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North Ryde Station Precinct, M2 Site

State Significant Development

Construction Assessment Acoustics & Air Quality Report

Report Number 610.13891-R1

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UrbanGrowth NSW
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State Significant Development

Construction Assessment Acoustics & Air Quality Report

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Table of Contents

Table of Contents

Table of Contents

TABLES

FIGURES

Table of Contents

APPENDICIES

1 INTRODUCTION

1.1 Overview

SLR Consulting Australia Pty Ltd (SLR) has been engaged by NPC on behalf of UrbanGrowth NSW to conduct a construction noise and vibration impact assessment and construction air quality assessment in support of a State Significant Development Application (SSDA) for the proposed M2 site which forms part of the North Ryde Station Precinct (NRSP).

The SSDA comprises the following subdivision, public domain and infrastructure works:

- Construction of primary roads and key intersections.
- Construction and provision of key pedestrian and cycle connections, including a pedestrian bridge over Delhi Road to the North Ryde Station.
- Public domain works including landscaping
- Open space lots
- Drainage and utility infrastructure

1.2 Terminology

Specific acoustic and air quality terminology is used within this assessment. An explanation of common terms used is included as **Appendix A** and **Appendix B**.

2 DIRECTOR GENERAL REQUIREMENTS

On 19 February 2014, the Minister for Planning and Infrastructure revised the Director General Requirements (DGRs) for the SSDA to include the following requirements related to the assessment of noise and vibration and air quality during construction:

> *"The EIS must address the key issues set out in 1 to 13 below:*
>
> *13. Construction and Operational Impacts*
>
> *Provide an assessment of construction and operational impacts and identify appropriate mitigation measures in accordance with the relevant guidelines. This should include (but not limited to) the following matters:*
>
> *Construction traffic impacts, including an estimation of truck movements expected during the construction phase.*
>
> *Measures to manage, where appropriate, accessibility, amenity and safety of public transport use, walking and cycling, and emergency vehicle access during construction works*
>
> - *Construction noise*
> - *Air quality*
> - *Water quality*
> - *Soil and erosion*
> - *Ground water impact*
> - *Impacts on groundwater dependent on ecosystems and*
> - *Waste*

3 PROJECT DESCRIPTION

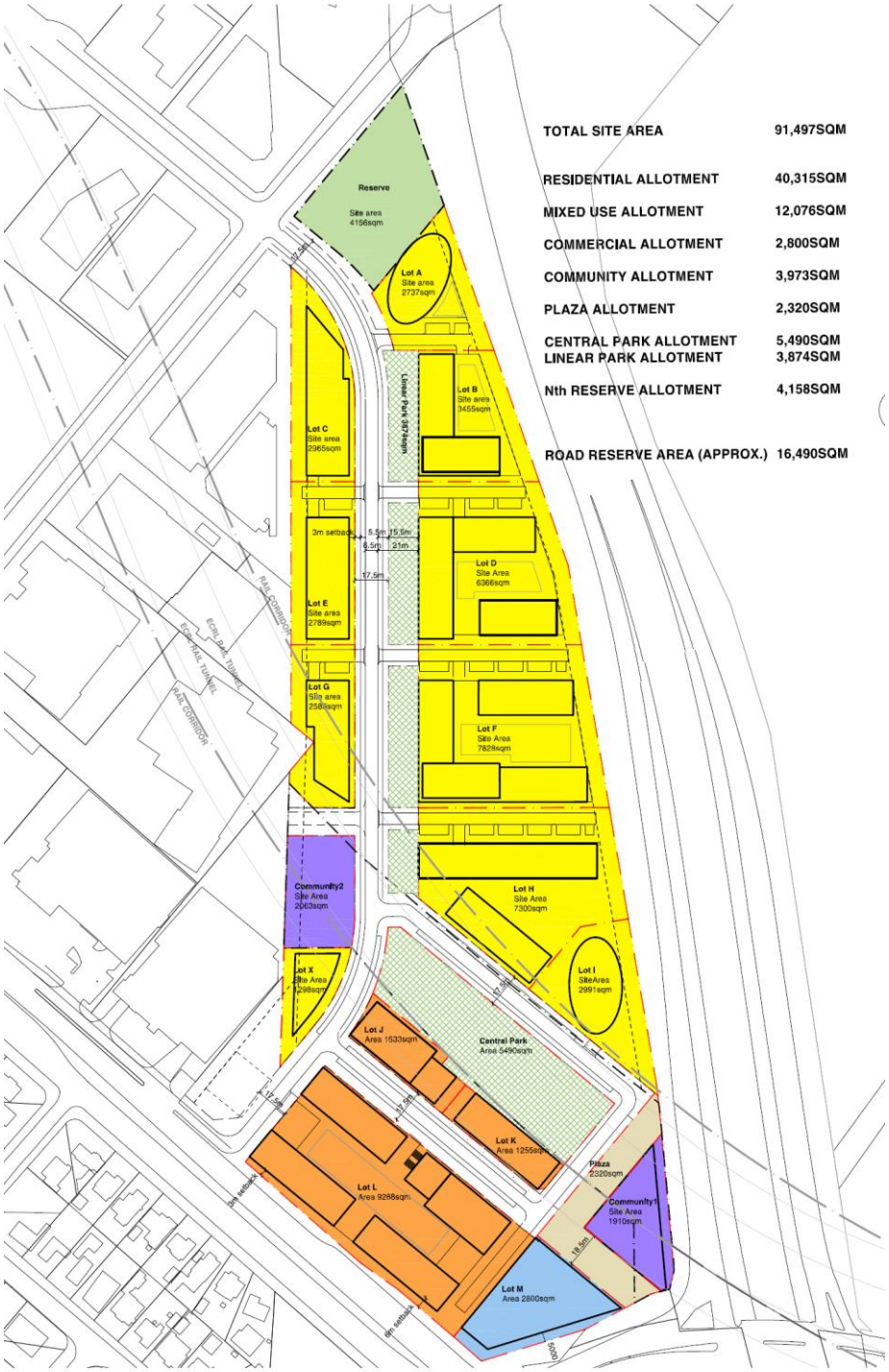
3.1 Overview

The M2 site forms part of the NRSP located within the Macquarie Park Corridor and comprises a total land area of approximately 91,500 square meters (m^2) which includes the following land uses:

- Residential 40,315 m^2
- Mixed Use 12,076 m^2
- Commercial 2,800 m^2
- Community 3,973 m^2
- Plaza 2,320 m^2
- Parks and Reserves 30,012 m^2

The site is bounded by Epping Road, Delhi Road and the M2 Motorway at North Ryde. An outline of the site is presented in **Figure 1**.

Figure 1 Project Site



The surrounding area is predominantly of a commercial nature. Residential properties are however situated to the immediate south west of the site across Epping road.

3.2 Sensitive Receivers

3.2.1 Noise and Vibration Sensitive Receivers

The sensitivity of occupants to noise and vibration varies according to the nature of the occupancy and the activities performed within the affected premises. For example, recording studios are more sensitive to noise and vibration than residential premises, which in turn are more sensitive that typical commercial premises. The sensitivity also depends on the existing environment. For example, higher noise levels may be acceptable in urban areas compared with suburban areas. Receivers may be classified into the following categories:

- Residential
- Educational
- Hospitals
- Places of worship
- Commercial
- Industrial
- Other (for example museums, heritage items, recreation areas).

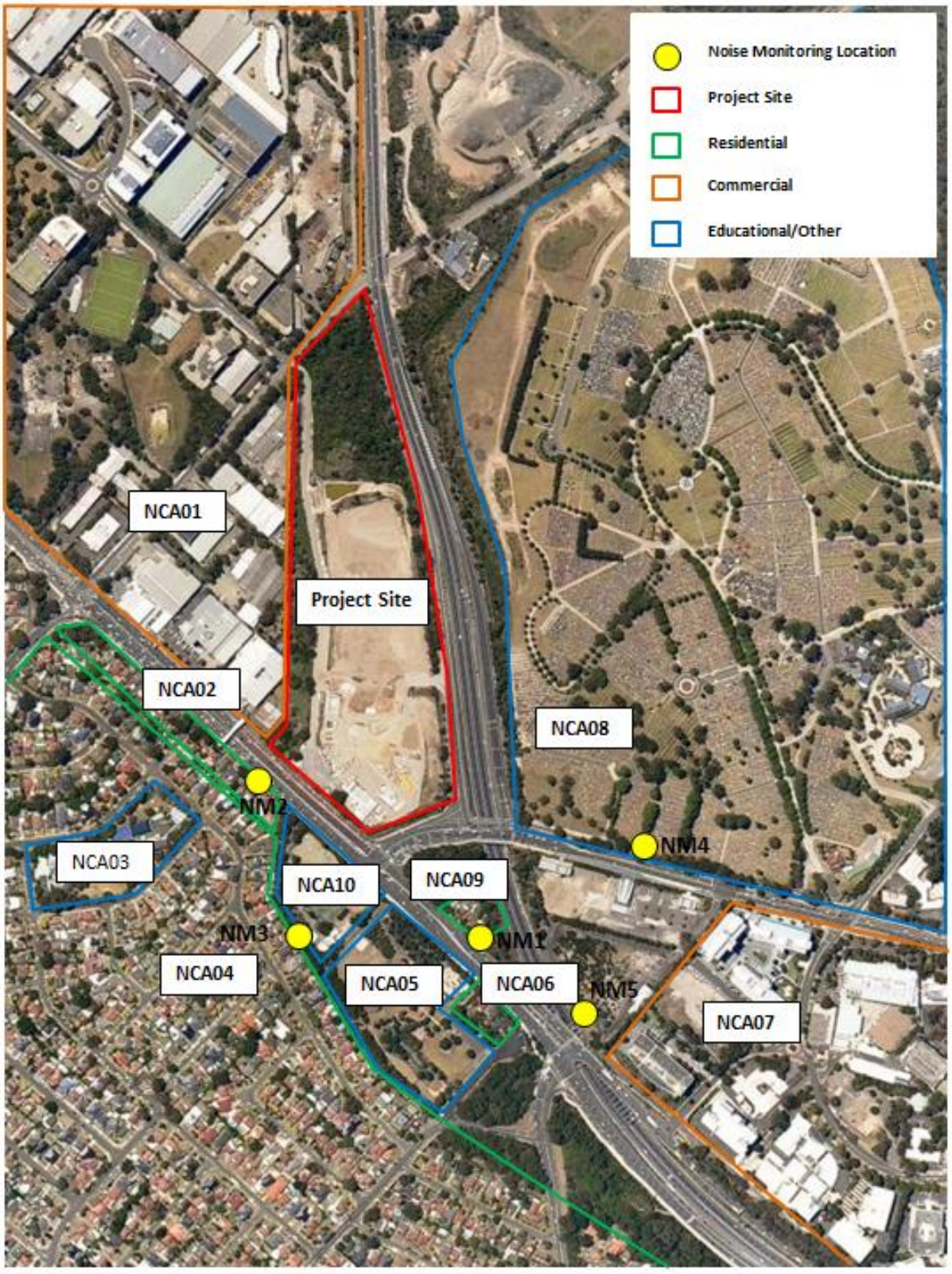
An indicative site layout showing designated Noise Catchment Areas (NCAs) within the study area is shown in **Figure 2**. **Table 1** presents a summary of each NCA identified within the project area.

Table 1 Noise Sensitive Receivers for M2 Construction Site

Noise Catchment Area	Receiver Type	Description
NCA 01	Commercial	Commercial Premises to the west of the project site.
NCA 02	Residential	Residential receivers to the south west of the project site.
NCA 03	Educational	Truscott Street Public School, North Ryde
NCA 04	Residential	Residential Receivers to the south west of the project site. Set back from Epping Road.
NCA 05	Other (Active Recreational Area)	Blenheim Park
NCA 06	Residential	Residential Receivers to the south of the project area on Epping Road.
NCA 07	Commercial	Commercial Premises to the south east of the North Ryde Station
NCA 08	Other (cemetery)	Macquarie Park Cemetery and Crematorium, Delhi Road, Macquarie Park
NCA 09	Residential	Residential Receivers to the South East of the project area on Epping Road.
NCA 10	Other (Active Recreational Area)	Tennis World, Epping Road

Note: It is understood that NCA 09 and NCA 10 are being developed and may not be considered to be sensitive receivers at the time of construction of the subject project.

Figure 2 Noise Sensitive Receivers and Monitoring Locations



3.2.2 Air Quality Sensitive Receivers

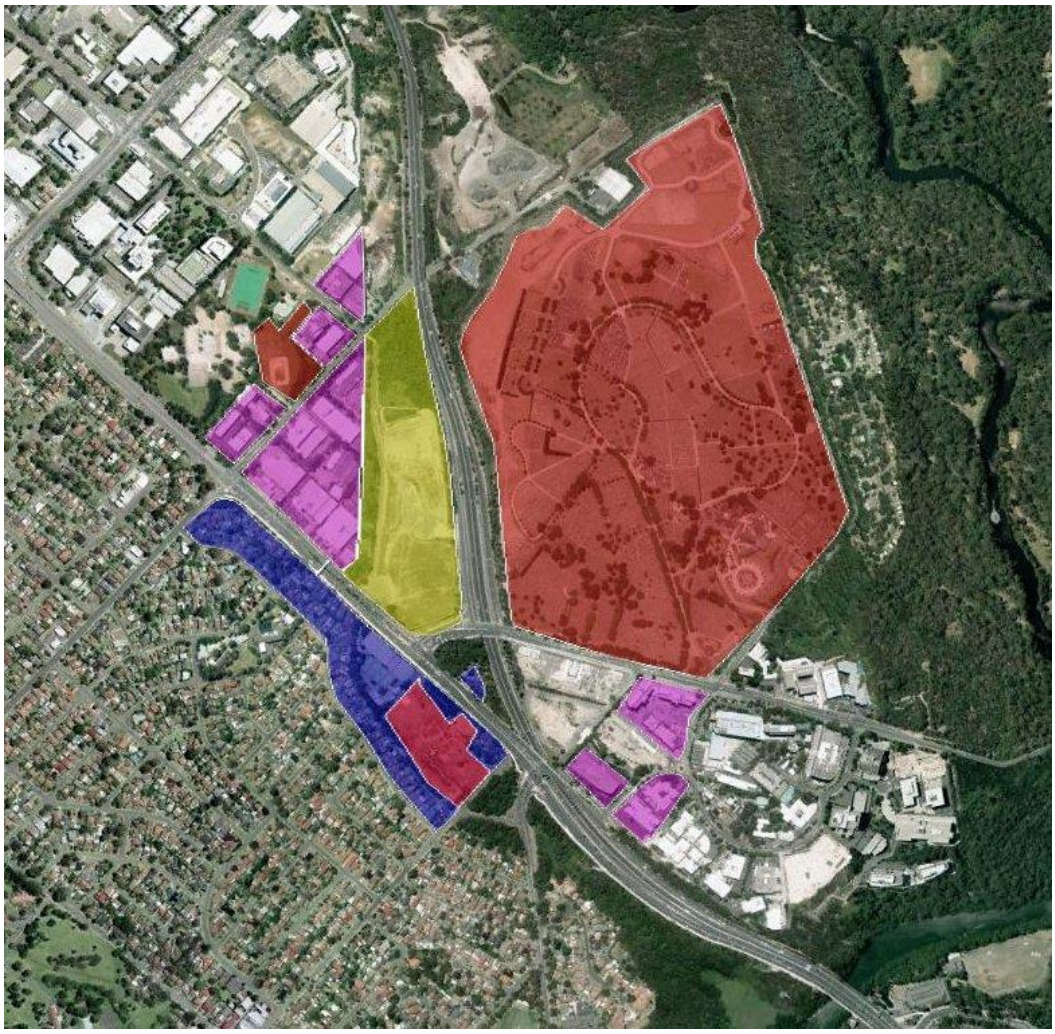
Construction works are proposed within each of the areas identified in **Figure 1** and the activities within each area have the potential to generate emissions to air.

Potentially sensitive receptor locations have been identified through desktop mapping studies and these are listed below. These are categorised according to their land-use type (i.e. residential, commercial, industrial, special and recreational). Refer to **Figure 3** for the location of these land uses.

Table 2 Air Quality Sensitive Receptors for M2 Construction Site

NRSPP Site	Receptor Type	Distance / Direction from Site (m / degrees true)	Nearest Road Location
M2 Site	Residential Area 1	40 / SW	Delhi Road
	Residential Area 2	100 / SE	Epping Road & M2 Freeway
	Commercial 1	10 / W	Epping & Wicks Roads
	Commercial 2	20 & 165 / NW	Wicks Road
	Industrial Area	100 / NE	Wicks Road
	Special Use (Cemetery)	100 / E	M2 Freeway
	Recreational Area 1	100 / NW	Wicks Road
	Recreational Area 2	90 / S	Epping Road

Figure 3 Air Quality Sensitive Receptor Areas



Courtesy of Google Earth

Note:

Yellow = Proposed Development Site
Blue = Residential Land Use
Purple = Commercial Land Use
Red = Recreational and Special Land Use

4 IMPACT ASSESSMENT PROCEDURES

4.1 Assessing Construction Noise

4.1.1 Construction Noise Metrics

The noise metrics used to describe construction noise emissions in the assessments are:

$L_{A1(1minute)}$ The "typical maximum noise level" for an event, used in the assessment of potential sleep disturbance during night-time periods. Alternatively, the assessment may be conducted using the L_{Amax} or maximum noise level.

$L_{Aeq(15minute)}$ The "energy average noise level" evaluated over a 15-minute period. This parameter is used to assess the potential construction noise impacts.

L_{A90} The "background noise level" in the absence of construction activities. This parameter represents the average minimum noise level during the daytime, evening and night-time periods respectively. The $L_{Aeq(15\ minute)}$ construction Noise Management Levels are based on the L_{A90} background noise levels, which are equivalent to the Rating Background Level or RBL.

The subscript "A" indicates that the noise levels are filtered to match normal human hearing characteristics (ie A-weighted).

4.1.2 Noise Management Levels

The *Interim Construction Noise Guideline* (ICNG) (DECC, 2009) contains procedures for management of noise in relation to construction type activities for residential and other sensitive receivers by defining Noise Management Levels (NMLs) and how they are applied. A summary of the derivation of NMLs from the ICNG is contained in **Table 3**, **Table 4** and **Table 5**.

Table 3 Interim Construction Noise Guideline (Residents)

Time of day	Management level $L_{Aeq(15minute)}$	How to apply
Recommended standard hours Monday to Friday 7am to 6pm Saturday 8am to 1pm No work Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured LAeq (15 min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dBA	The highly noise affected level represents the point above which there may be strong community reaction to noise. • Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences. 2. if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

Outside recommended standard hours	Noise affected RBL + 5 dB	A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community.

Table 4 Interim Construction Noise Guideline (Other than Residents)

Land Use	**Management Level, $L_{Aeq(15minute)}$ (applies when properties are being used)**
Classrooms at schools and other educational institutions	Internal noise level 45 dBA
Hospital wards and operating theatres	Internal noise level 45 dBA
Places of worship	Internal noise level 45 dBA
Active recreation areas[1]	External noise level 65 dBA
Passive recreation areas[2]	External noise level 60 dBA
Community Centres	Depends on the intended use of the centre Refer to the recommended 'maximum' internal levels in AS2107 for specific uses.

Note1: Characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion.

Note 2: Characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation.

Table 5 Interim Construction Noise Guideline (Commercial and Industrial Premises)

Land Use	**Management Level, $L_{Aeq(15minute)}$**
Industrial Premises	External noise level 75 dBA
Office, retail outlets	External noise level 70 dBA

4.2 Assessing Construction Vibration

The effects of vibration in buildings can be divided into two main categories – those in which the occupants or users of the building are inconvenienced or possibly disturbed and those in which the integrity of the building or the structure itself may be prejudiced.

4.2.1 Human Comfort Vibration

The EPA's *Assessing Vibration: a technical guideline* (DEC 2006) provides guideline values for continuous, transient and intermittent events that are based on a Vibration Dose Value (VDV) rather than a continuous vibration level. The VDV is dependent upon the level and duration of the short-term vibration event, as well as the number of events occurring during the daytime or night-time period.

The VDVs recommended in the document for vibration of an intermittent nature (ie construction works where more than three distinct vibration events occur) are presented in **Table 6**.

Table 6 Applicable Vibration Dose Value for Intermittent Vibration (m/s $^{1.75}$) (Assessing Vibration: A Technical Guideline)

Location	Daytime[1]		Night-time[1]	
	Preferred Value	Maximum Value	Preferred Value	Maximum Value
Critical Areas[2]	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.8	1.6	0.8	1.6

Note 1: Daytime is 7:00 am to 10:00 pm and night-time is 10:00 pm to 7:00 am.

Note 2: Examples includes hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive criteria for critical areas.

4.2.2 Effects on Building Contents

People can perceive floor vibration at levels well below those likely to cause damage to building contents or affect the operation of typical equipment. For most receivers, the controlling vibration criterion will be the human comfort criterion, and it is therefore not normally required to set separate criteria in relation to the effect of construction vibration on most building contents.

Where appropriate, objectives for the satisfactory operation of critical instruments or manufacturing processes should be sources from manufacturer's data and/or published objectives.

4.2.3 Structural Damage Vibration

Structural damage vibration limits are based on Australian Standard AS 2187: Part 2-2006 *Explosives - Storage and Use - Part 2: Use of Explosives* and British Standard BS 7385 Part 2-1993 *Evaluation and measurement for vibration in buildings Part 2*. These standards provide frequency-dependent vibration limits related to cosmetic damage, noting that cosmetic damage is very minor in nature, is readily repairable and does not affect the structural integrity of the building. The recommended vibration limits from BS7385 for transient vibration for minimal risk of cosmetic damage to residential and industrial buildings is shown in

Table 7 Transient Vibration Guide Values for Minimal Risk of Cosmetic Damage (BS 7385-2)

Line	Type of Building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

4.2.4 Ground Borne (Regenerated) noise

Ground-borne (or regenerated) construction noise can be present on construction projects where vibration from activities such as rock breaking, road heading, rotary cutting and rock drilling/sawing can be transmitted through the ground and into the habitable areas of nearby buildings. Ground-borne noise occurs when this vibration in the ground and/or building elements is regenerated as audible noise within areas of occupancy inside the building.

The NSW EPA's ICNG defines internal ground-borne noise goals for residential receivers of 40 dBA $L_{Aeq(15minute)}$ during the evening 6:00 pm to 10:00 pm and 35 dBA $L_{Aeq(15minute)}$ during the night-time (10:00 pm to 7:00 am). The goals are only applicable when ground-borne noise levels are higher than airborne noise levels.

4.3 Air Quality

Regulatory authorities manage air quality through a range of mechanisms, including ambient air quality guidelines and source emission limits.

Ambient air quality guidelines or standards relate to the maximum downwind ground level concentrations that may occur as a result of the emissions and are the maximum concentrations to which the public may be exposed, to ensure a reasonable protection of human health. These criteria are normally based on the results of epidemiological or other health-based studies and are generally designed to protect sensitive populations from adverse health effects, or to prevent damage to sensitive vegetation and crops. When assessing compliance with ambient air quality criteria it is necessary to account for other sources in the area so that the total cumulative impact of all sources is considered.

The impact assessment criteria relevant to this air quality assessment include a range of legislative criteria, and also an assessment matrix to determine the anticipated risks and identify where additional mitigation and controls may be required.

It should be noted that the impact assessment criteria below have been provided for construction phase compliance monitoring and informative purposes only.

4.3.1 Protection of the Environment Operations Act 1997 & Amendment Act 2011

The Protection of the Environment Operations Act 1997 (POEO Act) and Amendment Act 2011 is a key piece of environment protection legislation administered by the NSW EPA which enables the NSW Government to establish instruments for setting environmental standards, goals, protocols and guidelines.

Changes under the POEO Amendment Act 2011 include that the owner of a premises, the employer or any person carrying on the activity which causes a pollution incident is to *immediately* notify the relevant authorities when material harm to the environment is caused or threatened. A list of each relevant authority is provided in the POEO Amendment Act and should be noted in the Site Incident Register.

4.3.2 NSW EPA Policy

The primary NSW EPA air quality criteria applicable to construction activities are prescribed in their document, "*Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales"* (2005) (Approved Methods).

The main air quality constraints in terms of emissions to air due construction activities include particulate matter and dust deposition. Odorous emissions may also be generated during ground works and will need to be managed appropriately to minimise off-site amenity impacts.

The air quality criteria presented in **Table 8** has been provided for compliance air quality monitoring purposes where the requirement is deemed necessary for demonstration of compliance with air quality criteria during the construction phase of the NRSPP.

Table 8 NSW Impact Assessment Criteria

Pollutant	Averaging Period	Concentration		Source
		pphm	µg/m^3	
Sulphur dioxide (SO_2)	10 minutes	25	712	NHMRC (1996)
	1 hour	20	570	NEPC (1998)
	24 hours	8	228	NEPC (1998)
	Annual	2	60	NEPC (1998)
Nitrogen dioxide (NO_2)	1 hour	12	246	NEPC (1998)
	Annual	3	62	NEPC (1998)
Particulate matter <10µm (PM_{10})	Annual	-	30	NEPC (1998)
	24 hour	-	50	EPA (1998)
		ppm	mg/m^3	
Carbon monoxide (CO)	15 minute	87	100	WHO (2000)
	1 hour	25	30	WHO (2000)
	8 hours	9	10	NEPC (1998)

Note: pphm parts per hundred million
ppm parts per million
µg/m^3 micrograms per cubic metre of air
mg/m^3 milligrams per cubic metre of air

The above criteria have been provided for compliance monitoring purposes only and refer to total impact (i.e. incremental increase due to construction activities plus background concentrations due to all other sources) but excludes extraordinary events such as bushfires, prescribed burning, dust storms, fire incidents etc. These criteria are referenced in **Section 7.3**.

Dust Deposition

To avoid the nuisance impact of dust, NSW EPA has prescribed goals for dust fallout and this is expressed in terms of an acceptable increase in dust deposition over the existing background deposition levels. The annual average NSW EPA goals for depositional dust that apply to the construction phase of the proposed development site are provided in **Table 9** and should be used for compliance monitoring purposes.

Table 9 Assessment Criteria for Deposited Dust

Pollutant	Averaging Period	Maximum increase in deposited dust level	Maximum total deposited dust level
Deposited dust	Annual	2 g/m^2/month	4 g/m^2/month

Note: g/m^2/month = grams of deposited dust per square metre of ground per month
Deposited dust is assessed as insoluble solids as defined by Standards Australia, *AS/NZS 3580.10.1:2003: Methods for Sampling and Analysis of Ambient Air – Determination of Particulate Matter – Deposited Matter – Gravimetric Method*.

Odour

Impacts from odorous air contaminants are often nuisance-related rather than health-related. Odour performance goals guide decisions on odour management, and are intended to control odour to an acceptable level.

The NSW EPA make recommendations for the appropriate management and assessment of odour in their documents "*Assessment and Management of Odour from Stationary Sources in NSW: Technical*

Framework" (2006) (Odour Framework) and "*Assessment and Management of Odour from Stationary sources in NSW; Technical Notes"* (2006) (Odour Technical Notes).

Key principles adopted by the Odour Framework include:

- Planning to prevent and minimise odour (i.e. through careful location and design of new activities and sustainable land-use planning around existing activities to ensure the best environmental outcomes).
- Use of a range of strategies to manage odour (depending on the sources, odour nature and impacts of the emissions).
- Ongoing environmental improvement. Operators of all developments should adopt a risk management approach to minimise the potential for odour impacts.

A summary of the impact assessment criteria given for various population densities, as drawn from the NSW EPA's Approved Methods is provided in **Table 10**.

The proposed odour performance goals allow for population density, cumulative impacts, anticipated odour levels during adverse meteorological conditions and community expectations of amenity.

Table 10 NSW EPA Impact Assessment Criteria for Complex Mixtures of Odorous Air Pollutants (nose-response-time average, 99th percentile)

Population of Affected Community	Impact Assessment Criteria for Complex Mixtures of Odours (OU)
Urban area (≥ 2000)	2
~300	3
~125	4
~30	5
~10	6
Single residence (≤ 2)	7

Source: The Approved Methods (DEC, 2005)

The Approved Methods states that the impact assessment criteria for complex mixtures of odorous air pollutants must be applied at the nearest existing or likely future off-site sensitive receptor(s). These criteria have been provided for compliance monitoring purposes only and are not discussed further in this assessment.

4.3.3 Air Quality Impact Assessment Methodology

A *qualitative* risk-based assessment has been carried out according to the methodology detailed in the proceeding sections. This approach is considered appropriate for the purposes of the project (see justification of this method below). No dispersion modelling or air quality monitoring has been undertaken as part of this assessment.

Overall Approach

Predictions of air quality impacts are necessary when appraising potential future impacts on potentially sensitive land uses. Specific methodologies are described in further detail in the relevant sections of this document, however the following broad "risk based" approach has been adopted for each study area.

Construction worksites and scenarios were identified in consultation with NPC. For each worksite, the proposed construction scenarios were reviewed and a *qualitative* risk-based impact assessment undertaken of potential air quality impacts to identify a range of suitable control measures available to mitigate those impacts.

Given that these controls measures are to be considered for implementation at the source of the potential air pollution (i.e. on site), a significant level of control during site preparatory works may be realised through effective construction site design and management. Qualitative assessment is therefore deemed appropriate to assess the potential for air quality impacts associated with the NRSP site preparatory works.

The assessment criteria for receptor sensitivity, impact magnitude and the resultant impact significance have been developed by SLR Consulting.

The risk-based assessment takes account of a range of impact descriptors, including the following:

- **Nature of impact**: is the impact anticipated to result in an adverse or beneficial effect on the receiving environment?
- **Receptor Sensitivity**: how sensitive is the receiving environment to the anticipated impacts?
- **Magnitude of Impact**: what is the anticipated scale of the impact?

The integration of sensitivity with impact magnitude is used to derive the predicted significance of that impact, and may be adverse or beneficial in nature.

These terms, and the qualifying justification for each attributed value are described below.

Nature of Impact

Predicted impacts may be described in terms of the overall effect upon the environment. Terms such as “positive” and “negative” are not used to avoid complication (i.e. a positive increase in air pollutant concentration would have a negative impact, for example):

- **Beneficial:** the predicted impact will cause a beneficial effect on the receiving environment.
- **Neutral:** the predicted impact will cause neither a beneficial nor adverse effect.
- **Adverse:** the predicted impact will cause an adverse effect on the receiving environment.

Receptor Sensitivity

Sensitivity may vary with the anticipated impact or effect. For example, a receptor may be determined to have varying sensitivity to different environmental changes (i.e. high sensitivity to changes in air quality, but low sensitivity to noise impacts, for example). Sensitivity may also be derived from statutory designation which is designed to protect the receptor from such impacts.

Sensitivity terminology may vary depending upon the environmental effect, but generally this may be described in accordance with the following broad categories:

- Very high.
- High.
- Medium.
- Low.

Table 11 outlines the methodology used in this study to define the sensitivity of receptors to air quality impacts.

Table 11 Methodology for Assessing Sensitivity of a Receptor

Sensitivity	Description	Examples
Very High	Receptors are highly sensitive to changes in air quality	• Background concentrations are above 90% of the air quality criterion. • Receptors of very high sensitivity to dust and/or odour (e.g. dust or odour) such as: hospitals and clinics, retirement homes, painting and furnishing, hi-tech industries and food processing.
High	Receptors have a high sensitivity to changes in air quality	• Background concentrations are above 75% of the air quality criterion. • Receptors of high sensitivity to dust and/or odour, such as: schools, residential areas, food retailers, glasshouses and nurseries, horticultural land and offices.
Medium	Receptors have a medium sensitivity to changes in air quality	• Background concentrations are above 50% of the air quality criterion. • Receptors of medium sensitivity to air pollution, such as: farms, outdoor storage, light and heavy industry.
Low	Receptors have a low sensitivity to changes in air quality	• Background concentrations are below 50% of the air quality criterion. • All other air quality sensitive receptors not identified above.

Magnitude

Magnitude describes the anticipated scale of the predicted environmental change in terms of how that impact may cause a change to existing (baseline) conditions, and may be described quantitatively or qualitatively refer (**Table 12**).

Where an impact is defined by qualitative assessment, suitable justification is provided in the text.

Table 12 Magnitude of Impacts

Magnitude	Description	Examples
Substantial	Impact is predicted to cause significant consequences on the receiving environment	• A significant change which involves a variation in predicted concentration by > 10% of a long-term criterion or 50% of short-term criterion. • Substantial risk that the impacts will generate nuisance complaints, resulting in regulatory action. • Area affected is < 10m from an active construction site.
Moderate	Impact is predicted to possibly cause statutory objectives / standards to be exceeded	• A noticeable change which involves a variation in predicted concentration of 5% to 10% of long-term criterion or 25% to 50% of short-term criterion. • Moderate risk that the impacts will generate nuisance complaints, resulting in regulatory action. • Area affected is < 10m from an active construction site.
Slight	Predicted impact may be tolerated.	• A barely measureable change which involves a variation in predicted concentration of 2.5%-5% of short-term criterion or 10% to 25% of short-term criterion. • Slight risk that the impacts will generate nuisance complaints, resulting in regulatory action. • Area affected is < 1km from an active construction site.

Magnitude	Description	Examples
Negligible	Impact is predicted to cause no significant consequences.	• A negligible change which involves a variation in predicted concentration of < 2.5% of the short-term criterion or < 10% of the long-term criterion. • Negligible risk that the impacts will generate nuisance complaints, resulting in regulatory action. • Area affected is > 1km from an active construction site, and the construction site has adequate dust controls.

Significance

The risk-based matrix provided in **Table 13** illustrates how the definition of the sensitivity and magnitude interact to produce impact significance.

Table 13 Impact Significance Matrix

Sensitivity \ Magnitude [Defined by Table 12]		Substantial Magnitude	Moderate Magnitude	Slight Magnitude	Negligible Magnitude
[Defined by Table 11]	**Very High Sensitivity**	Major Significance	Major/ Intermediate Significance	Intermediate Significance	Neutral Significance
	High Sensitivity	Major/ Intermediate Significance	Intermediate Significance	Intermediate/Minor Significance	Neutral Significance
	Medium Sensitivity	Intermediate Significance	Intermediate/Minor Significance	Minor Significance	Neutral Significance
	Low Sensitivity	Intermediate/Minor Significance	Minor Significance	Minor/Neutral Significance	Neutral Significance

It is noted that the above approach is designed to provide an overall impact risk, and is not the defining determination for the requirement for mitigation and control. Impacts with a lower determined significance should also be minimised wherever possible.

The approach also may underestimate the impact significance in environments which are assessed as having low sensitivity to impacts of a substantial or moderate magnitude, and therefore a pragmatic approach to the assessment significance should be applied.

Any impacts identified as having a substantial magnitude should receive detailed appraisal of mitigation options. Refer to **Section 7.3.2** for a preliminary risk assessment and **Section 9** for a reappraisal of the potential impacts associated with each site where mitigation measures are applied.

5 EXISITING ENVIRONMENT

5.1 Existing Acoustical Environment

Ambient noise surveys were conducted within the vicinity of the project site to characterise the acoustical environment in the area surrounding the project site. The background noise monitoring was performed at the site over one week beginning 10 August 2011. The monitoring was conducted during the initial noise assessment of the NRSP conducted for Transport for NSW (TfNSW).

5.1.1 Unattended Noise Measurements

Five noise monitoring locations were selected based on an inspection of the potentially affected areas, giving consideration to accessibility, to other noise sources which may influence the recording and security issues for the noise monitoring device. The selected monitoring locations are illustrated in **Figure 2**.

The five locations are as follows:

- NM1 – 21A Epping Road
- NM2 – 24 Epping Road (across Epping Road from the subject M2 site).
- NM3 – 37 Morshead Street
- NM4 – Macquarie Park Cemetery
- NM5 – North Ryde Station Site South

No noise monitoring was carried out on the M2 Site as this was in use as a construction compound. Noise measurements on this site would have been dominated by construction activity and therefore not usable for determining either existing road traffic impacts or background noise levels.

The equipment utilised for the continuous unattended noise survey was three Acoustic Research Laboratories Type EL316 Environmental Noise Loggers and two Svantek SVAN Type 957 Noise Loggers, with microphones fitted with wind shields. All noise measurements and instrumentation carried appropriate and current National Association of Testing Authorities, Australia (NATA) calibration certificates. The calibration of each logger was checked both before and after the measurements, and the variation in calibration was found to be within the acceptable limits at all times.

The results of the noise monitoring have been processed in accordance with the procedures contained in the NSW INP so as to establish representative noise levels from all noise sources in the area.

The results of the unattended ambient noise surveys are summarised in **Table 14**. Representative Rating Background Levels (RBL) and L_{Aeq} (Energy averaged) noise levels during standard daytime, evening and night-time hours are shown.

Table 14 Summary of Noise Logging Results

Location	Daytime		Evening		Night-time	
	RBL (dBA)	L_{Aeq} (dBA)	RBL (dBA)	L_{Aeq} (dBA)	RBL (dBA)	L_{Aeq} (dBA)
NM1	60	74	56	71	44	69
NM2	60	72	59	70	46	68
NM3	45	55	44	55	38	51
NM4	57	69	54	67	45	64
NM5	63	70	59	68	45	66

5.1.2 Attended Noise Measurements

Attended noise measurements were undertaken at each logging location in order to quantify the noise levels from the various noise sources. Measurements were taken at the time of logger deployment and repeated on collection at two of the locations. At the remaining three locations, rain on the day of collection precluded useful measurements. The measurement data obtained is considered sufficient to indicate typical noise levels of the identified ambient noise sources.

The instrumentation used for the attended noise measurements was a Brüel & Kjær Type 2260 sound level meter. All measurements were performed at a height of approximately 1.2 m above ground level. Calibration of the sound level meter was checked before and after each measurement and the variation in calibration at all locations was found to be within acceptable limits at all times. During each of the attended noise measurements the observer noted the various noise sources and levels influencing the ambient noise environment. The acoustic environment at the attended locations is described in **Table 15**.

Table 15 Attended Noise Monitoring Results

Location	Date	Time of Day	Noise Levels (dBA)					Description
			LAmax	LA1	LA10	LAeq	LA90	
NM1 21A Epping Road	10/8/2011	11:26 am to 11:41 am	84	80	77	73	61	General Traffic 70-78 Trucks 76-84
NM2 24 Epping Road	10/8/2011	10:52 am to 11:07 am	82	76	72	69	60	General Traffic 66-74 Trucks 73-82 Bus 80 Aircraft 75
NM2 24 Epping Road	17/8/2011	11:39 am to 11:54 am	83	78	74	71	62	General Traffic 70-75 Truck 80 Background (no cars) 55
NM3 37 Morshead Street	10/8/2011	10:13 am to 10:28 am	64	56	51	49	45	Distant Traffic in background Birds 55-63 Bus idling in tennis centre 49-52 Dog barking 56-62 Aircraft 58
NM3 37 Morshead Street	17/8/2011	12:34 pm to 12:49 pm	69	61	56	51	46	Distant Traffic in background 47 Birds 50-60 Aircraft 63
NM4 Macquarie Park Cemetery	10/8/2011	12:08 pm to 12:23 pm	84	76	69	67	55	General Traffic 65-72 Trucks 75-84 Bus 74
NM5 North Ryde Station Site South	10/8/2011	9:31 am to 9:46 am	91	76	73	71	66	General Traffic 55-72 Trucks 75-76 Compression Braking 91

5.2 Existing Air Quality Environment

The NSW EPA operate a number of air quality monitoring sites to measure key air pollutant in the region and to evaluate compliance with air quality goals. The Lindfield monitoring site is located in the grounds of the CSIRO Division of Radio Physics and is located approximately 1.5 kilometres (km) east of the M2 Site. It is located within a predominantly residential area and is at an elevation of 60 metres (m) Australian Height Datum (AHD). The air quality monitoring station was commissioned in October 1992 and is still operational. The air pollutants currently measured at Lindfield include oxides of nitrogen (NO_X), sulphur dioxide (SO_2) and particulate matter (as PM_{10}).

Background monitoring data for NO_2, SO_2 and PM_{10} recorded at Lindfield over a 6-year period between 2008 and 2013 are presented in the sections below for comparison to NSW EPA guidelines.

5.2.1 Nitrogen Dioxide

- Annual average NO_2 concentrations in all years are significantly lower than the NSW EPA criterion of 62 µg/m^3 with a maximum annual average concentration of 20.5 µg/m^3 recorded in 2010 and 2011.
- The maximum daily 1-hour average NO_2 concentrations measured at Lindfield are typically less than 50 µg/m^3 with a small number of peaks up to 110 µg/m^3. These concentrations are significantly less than the 1-hour NO_2 air quality criterion of 246 µg/m^3.

5.2.2 Sulphur Dioxide

- The maximum daily 1-hour average SO_2 concentrations measured at Lindfield are significantly lower than the 1-hour SO_2 guideline of 570 µg/m^3, with a maximum 1-hour average of 60 µg/m^3 reported over the six year monitoring period.
- The annual average SO_2 concentrations are significantly below the guideline of 60 µg/m^3, with a maximum annual average of 2.9 µg/m^3 reported over the six year monitoring period.

5.2.3 Particulate Matter (as PM_{10})

- The 24-hour average PM_{10} concentrations for the area are typically between 10 µg/m^3 and 30 µg/m^3, however a number of exceedances of the NSW EPA 24-hour average guideline of 50 µg/m^3 were recorded during 2009. These five exceedances occurred on 16 April, 23 April and 26 September, and 22 November and 29 November.
- Exceedances of the 24-hour PM_{10} criterion were also experienced in November 2013, resulting from significant bushfire activity to the west of Sydney. The maximum 24 hour PM_{10} concentration at Lindfield in November 2013 was 63.4 µg/m^3.
- The annual average PM_{10} concentrations for the six years examined were 14.4 µg/m^3 (2008), 22.0 µg/m^3 (2009), 13.6 µg/m^3 (2010), 13.2 µg/m^3 (2011), 13.9 µg/m^3 (2012) and 14.3 µg/m^3 (2013) which are significantly lower than the NSW EPA guideline of 30 µg/m^3.

Analysis of the background monitoring data indicates that concentrations of NO_2 and SO_2 were considerably less than their respective NSW EPA guideline values for all years.

The NSW EPA 24-hour average PM_{10} guideline was exceeded on five occasions during 2009 and once during 2013. These exceedances were a result of natural sources rather than local emission sources.

5.2.4 Review of Environmental Protection Licence and National Pollutant Inventory Databases

A desktop study has been undertaken to further characterise the existing air quality environment and has included review of Environment Protection Licence (EPL) and National Pollutant Inventory (NPI) databases to identify neighbouring emissions intensive industries and to provide regional emissions estimates for common air pollutants.

Review of Environmental Protection Licence Database

A search of the NSW EPA public register returned the existing licence information for the neighbouring industries as presented in **Table 16**.

Table 16 EPA Licencing Detail

Facility Name	Sector	
SITA Australia Pty Ltd	Waste Treatment and Disposal Services	POEO Licence Number 4527. Composting of garden waste occurs on site. General solid putrescible and non-putrescible waste types also received on site. L4.1 Potentially Offensive Odour: No condition of this licence identifies a potentially offensive odour for the purposes of Section 129 of the POEO Act 1997. O2.1 Maintenance of Plant and Equipment: All plant and equipment installed at the premises or used in connection with the licensed activity must be maintained and operated in a proper and efficient manner. 03.1 Dust: The premises must be maintained in a condition which minimises or prevents the emission of dust from the premises.

Review of National Pollutant Inventory Database

The NPI database provides details on industrial emissions of over 4,000 facilities across Australia. The requirement to return emissions estimates to the NPI is determined by the processes being undertaken at the facility, and also whether those processes exceed process-specific thresholds in terms of activity rates (i.e. throughput and/or consumption). It is not intended to make a statement that impacts associated with those activities will be significant in terms of their potential for impact, generation of complaint, or constraint to the development of the site.

Neighbouring Sources

Table 17 presents the facilities that are located within North Ryde and are required to submit NPI returns. It is noted that NPI data is provided for the NPI 2011/12 reporting year.

Table 17 Neighbouring Sources

Facility Name	Sector	Air Emissions
CSIRO North Ryde Life Sciences	Scientific Research Services	Includes point source emissions of CO, NO_x, PM_{10}, $PM_{2.5}$, SO_2, TVOCs, PAHs
Ryde Waste and Recycling Centre	Waste Treatment and Disposal Services	No emissions to air reported. Only transfers data.

Regional Emissions Estimate

Table 18 presents selected air emissions data compiled from the NPI returns for Post Code NSW "2113", which encompasses the M2 Site. The emissions are presented along with the significant sectoral contributors to that total.

Table 18 NPI Regional Emissions Estimate

Substance	Source	Air (kg)
Carbon Monoxide (CO)	Motor Vehicles	5,699,196
	Lawn Mowing	190,292
	Solid fuel burning (domestic)	169,779
	Lawn Mowing (public spaces)	52,694
	Fuel Combustion (sub reporting threshold facilities)	1,774
	Total	**6,117,969**
Oxides of Nitrogen (NO_x)	Motor Vehicles	875,997
	Fuel Combustion (sub reporting threshold facilities)	4,161
	Gaseous fuel burning (domestic)	3,152
	Solid fuel burning (domestic)	2,197
	Scientific Research Services	1,491
	Total	**889,523**
Particulate Matter (PM_{10})	Motor Vehicles	33,106
	Solid fuel burning (domestic)	28,257
	Lawn Mowing	1,149
	Lawn Mowing (public spaces)	718
	Windblown Dust	362
	Total	**64,406**
Sulphur Dioxide (SO_2)	Motor Vehicles	16,368
	Solid fuel burning (domestic)	442
	Lawn Mowing	68
	Liquid fuel burning (domestic)	54
	Lawn Mowing (public spaces)	44
	Total	**17,059**
Total Volatile Organic Compounds (TVOCs)	Motor Vehicles	650,072
	Domestic/Commercial solvents/aerosols	108,504
	Architectural surface coatings	74,109
	Solid fuel burning (domestic)	57,986
	Lawn Mowing	24,815
	Total	**994,581**

The above data show that motor vehicles are the largest contributor of air pollution in the area, contributing approximately 93% of CO, 99% of NO_X, 51% of PM_{10}, 96% of SO_2 and 65% of TVOCs of the total estimated emissions for postcode 2113.

5.3 Prevailing Wind Conditions

No site-specific meteorological monitoring data was available at the time of reporting. For the purposes of this assessment, prevailing wind conditions for the region incorporating the M2 Site was characterised using data obtained from the Bureau of Meteorology's (BoM) Sydney Olympic Park Automatic Weather Station (AWS), which is located approximately 9.2 km to the SW of the M2 Site. Wind data for the year 2008 was chosen to generate annual and seasonal wind roses (i.e. plots of wind speed and wind direction) as this year has the most complete data capture rate available for that monitoring station.

Examination of data for the year 2012 indicates that 2008 data is representative and has been used within this assessment.

The annual wind rose shows light to strong wind conditions (between 1.5 m/s and 10.5 m/s) were experienced by the region during 2008 with prevailing winds from the west occurring approximately 13% of the time.

Calm wind conditions (wind speed less than 0.5 m/s) occurred approximately 20% of the time throughout 2008. Calm wind conditions may result in poor dispersion of air pollutants, but may conversely result in lower rates of pollutant emission as a result of wind scouring.

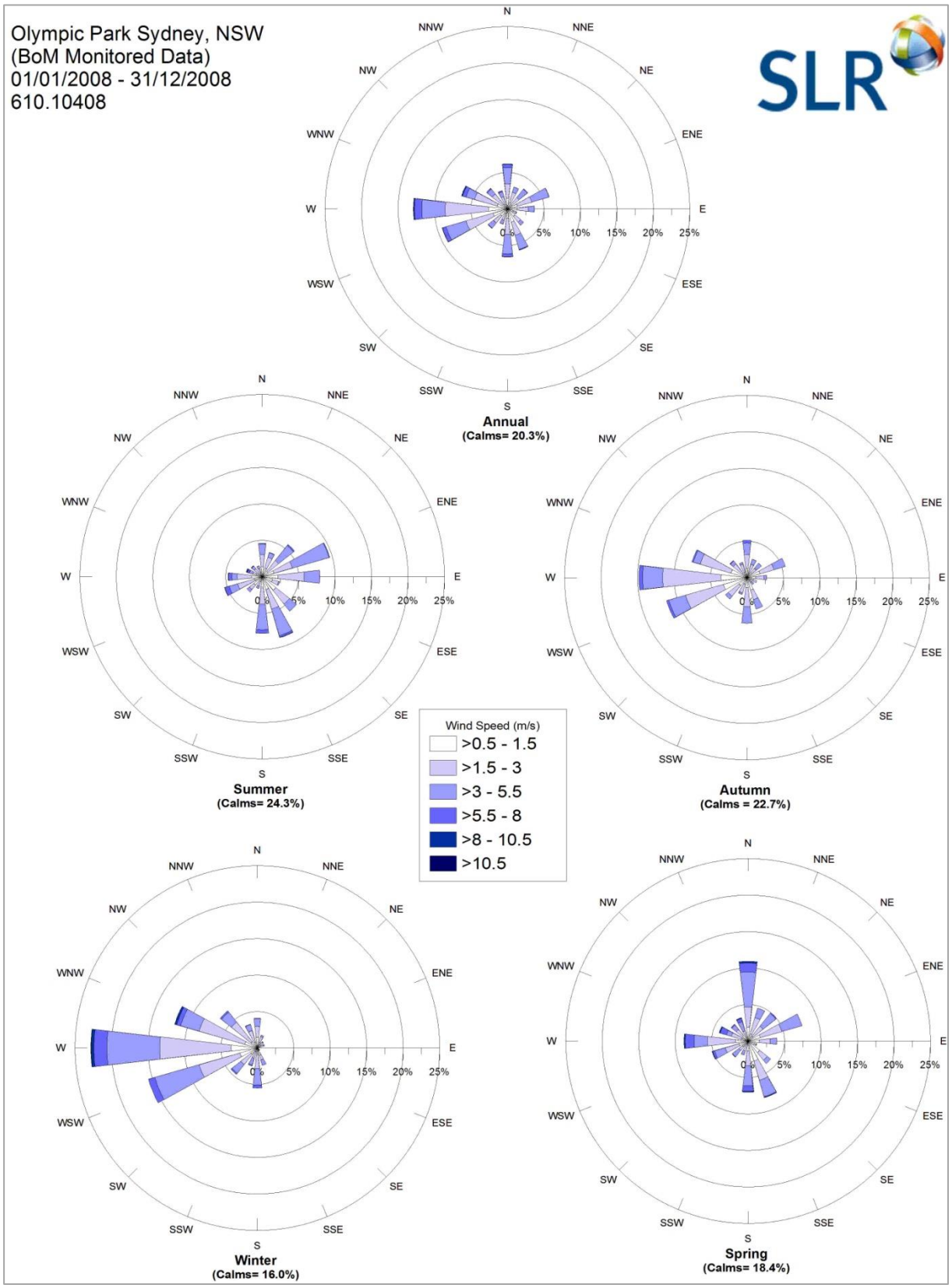
Winds speeds in excess of 5 m/s were experienced approximately 4% of the time during 2008. Wind erosion from exposed surfaces is initiated when actual wind speeds exceed the threshold friction velocity for a given surface or material, however a general rule of thumb is that wind erosion can be expected to occur at wind speeds of 5 m/s and greater.

Seasonal wind roses indicate the following:

- In the summer, predominant winds are experienced from the east north-east and south south-east approximately 10% and 9% of the time respectively.
- In the autumn, predominant winds are experienced from the west and west south-west approximately 15% and 12% of the time respectively.
- In the winter, predominant winds are experienced from the west and west south-west approximately 23% and 15% of the time respectively.
- In the spring, predominant winds are experienced from the north approximately 11% of the time.

Please refer to **Section 6.3** for a discussion of the potential for cumulative impacts due to the impact of construction works at the M2 Site and **Section 7.2.2** for a qualitative impact assessment including review of predominant wind conditions.

Figure 4 Wind Roses – Sydney Olympic Park

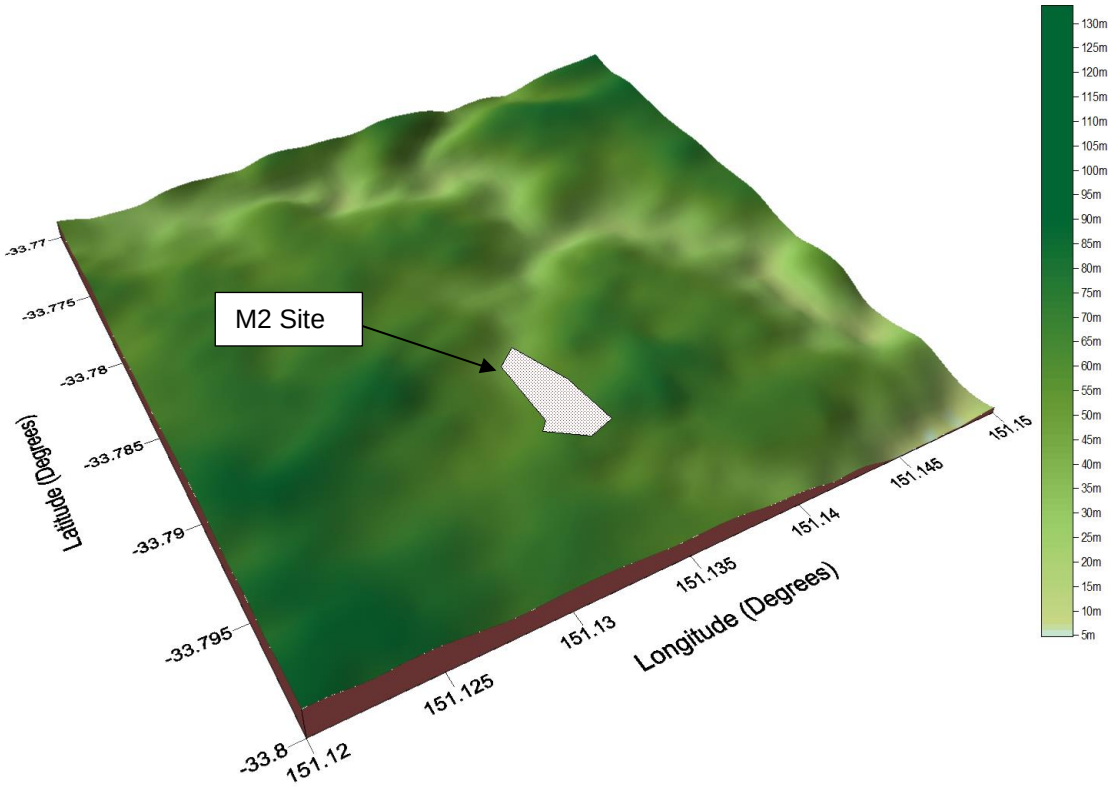


5.4 Topography

The M2 Site is located in an area of gently sloping terrain ranging from approximately 38m AHD at the north end of the site to approximately 66 m AHD at the south end of the site. Lane Cove National Park and the Lane Cove River are situated north to east of the M2 Site.

A three dimensional representation of the area is given in **Figure 5**.

Figure 5 Topography of the Local Area



Note: Vertical exaggeration of 11 applied. M2 site boundaries indicative only.

6 PROJECT SPECIFIC GOALS

6.1 Project Specific Noise Management Levels

The site specific construction noise goals for the project have been developed with reference to ICNG (**Section 4.1**) and the background noise monitoring (**Section 5.1**) and are detailed in **Table 19**.

Table 19 Noise Management Levels

NCA	Receiver Type	$L_{Aeq(15minute)}$ NML (dBA)			
		Standard Construction Hours	Out of Hours		
		Daytime (RBL +10)	Daytime (RBL +5)	Evening (RBL +5)	Night-time (RBL +5)
NCA 01	Commercial	70	70	70	n/a[2]
NCA 02	Residential	70	65	64	51
NCA 03	Educational	55[3]	55[3]	n/a[2]	n/a[2]
NCA 04	Residential	55	50	49	43
NCA 05	Other (Active Recreation)	65	65	65	n/a[2]
NCA 06	Residential	70	65	61	49
NCA 07	Commercial	70	70	70	n/a[2]
NCA 08	Other (cemetery)	60[4]	60[4]	60[4]	n/a[2]
NCA 09[5]	Residential	70	65	64	51
NCA 10[5]	Other (Active Recreation)	65	65	65	n/a[2]

Note 1: Standard hours are 7.00 am to 6.00 pm Monday to Friday, 8.00 am to 1.00 pm on Saturdays with no work on Sundays or Public Holidays. Evening is 6.00 pm to 10.00 pm. Night-time is 10.00 pm to 7.00 am Sundays to Saturday and 10.00 pm to 8.00 am on Sunday.

Note 2: Period not included in receivers assumed hours of operation.

Note 3: External level based on 10 dBA noise reduction from outside to inside for classroom (windows open).

Note 4: NMLs for a passive recreation area.

Note 5: It is understood that these sites are proposed to be developed and may not be applicable at time of construction.

6.2 Vibration Goals

The relevant applicable damage and human comfort vibration criteria for the nearest residential and commercial receivers are reproduced in

Table 20 Acceptable Vibration Dose Value for Intermittent Vibration ($m/s^{1.75}$) (Assessing Vibration: A technical guideline)

Location	Daytime		Night-time	
	Preferred Value	Maximum Value	Preferred Value	Maximum Value
Residences	0.20	0.40	0.13	0.26

Table 21 Transient Vibration Guide Values for Minimal Risk of Cosmetic Damage (BS 7385-2)

Type of Building	Peak component particle velocity in frequency range of predominant pulse	
	4 Hz to 15 Hz	15 Hz and above
Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

6.3 Air Quality Goals

Specific air quality goals for the Project are defined in **Section 4.3**. It is noted that these air quality goals are not specifically applied to the qualitative assessment performed but are to be achieved during construction works and monitored through the use of an air quality monitoring program (refer **Section 8.3.5**).

7 ASSESSMENT OF CONSTRUCTION PHASE IMPACTS

7.1 Construction Noise Impact Assessment

7.1.1 Construction Scenarios and Equipment

The following construction scenarios and equipment are proposed to be required during the construction works are detailed in **Table 22**.

Table 22 Construction Work Scenarios

SSDA Works Description	Ref	Scenario	Equipment	Location
Pedestrian and Cycle Provisions	A1	Install pedestrian/cycle bridge	Excavator (30t) Concrete trucks Concrete Pumps Post-tensioning equipment Semi-trailers Vibrating pad compactors* Mobile Crane (100t) Impact Wrench (pneumatic) Support Vehicle Elevated Working Platform	From M2 site, across Delhi Road to the Station
	A2	Install pedestrian and cycle connections/ infrastructure	Concrete truck Concrete Pumps Vibratory roller (light)* Excavator (30t)	Project site
	A3	Improvements to pedestrian and cycle infrastructure	Concrete truck Concrete Pumps Vibratory roller (light)* Excavator (30t)	External to the precinct Wicks Road, Epping Road and Delhi Road
Roads and Intersections	B1	Extension of Waterloo Road through the M2 site to Epping Road to create Spine Road	Vibratory Rollers (~10 - 12 tonne)* Paving Machines Tipper Trucks Ute Line Marking Plant Concrete Truck Concrete Pump Smooth Drum Roller Road Profiler	Waterloo Road and M2 site
	B2	Install signalised intersection at Wicks Road/Waterloo Road (north of M2 site)	Ute Concrete Saw* Excavator (1.5 tonne) Wacker Rammer Truck (HIAB) Elevated Working Platform	Wicks Road/Waterloo Road
	B3	Internal road construction (Retail Street)	Vibratory Roller (~10 - 12 tonne) Paving Machine Tipper Trucks Ute Line Marking Plant Concrete Truck Concrete Pump Road Profiler	Project Site

SSDA Works Description	Ref	Scenario	Equipment	Location
Public Domain	C1	Landscaping and street planting	Bobcat Mobile mortar mixer Front end loader Dozer Truck (10t)	Project Site
	C2	Install sustainable street lighting	Ute Saw Cutting Machine Excavator (1.5 tonne) Wacker Rammer Truck (HIAB) Elevated Working Platform Franna Crane	Project site
Civil Works	D1	Earthworks to facilitate SSDA works	Chainsaw Bobcat Jack hammer Excavator hammer Grader Dump truck (10 tonne) Concrete Saw Excavators Semi Trailer Front End Loader	Project site
	D2	Utility infrastructure	Excavator hammer Concrete Saw Generator Bobcat	Project site
Drainage and WSUD	E1	Install rain gardens and bioremediation swales	Excavator (20t) Dump truck (5 tonne) Mobile crane (25t) Bobcat	Project site
	E2	Drainage works	Excavator (20t) Dump truck (5 tonne) Trench Compactor Bobcat	Project site

The ICNG lists a number of construction activities which have been proved to be “annoying” and which require to have a 5 dB penalty applied to them. Annoying characteristics may include tones, impulses, low frequency and intermittent noise. The ICNG identifies the following activities as being particularly annoying and as such, a 5 dB correction has been incorporated into the noise modelling process from them:

- Use of power saws, such as used for cutting timber, rail lines, masonry, road pavement or steel work.
- Grinding metal, concrete or masonry.
- Rock drilling
- Line drilling
- Vibratory rolling
- Bitumen milling or profiling
- Jackhammering, rock hammering or rock breaking
- Impact piling.

7.1.2 Equipment Sound Power Levels

The proposed works consist of the various construction scenarios as detailed in **Table 22**. Typical L_{Amax} sound power levels for equipment assumed in the modelling (without mitigation) are presented in **Table 23**.

Table 23 Summary of Sound Power Levels used for Construction Equipment

Plant Item	L_{Amax} Sound Power Level (dBA)
Bitumen Spray Truck	100
Compressor (approx. 600 CFM)	100
Concrete Pump	109
Concrete Saw	118
Concrete Truck / Agitator	112
Crane (100 tonne)	110
Dozer (equiv. CAT D9)	120
Dump Truck (approx. 15 tonne)	108
Dumper (5 tonne)	95
Excavator (20 tonne)	105
Excavator (30 tonne)	110
Excavator with rock breaker	122
Flatbed Truck	100
Franna Crane	110
Front End Loader	111
Grader	110
Piling Rig (Bored)	110
Piling Rig (Vibratory)	121
Post-tensioning Equipment	95
Rock Saw	115
Saw Cutting Machine	113
Semi Trailer	106
Truck (10 tonne)	98
Vibrating Pad Compactor	104
Vibratory Roller (~10 - 12 tonne)	114
Vibratory Roller (light)	110

7.1.3 Prediction of Construction Noise Impacts

Construction noise levels have been predicted at the nearest receiver locations from the proposed construction works using computer modelling software SoundPLAN Version 7.1. The resultant daytime, evening and night-time $L_{Aeq(15minute)}$ noise level predictions where appropriate, are presented in **Table 24** for the various activities and compared with the relevant Noise Management Levels.

Construction work scenarios have been assumed to occur within the general site area as applicable (refer to **Table 22**). The predictions therefore represent the entire zone in which the work may take place. For all scenarios, the predicted noise levels presented in **Table 24** indicate the maximum $L_{Aeq(15minute)}$ noise level that is likely to be apparent at the worst affected receiver in each NCA in the vicinity of the works.

In practice, noise levels will depend on the number of plant items and equipment operating at any one time and their precise location relative to the receiver of interest. Noise levels will vary due to the movement of plant and equipment about the worksites and the concurrent operation of plant. In some cases, reductions in noise levels will occur when plant are located in cuttings or behind embankments, buildings or other items of equipment. The predictions in **Table 24** are representative of the worst-case scenario with all equipment listed in **Table 22** operating simultaneously.

Table 24 Construction Noise Predictions

Ref	Scenario	NCA	Noise Level - $L_{Aeq(15minute)}$ (dBA) at Most Affected Receiver		
			Worst-case Predicted	Daytime NML	Exceedance
A1	Pedestrian and Cycle Provisions - Install pedestrian/cycle bridge	NCA01	64	70	-
		NCA02	59	70	-
		NCA03	53	55	-
		NCA04	59	55	4
		NCA05	60	65	-
		NCA06	61	70	-
		NCA07	81	70	11
		NCA08	62	60	2
		NCA09	71	70	1
		NCA10	59	65	-
A2	Pedestrian and Cycle Provisions - Install pedestrian and cycle connections/ infrastructure	NCA01	70	70	-
		NCA02	56	70	-
		NCA03	45	55	-
		NCA04	53	55	-
		NCA05	44	65	-
		NCA06	43	70	-
		NCA07	46	70	-
		NCA08	43	60	-
		NCA09	48	70	-
		NCA10	52	65	-

Ref	Scenario	NCA	Noise Level - $L_{Aeq(15minute)}$ (dBA) at Most Affected Receiver		
			Worst-case Predicted	Daytime NML	Exceedance
A3	Pedestrian and Cycle Provisions - Improvements to pedestrian and cycle infrastructure (external to project area)	NCA01	**77**	70	7
		NCA02	**80**	70	10
		NCA03	53	55	-
		NCA04	65	55	10
		NCA05	55	65	-
		NCA06	**81**	70	11
		NCA07	**79**	70	9
		NCA08	58	60	-
		NCA09	**80**	70	10
		NCA10	68	65	3
B1	Roads and Intersections - Extension of Waterloo Road through the M2 site to Epping Road to create Spine road	NCA01	**93**	70	23
		NCA02	69	70	-
		NCA03	57	55	1
		NCA04	63	55	8
		NCA05	46	65	-
		NCA06	46	70	-
		NCA07	49	70	-
		NCA08	47	60	-
		NCA09	46	70	-
		NCA10	55	65	-
B2	Roads and Intersections - Install signalised intersection at Wicks Road/Waterloo Road (north of project site)	NCA01	**79**	70	9
		NCA02	32	70	-
		NCA03	33	55	-
		NCA04	36	55	-
		NCA05	<30	65	-
		NCA06	<30	70	-
		NCA07	38	70	-
		NCA08	39	60	-
		NCA09	<30	70	-
		NCA10	36	65	-
B3	Roads and Intersections - Internal road construction	NCA01	**76**	70	6
		NCA02	57	70	-
		NCA03	48	55	-
		NCA04	54	55	-
		NCA05	46	65	-
		NCA06	45	70	-
		NCA07	48	70	-
		NCA08	46	60	-
		NCA09	46	70	-
		NCA10	49	65	-

Ref	Scenario	NCA	Noise Level - $L_{Aeq(15minute)}$ (dBA) at Most Affected Receiver		
			Worst-case Predicted	Daytime NML	Exceedance
C1	Public Domain - Landscaping and street planting	NCA01	75	70	5
		NCA02	61	70	-
		NCA03	50	55	-
		NCA04	58	55	3
		NCA05	49	65	-
		NCA06	48	70	-
		NCA07	51	70	-
		NCA08	48	60	-
		NCA09	53	70	-
		NCA10	57	65	-
C2	Public Domain - Install sustainable street lighting	NCA01	**84**	70	14
		NCA02	60	70	-
		NCA03	48	55	-
		NCA04	54	55	-
		NCA05	40	65	-
		NCA06	39	70	-
		NCA07	42	70	-
		NCA08	41	60	-
		NCA09	42	70	-
		NCA10	46	65	-
D1	Civil Works - Earthworks to facilitate SSDA works	NCA01	**82**	70	12
		NCA02	68	70	-
		NCA03	57	55	2
		NCA04	65	55	10
		NCA05	56	65	-
		NCA06	55	70	-
		NCA07	58	70	-
		NCA08	55	60	-
		NCA09	60	70	-
		NCA10	64	65	-
D2	Civil Works - Utility infrastructure	NCA01	**80**	70	10
		NCA02	66	70	-
		NCA03	55	55	-
		NCA04	63	55	8
		NCA05	54	65	-
		NCA06	53	70	-
		NCA07	56	70	-
		NCA08	53	60	-
		NCA09	58	70	-
		NCA10	62	65	-

Ref	Scenario	NCA	Noise Level - $L_{Aeq(15minute)}$ (dBA) at Most Affected Receiver		
			Worst-case Predicted	Daytime NML	Exceedance
E1	Drainage and WSUD - Install rain gardens and bioremediation swales	NCA01	**83**	70	13
		NCA02	56	70	-
		NCA03	45	55	-
		NCA04	52	55	-
		NCA05	39	65	-
		NCA06	38	70	-
		NCA07	41	70	-
		NCA08	39	60	-
		NCA09	39	70	-
		NCA10	42	65	-
E2	Drainage and WSUD - Drainage works	NCA01	71	70	1
		NCA02	57	70	-
		NCA03	46	55	-
		NCA04	54	55	-
		NCA05	45	65	-
		NCA06	44	70	-
		NCA07	47	70	-
		NCA08	44	60	-
		NCA09	49	70	-
		NCA10	53	65	-

7.1.4 Discussion

Scenario A – Pedestrian and Cycle Provisions

Exceedance of the daytime (standard construction hours) $L_{Aeq(15minute)}$ noise goal of up to 11 dB is predicted at the most affected sensitive receiver locations. The worst affected receivers will be residential properties in along Epping Road during the installation of cycling infrastructure in close proximity to residences. This level of exceedance is common for construction activity and will be restricted to the daytime only. The overall duration of this activity is expected to take 52 weeks, however the noise impacts on any single receiver are only expected to be present for a relatively short time.

Scenario B – Roads and Intersections

Exceedance of the daytime (standard construction hours) $L_{Aeq(15minute)}$ noise goal of up to 23 dB is predicted at the most affected commercial receiver locations in NCA01 (east of the project site) during the construction of the Spine Road. In general, works to construct roads and intersections are predicted to have a low impact on residential receivers, with a worst case predicted exceedance of the daytime NML of 8 dB in NCA04 (back from Epping Road, SW of project site).

Scenario C – Public Domain Works

Exceedance of the daytime (standard construction hours) $L_{Aeq(15minute)}$ noise goal of up to 14 dB is predicted at the most affected commercial receiver locations in NCA01 (East of project site). In general, noise generated with this activity is only predicted to have a low impact on residential receivers, with a worst case predicted exceedance of the daytime NML of 3 dB at NCA04 (SW of the project site).

Scenario D – Civil Works

Exceedance of the daytime (standard construction hours) $L_{Aeq(15minute)}$ noise goal of up to 10 dB is predicted at the most affected residential receiver locations in NCA04 (SW of the project site), during earthworks. Similar noise levels are predicted during the construction of utility infrastructure. A minor exceedance of 2dB is predicted at NCA03 (Truscott Street Public School). This level of exceedance is common for construction involving excavation or bulk earthworks. Works will be restricted to the daytime only. While the overall duration of this activity is not finalised at this stage, the noise impacts on any single receiver are only expected to be present for a relatively short time due to movement of the construction works within the site.

Scenario E – Drainage and WSUD

Exceedance of the daytime (standard construction hours) $L_{Aeq(15minute)}$ noise goal of up to 13 dB is predicted at the most affected commercial receiver locations in NCA01 (East of the project site). Noise levels from this activity are not predicted to exceed the daytime NML at residential receivers.

Highly Noise Affected Receivers

Due to the close proximity to the proposed works the following residential receivers are predicted to be subjected to noise levels which exceed 75 dBA during some phases of construction and would therefore be considered as '*highly noise affected'*, as defined by the *Interim Construction Noise Guideline*:

- NCA02, NCA06 and NCA09 residential receivers (receivers along Epping Road) during periods when Scenario A3 works (installation of pedestrian and cycle infrastructure, external to the Precinct) are being conducted.

During noise intensive activities for Scenario D1 and D2 (Civil Works), it would be expected that residential receivers with a direct line of sight to the works and within a distance of approximately 65 m may experience noise levels in excess of 75 dBA and would therefore be considered *highly noise affected.*

Where $L_{Aeq(15minute)}$ construction noise levels are predicted to exceed 75 dBA, the relevant authority (consent, determining or regulatory) may require respite periods to be observed. This may include restricting the hours that the very noisy activities can occur.

Out-of-hours Works

Noise intensive activities should be scheduled during the daytime period where practicable. As with many infrastructure projects there may be activities that will be required to be undertaken outside of normal construction hours (eg due to safety reasons).

For out of hours work on this project, the more noise intensive activities would potentially exceed the night-time construction goals by significant margins.

Where a requirement for out of hours works for a specific construction scenario is identified, an assessment of potential impacts and identification of reasonable and feasible mitigation measures should be undertaken in accordance with the ICNG and in consultation with the directly affected community members.

7.2 Vibration Assessment

Energy from construction equipment is transmitted into the ground and transformed into vibration, which attenuates with distance. The magnitude and attenuation of ground vibration is dependent on the following:

- The efficiency of the energy transfer mechanism of the equipment (i.e. impulsive; reciprocating, rolling or rotating equipment).
- The frequency content of the source.
- The stiffness of the ground.
- The type of wave transmitted through the ground (surface or body).
- The ground type and topography.

Due to the above factors, there is inherent variability in ground vibration predictions without site-specific measurement data.

Indicative safe working distances to typical items of vibration intensive plant are listed in **Table 25** for both structural damage and human discomfort.

Table 25 Indicative Working Distances for Vibration Intensive Plant

Plant Item	Rating/Description	Indicative Working Distance	
		Cosmetic Damage	Human Response[1]
Vibratory Roller	< 50 kN (Typically 1-2 tonnes)	5 m	15 m to 20 m
	< 100 kN (Typically 2-4 tonnes)	6 m	20 m
	< 200 kN (Typically 4-6 tonnes)	12 m	40 m
	< 300 kN (Typically 7-13 tonnes)	15 m	100 m
	> 300 kN (Typically 13-18 tonnes)	20 m	100 m
	> 300 kN (> 18 tonnes)	25 m	100 m
Small Hydraulic Hammer	(300 kg - 5 to 12t excavator)	2 m	7 m
Medium Hydraulic Hammer	(900 kg - 12 to 18t excavator)	7 m	23 m
Large Hydraulic Hammer	(1600 kg - 18 to 34t excavator)	22 m	73 m
Vibratory Pile Driver	Sheet piles	2 m to 20 m	20 m
Pile Boring	≤ 800 mm	2 m (nominal)	N/A
Jackhammer	Hand held	1 m (nominal)	Avoid contact with structure

Note 1: The working distances for Human Response assume that the source of the vibration is continuous throughout the daytime period. Higher levels of vibration are acceptable when the vibration levels are intermittent or impulsive. The safe working distances are therefore considered to be conservative and it is likely that the safe working distances corresponding to a “low probability of adverse comment” would be lower than indicated.

7.2.1 Predicted Construction Vibration Impacts

For the construction scenarios in **Table 22**, equipment with the potential to generate ground-borne vibrations includes jackhammers, excavators and excavator hammers and vibratory rollers.

Vibration produced by the proposed construction activities are primarily expected to lie below the cosmetic damage criteria. The exception to this is for works along Spine road, where vibration intensive works would be expected to come within five metres from the nearest structure. It is recommended that at locations where vibration intensive activities are to be carried out within the safe working distances for cosmetic damage, judicious selection of plant and equipment would be necessary and vibration monitoring should be carried out in conjunction with a controlled staged commencement of the activity

7.2.2 Vibration near ECRL Tunnel

The Epping to Chatswood Rail Link (ECRL) tunnels cross underneath part of the southern extent of the project site. The tunnel is understood to be located around 25 metres below the existing ground level.

Based on the safe working distances for cosmetic damage on building structures given in **Table 25**, and noting that cosmetic damage is minor in nature and does not affect the structural integrity of the building, the proposed vibration intensive works are considered unlikely to compromise the structural integrity of the ECRL tunnel.

7.2.3 Ground-Borne Vibration Construction Noise

The nature of the works (surface works with minimal screening effects) means that ground-borne noise impacts are expected to be negligible. This is because airborne noise emissions in most circumstances are much higher than the ground-borne noise levels. For this reason ground borne noise is not anticipated to be the controlling factor for this project and further assessment is not warranted.

7.3 Construction Air Quality Assessment

7.3.1 Identification of Potential Air Quality Impacts

Based on a review of the construction staging and activities presented in **Section 7.1.1**, it is concluded that the site clearance and bulk earthworks are likely to represent the most significant source of emissions to air from construction phase activities, with the majority of construction activities to be undertaken at the M2 Site during 2014 to 2018.

Given the provided construction work activities (refer to **Section 7.1.1**), the potential air quality impacts associated with the construction phase may include:

- Dust emissions from construction phase activities such as:
    - Demolition;
    - site clearance;
    - site preparation and grading;
    - construction of services and temporary structures;
    - windblown materials from stockpiles;
    - truck loading and unloading;
    - materials management with FEL and other equipment; and,
    - dirt track-out onto paved roads surrounding the site.
- The emission of products of combustion from construction phase plant and machinery.
- Fugitive release of emissions to air associated with the storage, handling and potential accidental spillage of fuel.

- Odorous emissions of ground contaminants associated with construction phase activities, and in particular excavation or other ground invasive activities.

Dust Emissions from Construction Phase Activities

- During the construction phase, the potential for dust to be emitted from the M2 Site will be directly influenced by the nature of the activities being performed.
- Excavation and demolition works in particular are anticipated to potentially cause short-term emission of dust, which would require the application of suitable dust control measures. The loading and unloading of materials, wheel-generated dust generated by trucks travelling along unpaved roads and wind erosion of exposed surfaces may also lead to short-term emission of dust and should be managed appropriately to ensure off-site impacts due to dust are minimised
- A temporary elevation in particulate emissions and local dust levels is considered to be inevitable as part of the construction works, particularly where those activities are undertaken during periods of low rainfall and/or windy conditions.
- The impact of elevated dust emissions is dependent upon the potential for particulates to become and remain airborne prior to being deposited as dust or experienced as an ambient particulate concentration. Unlike other pollutants, the presence and deposition of dust is dependent upon the distance from source to receptor and the prevailing meteorological conditions.
- Dust emissions may be effectively managed at source through the implementation of appropriate measures. Refer to **Section 8** for control measures.
- Pro-active measures for dust control should be detailed within the Construction Environmental Management Plan (CEMP). Dust monitoring should also be considered at residential receptor locations, particularly in close proximity to the M2 Site.
- The CEMP should provide a description of dust management measures, including the identification of conditions during which dust-generating activities may be curtailed or ceased, dust suppression measures (e.g. waster bowsers and sprays) which may be employed to damp-down earthworks or hard-standing areas during construction, the provision of dust screens, appropriate management of stockpiled materials, visual inspection of off-site compliance, and a clear communication strategy for the management and prompt investigation of dust complaints.
- Reference should be made to Section 4.16 of the NSW EPA's Local Government Air Quality Toolkit, "*Module 1: Air pollution control techniques*" for an overview of dust suppression techniques and management strategies (see **Section 8.3.2**).

The Emission of Products of Combustion from Plant and Machinery

- Exhaust emissions from trucks, plant and machinery associated with the construction phase of the M2 Site may be regarded as an additional source of emissions to air on the local network.
- To reduce the impact of construction plant emissions, plant should be located as far from local receptors as practicable and engines should not be left idling when not in use. Trucks should avoid using the local road network during peak traffic periods. All equipment used on site should also be maintained to the required performance standards. Refer to **Section 8.3.3** for additional control measures.

Fugitive Release of Emissions from Fuel Storage Areas

- Fuels and chemicals associated with construction activities have the potential to cause fugitive emissions of VOCs through normal use and accidental spillage.
- To reduce the potential impact of these fugitive emissions, bunded areas should be used for the storage of all fuels, oils, chemicals, flammable and combustible liquids, with storage areas located away from sensitive receptors. Refer to **Section 8.3.3** for additional control measures.

Potentially Odorous Emissions due to Ground Invasive Activities

- The disturbance of contaminated soil and sediment will need to be addressed in the CEMP with reference to the Phase 1 and 2 Contamination Assessments for the M2 Site.
- Where there is the potential for invasive ground works to cause the emission of ground vapour or contaminated dust particles, these impacts would be specifically addressed in the CEMP, and an odour assessment and management procedure developed to manage the risks of off-site odour impacts and/or health impacts from the volatilisation of ground contaminants.
- Pro-active odour management procedures should include recording of site activities and observations during construction activities, providing a range of odour control methods to manage the risk of odour emissions during construction activities, and provide a methodology for the recording and response to any received odour complaints. Refer to **Section 8.3.3** for additional control measures.
- Reference should be made to the Phase 1 and 2 Contamination Assessments for the M2 Site prior to assigning odour control measures.

7.3.2 Impact Assessment

This section provides a framework for the assessment of risks associated with sensitive receptors identified in **Table 2**. The impact assessment uses the methodology presented in **Section 4.3.3** of this report. In the context of this methodology, the risk is termed "*impact significance*".

Site preparatory works planned for 2014 to 2018 (refer to **Section 7.1.1**) will primarily be undertaken at the M2 Site. The nearest sensitive receptor locations to these sites include adjacent commercial areas (Commercial Areas 1 and 2), and residences (Residential Areas 1 and 2).

Receptor Sensitivity

In accordance with the methodology presented in **Section 4.3.3**, the following receptor sensitivities have been applied:

- The sensitivity of residential / commercial / special / recreational land use areas to dust emissions generated by construction works should be considered to be ***high***.
- The sensitivity of residential / commercial / special / recreational land use areas to odour emissions generated by construction works should be considered to be ***high***.
- The sensitivity of industrial areas to dust and odour emissions generated by construction works should be considered to be ***medium***.
- The sensitivity of residential / commercial / special / recreational land use areas to fugitive emissions of VOCs due to fuel storage and products of combustion due to plant and machinery should be considered to be ***medium***.
- The maximum background 1-hour average concentrations of NO_2 have been noted in **Section 5.2.1** of up to 110 µg/m^3, which is approximately 40% of the impact assessment criterion of 246 µg/m^3. In accordance with the methodology outlined in **Section 4.3.3**, for the purposes of this assessment the sensitivity of the receiving environment to emissions on NO_2 of is considered to be ***low***.
- The maximum background 1-hour average concentrations of SO_2 have been noted in **Section 5.2.2** of up to 60 µg/m^3, which is approximately 10% of the impact assessment criterion of 570 µg/m^3. In accordance with the methodology outlined in **Section 4.3.3**, for the purposes of this assessment the sensitivity of the receiving environment to emissions on SO_2 of is considered to be ***low***.

- The typical background 24-hour average concentrations of PM_{10} have been noted in **Section 5.2.3** of up to 30 µg/m^3, which is approximately 60% of the impact assessment criterion of 50 µg/m^3. In accordance with the methodology outlined in **Section 4.3.3**, for the purposes of this assessment the sensitivity of the receiving environment to emissions on PM_{10} of is considered to be ***medium***.

Potential Dust Impacts due to Construction Works on Residential Land Uses

Residential Area 1

Residential Area 1 is made up of numerous residences (refer to **Figure 6**). Residences to the north-west are situated closest to the M2 Site. Epping Road lies between the M2 Site and residential receptors providing a separation distance of approximately 40m.

Air pollutants generated by construction activities at the M2 Site, and also by construction-phase road traffic on Epping Road and Delhi Road, may be experienced at these residential receptors during winds blowing from the north to north-eastern quadrants.

Analysis of the prevailing seasonal winds in **Section 5.3** shows that light to fresh wind speeds from the north to north-east are prevalent during the spring and were experienced approximately 10% of the time during 2008.

The impacts are assessed as being *adverse* in nature, *short term* (for the duration of the construction works) and *reversible*.

For residential receptors located within 1km of the M2 site, the potential impact is considered to be ***slight*** i.e. the impact is tolerable). Correspondingly, the impact significance should be considered to be ***intermediate/minor***. Mitigation measures (as detailed in **Section 8** should be considered and adopted where applicable at the M2 construction site, particularly where activities are located along site boundaries facing residential areas and during adverse weather conditions.

Residential Area 2

There are currently five residential properties located within Residential Area 2 (refer to **Figure 6**) which are situated to the south of the M2 Site. Four of these residences are tenanted and owned by the RMS and the fifth property, adjoining Bundara Reserve, is privately owned. The properties are likely to remain tenanted during construction works carried out on the M2 Sites.

Delhi Road and the Bundara Reserve lie between the M2 Site and the residential receptors providing a separation distance of approximately 100 m.

Air pollutants generated by construction activities at the M2 Sites, and also by construction-phase road traffic on nearby roads and freeways, may be experienced at these residences during winds blowing from the north-west to north north-west quadrants.

Analysis of the prevailing seasonal winds (refer to **Section 5.3**) shows that low occurrences of light to moderate wind speeds from the north-west to north north-west (less than 10% each) were experienced during 2008.

The impacts are assessed as being *adverse* in nature, *short term* (for the duration of the construction works) and *reversible*.

For residential receptors located within 1km of the M2 site, the potential impact is considered to be ***slight*** i.e. the impact is may be tolerated). Correspondingly, the impact significance should be considered to be ***intermediate/minor***. Mitigation measures (as detailed in **Section 8** should be considered and adopted where applicable at the M2 construction site, particularly where activities are located along site boundaries facing residential areas and during adverse weather conditions.

Residential Area 3

Residential receptors within Residential Area 3 (refer to **Figure 6**) are situated approximately 400m to the south of the M2 Site.

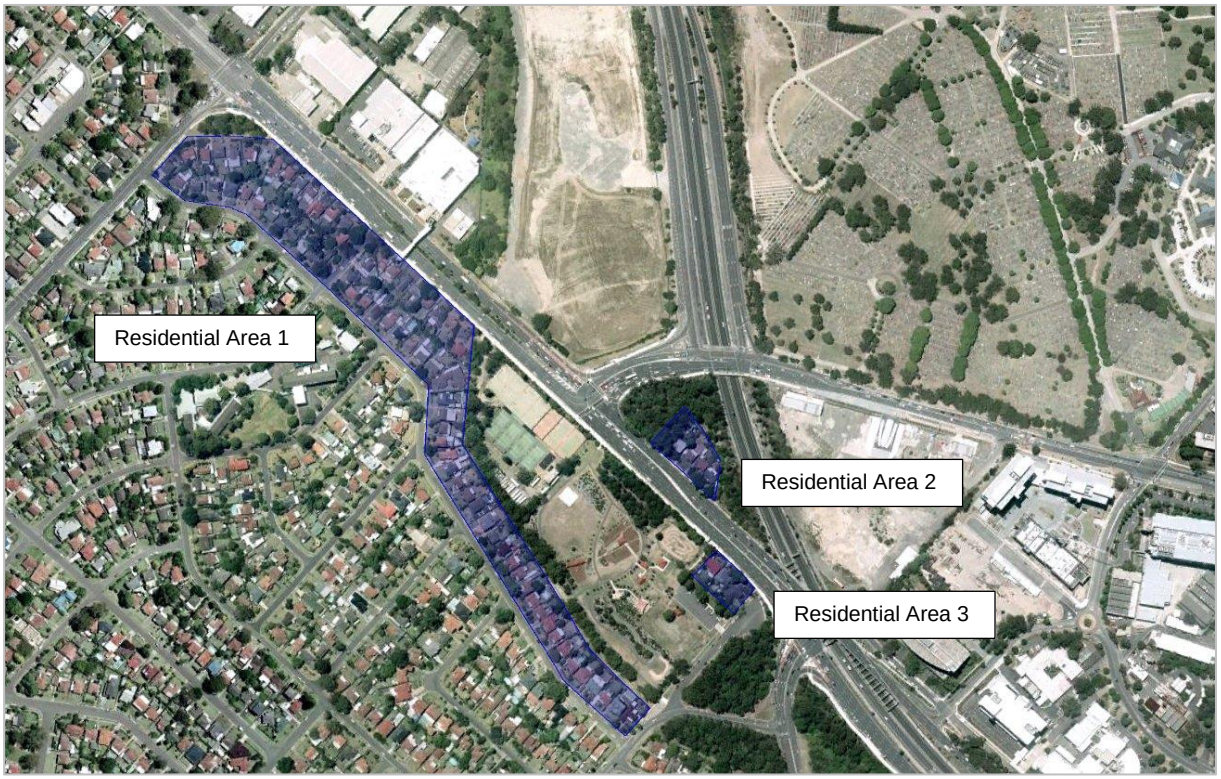
Air pollutants generated by construction activities at the M2 Site, and also by construction-phase road traffic on nearby roads and freeways, may be experienced at these residences during winds blowing from the north and north-west quadrants.

Analysis of the prevailing seasonal winds in **Section 5.3** shows that small amounts of light to moderate wind speeds from the north-west occur during the winter and were experienced less than 10% of the time during 2008. North north-west winds were experienced for less than 5% of the time during 2008.

The impacts are assessed as being *adverse* in nature, *short term* (for the duration of the construction works) and *reversible*.

Given the relative proximity of the M2 Site to residential receptors, the potential impact (see **Table 12**) on residential receptors within Residential Area 3 is considered to be ***slight*** (i.e. the impact is may be tolerated). Correspondingly, the impact significance should be considered to be ***intermediate/minor***. Mitigation measures (as detailed in **Section 8**) should be considered and adopted where applicable at the M2 Site construction site, particularly during adverse weather conditions.

Figure 6 Residential Land Use Locations



Source: Google Earth 2014

It is noted that vegetative buffers currently exist between the M2 Site and residences. Vegetative buffers can be effective at intercepting wind-blown dust, by physical entrapment of airborne particles and also by creating a blockage to the prevailing wind, reducing wind speed and thereby increasing the rate of particulate deposition.

Potential Dust Impacts due to Construction Works on Commercial Land Uses

Commercial Area 1

Commercial land uses are situated approximately 10m to the west and from 20m to 165m to the north-west of the M2 Site (refer to Commercial Area 1, **Figure 7**). Receptors to the north-west are separated from the M2 Site by Wicks Road.

Air pollutants generated by construction works at the M2 Site may be expected at commercial receptors during winds blowing from the north-east to south-eastern quadrants. Analysis of the prevailing seasonal winds in **Section 5.3** shows that light to moderate wind speeds from these directions occur during the warmer months (i.e. spring and summer) and were experienced approximately 13% of the time during 2008.

It is noted that a vegetative buffer currently exists between the M2 Site and commercial receptors to the west which, if retained during site preparatory construction works, will help to mitigate off-site air quality impacts. Similarly, a dense vegetative buffer exists at the north of the M2 Site and is retained in the draft layout plan. The majority of commercial buildings located near the M2 Site will also be air-conditioned which will assist in mitigating off-site air quality impacts.

The impacts are assessed as being *adverse* in nature, *short term* (for the duration of the construction works) and *reversible*.

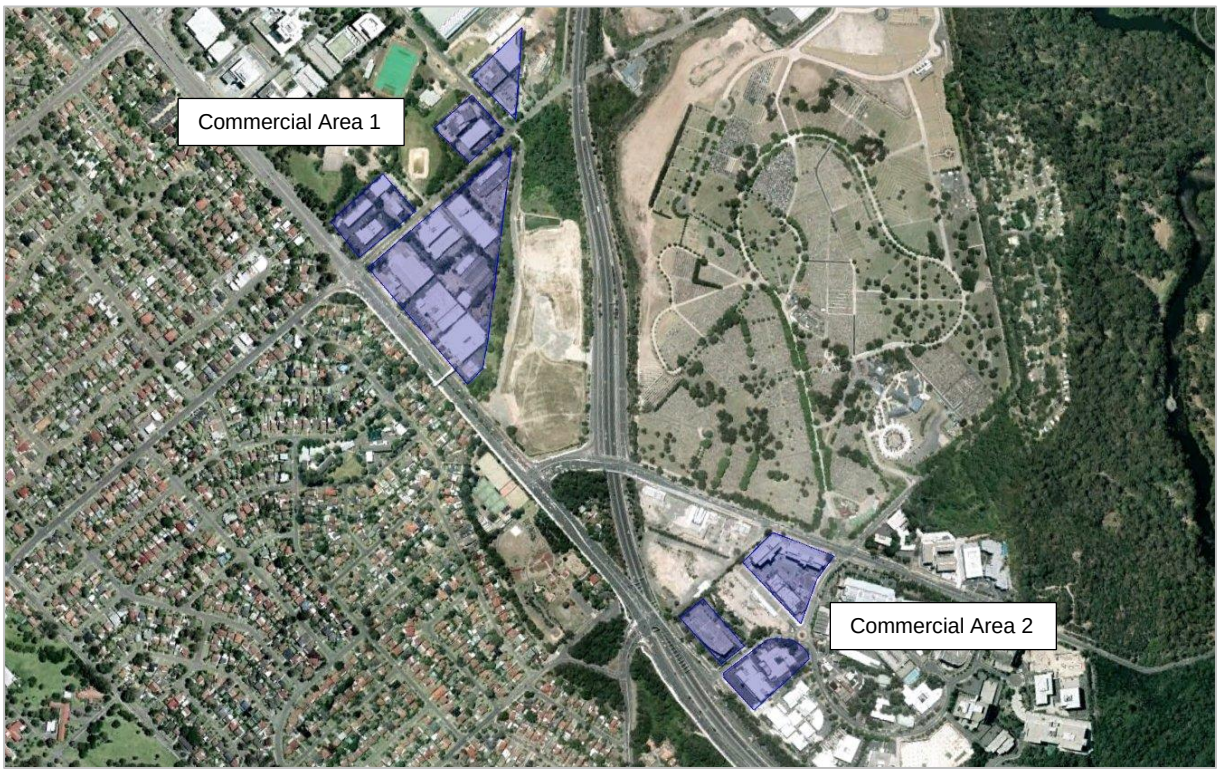
Given the above information, the potential impact (see **Table 12**) on commercial receptors situated at approximately 10m from the M2 site is considered to be ***moderate*** (i.e. the impact is predicted to possibly cause statutory objectives/standards to be exceeded). Correspondingly, the impact significance should be considered ***intermediate***.

For commercial receptors situated at greater distances from the M2 site, the potential impacts is considered to be ***slight*** (i.e. the predicted impact may be tolerated). Correspondingly, the impact significance should be considered to be ***intermediate/minor***.

Commercial Area 2

Commercial Area 2 is located approximately 600 m from the M2 Site and given this significant separation distance, the potential impact is considered to be ***slight*** (i.e. the predicted impact may be tolerated). Correspondingly, the impact significance should be considered to be ***intermediate/minor***.

Figure 7 Commercial Land Use Locations



Source: Google Earth 2014

Potential Dust Impacts due to Construction Works on Special / Recreational Land Uses

Special Land Use (Cemetery)

The Macquarie Park Cemetery and Cremation site is situated approximately 100m east of the M2 Site, (refer to **Figure 8**). The M2 Freeway and Delhi Road lie between the M2 Site and the cemetery.

Air quality impacts due to construction activities at the M2 Site, and also by construction-phase road traffic on nearby roads and freeways, may be expected at the cemetery during winds blowing from the south-west to north-west quadrants.

Analysis of the prevailing seasonal winds in **Section 5.3** shows light to fresh wind speeds blowing from the south-west to north-west are prevalent in during the cooler months (i.e. autumn and winter) and were experienced approximately 30% of the time during 2008.

The impacts are assessed as being *adverse* in nature, *short term* (for the duration of the construction works) and *reversible*.

Given the above information, the potential impact (see **Table 12**) due to the M2 Site on special land uses is considered to be ***slight*** (i.e. the predicted impact may be tolerated). Correspondingly, the impact significance should be considered to be ***intermediate/minor***.

Recreational Areas 1 and 2

Recreational Area 1 is situated approximately 100 m to the north-west of the M2 Site. Air quality impacts due to construction activities at the M2 Site, and also be construction-phase road traffic on Wicks Road, may be expected at Recreational Area 1 during winds blowing from the east to south-eastern quadrants. Analysis of the prevailing seasonal winds in **Section 5.3** shows that light to moderate wind speeds from these directions were experienced during 2008 (less than 5% combined).

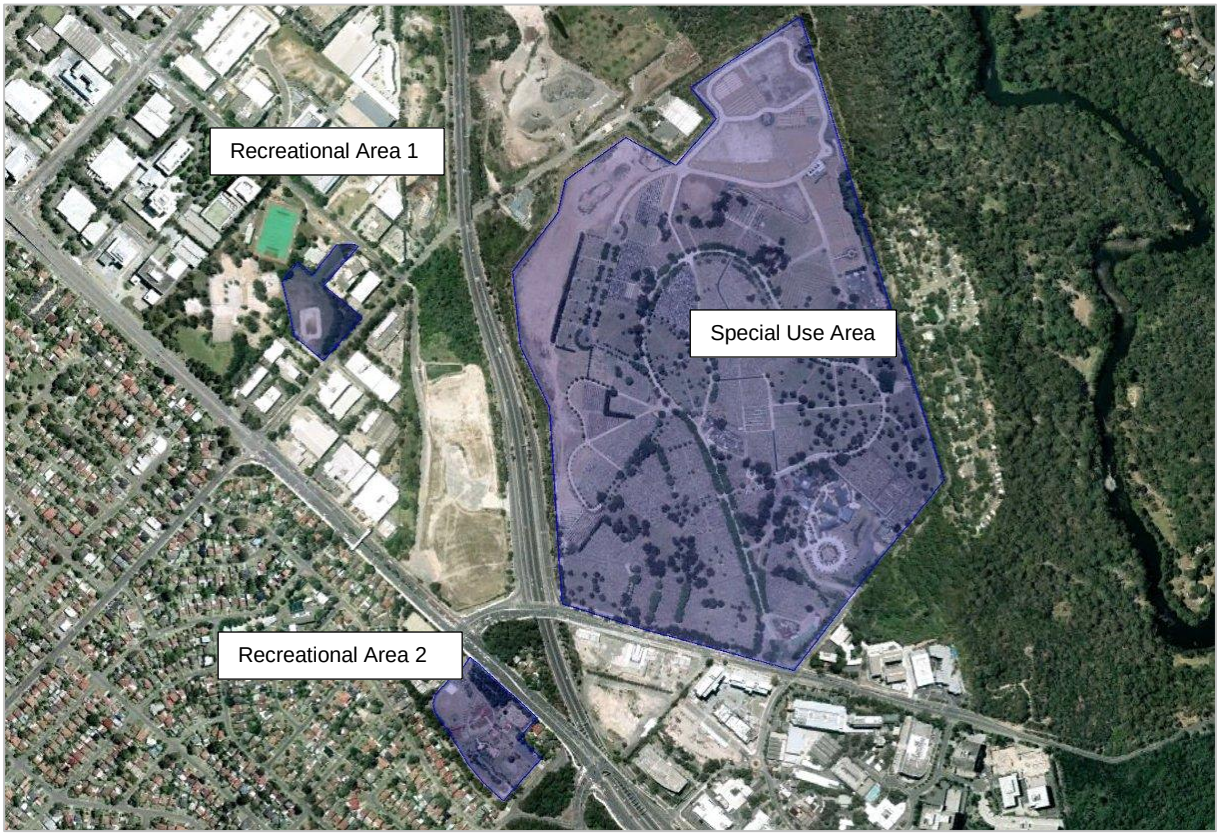
Recreational Area 2 (Blenheim Park) is situated approximately 90m to the south of the M2 Site. Air quality impacts due to construction activities at the M2 Site may be expected at Recreational Area 2 during winds blowing from the north and north-west quadrants. Analysis of the prevailing seasonal winds in **Section 5.3** shows that light to fresh northerly winds occur during the spring and were experienced approximately 6% of the time during 2008.

It is noted that vegetative buffers currently exist between the M2 Site and the recreational area on Wicks Road. Vegetative buffers can be effective at intercepting dust and other ambient air pollutants.

The impacts are assessed as being *adverse* in nature, *short term* (for the duration of the construction works) and *reversible*.

Given the above information, the potential impact (see **Table 12**) due to the M2 Site on recreational areas is considered to be ***slight*** (i.e. the predicted impact may be tolerated). Correspondingly, the impact significance for these sites should be considered to be ***intermediate/minor***.

Figure 8 Special and Recreational Land Use Locations



Source: Google Earth 2014

Potential Dust Impacts due to Construction Works on Industrial Land Uses

An industrial land use (i.e. the Ryde Resource Recovery Centre) is situated approximately 100m to the north of the M2 Site on the northern side of Wicks Road.

Air quality impacts due to construction activities at the M2 Site, and also by construction-phase road traffic on Wicks Road, may be expected at the Ryde Resource Recovery Centre during winds blowing from the south to south-west and south to south-eastern quadrants.

Analysis of the prevailing seasonal winds in **Section 5.3** shows south to south-west winds were experienced less than 5% of the time during 2008. Light to moderate wind speeds blowing from the south to south-east are most common during the warmer months (i.e. spring and summer) and were experienced approximately 12% of the time during 2008.

The impacts are assessed as being *adverse* in nature, *short term* (for the duration of the construction works) and *reversible*.

Given the scale and nature of the industrial land use and its relative proximity to the M2 Site, the potential impact (see **Table 12**) for the M2 Site is considered to be ***slight*** (i.e. the predicted impact may be tolerated). Correspondingly, the impact significance should be considered to be ***minor***.

Figure 9 Industrial Land Use Location

Source: Google Earth 2014
Note: Indicated boundary of industrial area indicative only.

Products of Combustion from Construction Plant and Machinery

The construction activities are anticipated to require a range of plant and machinery, which will give rise to increased emissions of products of combustion, principally comprising carbon monoxide (CO), carbon dioxide (CO_2), oxides of nitrogen (NO_X), sulphur dioxide (SO_2), particulate matter, and a range of VOC compounds including (but not limited to) benzene (C_6H_6) and 1,3-butadiene (C_4H_6).

The range of combustion plant and machinery anticipated to be utilised to perform the various construction activities is presented in **Section 7.1.1**. The impact of products of combustion from construction plant and machinery has been assessed qualitatively.

The impact is considered to be *adverse* in nature, *short term* in duration (for the duration of the construction works) and *reversible*.

The sensitivity of the receiving environment is assessed as being of ***medium*** sensitivity due to the background concentrations of PM_{10} in the area surrounding the M2 Site. The predicted magnitude of the impact is assessed as being ***moderate*** due to the distance from the identified receptor locations to the sources (i.e. approximately 10m or greater). For reference, it is commonly observed that measureable impacts from road traffic emissions are limited to within 200m of the source. Therefore, in accordance with the methodology outlined in **Section 4.3.3**, the impact magnitude is predicted to be of ***intermediate/minor*** significance.

Potential VOC Exposure from Stored Fuels

Fuels and chemicals associated with the construction phase of the M2 Site have the potential to cause VOC emissions through normal use and additionally be accidental spillage. The volume of fuel stored at the M2 Site during the construction phase is currently unknown, although it is assumed to be in low volume.

In lieu of specific details concerning the proposed control of evaporative VOC emissions from fuel storage and distribution, or the control of accidental spillage, a qualitative assessment of those impacts has been performed.

The impacts are assessed as being *adverse* in nature, *short term* (for the duration of the construction works) and *reversible*.

The sensitivity of the receiving environment is assessed as being of ***medium*** sensitivity due to the likelihood of complaints in close proximity to those emissions, and the potential for nuisance. The predicted magnitude of the impact is assessed as being ***slight*** due to the distance from the identified receptor locations to the sources (i.e. approximately 100m or greater). Therefore, in accordance with the methodology outlined, the impact magnitude is predicted to be of ***minor*** significance.

However, it is noted that this assessment determines off-site impacts, and excludes the potential impact upon site workers, who may experience elevated exposure rates of VOCs near to the fuel storage area and close to the points of redistribution. It is strongly recommended that additional control measures are applied to offer effective control of workforce exposure to VOCs, and that a program of monitoring is performed to verify that exposure rates are below the relevant Health and Safety exposure thresholds.

Potential Odour from Ground Works

Invasive ground works have the potential to cause the emission of odorous ground vapour. At the time of compiling this report, the details of the site investigation and ground contamination report were not available, so the potential contaminants at the site, their location, concentration, depth and nature (if relevant) have not been confirmed. However, to in order to perform an assessment of potential air quality impacts associated with the emission of odour from invasive ground work, an assumption has been made on the ground contamination, which may need to be revised when additional information is available.

The impacts are assessed as being *adverse* in nature, *short term* (for the duration of the construction works) and *reversible*.

The sensitivity of the receiving environment is assessed as being of ***high*** sensitivity due to the potential for complaints in close proximity to those emissions, and the potential for nuisance. The predicted magnitude of the impact is assessed as being ***moderate*** due to the distance from the identified receptor locations to the sources (i.e. approximately 10m or greater). Therefore, in accordance with the methodology outlined, the impact magnitude is predicted to be of ***intermediate*** significance.

Reference should be made to the Phase 1 and 2 Land Contamination Assessments for the M2 Site for a full assessment of the associated risks.

8 MANAGEMENT SAFEGUARDS AND MITIGATION MEASURES

8.1 Noise

The ICNG describes strategies for construction noise mitigation and control that are applicable for this project. The approach to construction noise control can include time restrictions, level restrictions and other feasible and reasonable mitigation measures.

Specific mitigation measures which are considered appropriate for these works are:

- Use of localised acoustic hoarding around all significantly noise generating items of plant where practicable. This would expect to provide between 5dB and 10 dB of additional noise attenuation provided the line-of-sight between all receivers and construction equipment is broken. Barriers are most affective when located either close to the noise source of the receiver.
- Scheduling of the higher Noise Management Level exceedance activities/locations to be undertaken predominately during less noise-sensitive periods, where available and possible.
- Avoid the coincidence of noise plant working simultaneously close together and adjacent to sensitive receivers.
- Briefing of the work team in order to create awareness of the locality of sensitive receivers and the importance of minimising noise emissions.
- Use of less noise intensive equipment, where reasonable and feasible.
- Use of non-tonal reversing alarms fitted to all construction vehicles.
- Loading and unloading should be carried out away from sensitive receivers, where practical.

Liaising with affected residents and informing them when noisy works will occur and what is being done to minimise the noise.

8.2 Vibration

The following vibration mitigation measures are recommended where deemed to be reasonably and feasibly practicable:

- Relocate vibration generating plant and equipment to areas within the site in order to lower the vibration impacts at affected locations.
- Construction works should be carried out Monday to Friday, 7.00 am to 6.00 pm, where possible. Work generating high vibration levels should be scheduled during less sensitive periods.
- Use lower vibration generating items of excavation plant and equipment where feasible.
- Minimise consecutive works in the same locality (if applicable).
- High vibration generating activities such as vibratory rolling, hydraulic hammering and piling should only be carried out in continuous blocks, not exceeding 3 hours each, which a minimum respite period of 1 hour between each block where these works are proposed in proximity to sensitive receivers.

In the event that work within the safe work distance identified in **Table 25** for cosmetic damage is required, it is recommended that vibration monitoring be carried out in conjunction with a controlled commencement of the activity, in particular at areas along Spine Road.

Supplementary vibration monitoring could be carried out in response to complaints, exceedances or for the purpose of refining construction techniques in order to reduce vibration emissions (if required). Monitoring would be attended under these circumstances, in order to provide immediate feedback to the operators.

During the detailed design stage, when more specific information is available in relation to the proposed construction works, a site specific Construction Noise and Vibration Management Plan would be prepared. This would address each major stage of the construction works and identify the appropriate mitigation and management measures, consistent with the requirements of the ICNG.

8.3 Air Quality

The potential for atmospheric emissions during construction works and the predicted impact on surrounding sensitive receptors (as highlighted in **Section 7.3.2**) are anticipated to be largely controllable through a range of mitigation measures including good site management, good housekeeping measures, vehicle maintenance and applying appropriate dust mitigation measures where required.

8.3.1 Best Available Techniques (BAT)

Best Available Techniques (BAT) was introduced as a key principle of the European Integrated Pollution Prevention and Control (IPPC) Directive (96/61/EC). The European Commission produced BAT Reference Documents (BREFs) for a number of industries which are intended to be used as an input into determination of BAT for specific cases.

The essence of BAT is that the selection of techniques to protect the environment should achieve an appropriate balance between realising environmental benefits and the costs incurred by the person carrying out the activities. In other words, it would be possible to spend infinite time and money to attempt to reduce dust impacts to zero but the cost involved may be grossly disproportionate to the benefit gained.

While no legislative driver exists in Australia at present, some of the relevant BAT mitigation measures for dust control are summarised below:

- Water sprays are a commonly used control method for particulate matter emissions. The addition of dust control suppressants such as polymers and acrylics to the water increases the effectiveness of the spraying.

- Stockpiles can be sprayed with a lime slurry (or similar polymer) which forms a hard crust and prevents dust emissions.
- Spraying of the shovel / bucket for excavators / FELs when loading trucks.
- Spraying the bucket of trucks before loading.
- Direct water spraying of trucks.
- Sprays / atomisers to moisten ambient air during operations with the potential to generate high volumes of dust.
- Wheel-wash / shaker grids and visual inspection of trucks prior to exiting construction sites onto public roads.
- Vacuuming / sweeping of dirt track-out out onto public roads.

While it is not anticipated that blasting works will be required during site preparatory works, best practice control measures include restricting blasting to times of favourable weather conditions.

8.3.2 NSW EPA Guidance

The NSW EPA guidance is provided in the Local Government Toolkit, Module 3, Part 1, Section 4.16 *Dust Suppression*.

This guidance lists the following generic measures:

The Principals of Dust Suppression

- Avoiding exposure of loose dust particles to winds of sufficient velocity to lift the particles from the surface they are resting on.
- Minimising the unnecessary formation of dusty materials through abrasion and crushing of solids due to moving and handling equipment.
- Avoiding unnecessary disturbance of surfaces that might generate dust particles.
- Avoiding free dusty material falling through air where it can be exposed to cross currents of wind.
- Maintaining sufficient moisture in dusty materials to keep surface forces strong enough to resist wind entrainment.
- Using matting or another type of covering over surfaces likely to generate dust.
- Revegetating surfaces likely to generate dust.
- Using water sprays to moisten dusty surfaces on a systematic basis to maintain moisture content at potentially dusty surfaces.
- Re-stabilising dusty surfaces by undertaking vegetative-cover planting, rehabilitation or sealing as soon as possible after the work requiring the disturbance has been completed.
- Designing and installing wind breaks, wind barriers and enclosures at key points, such as truck unloading stations to avoid falling dusty material being exposed to external winds.
- Maintaining moisture content of solid materials being transported or conveyed wherever possible.
- Using water suppression sprays at transfer points in solid material conveying systems and solids unloading or loading stations to minimise fugitive dust.
- Applying fixed water sprays to stockpiles of dusty materials to thoroughly wet and crust the stockpile surfaces for storage.
- Using careful design to ensure that wetting and agglomeration is adequate at sensitive entrainment points, such as the tops of stockpiles.

- Using agglomeration and stabilising agents in water sprays were the degree of movement is intense or the materials are particularly dusty or dry.
- Providing a mobile water spray vehicle to ensure surfaces not reached by fixed sprays can be kept moist; for surfaces unreachable by vehicle, hand-held watering can be used.
- Avoiding driving on stockpile surfaces in rubber-tyred vehicles; tracked vehicles or mechanical stacking equipment should be used for emplacement and recovery at stockpiles.
- Ensuring engine exhausts from all heavy moving machinery are not directed onto stockpile or road surfaces.
- Ceasing operations such as bulk storage loading and unloading and surface grading during strong wind conditions; an average wind speed of over 15 m/s is commonly used as the trigger for stopping certain operations, and where this is the case, a recording and alarmed anemometer should be installed, maintained and records kept.
- Practising thorough truck washing, especially washing of tyres, to prevent the tracking of dusty materials in a wet condition onto sealed roadways; once deposited on roads these materials dry out and are further reduced in size by abrasion due to multiple tyre contact, and are resuspended by tyres and local winds.
- Covering loads of dusty material transported by road in open-topped trucks.

8.3.3 Site Specific Mitigation Measures

Dust Emissions from Construction Phase Activities

Ambient dust emissions from wheel-generated dust, excavation and rehabilitation, clearing and grading, truck loading and unloading, and wind erosion areas will be the primary focus of dust control at the M2 site. Typically, emissions from these processes can be minimised through the implementation of water spraying, particularly during periods of heavy on-site activity.

The use of water is a key method for the suppression of dust generation. Increasing the water content of surfaces (e.g. implementing water sprays) leads to agglomeration and weak cementation of loose particles on an unconsolidated surface. Spraying increases moisture content and bonding and, even on drying, wind entrainment will be minimised by the weak cementation or ‘crusting’ which results.

The movement of vehicles within the M2 Site presents a high potential for wheel generated dust. Vehicles travelling over paved (or unpaved) surfaces tend to pick up and drop surface particles and expose them to air currents caused by the turbulent shear between the wheels and the surface. These resuspended dust particles are also entrained in the turbulent wake left behind vehicles.

Loads carried by trucks are another potential problem, as fugitive dust can be caused by wind or spillages. Dirt track-out can also be a problem on paved surfaces surrounding the site as dust can build up around curbs and gutters and present as a source for wind erosion.

Dust mitigation measures (additional to those already outlined in previous sections) that may be implemented during the construction phase include:

- Silt and other material be removed from around erosion and sediment control structures to ensure deposits do not become a dust source.
- Amending of dust-generating construction activities during adverse wind conditions blowing in the direction of sensitive receptors.
- Minimising the use of material stockpiles and locating them away from sensitive receptor locations.
- Reducing the truck speeds on site will reduce wheel generated dust. It is noted that the physical size and layout of the site will act to limit truck speeds.

- If dirt track out is causing problems, manual brushing of the truck's flanks and wheels could be implemented as a further precaution. Also, trucks exiting the site should be observed to determine if the both wheels travel over the shaker grid.

The Emission of Products of Combustion from Plant and Machinery

Control measures that may be implemented during the construction phase include:

- Ensuring vehicles and machinery are maintained in accordance with manufacturer's specifications.
- Minimising truck queuing and unnecessary trips through logistical planning of materials delivery and work practices.
- Stationary trucks should switch off engines if idling time on-site is likely to exceed 2 minutes and should avoid using the local road network during peak traffic periods.
- Fixed plant should be located as far from local receptors as practicable.

Fugitive Release of Emissions from Fuel Storage Areas

The storage of fuels will be performed in accordance with the relevant Australian Standards, including:

- Australian Standard (AS) 1692 *Tanks for flammable and combustible liquids*.
- AS 1940 *The storage and handling of flammable and combustible liquids*.
- AS 4897 *The design, installation and operation of underground petroleum storage tanks.*
- AS 1657 *Fixed platforms, walkways, stairways and ladders – design construction and installation*.

The Australian Institute of Petroleum's document, *Guidance for the Safe Above Ground Fuel Storage on Farms and Industrial Sites* (AIP GL12-2003), provides a succinct summary of the above requirements and a checklist to appraise whether the fuel storage facility is deigned and operated in compliance with the relevant AS.

The Australian Capital Territory (ACT) Government has produced a guidance document entitled *Environmental guidelines for service station sites and hydrocarbon storage* (2011), which provides further clarification and advice concerning environmental monitoring around fuel storage facilities.

Control measures that may be implemented during the construction phase will be referenced from the above AS, and will:

- Locate fuel storage and handling areas as far from local receptors as practicable.
- Storage areas for all liquids should be appropriately bunded.
- Spill kits including absorbing materials should be provided nearby handling and storage areas.
- Where possible, the delivery of liquid fuels should utilise reciprocal feeds, so that tank vapours are displaced into the delivery vehicle rather than being emitted to the atmosphere as a fugitive emission.
- Empty containers should be managed and disposed of in appropriate manner.

Potentially Odorous Emissions due to Ground Invasive Works

Where there is the potential for invasive ground works to cause the emission of odorous ground vapour or contaminated dust particles, these impacts would be specifically addressed in the CEMP, and an odour assessment and management procedure developed to manage the risks of off-site odour impacts and/or health impacts from the volatilisation of ground contaminants.

General odour mitigation measures and controls that may be implemented during the construction phase include:

- Restricting ground invasive works to the hours of 7am and 6pm, Monday to Friday, and between the hours of 8am and 1pm on Saturdays.
- Keeping excavation surfaces moist.
- Using appropriate covering techniques to cover excavation faces or stockpiles.
- Use of soil vapour extraction systems and regular monitoring of discharges.

8.3.4 Implementation of a Construction Environmental Management Plan

Air emissions associated with all construction activities should also be managed through compliance with the CEMP. This would include implementation of procedures designed to meet the air quality objectives adopted for the M2 Site and other relevant guidelines/standards. The CEMP would be implemented so that:

- The works are conducted in a manner that minimises the generation of air emissions.
- The effectiveness of the controls being implemented is monitored.
- Additional measures are implemented where required, as determined by the monitoring program.
- A complaints management system is implemented so that any identified incidents or complaints are dealt with through investigation and implementation of corrective treatments.

8.3.5 Monitoring Program

Data from an air quality monitoring program can be used to determine the impact of construction works on the surrounding air environment and community.

Where monitoring is deemed necessary during M2 site construction works, a program of background air quality monitoring is recommended to enable background levels of air pollutants (in particular, dust deposition and PM_{10}) and therefore the increment due to construction works, to be measured.

As a minimum, wind socks should be installed and be visible to each active construction site to assist in reactive response procedures (i.e. to determine when construction activities should be postponed, minimised or relocated in windy conditions). Ideally, a recording and alarmed anemometer should be installed, maintained and records kept.

8.3.6 Daily Environmental Inspections

Construction contractors should undertake regular environmental inspections of their works and worksite. This may include, but not be limited to:

- Visual inspection of airborne dust.
- Ensure roads leaving the site are free of soil, and prevention of soil tracking onto the road network.
- Inspection of the erosion and sediment controls.
- Inspection of the waste storage areas.
- Inspection of any rehabilitated areas (where relevant).
- Ensure all hazardous goods, including fuel and oil, are adequately stored or bunded.
- Ensure spill kits are appropriately located and stocked.

These environmental inspection reports should include the above observations, with remedial or corrective actions noted (as appropriate). Any remedial or corrective actions should be reported to the Site Manager as soon as is practicable.

These reports should be issued on a weekly basis to the Project Manager for review. The Project Manager should make these available to the relevant agencies on request.

8.3.7 Complaints Handling

A complaints handling system should be maintained to monitor complaints and to effectively manage any requests for information or respond to any public concerns in relation to the proposed construction activities. All information relating to complaints should be kept in a complaints register. The complaints register should note the following details of a complaint relating to nuisance odour or dust:

- Date and time that the complaint was made.
- Name and contact details of the complainant.
- Location where the nuisance odour/dust was noted.
- Weather conditions experienced on the day (e.g. temperature, humidity, wind characteristics, clear or rainy).
- The perceived frequency and duration of the conditions giving rise to the complaint.
- The perceived (or assumed) cause of the condition giving rise to the complaint.
- A description of the conditions and the effect upon the complainant.
- Project-related activities undertaken at the time of the complaint.
- Actions taken where site activities are determined to be the cause of the complaint as per internal reporting requirements or on a priority basis (i.e. depends on the cause and required action).
- Sign-off by a responsible person.
- Follow-up with the complainant.

Similarly, Council should maintain a complaints logging system (also requiring the above details in relation to a complaint) for complaints associated with the surrounding industries that are reported directly to Council.

Where a complaint is made, investigation into the cause of the complaint should be made and remedial control measures undertaken to reduce emissions to a level that does not cause a continuation of unacceptable nuisance.

8.3.8 Reactive Response Procedures

Non-Compliance Response Procedure

In the event where dust or odorous emissions are noted on site, or emissions are identified as exceeding the relevant air quality criteria, the following measures should be considered:

- The situation should be investigated to determine the source of the visible emissions or increased pollutant concentrations.
- Where the source is identified at the construction site, additional controls should be implemented or operational activities altered until a favourable outcome can be achieved.
- The site manager should be informed of any corrective action taken or complaint received.
- A full and complete record of any incident, actions and sign-off by an authorised person should be recorded at the site.

Contingency Plan

Where pro-longed occurrences of visible dust occur, mitigation measures for excessive dust events/adverse weather conditions should be implemented including:

- Deployment of additional water carts.
- Relocation or modification of dust-generating sources where possible.
- Temporary halting of activities and resuming when conditions have improved.

An excessive dust event includes prolonged visual dust or elevation above air pollutant criteria for a particular area. Adverse weather conditions include hot, dry and windy conditions (i.e. wind speeds over 5 m/s blowing in the direction of sensitive receptors).

In addition to the above, further air quality control measures and/or air quality monitoring should be investigated and construction activities moderated until visible dust/nuisance odours/air pollutant concentrations return to an acceptable level and/or the source of the exceedances can be determined and managed appropriately.

8.3.9 Compliance Reporting

Monitoring results, environmental inspection reports and incident reports should be reviewed by the Project Manager on a monthly basis to ensure compliance with the CEMP and environmental goals.

The NSW EPA should immediately be notified of any incidents causing or threatening material harm to the environment as per the POEO Amendment Act 2011 (see **Section 4.3.1**) with incidents recorded in the Site Incident Register.

8.3.10 Roles and Responsibilities

All construction contractors should implement an organisational structure for the management of air quality control and reporting procedures. **Table 26** details the roles and responsibilities further.

Table 26 Roles and Responsibilities

Role	Responsibility
Site Manager	• Oversee the environmental management of construction works. • Liaise as necessary with other on-site personnel. • Liaise with the relevant regulatory authority as required. • Responsible for undertaking the required environmental monitoring. • Responsible to ensuring that any complaint is actioned. • Ensure daily environmental inspections are undertaken.
Project Manager	• Ensure that the environmental management practices detailed within the CEMP are followed. • Review reporting items on a monthly basis to ensure compliance with environmental goals. • Liaise with the relevant regulatory authority as required.

The purpose of this structure is to ensure the following:

- The environmental procedures are effectively implemented and have the intended outcome, that is, no off-site nuisance.
- Non-compliance with any of the desired environmental outcomes are reported promptly and corrective action will be taken to mitigate any impacts.

The management and reporting of environmental aspects of construction activities should be the responsibility of the Project Manager, with specific tasks delegated to on-site personnel.

8.3.11 Performance Indicators

The following commitments relating to the management of air quality should be incorporated into a CEMP for development works:

1 The frequency and nature of complaints reported in relation to air quality.

2 Contractor and employee awareness of the CEMP and air quality control measures.

3 Compliance with air quality controls required of the CEMP, as indicated by associated reporting requirements.

9 REAPPRAISAL OF CONSTRUCTION IMPACTS ON SENSITIVE RECEPTORS

9.1 Air Quality

Table 27 presents a reappraisal of predicted unmitigated air quality impacts on sensitive receptors to demonstrate the opportunity for minimising risks associated with the construction phase through the use of site specific mitigation measures.

Table 27 Impact Significance Reappraisal for Mitigated NRSPP Construction Works

Receptor / Air Quality Impact Type	Nature	Predicted Unmitigated Impact			Proposed Mitigation Methods	Predicted Residual Impact		
		sensitivity	magnitude	impact significance		sensitivity	magnitude	impact significance
Construction dust impacts at residential receptors (> 10m)	adverse, short-term, reversible	high	slight	intermediate/ minor	See **Section 8**	high	negligible	minor
Construction dust impacts at commercial receptors (< 10m)	adverse, short-term, reversible	high	moderate	intermediate	See **Section 8**	high	slight	intermediate/ minor
Construction dust impacts at commercial receptors (> 10m)	adverse, short-term, reversible	high	slight	intermediate/ minor	See **Section 8**	high	negligible	minor
Construction dust impacts at special land uses (> 10m)	adverse, short-term, reversible	high	slight	intermediate/ minor	See **Section 8**	high	negligible	minor

Receptor / Air Quality Impact Type	Nature	Predicted Unmitigated Impact			Proposed Mitigation Methods	Predicted Residual Impact		
		sensitivity	magnitude	impact significance		sensitivity	magnitude	impact significance
Construction dust impacts at recreational land uses (> 10m)	adverse, short-term, reversible	high	slight	intermediate/ minor	See **Section 8**	high	negligible	minor
Construction dust impacts at industrial uses (>10m)	adverse, short-term, reversible	low	slight	minor	See **Section 8**	low	negligible	neutral
Products of combustion from construction plant and machinery (<10m)	adverse, short-term, reversible	medium	moderate	intermediate/ minor	See **Section 8**	medium	slight	minor
Potential exposure from stored fuels (>10m)	adverse, short-term, reversible	medium	slight	minor	See **Section 8**	medium	negligible	minor
Potential odour from ground works (<10m)	adverse, short-term, reversible	high	moderate	intermediate	See **Section 8**	high	slight	minor

10 CONCLUSION

10.1 Noise and Vibration

Noise predictions have been conducted for the construction works associated with the M2 Site. The construction noise assessment has been assessed in accordance with the *Interim Construction Noise Guideline* (ICNG).

Noise emissions from the proposed activities are predicted to exceed the construction noise goals at nearby sensitive receiver locations during periods of noise intensive works and should therefore be managed in accordance with the recommendations contained in this report.

The potential impacts of vibration caused by construction activities has been assessed considering both risk of damage to structures and the exceedance of the human comfort vibration criteria. Vibration impacts when operating in close proximity to sensitive receivers (within 5 metres at some locations) are expected to be within the recommended safe working distance for cosmetic damage, in particular during works along Spine Road. It is recommend that when vibration intensive activities occur in close proximity to sensitive receivers, that vibration monitoring should be conducted.

During the detailed design stage, when more specific information is available in relation to the proposed construction works, it is recommended that a site specific Construction Noise and Vibration Management Plan be prepared, consistent with the requirements of the *Interim Construction Noise Guideline* (ICNG).

10.2 Air Quality

The proposed construction scenarios associated with the M2 Site preparatory works have been reviewed and a qualitative risk-based impact assessment undertaken of the potential air quality impacts to identify a range of suitable control measures available to mitigate those impacts.

The risk assessment has determined that where dust impacts are unmitigated during the construction phase, an 'intermediate/minor' impact significance exists for residential receptors situated greater than 10m of the M2 Site, and an 'intermediate' risk exists for commercial receptors located within 10m of the M2 Site, and for potentially odorous ground works (refer to **Section 7.3.2**). Lesser impact significance ratings apply to receptors impacts located at greater distances from construction worksites and to other air pollutants associated with the construction phase of the M2 Site.

It is noted that site preparatory works are planned for 2014 to 2018 (refer to **Section 7.1.1**). Closest sensitive receptor locations to the M2 Site include commercial areas and residences.

Review of the prevalence of winds (measured for the area during 2008) in **Section 5.3** (winds that have the potential to blow air pollutants across multiple sites in the direction of the receptors) suggests that the likelihood for cumulative impacts at receptor locations will be low. However, given the proximity of the development site to the receptors, it is recommended that a coordinated approach be adopted throughout the construction phase to ensure that multiple construction activities are not operating significant dust-generating processes or activities during adverse winds.

The predicted air quality impacts are anticipated to be largely controllable through a range of mitigation and control measures including good site management and housekeeping, vehicle maintenance and through application of appropriate dust and odour mitigation measures where required. Site specific mitigation measures have been detailed in **Section 8**.

A reappraisal of the predicted air quality impacts has additionally been undertaken assuming that site specific and site appropriate mitigation measures will be employed at the M2 Site during the construction phase. The results of the reappraisal show that reduced impact significance may be achieved where site specific mitigation measures are effectively employed (refer to **Section 9**).

11 REFERENCES

- Bureau of Meteorology's Sydney Olympic Park Automatic Weather Station, 2008 wind data.
- European Integrated Pollution Prevention and Control Directive (96/61/EC)
- National Pollutant Inventory database, 2011/12 reported emissions data.
- NSW EPA Environmental Protection Licence database.
- NSW EPA, Local Government Air Quality Toolkit - Module 1: Air pollution control techniques.
- NSW Department of Environment and Climate Change, Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales, 2005.
- NSW Department of Environment and Conservation, Assessment and Management of Odour from Stationary Sources in NSW: Technical Framework, 2006, and, Assessment and Management of Odour from Stationary sources in NSW; Technical Notes, 2006.
- NSW Government, Protection of the Environment Operations Act, 1997 and Amendment Act, 2011.

1 Sound Level or Noise Level

The terms 'sound' and 'noise' are almost interchangeable, except that in common usage 'noise' is often used to refer to unwanted sound.

Sound (or noise) consists of minute fluctuations in atmospheric pressure capable of evoking the sense of hearing. The human ear responds to changes in sound pressure over a very wide range. The loudest sound pressure to which the human ear responds is ten million times greater than the softest. The decibel (abbreviated as dB) scale reduces this ratio to a more manageable size by the use of logarithms.

The symbols SPL, L or L_P are commonly used to represent Sound Pressure Level. The symbol L_A represents A-weighted Sound Pressure Level. The standard reference unit for Sound Pressure Levels expressed in decibels is 2×10^{-5} Pa.

2 'A' Weighted Sound Pressure Level

The overall level of a sound is usually expressed in terms of dBA, which is measured using a sound level meter with an 'A-weighting' filter. This is an electronic filter having a frequency response corresponding approximately to that of human hearing.

People's hearing is most sensitive to sounds at mid frequencies (500 Hz to 4000 Hz), and less sensitive at lower and higher frequencies. Thus, the level of a sound in dBA is a good measure of the loudness of that sound. Different sources having the same dBA level generally sound about equally loud.

A change of 1 dBA or 2 dBA in the level of a sound is difficult for most people to detect, whilst a 3 dBA to 5 dBA change corresponds to a small but noticeable change in loudness. A 10 dBA change corresponds to an approximate doubling or halving in loudness. The table below lists examples of typical noise levels

Sound Pressure Level (dBA)	Typical Source	Subjective Evaluation
130	Threshold of pain	Intolerable
120	Heavy rock concert	Extremely noisy
110	Grinding on steel	
100	Loud car horn at 3 m	Very noisy
90	Construction site with pneumatic hammering	
80	Kerbside of busy street	Loud
70	Loud radio or television	
60	Department store	Moderate to quiet
50	General Office	
40	Inside private office	Quiet to very quiet
30	Inside bedroom	
20	Recording studio	Almost silent

Other weightings (eg B, C and D) are less commonly used than A-weighting. Sound Levels measured without any weighting are referred to as 'linear', and the units are expressed as dB(lin) or dB.

3 Sound Power Level

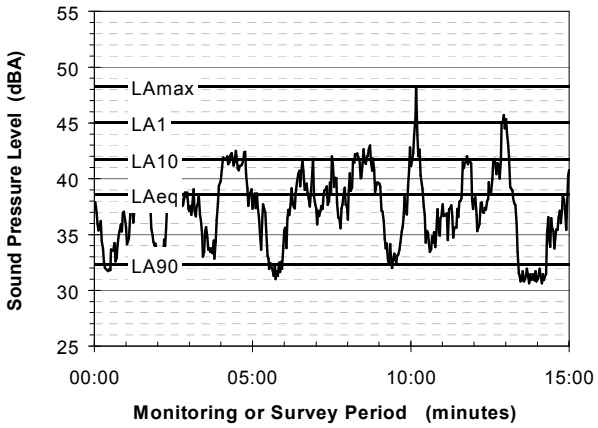
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or L_W, or by the reference unit 10^{-12} W.

The relationship between Sound Power and Sound Pressure may be likened to an electric radiator, which is characterised by a power rating, but has an effect on the surrounding environment that can be measured in terms of a different parameter, temperature.

4 Statistical Noise Levels

Sounds that vary in level over time, such as road traffic noise and most community noise, are commonly described in terms of the statistical exceedance levels L_{AN}, where L_{AN} is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the L_{A1} is the noise level exceeded for 1% of the time, L_{A10} the noise exceeded for 10% of the time, and so on.

The following figure presents a hypothetical 15 minute noise survey, illustrating various common statistical indices of interest.



Of particular relevance, are:

L_{A1} The noise level exceeded for 1% of the 15 minute interval.

L_{A10} The noise level exceed for 10% of the 15 minute interval. This is commonly referred to as the average maximum noise level.

L_{A90} The noise level exceeded for 90% of the sample period. This noise level is described as the average minimum background sound level (in the absence of the source under consideration), or simply the background level.

L_{Aeq} The A-weighted equivalent noise level (basically the average noise level). It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.

When dealing with numerous days of statistical noise data, it is sometimes necessary to define the typical noise levels at a given monitoring location for a particular time of day. A standardised method is available for determining these representative levels.

This method produces a level representing the 'repeatable minimum' L_{A90} noise level over the daytime and night-time measurement periods, as required by the EPA. In addition the method produces mean or 'average' levels representative of the other descriptors (L_{Aeq}, L_{A10}, etc).

5 Tonality

Tonal noise contains one or more prominent tones (ie distinct frequency components), and is normally regarded as more offensive than 'broad band' noise.

6 Impulsiveness

An impulsive noise is characterised by one or more short sharp peaks in the time domain, such as occurs during hammering.

7 Frequency Analysis

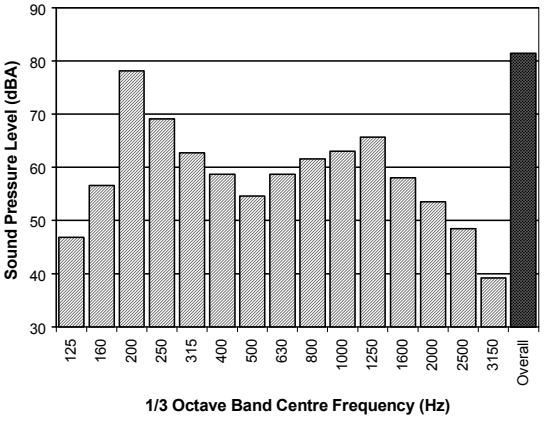
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal. This analysis was traditionally carried out using analogue electronic filters, but is now normally carried out using Fast Fourier Transform (FFT) analysers.

The units for frequency are Hertz (Hz), which represent the number of cycles per second.

Frequency analysis can be in:

- Octave bands (where the centre frequency and width of each band is double the previous band)
- 1/3 octave bands (3 bands in each octave band)
- Narrow band (where the spectrum is divided into 400 or more bands of equal width)

The following figure shows a 1/3 octave band frequency analysis where the noise is dominated by the 200 Hz band. Note that the indicated level of each individual band is less than the overall level, which is the logarithmic sum of the bands.



8 Vibration

Vibration may be defined as cyclic or transient motion. This motion can be measured in terms of its displacement, velocity or acceleration. Most assessments of human response to vibration or the risk of damage to buildings use measurements of vibration velocity. These may be expressed in terms of 'peak' velocity or 'rms' velocity.

The former is the maximum instantaneous velocity, without any averaging, and is sometimes referred to as 'peak particle velocity', or PPV. The latter incorporates 'root mean squared' averaging over some defined time period.

Vibration measurements may be carried out in a single axis or alternatively as triaxial measurements. Where triaxial measurements are used, the axes are commonly designated vertical, longitudinal (aligned toward the source) and transverse.

The common units for velocity are millimetres per second (mm/s). As with noise, decibel units can also be used, in which case the reference level should always be stated. A vibration level V, expressed in mm/s can be converted to decibels by the formula 20 log (V/V_o), where V_o is the reference level (10^{-9} m/s). Care is required in this regard, as other reference levels may be used by some organizations.

9 Human Perception of Vibration

People are able to 'feel' vibration at levels lower than those required to cause even superficial damage to the most susceptible classes of building (even though they may not be disturbed by the motion). An individual's perception of motion or response to vibration depends very strongly on previous experience and expectations, and on other connotations associated with the perceived source of the vibration. For example, the vibration that a person responds to as 'normal' in a car, bus or train is considerably higher than what is perceived as 'normal' in a shop, office or dwelling.

10 Over-Pressure

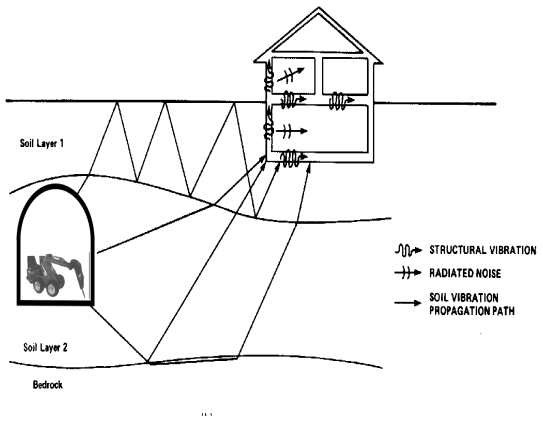
The term 'over-pressure' is used to describe the air pressure pulse emitted during blasting or similar events. The peak level of an event is normally measured using a microphone in the same manner as linear noise (ie unweighted), at frequencies both in and below the audible range.

11 Ground-borne Noise, Structure-borne Noise and Regenerated Noise

Noise that propagates through a structure as vibration and is radiated by vibrating wall and floor surfaces is termed 'structure-borne noise', 'ground-borne noise' or 'regenerated noise'. This noise originates as vibration and propagates between the source and receiver through the ground and/or building structural elements, rather than through the air.

Typical sources of ground-borne or structure-borne noise include tunnelling works, underground railways, excavation plant (eg rockbreakers), and building services plant (eg fans, compressors and generators).

The following figure presents the various paths by which vibration and ground-borne noise may be transmitted between a source and receiver for construction activities occurring within a tunnel.



The term 'regenerated noise' is also used in other instances where energy is converted to noise away from the primary source. One example would be a fan blowing air through a discharge grill. The fan is the energy source and primary noise source. Additional noise may be created by the aerodynamic effect of the discharge grill in the airstream. This secondary noise is referred to as regenerated noise

AIR QUALITY TERMINOLOGY

Units of Measurement and Air Pollutants

AHD	Australian Height Datum
CO	Carbon monoxide
µg	microgram (g x 10^{-6})
µm	micrometre or micron (metre x 10^{-6})
m^3	cubic metre of air
NO_x	Total oxides of nitrogen
NO_2	Nitrogen dioxide
NO	Nitrous oxide
pphm	part per hundred million
ppm	parts per million
PAH	Polycyclic Aromatic Hydrocarbon
PM_{10}	Particulate matter with an aerodynamic diameter of 10 microns or less
$PM_{2.5}$	Particulate matter with an aerodynamic diameter of 2.5 microns or less
SO_2	Sulphur dioxide
TVOCs	Total Volatile Organic Compounds
VOCs	Volatile Organic Compounds

Commonly Used Terminology

ambient	Pertaining to the surrounding environment or prevailing conditions
anemometer	An instrument for measuring wind force and velocity
atmosphere	A gaseous mass surrounding the planet Earth that is retained by Earth's gravity. It is divided into five layers. Most of the weather and clouds are found in the first layer
background	The existing air quality in the project area excluding the impacts from the proposed development
baseline monitoring program	A monitoring program designed to measure the ambient concentration levels which currently exist prior to the proposed development
calms	Refers to calm wind speeds of less than 0.5 m/s.
combustion	The process of burning. A chemical change, especially oxidation,

	accompanied by the production of heat and light
dust deposition	Settling of particulate matter out of the air through gravitational effects (dry deposition) and scavenging by rain and snow (wet deposition)
dispersion	The spreading and dilution of substances emitted in a medium (e.g. air or water) through turbulence and mixing effects
downwind	The direction in which the wind is blowing
emission factor	A measure of the average amount of a specific pollutant or material emitted by a specific process, fuel, equipment, or source based on activity data such as the quantity of fuel burnt, hours of operation or quantity of raw material consumed.
fugitive emissions	Pollutants which escape from an industrial process due to leakage, materials handling, transfer, or storage
guideline	A general rule, principle, or piece of advice. A statement or other indication of policy or procedure by which to determine a course of action.
mitigate	To moderate (a quality or condition) in force or intensity; alleviate
meteorological	The science that deals with the phenomena of the atmosphere, especially weather and weather conditions
particulate	Of, relating to, or formed of minute separate particles. A minute separate particle, as of a granular substance or powder
plume	A space in air, water, or soil containing pollutants released from a point source
pollutant	A substance or energy introduced into the environment that has undesired effects, or adversely affects the usefulness of a resource
qualitative assessment	An assessment of impacts based on a subjective, non-statistical oriented analysis.
quantitative assessment	An assessment of impacts based on estimates of emission rates and air dispersion modelling techniques to provide estimate values of ground level pollutant concentrations.
receptor	Coordinate locations specified in an air dispersion model where ground level pollutant concentrations are calculated by the model
sensitive receptor	Locations such as residential dwellings, hospitals, churches, schools, recreation areas etc where people (particularly the young and elderly) may often be present, or locations with sensitive vegetation and crops.
standard	The prescribed level of a pollutant in the outside air that should not be exceeded during a specific time period to protect public health
topography	Detailed mapping or charting of the features of a relatively small area, district, or locality
volatile organic compounds	All organic compounds (substances made up of predominantly carbon and hydrogen) with boiling temperatures in the range of 50-260°C, excluding pesticides. This means that they are likely to be present as a vapour or gas in normal ambient temperatures.

wind direction	The direction from which the wind is blowing
wind erosion	Detachment and transportation of loose topsoil or sand due to action by the wind
wind rose	A meteorological diagram depicting the distribution of wind direction and speed at a location over a period of time