.7 | 23.6 | 2.8 | 96.4 | 40.4 |
| | June | 1.1 | 71.8 | 19.2 | 2.5 | 104.6 | 35.6 |
| | July | 1.3 | 69.7 | 18.8 | 2.9 | 90.2 | 30.0 |
| | August | 0.9 | 67.7 | 16.6 | 2.1 | 123.0 | 34.1 |
| | September | 0.8 | 73.8 | 18.4 | 2.4 | 121.0 | 42.2 |
| | October | 0.5 | 65.6 | 19.2 | 2.0 | 149.7 | 41.4 |
| | November | 0.5 | 61.5 | 21.7 | 2.3 | 123.0 | 41.3 |
| | December | 0.2 | 47.2 | 24.4 | 0.9 | 147.6 | 49.6 |
| 2005 | January | 0.2 | 41.2 | 22.1 | 0.5 | 90.7 | 46.5 |
| | February | 0.4 | 58.0 | 21.5 | 1.2 | 144.9 | 41.0 |
| | March | 0.4 | 46.8 | 18.1 | 1.1 | 76.0 | 30.8 |
| | April | 0.9 | 63.2 | 22.2 | 2.5 | 99.8 | 32.9 |
| | May | 1.2 | 70.1 | 20.8 | 2.8 | 122.3 | 35.2 |
| | June | 1.3 | 72.7 | 21.1 | 2.9 | 112.2 | 39.3 |

**Table 4 Post-Commissioning of the Cross City Tunnel Ambient Air Monitoring Results at Tumbalong Park (Sep 2005 to Aug 2008) (BHO&M 2005-2007 and LO&M 2007-2008)**

| Year | Month | Monthly Average | | | Monthly Maximum | | |
|---|---|---|---|---|---|---|---|
| | | 8-hour CO (mg/m³) | 1-hour $NO_2$ (µg/m³) | 24-hour $PM_{10}$ (µg/m³) | 8-hour CO (mg/m³) | 1-hour $NO_2$ (µg/m³) | 24-hour $PM_{10}$ (µg/m³) |
| 2005 | September | 0.6 | 67.7 | 16.2 | 1.4 | 98.4 | 32.2 |
| | October | 0.5 | 61.5 | 21.1 | 1.8 | 96.4 | 43.6 |
| | November | 0.3 | 39.0 | 19.4 | 0.6 | 100.5 | 37.8 |
| | December | 0.9 | 55.4 | 27.2 | 2.4 | 153.8 | 46.8 |
| 2006 | January | 0.2 | 41.0 | 25.5 | 0.5 | 67.7 | **118.0** |
| | February | 0.3 | 53.3 | 21.5 | 0.6 | 153.8 | 33.1 |
| | March | 0.6 | 51.3 | 22.4 | 1.2 | 94.3 | 37.3 |
| | April | 0.8 | 67.7 | 19.7 | 1.4 | 108.7 | 35.1 |
| | May | 1.1 | 63.6 | 16.8 | 2.0 | 90.2 | 27.9 |
| | June | 1.5 | 63.6 | 16.2 | 3.1 | 86.1 | 25.4 |

| Year | Month | Monthly Average | | | Monthly Maximum | | |
|---|---|---|---|---|---|---|---|
| | | 8-hour CO ($mg/m^3$) | 1-hour $NO_2$ ($\mu g/m^3$) | 24-hour $PM_{10}$ ($\mu g/m^3$) | 8-hour CO ($mg/m^3$) | 1-hour $NO_2$ ($\mu g/m^3$) | 24-hour $PM_{10}$ ($\mu g/m^3$) |
| | **July** | 1.4 | 65.6 | 15.9 | 2.7 | 84.1 | 29.6 |
| | **August** | 1.4 | 73.8 | 18.8 | 3.2 | 94.3 | 27.9 |
| | **September** | 0.9 | 69.7 | 21.4 | 1.6 | 110.7 | 43.0 |
| | **October** | 0.7 | 61.5 | 23.7 | 1.3 | 92.3 | 33.0 |
| | **November** | 0.7 | 61.5 | 24.8 | 1.9 | 172.2 | **60.3** |
| | **December** | 0.6 | 47.2 | 23.5 | 0.7 | 100.5 | **51.2** |
| **2007** | **January** | 0.5 | 41.0 | 25.6 | 0.8 | 84.1 | 42.0 |
| | **February** | 0.6 | 41.0 | 17.8 | 1.1 | 82.0 | 23.8 |
| | **March** | 0.8 | 59.5 | 20.4 | 1.6 | 116.9 | 32.0 |
| | **April** | 0.9 | 61.5 | 20.8 | 1.7 | 98.4 | 37.0 |
| | **May** | 1.1 | 73.8 | 20.5 | 2.5 | 118.9 | **57.9** |
| | **June** | 1.2 | 59.5 | 14.5 | 3.3 | 73.8 | 25.1 |
| | **July** | 0.9 | 63.6 | 13.3 | 2.4 | 84.1 | 21.1 |
| | **August** | 0.9 | 65.6 | 13.6 | 1.8 | 86.1 | 22.6 |
| | **September** | 0.8 | 65.6 | 19.8 | 1.8 | 102.5 | 33.8 |
| | **October** | 0.7 | 69.7 | 25.2 | 2.5 | 112.8 | 42.2 |
| | **November** | 0.2 | 43.1 | 16.1 | 1.0 | 80.0 | 31.3 |
| | **December** | 0.5 | 43.1 | 18.2 | 0.8 | 77.9 | 29.7 |
| **2008** | **January** | 0.5 | 41.0 | 22.5 | 0.8 | 65.6 | 34.4 |
| | **February** | 0.5 | 47.2 | 15.2 | 0.9 | 61.5 | 31.6 |
| | **March** | 0.6 | 49.2 | 18.8 | 0.8 | 75.9 | 30.2 |
| | **April** | 0.8 | 57.4 | 14.7 | 1.3 | 73.8 | 22.6 |
| | **May** | 1.2 | 71.8 | 20.1 | 2.0 | 92.3 | 28.7 |
| | **June** | 0.8 | 55.4 | 12.8 | 2.4 | 75.9 | 21.0 |
| | **July** | 0.8 | 67.7 | 17.4 | 1.6 | 82.0 | 34.6 |
| | **August** | 0.8 | 69.7 | 15.3 | 1.5 | 84.1 | 23.5 |

**Table 5** **Comparison of Pre and Post CCT Commissioning Ambient Air Monitoring Results at Tumbalong Park (BHBB 2004a, 2004b and 2005, BHO&M 2005-2007, and LO&M 2007-2008)**

| CCT Operational Status | Annual Average | | | Maximum | | |
|---|---|---|---|---|---|---|
| | CO ($mg/m^3$) | $NO_2$ ($\mu g/m^3$) | $PM_{10}$ ($\mu g/m^3$) | 8-hour CO ($mg/m^3$) | 1-hour $NO_2$ ($\mu g/m^3$) | 24-hour $PM_{10}$ ($\mu g/m^3$) |
| Pre-Commissioning | 0.74 | **62.2** | 21.7 | 2.9 | 149.7 | **51.1** |
| Post-Commissioning | 0.76 | 58.0 | 19.4 | 3.3 | 172.2 | **57.9*** |
| **Criteria** | **-** | **62** | **30** | **10** | **246** | **50** |

*Excludes reported maximum 24-hour $PM_{10}$ concentrations recorded in 2005 and 2006 attributed to fireworks and bushfires

It can be seen from the above tables that there were no exceedence of the CO 8-hour maximum EPA criterion of 10 mg/$m^3$ during pre or post commissioning of the CCT during the monitoring period (see **Table 3**, **Table 4** and **Table 5**). Recorded maximum concentrations between the two data sets were also found to be relatively similar with maximum results of approximately one third of the EPA criterion. Hourly and 15 minute CO data was not available however; given the relatively low 8-hour data it is unlikely to be an exceedence of the maximum 1-hour and 15-minute EPA criteria. There is no criterion set by the EPA for annual average CO concentration, however the data suggests there is little difference between the pre and post CCT commissioning results.

Review of the 1-hour $NO_2$ monitoring data revealed no exceedence of the EPA criterion of 246 µg/$m^3$ during pre or post commissioning of the CCT. The data however does show an increase in the maximum 1-hour $NO_2$ recorded post commissioning of the CCT (see **Table 5**). The average $NO_2$ concentration recorded during the post commissioning monitoring shows a small reduction in $NO_2$ concentration (58 µg/$m^3$) when compared to the pre-commissioning results of 62.2 µg/$m^3$ which is just above the EPA annual average criterion (see **Table 5**).

A comparison of pre-commissioning and post-commissioning monitoring data for $PM_{10}$ concentrations revealed a slight decrease in the average $PM_{10}$ concentration in the post monitoring period. Both data sets were below the EPA annual average criterion of 30 µg/$m^3$. Both data sets indicate the occasional exceedence of the 24-hour maximum $PM_{10}$ concentration criterion of 50 µg/$m^3$ (see **Table 3**, **Table 4** and **Table 5**).

Between January 2004 and June 2005 prior to commissioning of the CCT three exceedence of the 24-hour maximum $PM_{10}$ concentration criterion were recorded. On 10 January 2004 a maximum concentration of 50.3 µg/$m^3$ just above the EPA criterion was recorded. On the 20 and 21 of February 2004 exceedence were also recorded with a maximum 24-hour concentration for the month of 51.1µg/$m^3$ (see **Table 3**).

A total of five exceedances were recorded at Tumberlong Park during the post-cross city tunnel opening monitoring period (see **Table 4**). The maximum 24-hour $PM_{10}$ concentration µg/$m^3$ was found to be 118 µg/$m^3$ on the 15th January 2005, more than double the EPA criterion of 50 µg/$m^3$. According to the January 2006 monitoring report this was attributed to nearby fireworks being released (BHO&M 2005). Three other exceedence recorded in late November and early December in 2006 were also attributed to unfavourable wind conditions, transporting particulates from bushfires occurring in the Blue Mountains across the Sydney region (BHO&M 2006). The remaining exceedence of 58 µg/$m^3$ on 4 May 2007 was noted to be a Sydney-wide event with similarly high readings recorded from a number of external monitoring stations including at Lane Cove Tunnel, M5 East and a number of EPA monitoring stations (BHO&M 2007). As such the CCT was not taken to be a major contributor of the recorded exceedence.

Based on the above data, it can be seen for all pollutants, measured concentrations both prior to and following commissioning of the cross city tunnel are relatively similar. As such it is unlikely the ventilation stack is a major contributor to ground level pollutant concentrations within the proposed Project area. Measured CO and $NO_2$ both prior to and following commissioning of the cross city tunnel were within the EPA criterion. A number of exceedence of the $PM_{10}$ 24-hour concentration have been recorded in both sets of monitoring data, however given each exceedence recorded following commissioning of the CCT has been attributed other sources including fireworks and bushfires or regional events it is unlikely the CCT vent was a major contributor to these exceedence. The recorded average $PM_{10}$ concentration over the monitoring periods were both found to be well below the annual average EPA criterion. It is therefore considered unlikely that these pollutants from the cross city tunnel vent would greatly impact on the proposed residential tower at 505-523 George St, Sydney.

# 6.0 Recommendations and Conclusion

This report was prepared by AECOM to support a Planning Proposal submitted to the City of Sydney Council on behalf of Coombes Property Group and Mirvac; which included the construction of a mixed use residential tower at 505-523 George Street, Sydney, NSW. Specifically this report aims to address clause 7.24 of the *Sydney Local Environmental Plan 2012,* which requires persons using the proposed development to not be unduly affected by emissions from the CCT ventilation stack.

A qualitative air quality assessment was undertaken on the potential air quality impacts on the residential tower from the cross city tunnel (CCT) vent located near the north-western corner of the Harbour and Bathurst Street intersection. Potential impacts on the residential tower which includes a number of sensitive receivers including residential, retail and community development from ventilation stack emissions were examined including elevated and ground level pollutant concentrations for CO, $NO_2$ and $PM_{10}$.

A review of available literature found during preparation of the environmental impact statement (EIS) for the construction of the CCT; air quality and in particular the health impacts associated with the emissions from the ventilation stack was the most notable issue raised as part of the development (DUAP 2001). Assessment of air quality emissions from the ventilation stack undertaken for the EIS indicated emissions of pollutants from the stack for existing nearby local residents including at Ultimo/Pyrmont and Darling Harbour at ground level were expected to be negligible. However elevated receivers at rooftop level at Darling Park (DoP 2002) and other nearby high-rise apartments including the Millennium Towers were predicted to experience an increase in pollutant concentrations including an exceedence of $NO_2$ concentrations (DUAP 2001).

As part of the Minister for Planning's Approval (MPA) Conditions for the CCT development, ambient air quality monitoring of CO, $NO_2$ and $PM_{10}$ were required at four monitoring stations to assess the predicted air quality concentrations against monitoring data including two elevated and two ground level monitoring stations.

One year of monitoring data from opening the CCT to traffic was available from two elevated monitoring stations located at Millennium Towers and 51 Druitt. Monitoring data from the elevated monitoring stations between September 2005 and August 2006 revealed no exceedence of the EPA criteria for CO, $NO_2$ and $PM_{10}$, contrary to modelled predictions presented in the EIS. Based on the CCT monitoring data it is unlikely that the proposed residential tower at 505-523 George Street, Sydney would experience exceedence of the EPA criteria for CO, $NO_2$ and $PM_{10}$.

One ground level monitoring station was located at Tumbalong Park, approximately 300m south east of 505-523 George Street and 250m south of the CCT ventilation stack. Data reviewed from this monitoring station prior to and after opening the CCT indicated for all pollutants, measured concentrations between data sets are relatively similar. As such it is unlikely the ventilation stack is a major contributor to ground level pollutant concentrations within the proposed Project area. Measured CO, $NO_2$ both prior to and following commissioning of the cross city tunnel were within the EPA criteria. A number of exceedence of the $PM_{10}$ 24-hour concentration have been recorded in both sets of monitoring data, however given each exceedence recorded following commissioning of the CCT has been attributed other sources including fireworks and bushfires or regional events it is unlikely the CCT vent was a major contributor to these exceedence. The recorded average $PM_{10}$ concentration over the monitoring periods were both found to be well below the annual average EPA criterion. It is therefore considered unlikely that these pollutants from the cross city tunnel vent would greatly impact on the proposed residential tower at 505-523 George Street, Sydney.

In conclusion the review of elevated and ground level monitoring data undertaken for the Cross City Tunnel MPA Conditions indicates it is unlikely that elevated receivers at the proposed residential tower at 505-523 George Street, Sydney would experience an exceedance of the EPA criteria for CO, $NO_2$ and $PM_{10}$ due to the operation of the CCT and it is unlikely the ventilation stack is a major contributor to ground level pollutant concentrations within the proposed Project area.

# References

BHBB (2004a) *Cross City Tunnel Six-monthly Air Quality Monitoring Report, Tumbalong Park Community Based Monitoring Station (CBMS) Validated Data, January 2004 to June 2004*, Baulderstone Hornibrook and Bilfinger Berger, Sydney, NSW Australia

BHBB (2004b) *Cross City Tunnel Six-monthly Air Quality Monitoring Report, Tumbalong Park Community Based Monitoring Station (CBMS) Validated Data, June2004 to December 2004*, Baulderstone Hornibrook and Bilfinger Berger, Sydney, NSW Australia

BHBB (2005) *Cross City Tunnel Six-monthly Air Quality Monitoring Report, Tumbalong Park Community Based Monitoring Station (CBMS) Validated Data, January 2005 to June 2005*, Baulderstone Hornibrook and Bilfinger Berger, Sydney, NSW Australia

*BHO&M* (2005 to) *Cross City Tunnel Air Quality Monitoring Report Validated Data*, (monthly monitoring reports September 2005 to August 2007) Baulderstone Hornibrook Pty Ltd, Sydney, NSW Australia

CCT Motorway Group Holding (2010) Air Quality Monitoring, Air Quality Ventilation System, Cross City Tunnel Motorway Group Holding, Accessed 22 October 2014: http://www.crosscity.com.au/AirQuality.htm

CCT Motorway Group Holding (2004-2005) Air Quality Monitoring, Air Quality Ventilation System, Cross City Tunnel Motorway Group Holding, Accessed 22 October 2014: http://www.crosscity.com.au/AirQuality.htm

DEC (2005) *Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in New South Wales.* Department of Environment and Conservation: Sydney, Australia

EPA (2012) Ambient Air Quality Data, Rozelle, NSW Environmental Protection Agency, Office of Environment and Heritage, Sydney, Accessed 22 October 2014: http://www.environment.nsw.gov.au/air/

DUAP (2001) *Proposed Cross City Tunnel; Kings Cross to Darling Harbour, Volume 1, Director-General's Report, Section 115C of the Environmental Planning and Assessment Act 1979, September 2001,* NSW Department of Urban Affairs and Planning, Sydney, NSW, Australia.

DoP (2002) *Crone City Tunnel Proposed Modifications to Approved Project, Director Generals Report Prepared under Section 115C of the Environmental Planning and Assessment Act 1979, December 2002*, NSW Department of Planning, Sydney, NSW, Australia.

*LO&M* (2007 to 2008) *Cross City Tunnel Air Quality Monitoring Report Validated Data* (monthly monitoring reports September 2007 to August 2008) , Leighton Contractors Pty Ltd, Sydney, NSW Australia

NHMRC (2008) *Systematic Literature Review, Air Quality in and around Traffic Tunnels, Final Report*, National Health and Medical Research Council with support from The Australian Government Department of Health and Agency, Canberra, ACT, Australia.

OEH (2013) *New South Wales Air Quality Statement 2013*, NSW Office of Environment & Heritage, Sydney, Accessed 22 October 2014: http://www.environment.nsw.gov.au/aqms/140057nswairqual13.htm