Lend Lease
18 March 2013

Cross City Tunnel Impacts on SICEEP

Air Quality Assessment

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Prepared for

Lend Lease

Prepared by

AECOM Australia Pty Ltd
17 Warabrook Boulevarde, 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

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1.0 Introduction

This report supports a State Significant Development Application (SSD 12_5752) submitted to the Minister for Planning and Infrastructure pursuant to Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The SICEEP Project will deliver Australia's global city, Sydney with world class convention, exhibition and entertainment facilities that can compete effectively in the national and international events markets. The SICEEP Project importantly forms a critical element of the NSW Government's aspiration to "make NSW number one again". The SICEEP Project also involves the creation of a new neighbourhood and a community hub.

1.1 Overview of Proposed Development

1.1.1 PPP Component

The proposed development involves construction of the PPP component of the SICEEP Project, comprising new, integrated and world-class convention, exhibition and entertainment facilities with associated retail and public domain upgrades.

The application more specifically seeks approval for the following development:

- Demolition of existing improvements on the site, the including existing Sydney Convention Centre (part) and the Sydney Exhibition Centre;
- Associated tree removal and replanting;
- Construction of a new, integrated and world-class Convention, Exhibition and Entertainment Centre;
- Public domain improvements, including:
    - reinvigorating and expanding Tumbalong Park;
    - provision (part) of a new active north-south pedestrian connection (known as the Boulevard);
    - provision of new east-west connections, including Harbourside Place and Tumbalong Place;
    - Provision of a pedestrian bridge link from Quarry Street;
    - Retention of the tidal cascade water feature;
    - Reconfiguration and upgrade of Darling Drive (part);
    - Provision of a new square adjoining the Chinese Garden;
    - Provision of a new open space 'event deck' (connected with the Exhibition Centre);
    - Integrated art, play zones, water play and recreation areas; and
    - Provision of retail kiosks.
- Provision of ground level parking within the Exhibition and Entertainment Centre facilities;
- Ground and elevated loading docks (accessed off Darling Drive) for Convention, Exhibition and Entertainment Centre facilities;
- Two vehicle drop off points off Darling Drive;
- Provision of signage; and
- Extension and augmentation of physical infrastructure / utilities as required.

1.1.2 The Haymarket Precinct

The Haymarket will include student housing, public car parking, a commercial office building, and four mixed use development blocks (retail/commercial/residential podium with residential towers above) centred around a new public square to be named Haymarket Square.

More specifically concept approval is sought for the following:

- Demolition of existing site improvements, including the existing Sydney entertainment Centre (SEC), Entertainment car park, and part of the pedestrian footbridge connected to the Entertainment car park and associated tree removal;
- North-west block – construction of a part public car park and part commercial/office building;
- North-east block – construction of a mixed use podium (comprising retail, commercial, above ground parking, and residential) with three residential buildings above;
- South-east block - construction of a mixed use podium (comprising retail, commercial, above ground parking, and residential) with three residential buildings above;
- South-west block - construction of a mixed use podium (comprising retail, commercial, above ground parking, and residential) with three residential buildings above;
- North block – construction of a mixed use building comprising retail, commercial and residential;
- Student housing – construction of two buildings providing for up to 1,000 beds;
- Public domain improvements including a new square, water features, new pedestrian streets and laneways, streetscape embellishments, and associated landscaping. (It is intended that a Stage 2 DA seeking approval for parts of the public domain (The Boulevard and Haymarket Square) will be lodged with the first residential stage);
- Reconfiguration and upgrade of Darling Drive (part); and
- Car parking rates.

1.1.3 Hotel

The third component of the development is the construction of a hotel complex containing 900 rooms.

1.2 Background

The existing convention, exhibition and entertainment centre facilities at Darling Harbour were constructed in the 1980s and have provided an excellent service for Sydney and NSW.

The facilities however have limitations in their ability to service the contemporary exhibition and convention industry which has led to a loss in events being held in Sydney.

The NSW Government considers that a precinct-wide renewal and expansion is necessary and is accordingly committed to Sydney reclaiming its position on centre stage for hosting world-class events with the creation of the SICEEP Project.

Following an extensive and rigorous Expressions of Interest and Request for Proposals process, Darling Harbour Live (formerly known as 'Destination Sydney'- a consortium comprising AEG Ogden, Lend Lease, Capella Capital and Spotless) was announced by the NSW Government in December 2012 as the preferred proponent to transform Darling Harbour and create the new Sydney International Convention, Exhibition and Entertainment Precinct.

Key features of the Darling Harbour Live Preferred Master Plan include:

- Delivering world-class convention, exhibition and entertainment facilities, including:
  - Up to 40,000m^2 exhibition space;
  - Over 8,000m^2 of meeting rooms space, across 40 rooms;
  - Overall convention space capacity for more than 12,000 people;
  - A ballroom capable of accommodating 2,000 people; and
  - A premium, red-carpet entertainment facility with a capacity of 8,000 persons.
- Providing up to 900 hotel rooms in a hotel complex at the northern end of the Precinct.
- A vibrant and authentic new neighbourhood at the southern end of the precinct, called 'The Haymarket', home to an IQ Hub focused on the creative industries and high-tech businesses, apartments, student accommodation, shops, cafes and restaurants.
- Renewed and upgraded public domain, including an outdoor event space for up to 25,000 people at an expanded Tumbalong Park.
- Improved pedestrian connections linking to the proposed Ultimo Pedestrian Network drawing people between Central, Chinatown and Cockle Bay Wharf as well as east-west between Ultimo/Pyrmont and the City.

1.3 Site Description

The SICEEP Site is located within the Darling Harbour precinct. Darling Harbour is a 60 hectare waterfront precinct on the south-western edge of the Sydney Central Business District that provides a mix of functions including recreational, tourist, entertainment and business.

With an area of approximately 20 hectares, the SICEEP Site is generally bound by the Light Rail Line to the west, Harbourside shopping centre and Cockle Bay to the north, Darling Quarter, the Chinese Garden and Harbour Street to the east, and Hay Street to the south.

The SICEEP Site has been divided into three distinct redevelopment areas (from north to south) – Bayside, Darling Central and The Haymarket. The PPP facilities are area is located within Bayside and Darling Central as shown in **Figure 1**.

Figure 1 Location of the SICEEP Site

1.4 Planning Approvals Strategy

In response to separate contractual agreements with the NSW Government and staging requirements, Darling Harbour Live is proposing to submit a number of separate development applications for key elements of the overall Project.

A Development Appication (DA) will be submitted for the PPP component of the SICEEP Project, comprising the convention centre, exhibition centre, entertainment facility, and associated public domain upgrades.

Development of The Haymarket is to be staged and accordingly a staged development application is to be lodged. Detailed development applications will follow seeking approval for specific aspects of The Haymarket.

A separate development application will also be submitted for the Hotel Complex.

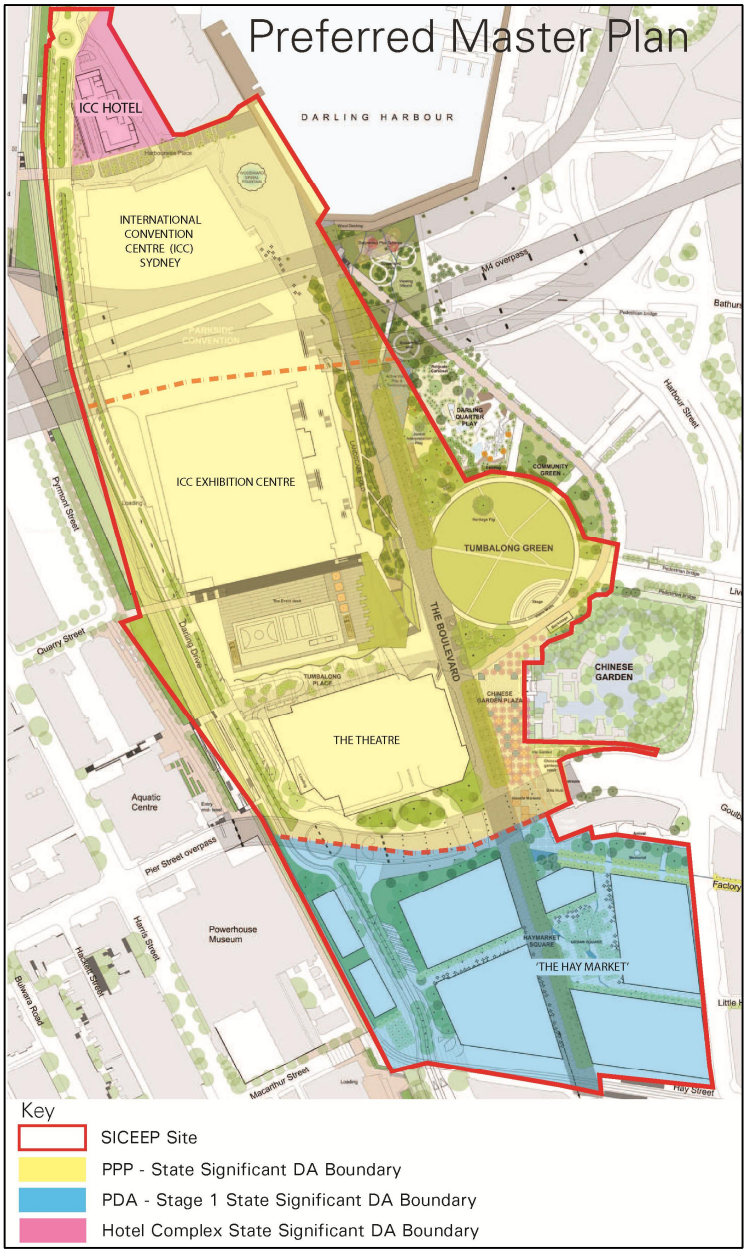

Figure 2 Preferred Master Plan

1.5 Purpose of Report

AECOM has been commissioned by Lend Lease to undertake a qualitative air quality assessment on the potential air quality impacts on the SICEEP site from the cross city tunnel (CCT) vent located approximately 120m to the east of the SICEEP between the Western Distributor viaducts near the north-western corner of the existing Harbour and Bathurst Street intersection (see **Figure 3**). This assessment addresses Item 15 of the general key assessment requirements in accordance with the Director General's Requirements (DGRs) issued by the NSW Department of Planning and Infrastructure for the SICEEP on 21 January 2013.

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 SICEEP with regard to ambient nitrogen dioxide, carbon monoxide and particulate concentrations; and
- Recommendations and conclusions.

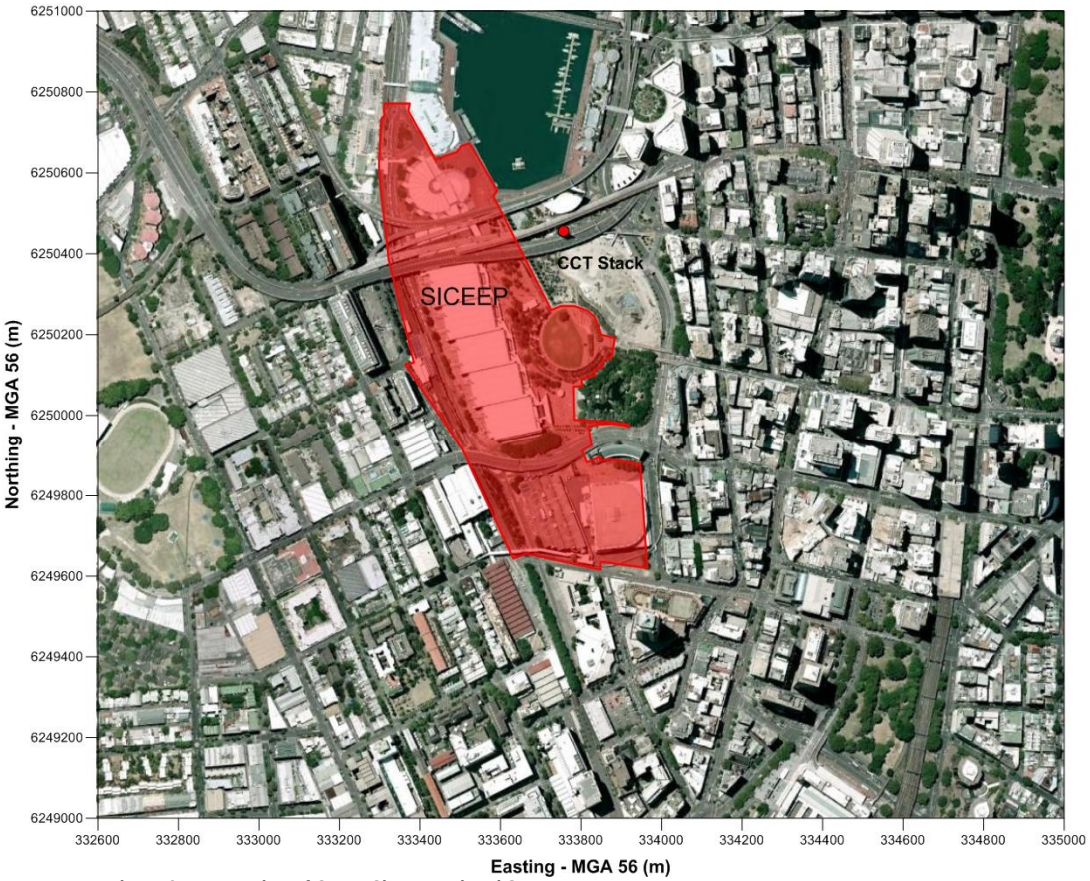

Figure 3 Location of Cross City Tunnel and SIEEP

Source: Satellite Imagery Google Earth 2009, 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 *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 120m to the east of the SICEEP site boundary at its closest point.

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.
- 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 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 resource recovery centre 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 indicate 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).

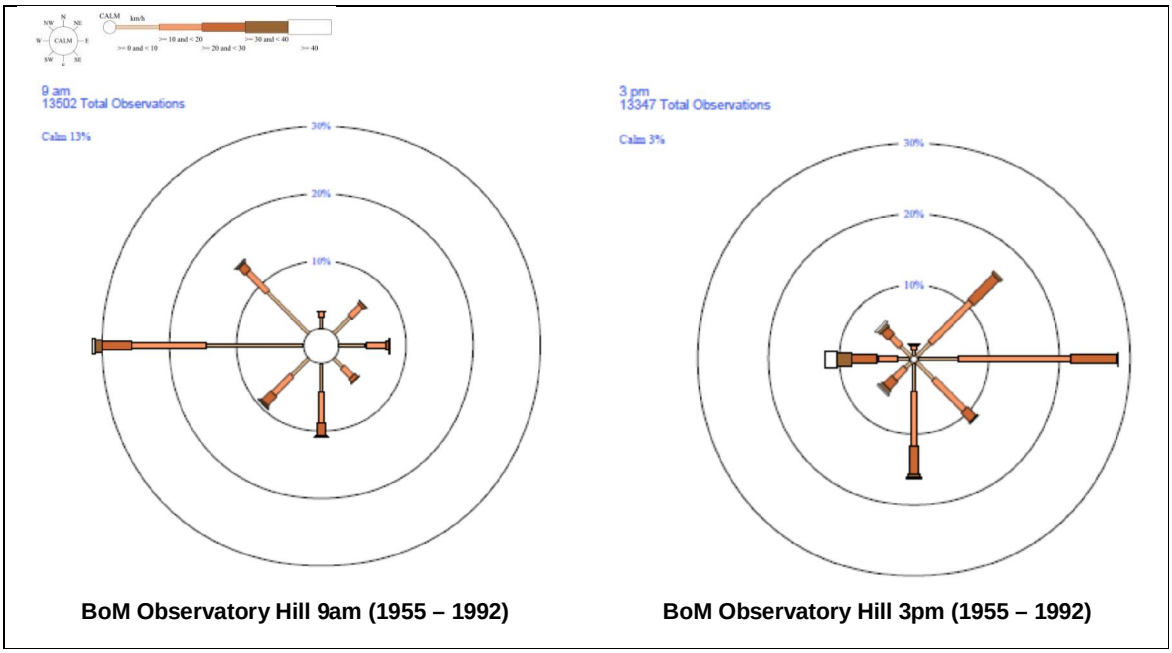

Figure 4 9 am and 3 pm wind roses from Observatory Hill (BoM, 1955 - 1992)

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 3.5 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 2012 are presented in **Table 2.** It can be seen from **Table 2** that all pollutant concentrations were within the relevant EPA criterion.

Table 2 Ambient Pollutant Concentrations at Rozelle (EPA 2012)

Pollutant	Averaging Period	Pollutant Concentration $\mu g/m^3$	EPA Criteria
Carbon monoxide (CO)	Maximum 8-hour average	3	10
Nitrogen dioxide (NO_2)	Maximum 1-hour average	187	246
	Annual average	25	62
Particulate matter (PM_{10})	Maximum 24-hour average	41	50
	Annual average	17	30

In addition to the ambient air quality monitoring data at Rozelle, monitoring was undertaken at Tumbalong Park 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**.

5.0 Impact Assessment

This qualitative assessment looks at the potential air quality impacts at sensitive receptors within the SICEEP 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 SICEEP includes both public recreational areas and a number of dwellings including a Hotel Complex approximately 340 north east of the stack and residential development approximately 400m from the stack just south of Pier Street including apartments and student accommodation.

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 nearby high-rise apartments including the Millennium Towers were predicted to suffer 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 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 and Mary Anne Street Park both prior to and for three years following the tunnel opening (DUAP 2001).

The elevated monitoring stations were located approximately 200m northeast and southeast of the CCT ventilation stack. 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 hotel complex and residential apartments would experience exceedence of the EPA criterion for CO, NO_2 and PM_{10}. Furthermore according the above BoM data winds do not commonly occur from the north and thus the proposed residential development south of Pier Street located approximately 400m south of the stack is unlikely to experience notable elevated concentrations of pollutants attributed to the ventilation stack.

The ground level monitoring station at Tumbalong Park is located within the proposed SICEEP Project area approximately 250m south of the CCT ventilation stack, and would be considered representative of the SICEEP 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**.

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/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} ($\mu g/m^3$)
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/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} ($\mu g/m^3$)
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	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 approximate 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 µg/m^3 which is equal to the OEH 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 50µg/m^3 equal to the EPA criterion was recorded. On the 20 and 21 of February 2004 exceedence were also recorded with a maximum 24-hoour concentration of 50µg/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, 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 pollutant, measured concentrations of these pollutants both prior to and following commissioning of the cross city tunnel and the associated ventilation stack are relatively similar. As such it is unlikely the ventilation stack is a major contributor to ground level pollutant concentrations within the proposed SICEEP Project area. Measured CO, 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 SICEEP Project.

6.0 Recommendations and Conclusion

This report was prepared by AECOM for Lend Lease Pty Ltd to support the State Significant Development Application (SSD 12_5752) submitted to the Minister for Planning and Infrastructure pursuant to Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

This qualitative assessment looks at the potential air quality impacts at sensitive receptors within the SICEEP 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,

A qualitative air quality assessment was undertaken on the potential air quality impacts on the SICEEP site from the cross city tunnel (CCT) vent located near the north-western corner of the Harbour and Bathurst Street intersection. Potential impacts on the SICEEP which includes a number of sensitive receivers including public recreational areas, a hotel complex and residential development from ventilation stack emissions were examined including elevated and ground level pollutant concentrations for CO, NO_2 and PM_{10}.This assessment addresses item 15 of the general key assessment requirements in accordance with the Director General's Requirements (DGRs) issued by the NSW Department of Planning and Infrastructure for the SICEEP on 21 January 2013.

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 nearby high-rise apartments were predicted to suffer 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}. Based on the CCT monitoring data it is unlikely that high rise buildings such as the hotel complex and residential development south of Pier Street within the SICEEP would experience exceedence of the EPA criterion for CO, NO_2 and PM_{10}.

One ground level monitoring station was located at Tumbalong Park within the SICEEP Project area approximately 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 SICEEP Project area. Measured CO, 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 SICEEP Project area.

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