AIR QUALITY ASSESSMENT PROCESS - CROSS CITY TUNNEL

PROTOCOL TO ADDRESS PROVISIONS OF CONDITION OF APPROVAL 274

GLOSSARY OF TERMS AND ABBREVIATIONS

- Air intake points: Locations on buildings where air may enter the building potentially exposing individuals within the building to ambient air pollution, for example openable windows, balconies and air conditioning intake points.
- Air quality goal: A concentration of a particular pollutant in the ambient air which is deemed by regulatory authorities to be the upper limit of acceptability to protect human health and amenity.
- Air Quality Impact Assessment Report: The report to be submitted with a development application documenting the methodology and results of the air quality assessment. For more information refer to section 9 of the DECC's *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*.
- Ambient air: As defined in the Ambient Air Quality National Environment Protection Measure: "ambient air means the external air environment. It does not include the air environment inside buildings or structures.'
- Applicant/s: refers to the development proponent
- Application: means a Development Application under Part 4 of the EP&A Act and Projects under Part 3A of the EP&A Act, including *Concept Plans and Project Applications.*
- Approved Methods: *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* by the NSW Department of Environment and Climate Change. The document identifies the statutory methods for modelling and assessing emissions of air pollutants from stationary sources. (http://www.environment.nsw.gov.au/air/index.htm)
- ASCII: American Standard Code for Information Interchange
- Ausplume: An air dispersion model for modelling emissions of wastes to air.
- Background concentration: The level of emissions from sources other than the CCT stack and, for nitrogen dioxide, will be dominated by emissions from vehicles on the surface road network
- Buffer volume: The three-dimensional plume that extends from the ventilation stack where there is potential for the relevant air quality goals to be exceeded depending on meteorological and atmospheric conditions.
- CALPUFF: Computer-based dispersion model that simulates emissions as a series of puffs
- CCT: Cross City Tunnel
- CFD: Computational Fluid Dynamic
- CoS: Council of City of Sydney
- DECC: Department of Environment and Climate Change, the New South Wales State Government Department responsible for protection of the environment
- DoP: Department of Planning
- Dispersion: The process of emissions being spread throughout an increasing volume of the atmosphere and thereby decreasing their concentration.
- EIS: Environmental Impact Statement

- Level 1 Assessment: As defined by the Approved Methods, it is a conservative and less specific assessment that involves screening-level dispersion modelling based on worst-case input data.
- Level 2 Assessment: As defined by the Approved Methods, it is a refined dispersion modelling technique that uses site specific input data to give a more accurate impact estimate than a Level 1 Assessment.
- NO_x: Oxides of nitrogen
- NO_2: Nitrogen Dioxide. NB. This is the determining pollutant for the Cross City Tunnel Stack emissions.
- NO: Nitrogen monoxide or more commonly nitric oxide
- Plume: The volume of emissions that moves through the air and away from the Cross City Tunnel Stack.
- Potential adverse impact zone of the plume: The three-dimensional extent of the plume in which the predicted concentration plus background exceeds the air quality goal – equivalent to the buffer volume
- Proposed building/s: refers to a new building or additions to an existing building
- RTA: Roads and Traffic Authority
- SEIS: Supplementary Environmental Impact Statement
- SHFA: Sydney Harbour Foreshore Authority
- TAPM: The Air Pollution Model
- $\mu g/m^3$: Micrograms per cubic metre

1. Introduction

1.1. Background

The Cross City Tunnel (CCT) project includes twin two-lane road tunnels for traffic travelling east-west across the city. It has been constructed between Darling Harbour and Kings Cross and links the Western and Eastern Distributors. Vehicle emissions from the tunnel are removed via a ventilation stack located at the Western end of the tunnel, adjacent to the Western Distributor near Harbour Street.

The CCT was constructed and is operated in accordance with the planning approval for the Cross City Tunnel, issued by the then Minister for Planning in October 2001, and modified by the Minister in December 2002, under Part 5 of the *Environmental Planning and Assessment Act* 1979. Environmental assessment for the CCT project indicated that emissions from the ventilation stack were likely to form a "plume" in the initial phase of dispersion, and the consideration of the likely characteristics of this "plume" formed an important part of the assessment.

Throughout the day, depending on tunnel traffic numbers, the ventilation stack emissions can vary and contain levels of pollutants above ambient air quality goals. The stack has been designed so that at ground level, the pollutant concentrations due to the stack are very low. At elevated receptors, before the plume has had an opportunity to significantly disperse, the plume has the potential to impact on nearby buildings under particular atmospheric conditions. This is only a potential problem if the building in question has air intake points such as balconies, openable windows or air conditioning intakes, which are in the path of the plume.

A less significant but still important consideration, is the potential for any proposed nearby buildings to affect the behaviour of the plume to such an extent, that existing buildings or ground level receptors are impacted at levels above the air quality goals.

In the Environmental Impact Statement (EIS) for the project, a detailed assessment was carried out on the potential impacts on existing buildings in the proximity of the stack through computer–based dispersion modelling and wind tunnel testing using a specifically constructed scale model. All plausible meteorological conditions were considered. This assessment was extensively reviewed by regulatory authorities and potential impacts were found to be acceptable at all existing buildings.

During the assessment process, the original location proposed for the stack was subsequently moved and the height increased from 39 to 60 metres above local ground levels. The impacts at critical elevated receptors were examined and the potential impacts found to be acceptable at existing buildings.

Condition 274 of the planning approval requires the development of an air quality assessment process, for inclusion in a development control plan or other appropriate planning instrument, to assist in the consideration by applicants and consent authorities of potential air quality effects associated with development proposals in the vicinity of the ventilation stack.

Condition 274 is in the following terms:

"The Proponent shall assist the relevant Councils in developing an air quality assessment process for inclusion in a Development Control Plan or other appropriate planning instrument, in considering planning and building approvals for new development in the area which would be within a potential three (3) dimensional zone of affectation (buffer volume). This process shall include procedures for identifying the width and height of buildings that are likely to be either affected by the plume from the ventilation stack or affect the dispersion of the plume from the ventilation stack through

building wake effects. The Proponent shall meet all costs for the development of this process and any necessary amendments to the planning instrument(s) required to implement the process."

1.2. Development of Protocol

This protocol has been developed by the RTA as proponent in consultation with CoS, SHFA and DoP , to meet Condition 274 and addresses the following:

- buildings potentially affected by the plume from the ventilation stack, being those buildings where, at any air intake point on the building, the predicted total concentration, due to the ventilation stack emissions plus the background pollutant level, is above the air quality goal; and
- buildings which affect the dispersion of the plume and expand the plume footprint so that the plume potentially affects an existing building or ground level receptor, being those existing buildings or ground level receptors where, at any air intake point, the predicted total concentration, due to the ventilation stack emissions plus the background pollutant level, is above the air quality goal**.**

Whilst the full range of pollutants in the stack emissions, including odorous compounds were assessed in the EIS, nitrogen dioxide was found to be the determining pollutant, that is, if the goal or air quality assessment criterion for nitrogen dioxide is satisfied then the goals for all other pollutants would also be satisfied.

The air quality goal for nitrogen dioxide is 246 micrograms per cubic metre ($\mu g/m^3$) based on a one hour average. In this protocol:

- A background concentration for nitrogen dioxide of 96 $\mu g/m^3$ is used based on the approach adopted in the EIS; and
- To meet the goal of 246 $\mu g/m^3$ the contribution from the CCT stack cannot therefore exceed 150 $\mu g/m^3$.

NB. In the EIS, a background nitrogen dioxide concentration of 100 $\mu g/m^3$ was assumed based on historic air quality monitoring data In this protocol the background value has been refined to 96 $\mu g/m^3$ to provide a precise agreement with the air quality goal of 246 $\mu g/m^3$ based on a maximum predicted concentration of 150 $\mu g/m^3$. Monitoring at elevated receptors conducted in 2005 and 2006 during the initial operational phase of the CCT, showed that over 99.5% of hourly measurements of nitrogen dioxide were below 96 $\mu g/m^3$

1.3. Protocol Assessment Process

The protocol has the following parts:

Part 1: Air Quality Assessment Trigger

Part 1 establishes when an Air Quality Assessment is required to be undertaken for a *proposed building.*. It comprises an initial screening procedure that has been developed on the basis of the height of the proposed building, its distance from the CCT Stack and modelling results for existing buildings. This screening procedure identifies:

1. Proposed buildings which have the potential to be adversely affected by the CCT Stack plume; and

2. Proposed buildings which have the potential to affect the CCT Stack plume causing the plume to adversely affect another building or ground level receptors .

The screening procedure is intentionally conservative so that there can be confidence that the potential building would not be adversely impacted upon by emissions from the CCT Stack or affect the CCT Stack plume causing adverse impact elsewhere.

Part 2: Air Quality Assessment

Part 2 provides advice and guidance on the Air Quality Assessments, using air quality models, that are required if Part 1 determines that the proposed building is in the potential adverse impact zone of the stack plume. The modelling studies are based on the NSW Department of Environment and Climate Change (DECC) *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*, 2005 (Approved Methods). Air Quality Assessments will require input from a specialist air quality consultant.

The modelling study in Part 2 of the Protocol features two levels of Air Quality Assessment:

1. Level 1 Air Quality Assessment: A simple and conservative Level 1 Assessment, as defined by the DECC, is undertaken first and may be all that is required to determine whether the building is affected by the plume or causes the plume to adversely affect another building or ground level receptor. The modelling inputs to this Level 1 Assessment should be based on a simplified version of the modelling carried out in the EIS and Supplementary Report.
2. Level 2 Air Quality Assessment: If the building is found to be affected by the plume on the basis of the Level 1 Assessment, a more advanced Level 2 Assessment will be required. There is a variety of models and modelling techniques which may be appropriate. Examples include the AUSPLUME model, the CALPUFF or TAPM models, Computational Fluid Dynamics (CFD) modelling or physical modelling such as wind tunnel modelling. Detailed information on emissions, meteorology and other modelling parameters as used in the EIS and Supplementary Report are available from the consent authorities.

It is recommended that applicants consult with the DECC on appropriate modelling methodologies.

1.4. Purpose and Limitations

It is intended that the protocol will be used by consent authorities and applicants initially to assist consideration of whether the consent authority will require specialised air quality assessment in order to determine an application with respect to a particular development proposal. In addition, it is also intended that the protocol be used as a trigger for communication and consultation between the consent authorities and RTA in regard to the submission and progress of such development proposals. In this regard, it is important to note that if an applicant proposes, or a consent authority requires, specialised air quality assessment for a particular development proposal, then the nature and scope of that assessment should be determined on a case-by-case basis. For example, it may be appropriate to use dispersion modelling, wind tunnel testing, some other method of assessment, or a combination of methods of assessment.

Unless otherwise specified, all building heights to which the protocol refers are heights above the lowest pre-development ground level of the development site.

1.5. Revisions to the Protocol

The protocol was prepared initially by RTA in 2004, during construction of the CCT, with subsequent input from the (DoP), (SHFA) and (CoS).

The protocol should be reviewed from time to time and, if necessary, revised if there are substantial adverse changes to motor vehicle fleet emissions or background concentration of pollutants in the CBD.

1.6. Consultation with RTA

The consent authority should consult with RTA in any of the following events:

a) An application for a *proposed building* has been submitted and, having regard to the terms of this protocol, it is determined that an Air Quality Assessment should be carried out for the proposed development;

b) An application for a *proposed building* has been submitted, and irrespective of whether or not an Air Quality Assessment has been or will be carried out for the proposed building development, the proposed development may affect the ability of either of RTA's two ambient monitoring stations for the CCT Stack to operate in accordance with AS2922 – 1987 or AS2923 – 1987. If the proposed building is within 200 metres of either of the two existing RTA monitoring stations, located at Tumbalong Park and Maryann Park, the RTA must be notified. No further action need to be taken by the applicant. Refer to Appendix A for locations of the monitoring stations.

c) A consent authority has received an Air Quality Assessment in relation to a development proposal to which "a)" or "b)" above relates.

Consultation relating to the above matters is in addition to the current policies and procedures in operation between the consent authorities and RTA relating to development proposals for roads and traffic related matters.

For the purposes of enabling effective consultation with RTA, the consent authority:

a) will provide RTA with copies of the documents relating to the development proposal which the consent authority has received and which could be relevant in any way to any of the matters outlined in "a)", "b)" or "c)" above; and

b) will not make any determination regarding the development proposal until the consent authority has provided the RTA with a period of 28 days to review and comment on the *proposed building* development.

1.7. Consultation with the DECC

The applicant should consult with the DECC regarding the appropriate methodology to assess the impacts of the proposal. In the first instance, the DECC's Approved Methods (DEC, 2005) provide information on acceptable approaches. The applicant would need to consult further with the DECC if a different assessment methodology from those outlined in the Approved Methods is proposed.

1.8. Consent authorities

For the purposes of this protocol, the consent authority is either the Council of the City of Sydney (COS), Central Sydney Planning Committee or Minister for Planning and his delegates.

Enquiries about the protocol and air quality assessment for a particular development proposal should be directed to the relevant consent authority for that proposal.

2. Protocol Part 1: Air Quality Assessment Trigger

2.1. Aim

Part 1 of the protocol is intended to identify, by reference to building height and proximity to the CCT Stack, proposed buildings which have the potential to be adversely affected by the plume of emissions from the CCT Stack and/or have the potential to affect the dispersion of the plume. A *proposed building* identified as potentially affected by, or that affect, the plume trigger the need to undertake some level of air quality assessment involving air quality dispersion modelling.

2.2. Trigger for Air Quality Assessment

The EIS established an indicative *buffer volume* based on computer and wind tunnel modelling. On the basis of this and subsequent studies, a conservative *potential adverse impact zone* has been determined for building heights within specified distances of the stack.

Table 1 below includes height thresholds for buildings within a particular distance from the CCT Stack. A *proposed* building of any width which exceed the height threshold are within the *potential adverse impact zone.*

For a *proposed building* within the *potential adverse impact zone* an air quality assessment will need to be undertaken and an application will require a Level 1 Air Quality Impact Assessment Report or a Level 2 Air Quality Impact Assessment Report in accordance with Part 2 of the Protocol.

Table 1 Table for determining whether a specific air quality assessment is triggered

Distance of proposed building from stack* (metres)	Height of a proposed building** in the *potential adverse impact zone* of the plume (metres)
0 - 50	>25
50 - 100	>30
100 - 150	>40
150 - 200	>50
200 - 250	>60
250 - 300	>70
300 - 400	>90
400 - 500	>100
> 500	no restriction due to CCT stack plume

* To assist applicants a map showing the location of the CCT Stack has been included in Appendix B.
**Building heights are the height above the lowest pre-development ground level of the development site.

In assessing the potential for adverse impacts it is noted that there are already buildings of at least the heights shown in Table 1 within the designated distances from the stack. Therefore it is considered that the plume is unlikely to affect, or be significantly affected by, a *proposed building* with heights less than those shown in Table 1.

3. Protocol Part 2: Air Quality Assessment

3.1. Aim

Part 2 of the protocol broadly describes the type of air quality assessment which would be required if the building is in the potential adverse impact zone of the CCT Stack plume as determined by Part 1 of the Protocol. This section provides guidance to agencies and consultants on the level of assessment.

The procedures discussed follow the approach outlined in the NSW DECC's Approved Methods.

3.2. Level 1 Assessment

Background

A Level 1 Assessment involves air quality dispersion modelling and uses a number of conservative assumptions regarding emissions and meteorology to provide a simple means of assessing projects to determine if a more detailed assessment of potential air quality impacts is required.

Pollutant emission rates and air flow from the CCT stack will vary throughout the day depending on traffic flow. Low, medium and high emission scenarios have been determined for the Level 1 modelling purposes. These should be used in conjunction with meteorological data and building dimensions to determine if the proposed or existing buildings are potentially adversely affected by the plume from the CCT Stack as defined by the Air Quality Goal for NO_2.

The emission scenarios are based on modelling undertaken for the CCT stack (Holmes Air Sciences, 2002) and include the assumption that 20% of the oxides of nitrogen are emitted as nitrogen dioxide.

Assessment

In undertaking the assessment an applicant is to assume that air intake points of the proposed building are facing the CCT Stack and therefore potentially receive the highest predicted concentrations. An applicant is to use the PRIME algorithm (Schulman and Scire, 1996) to assess the potential adverse impacts on buildings and at ground level from the dispersion of the plume by a proposed building.

The Level 1 Assessment is to model the effects of the plume on the proposed buildings and assess whether the proposed building:

1. is potentially adversely impacted by the plume; and
2. disperses the plume causing potential adverse impact on existing buildings or at ground level.

The modelling is to use the following information:

1. Level 1 meteorological data as outlined in the Approved Methods and available from the consent authorities (Appendix C);
2. Relevant building dimensions including height, cross sectional area and distance from the stack; and
3. assumptions for emission conditions as shown in Table 2 below.

A building or a ground level receptor will be considered to be potentially adversely impacted by the plume if the Level 1 Assessment modelling shows the predicted concentration of emissions, including the background concentration of 96 μg/m³ of NO_2, exceeds the Air Quality Goal of 246 μg/m³ of NO_2.

Table 2 Assumptions for low, medium and high emission conditions for CCT stack

Scenario	NO_2 emission rates (grams per second)	Exit velocity from stack (metres per second)
Low emissions (night-time)	0.4	5
Medium emissions (off-peak hour)	1	11
High emissions (Peak hour)	1.8	21

Report

If the results of the Level 1 Assessment show that there is no potential adverse impact from the plume on the proposed building, existing buildings or at ground level then an Air Quality Impact Assessment Report should be prepared to accompany the Application. The report is to be consistent with the requirements specified in the Approved Methods and should clearly document the methodology used and the results of the assessment. The report should include but not be limited to the following information:

- Site plan to scale showing location and dimensions of the proposed building and nearby buildings;
- Assumed emission conditions for the ventilation stack in tabular form;
- Model used and meteorological condition assumed; and
- Predicted concentrations at all air intake points (assuming air intake points are facing the CCT Stack), presented in tabular form.

3.3. Level 2 Assessment

Background

If the results of the Level 1 Assessment show that the building is potentially adversely affected by the plume or affects the plume causing potential adverse impact on an existing building or at ground level a more detailed Level 2 Assessment, as outlined in the Approved Methods, is to be undertaken.

A Level 2 Assessment uses refined modelling techniques and site-specific input data. The Level 2 Assessment methodologies consist of techniques that provide more detailed treatment of physical and chemical atmospheric processes, require more detailed and precise input data, and provide more specialised emission estimates. As a result they provide a more refined and, at least theoretically, a more accurate estimate of potential impact.

As stated in the Approved Methods, the use of an approach other than those described in that document is to be discussed with the Air Technical Advisory Services Unit of the DECC.

Information on emissions, terrain, meteorology and building configurations, as included in the Holmes Air Sciences 2002 report, are held by the consent authorities and can be provided on request. Details of the information available are included in Appendix C.

Assessment

The Level 2 Assessment is to model the effect of the plume on the proposed building and assess whether the proposed building:

1. is potentially adversely impacted by the plume; and
2. disperses the plume causing potential adverse impact on existing buildings or at ground level.

A building or ground level receptor will be considered to be potentially adversely impacted by the plume when the predicted concentration of emissions exceeds the Air Quality Goal of 246 $\mu g/m^3$ of NO_2.

Report

If the results of the Level 2 Assessment show that there is no potential adverse impact from the plume on the proposed building, existing buildings or at ground level then an Air Quality Impact Assessment Report should be prepared to accompany the Application. The report is to be consistent with the requirements specified in the Approved Methods and should clearly document the methodology used and the results of the assessment.

A Level 2 Air Quality Impact Assessment Report is to include the following:

- *Emissions*
  - Detailed discussion of the methodology used to calculate the expected pollutant emission rates from the CCT Stack.
  - Tables showing all release parameters of CCT Stack emissions (eg temperature, exit velocity, stack dimensions , emission concentrations and rates).
- *Meteorological data*
  - A detailed discussion of the prevailing dispersion meteorology at the site. The report should typically include wind rose diagrams — an analysis of wind speed, wind direction, stability class, ambient temperature and mixing height — and joint frequency distributions of wind speed and wind direction as a function of stability class.
  - A description of the techniques used to prepare the meteorological data into a format for use in the dispersion modelling.
- *Characteristics of proposed and all nearby buildings*
  - To include location, height, width and location of all air intakes.
- *Background air quality data*
  - Tables summarising the ambient monitoring data.
- *Dispersion modelling*
  - A detailed discussion of all parameters used in the dispersion modelling and the manner in which topography, building wake effects and other site-specific peculiarities that may affect CCT Stack plume dispersion have been treated.

- A detailed discussion of the methodology used to account for any atmospheric pollutant formation and chemistry.
- A detailed discussion of air quality impacts based on predicted concentrations at relevant sensitive receptors including background concentrations.

Relevant Documents

Note that the following documents need to be used in conjunction with Part 2 of the Protocol:

Holmes Air Sciences (2002)

"Proposed alteration to the Modified Activity as outlined in the Supplementary Environmental Impact Statement for the Cross City Tunnel" October 2002

NSW DEC (2005)

"Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW", August 2005

Schulman LL and Scire JS (1996)

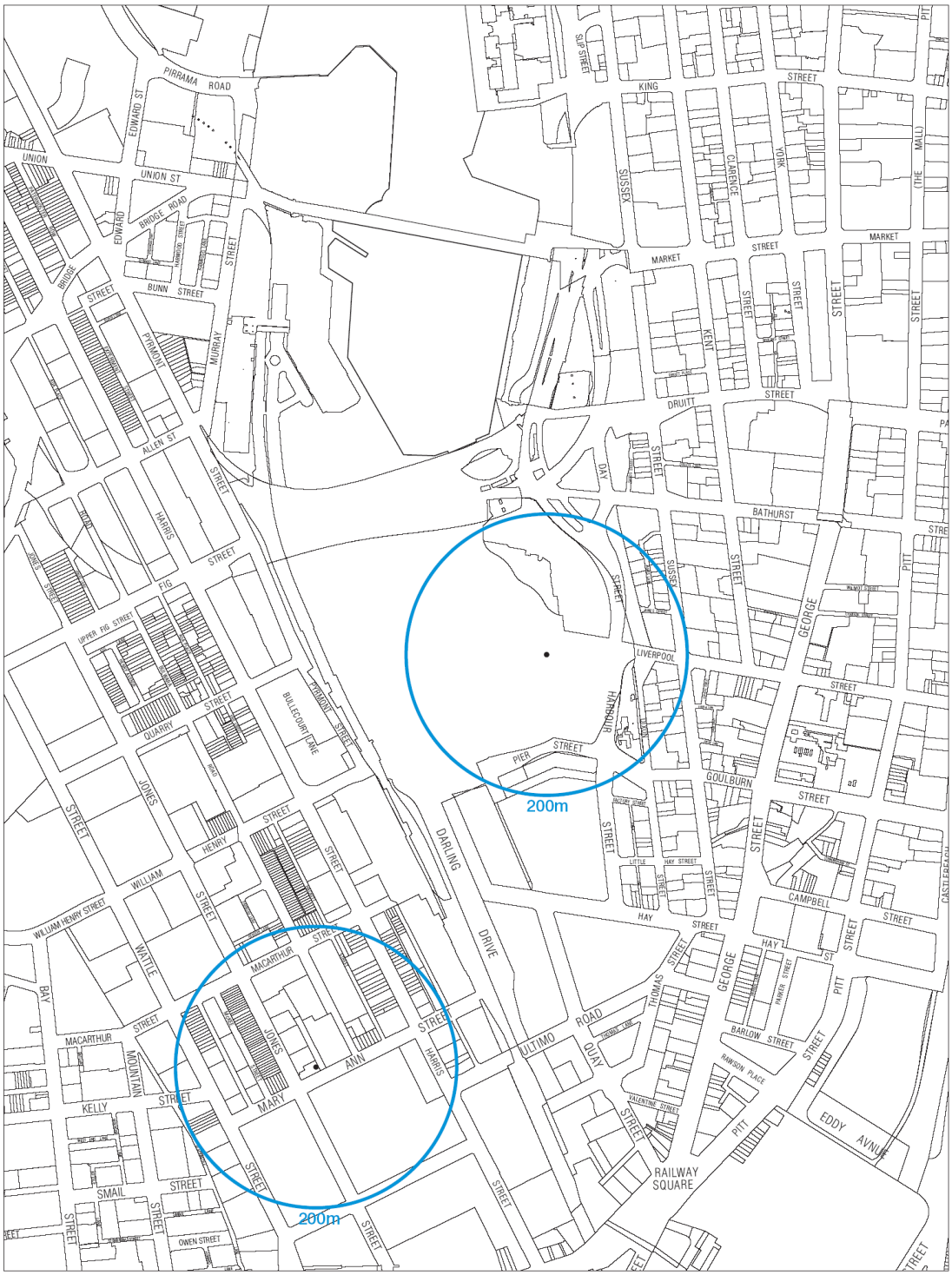
"The development of the Plume Rise Model Enhancement (PRIME): The EPRI Plume Rise and Downwash Modeling Project " Paper 6.1, Ninth Joint Conference on Applications of Air Pollution Meteorology with A&WMA, January 28-February 2, 1996,Atlanta GA.

Tikvart, JA (1996)

"Application of Ozone Limiting Method" Model Clearinghouse memorandum No. 107, US Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC USA.

Appendix A

Map showing location of Monitoring Stations and 200m radii

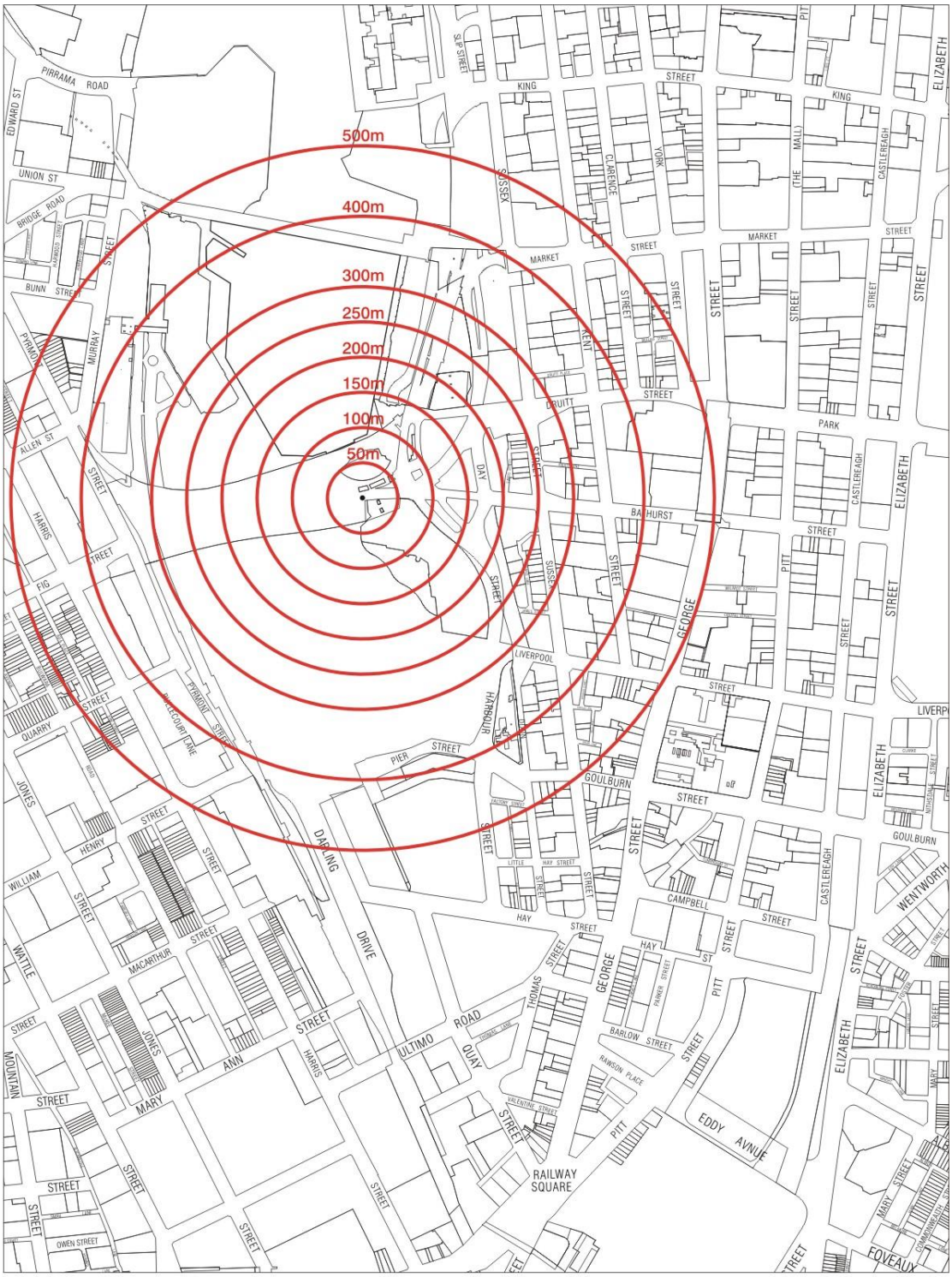


Cross City Tunnel - Ambient Air Monitoring Stations

- Location of monitoring stations
- Radii from monitoring stations

Appendix B

Map showing distances from the CCT Stack



Appendix C

List of reports and data held by CoS and DoP relating to the modelling of emissions from the CCT Stack

Appendix C

Documents and information held by CoS and DoP

1. Air quality assessment report supporting the SEIS entitled ”Proposed alteration to the Modified Activity as outlined in the Supplementary Environmental Impact Statement for the Cross City Tunnel” prepared by Holmes Air Sciences, October 2002.
2. Input modelling files in AUSPLUME and CALPUFF format including details of significant nearby buildings
3. Meteorological data in AUSPLUME modelling format, collected at Goat Island in 1984 and used in the SEIS
4. Meteorological data in ASCII, AUSPLUME and CALPUFF format collected in Darling Harbour as part of the approval conditions for the CCT
5. Terrain data for Darling Harbour and surrounds in a form suitable for AUSPLUME and CALPUFF modelling
6. Ambient monitoring data from Darling Harbour collected for the CCT approval process.
7. Stack emissions data collected during operation of the CCT
8. Traffic data collected during operation of the CCT
9. Full documentation of the modelling assumptions, including fleet composition and projected improvement in fleet emissions