Final report

Hanson Glebe Island Concrete Batching Plant Air Quality Assessment

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1 Executive summary

Pacific Environment has been commissioned by Hanson Construction Materials Pty Ltd (Hanson) to undertake an air quality and greenhouse gas assessment for the proposed construction and operation of a Concrete Batching Plant (CBP) at Glebe Island, within the Bays Precinct, NSW.

As part of the proposal, an Environmental Impact Statement (EIS) including an air quality and greenhouse gas assessment is required.

The assessment is based on a conventional approach following the procedures outlined in the NSW Environment Protection Authority's (EPA) document titled "Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW" (the Approved methods; EPA, 2016). This assessment has also been completed to meet the Secretary's Environmental Assessment Requirements (SEARs) dated 7 July 2017, reference number SSD 8544.

This assessment has adopted the use of the computer-based dispersion model, AERMOD, to predict off site particulate matter (PM) and gaseous air quality metrics.

Modelling results indicate that potential air quality impacts associated with the Project will be below ambient air quality impact assessment criteria. Further, an assessment of cumulative air quality impacts indicates that the Project is not anticipated to result in any additional exceedances of the impact assessment criteria.

A semi-quantitative screening assessment of construction phase impacts identified human receptors within 350 m of the boundary of the site. Various measures for limiting the impacts of construction dust have been recommended. Most of the recommended measures are routinely employed as 'good practice' on construction sites.

Average annual scope 1 and 2 greenhouse gas emissions from the Project (2,170 tonnes CO_2-e) would represent approximately 0.0000004% of Australia's 2016 emissions (537.4 Mt CO_2-e). This in turn comprises an extremely small component of global GHG emissions, given that Australia contributed approximately 1.5% to global GHG emissions in 2005 (Commonwealth of Australia, 2011).

A range of mitigation measures have been proposed to manage the Project's construction, operation and greenhouse gas emissions.

Accordingly, based on the analysis undertaken in this assessment, the potential for the Project to adversely impact air quality is considered to be low and acceptable.

Table of contents

List of Figures

List of Tables

1 Introduction

Pacific Environment has been commissioned by Hanson Construction Materials Pty Ltd (Hanson) to undertake an air quality and greenhouse gas assessment for the proposed construction and operation of a concrete batching plant (CBP) at Glebe Island, within the Bays Precinct, NSW.

As part of the proposal, an Environmental Impact Statement (EIS) including an air quality and greenhouse gas assessment is required.

This assessment has adopted the use of the computer-based dispersion model, AERMOD, to predict off site particulate matter (PM) and gaseous air quality metrics. To assess the effect that potential emissions could have on existing air quality, the dispersion model predictions have been compared to relevant regulatory air quality criteria.

The assessment is based on a conventional approach following the procedures outlined in the NSW Environment Protection Authority's (EPA) document titled "Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW" (the Approved methods; EPA, 2016). This assessment has also been completed to meet the Secretary's Environmental Assessment Requirements (SEARs) dated 7 July 2017, reference number SSD 8544.

In summary, this report provides information on the following:

- Overview of operations
- Relevant air quality criteria
- Meteorological conditions in the area
- Emission sources and estimates of these emissions
- Methods used to predict off-site air quality impacts from the site
- Expected dispersion patterns and predicted impacts
- Risk based assessment of construction impacts; and
- Greenhouse gas emissions assessment

2 Project description

2.1 Overview

Hanson propose to develop a new intermodal aggregate storage facility and concrete plant to be located adjacent to Glebe Island Berth One (GLB1) (Lot 10 in DP 1170710) (the Site), as shown in Figure 2-1. The plant will be designed with a capacity to produce up to 1 million cubic metres of concrete per annum and will supply aggregate to other Hanson sites in the vicinity. The proposed plant will serve two purposes:

- To act as a shipping facility that will support a number of Hanson (and Hymix) concrete batching plants by improving the delivery of aggregates into the city centre; and
- To operate as a concrete batching plant that can supply concrete for infrastructure and buildings in the CBD and inner suburbs.

The concrete batching plant will be supported by new aggregate shipping terminal facilities at GLB1 with the capacity to manage up to 1 million cubic metres of concrete aggregates per annum delivered by ship from the Hanson Bass Point Quarry and other facilities if deemed viable. By facilitating delivery by ship, the proposed development will reduce the number of trucks required to haul aggregates into Sydney on the regional road network by up to 65,000 trips per annum.

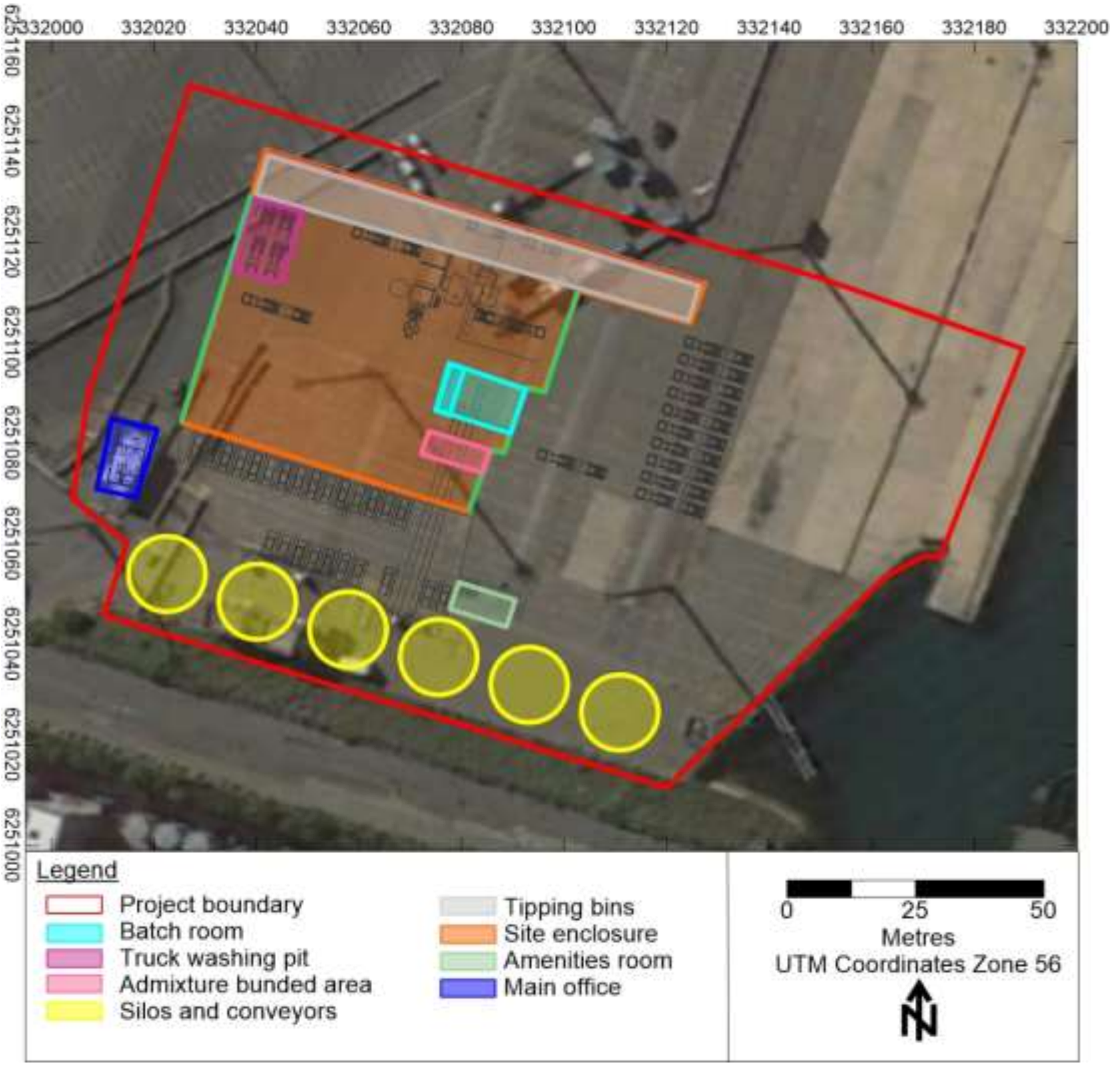


Figure 2-1: Proposed site layout

2.2 Description of Process

2.2.1 Operation

The proposed hours for the operation of the concrete batching plant are 24 hours a day, seven days a week. Three main types of commercial vehicles will operate at the plant:

- A total of 55 concrete agitator trucks – delivering concrete mixed at the plant (on-site) to construction sites throughout the city. Some of these are standard rigid-axle agitator vehicles and some are articulated agitator vehicles.
- Cement tankers – delivering cement to the Site, this cement will most likely come from the Cement Australia Glebe Island facilities and therefore will not have to access the public road network.
- Aggregate trucks – two tipper trucks will be based at the Site, trucks based at other concrete batching plant facilities may also access the plant. Aggregate trucks dispatch aggregates and sand to other concrete batching plant facilities – including the Hymix plant at Pyrmont. These are truck and dog trailer combinations.

Other on-site vehicles will include a forklift, a bobcat and two loaders. Deliveries are expected to be made by B-Double tankers and truck and dog trailers. Concrete agitator trucks are usually parked on the Site overnight. Day shift drivers will arrive to the Site in the morning between 5am and 8am to start the shift, leaving the Site between 3pm and 6pm in the evening. It is anticipated that the majority of staff will travel to the Site by car. All batching activities will take place within an enclosed building. A plan of the proposed plant is provided in Figure 2-1. A brief description of the batching process is provided below.

2.2.1.1 Delivery

Delivery vehicles will access the Site from James Craig Road beneath the old Glebe Island Bridge abutment. Cement tankers will enter the building from the east and exit from the west. Aggregate trucks will deliver sand entering the building from the west and exit from the east. Cement and fly ash delivered to the Site will be stored in silos. All deliveries will take place within the enclosed building. Ships will deliver aggregate to the Site via the GLB1 wharf. Aggregate and sand will be conveyed to the storage silos by enclosed overhead conveyors.

2.2.1.2 Batching

Concrete agitator trucks will move from their holding area to within the enclosed building to receive the concrete for delivery. Concrete agitator trucks will enter the building from the east. Aggregate, sand, cement and fly ash will be transported from their storage silos via an enclosed conveyor system to a weigh hopper. From here, the ingredients will be transferred to an agitator truck within the enclosed building. The concrete agitator trucks will mix the ingredients before moving to the slump stand for final quality checking. Getting the correct consistency in the mix is important to ensure that the concrete is able to be transported to the required destination without drying out.

2.2.1.3 Dispatch

Once the concrete is loaded into the concrete agitator trucks, they can depart from the west of the enclosed building. Concrete agitator trucks will exit the Site via James Craig Road and from there, travel to where their delivery is required. When the plant is operating at peak capacity, up to 120 concrete deliveries will be made from the plant in an hour.

Aggregates not used in the batching of concrete on the Site will be dispatched from the storage silos by conveyor directly for loading to an aggregate truck for dispatch to another concrete batching plant.

2.3 Physical Description

The plant is proposed to adopt a low profile design sympathetic to its surrounding environs. The majority of the batching activities will be undertaken in an enclosed area to limit the noise and air quality impacts of the proposed plant. The highest structures will be the cement silos which will be up to 34m tall, substantially lower than the adjacent heritage listed Glebe Island Silos..

Physical elements of the plant will include:

- Cement silos
- Aggregate silos
- Sand silos
- Water tanks

- Weigh hoppers
- Slump stand
- Conveyors
- Truck parking
- Car parking
- Weigh bridges
- Water tanks
- Building enclosure; and
- Ancillary offices and staff areas.

2.4 Operational scenarios

2.4.1 Normal day

On an average production day (referred to as a normal day in this report) the production rate and storage requirements would be approximately 35% of that for a peak operational day. Table 2-1 summarises the quantities of raw materials used, production rates that might be expected on a normal day calculated from annual throughputs.

Table 2-1: Normal day material quantities

Material	Daily quantity (tonnes/day)	Annual quantity (tonnes/year)
Concrete	6,301	2,300,000
Aggregate	2,740	1,000,000
Sand	2,740	1,000,000
Cement	821	300,000

2.4.2 Peak operational day

Table 2-2 summarises the quantities of raw materials delivered to the site, production rates that might be expected on a peak operational day, and based on maximum concrete agitator truck movements. The delivery and production rates modelled for a peak operational day are based on 100% storage and production capacity of the plant. This is a conservative approach for short-term impact assessment purposes.

Table 2-2: Peak operational day material quantities

Material	Daily quantity (tonnes/day)
Concrete	8,716
Aggregate	3,790
Sand	3,790
Cement	1,137

3 Local setting

The concrete batching plant is proposed to be located on Glebe Island immediately to the north of Glebe Island Bridge. Glebe Island is one of the last remaining industrial port facilities within 2km of Sydney CBD. The port has historically been used for the transportation of bulk construction materials such as cement, gypsum and sand and currently functions as a deep water port for common user berths, dry bulk imports and cruise ships.

In addition to the port related uses, Glebe Island accommodates warehouses, manufacturing plants, and low to mid-rise commercial office buildings. The port's two eastern berths (GLB1 and GLB2) are located along the length of the Island's south-eastern edge. Much of the Glebe Island's remaining eastern part is undeveloped and currently incorporates at-grade parking.

The Island also contains several heritage listed items of local and state heritage significance. Of particular relevance to the area is the heritage listed Glebe Island Silos, which are located along Sommerville Road. The silos are understood to be used in association with Cement Australia's cement distribution facility.

3.1 Cumulative sources

Other industries operating in the vicinity of the proposed Project include:

- Boat maintenance and repair workshops
- Shipping yards
- Existing Hanson (to be replaced by the proposed Project) and Hymix concrete batching plants
- Major infrastructure projects including WestConnex (M4-M5 Link), Western Harbour Tunnel, Iron Cove Link, Sydney Metro West, the adjacent Multi User Facility and potential future developments associated with the Bays Precinct that are currently under construction or within the project approval pathway.

The above industries and activities may be a local source of a range of particulate and gaseous emissions. However, emissions from these sources will be subject to their own dedicated air quality assessment processes, where the onus will be upon the proponent to demonstrate that air quality impacts associated with the developments are well managed and likely to be acceptable.

By way of example, an air quality assessment has been produced for the adjacent Multi User Facility (AECOM, 2018). This contains a qualitative evaluation of air quality impacts, and concludes that providing standard construction and operational mitigation measures are adopted, no significant air quality impacts are anticipated from this source.

On the basis that each of these future infrastructure projects will be required to demonstrate no additional exceedances of air quality criteria, their contribution to the existing air shed is considered to be adequately characterised within the background concentrations of air quality metrics adopted within the assessment. Therefore, they have not been considered further.

For example, the periodic use of nearby shipping berths (i.e. ships using auxiliary engines at GLB1 and GLB2) will already be captured within the ambient air quality monitoring data collected locally.

3.2 Sensitive receptors

A sensitive receptor is defined as a location where people are likely to work or reside; and may include a dwelling, school, hospital, office or public recreational area in addition to known or likely future locations (NSW EPA, 2016).

Air quality impacts are assessed at the closest sensitive receptors as shown. Included in this assessment are the potential future receptors that may be located within the adjacent industrial estate.

The discrete receptor locations presented in Figure 3-1 were selected to assess potential impacts from the Project. The discrete receptor list is provided in Appendix A.

Figure 3-1: Local setting and sensitive receptor locations

4 Air quality assessment criteria

The Approved Methods specify air quality assessment criteria relevant for assessing impacts from air pollution (NSW EPA, 2016). These criteria are health-based (i.e. they are set at levels to protect against health effects).

For the purposes of this assessment, it is anticipated that the primary air emissions from the Project will comprise those associated with particulate matter (PM_{10}, $PM_{2.5}$ and deposited dust), nitrogen dioxide (NO_2) and sulfur dioxide (SO_2).

Table 4-1 summarises the air quality criteria for atmospheric emissions relevant to this assessment. It is important to note that these criteria are also applied to the cumulative impact assessment (i.e. due to the proposed activities in combination with other background sources).

Table 4-1: Air quality criteria for key air quality metrics

Pollutant	Averaging period	Assessment	Concentration
Nitrogen dioxide (NO_2)	1-hour	Cumulative	246 µg/m^3
	Annual	Cumulative	62 µg/m^3
Sulfur dioxide (SO_2)	10-minute	Cumulative	712 µg/m^3
	1-hour	Cumulative	570 µg/m^3
	24-hour	Cumulative	228 µg/m^3
	Annual	Cumulative	60 µg/m^3
PM_{10}	24-hour	Cumulative	50 µg/m^3
	Annual	Cumulative	25 µg/m^3
$PM_{2.5}$	24-hour	Cumulative	25 µg/m^3
	Annual	Cumulative	8 µg/m^3

In addition to health impacts, airborne dust also has the potential to cause nuisance effects by depositing on surfaces, including vegetation. Larger particles do not tend to remain suspended in the atmosphere for long periods of time and will fallout relatively close to source. Dust fallout can soil materials and generally degrade aesthetic elements of the environment, and are assessed for nuisance or amenity impacts.

Table 4-2 shows the maximum acceptable increase in dust deposition over the existing dust levels from an amenity perspective. These criteria for dust fallout levels are set to protect against nuisance impacts (NSW EPA, 2016).

Table 4-2: EPA Assessment Criteria for Dust Deposition

Pollutant	Averaging period	Maximum increase (due to project)	Maximum cumulative level
Deposited dust (insoluble solids)	Annual average	2 g/m^2/month	4 g/m^2/month

4.1 Odour Assessment

It is noted that the SEARs require an assessment of odour for the Project. There are not expected to be any odour emissions from the proposed operation, and as such, this has not been addressed further in this report.

It is acknowledged that adverse odour impacts may occur as a result of ship emissions in berth at near-field receptors. The current assessment makes the assumption that if ambient air quality criteria for specific pollutants from ship exhausts are satisfied, then odour impacts will also be acceptable.

5 Local air quality

5.1 Air quality and assumed background concentrations

There has not been any air quality monitoring undertaken at the site of the proposed development. A project of this scale typically does not warrant a specific monitoring program, but understanding the general levels in a similar environment is important.

To this end, monitoring data collected by the NSW EPA at Rozelle may be considered representative of the air quality in the study area. The Rozelle monitoring station is located in a residential area close to road networks. The Rozelle monitoring station is likely to record higher concentrations of air quality metrics than the site given that the project site is open to Sydney harbour and less exposed to local sources such as domestic wood burning. The measured values are therefore likely to be conservative when applied as background levels to the site.

In addition, the NSW Ports Authority installed and air quality station in September 2015 to measure local ambient air quality in the vicinity of the White Bay Cruise Terminal (WBCT) (Port Authority of NSW, 2016). This station is maintained by Pacific Environment and is located approximately 0.8 km north-west of the proposed site. Due to the proximity of the station, the data recorded by this station may also be considered representative of the air quality in the study area. The relevant data to this project is that related to $PM_{2.5}$ and SO_2 concentrations.

Supplementary data has also been used to characterise the local air quality. These data have been collected by Pacific Environment and include continuous (campaign) NO_2 and PM_{10} monitoring data in the vicinity of B1-B2 Wharves at Bridge Road, Glebe (Pacific Environment, 2017). This campaign monitoring was located in the Blackwattle Bay Marina, approximately 1km from the proposed Project. The campaign took place from 14 March 2017 to 28 March 2017 and provides a two week snapshot of monitoring data. As the monitoring was during a short term period, the collected data from the Pacific Environment, 2017 assessment cannot be used for comparison against the long term dataset available from the OEH monitoring station at Rozelle. However, these data are useful in providing a comparison with other data sets to show spatial variance in ambient air quality.

5.2 Nitrogen dioxide (NO_2)

5.2.1 OEH NO_2 monitoring

The OEH monitoring station at Rozelle provides continuous measurements of NO_2. A summary of the NO_2 data from January 2011 to December 2016 is presented in Table 5-1. All values are well below the EPA impact assessment criteria of 62 µg/m^3 for the annual average and 246 µg/m^3 for the 1-hour average.

Table 5-1: Summary of NO_2 monitoring data at Rozelle from 2011 to October 2016

Year	NO_2 ($\mu g/m^3$)	
	Maximum 1-hour average	Annual average
Criteria	**246**	**62**
2011	96	21
2012	127	23
2013	144	21
2014	113	21
2015	123	21
2016	103	21

5.2.2 Pacific Environment (2017) NO_2 monitoring

Figure 5-1 provides a time series of the 1-hour average NO_2 concentrations measured as part of Pacific Environment (2017). The maximum 1-hour average NO_2 concentration measured during the two week monitoring period was 53.4 $\mu g/m^3$, well below the impact assessment criterion of 246 $\mu g/m^3$ and comparable to the values observed at OEH Rozelle.

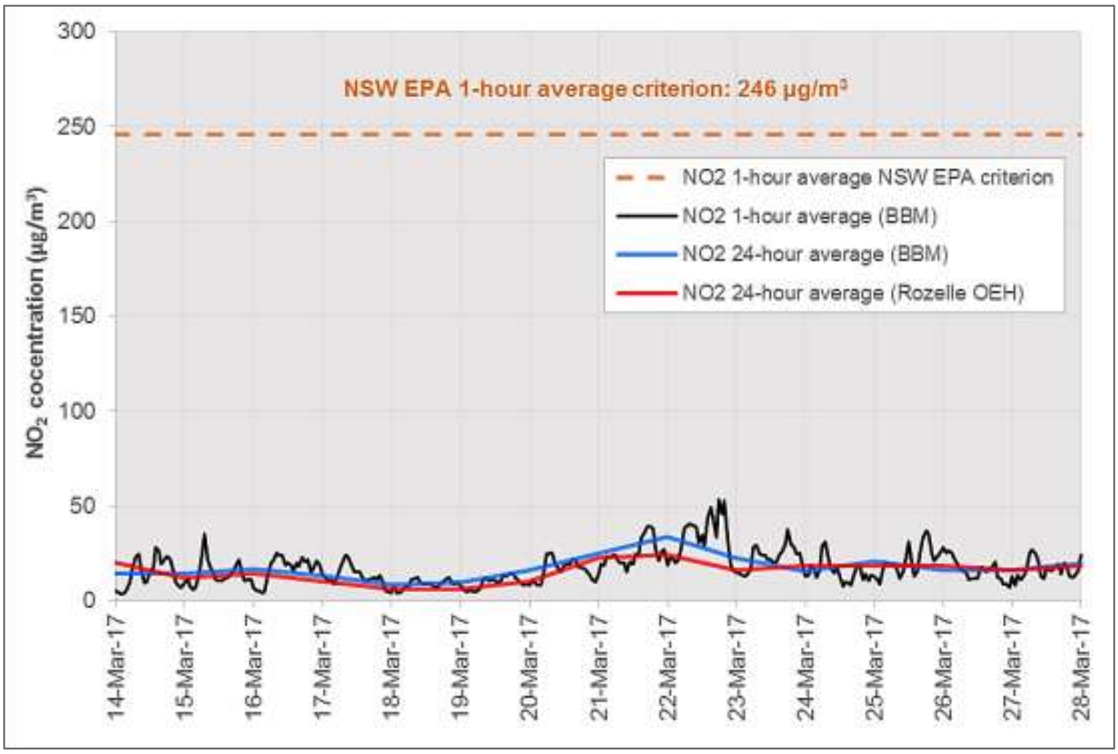


Figure 5-1: Time-series plot of 1-hour average NO_2 concentration measured at Black Bay Marina and at OEH Rozelle during the monitoring period.

5.3 Particulate matter as PM_{10}

5.3.1 OEH PM_{10} monitoring

A summary of the PM_{10} data measured between 2011 and 2016 at the OEH Rozelle monitoring station is presented in Table 5-2. This indicates that existing concentrations of PM_{10} are below the EPA impact assessment criterion of 50µg/m³ for the 24-hour average for the majority of days, and below the 30µg/m³ criterion for the annual average. Also provided are the number of days per year that the 24-hour average criterion of 50µg/m³ were exceeded.

Table 5-2 Maximum 24-hour average and annual average PM_{10} concentrations (µg/m³) at Rozelle

Year	PM_{10} 24-hour maximum	No. days per year >50µg/m³	PM_{10} annual average
EPA Criterion	**50**	**n/a**	**25**
2011	39	0	17
2012	41	0	17
2013	59	3	18
2014	44	0	18
2015	60	1	17
2016	59	1	17

5.3.2 Pacific Environment (2017) PM_{10} monitoring

Figure 5-1 provides a time series of the 24-hour average PM_{10} concentrations measured as part of Pacific Environment (2017). The maximum 24-hour average PM_{10} concentration measured during the two week monitoring period was 22.9 µg/m³, well below the impact assessment criterion of 50 µg/m³. Again, values are seen to be comparable with those observed at OEH Rozelle.

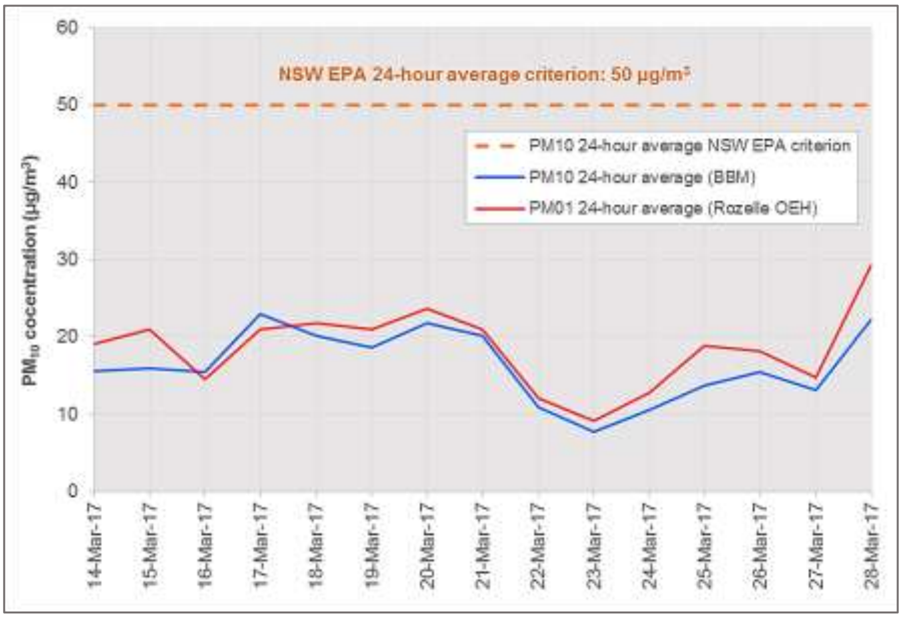


Figure 5-2: Time-series plot of 24-hour average PM_{10} concentrations measured at Blackwattle Bay Marina and at OEH Rozelle during the monitoring period.

5.4 Particulate matter as $PM_{2.5}$

5.4.1 OEH $PM_{2.5}$ monitoring

A summary of the $PM_{2.5}$ data measured for 2015 and 2016 (only) at the OEH Rozelle monitoring station is presented in Table 5-3. This indicates that existing concentrations of $PM_{2.5}$ are mostly below the EPA impact assessment criterion of 25 µg/m³ for the 24-hour maximum and 8 µg/m³ for the 24-hour annual average. There have been several occasions where the 24-hour average criterion of 25 µg/m³ has been exceeded. These days are most likely associated with regional events such as bushfire / back-burning activity or domestic wood burning in winter.

Table 5-3 Maximum 24-hour average and annual average $PM_{2.5}$ concentrations (µg/m³) at Rozelle

Year	$PM_{2.5}$ 24-hour maximum	No. days per year >25µg/m³	$PM_{2.5}$ annual average
EPA Criterion	**25**	**n/a**	**8**
2015	33	1	7
2016	49	5	7

5.4.2 White Bay Cruise Terminal $PM_{2.5}$ monitoring

The summary of results of the maximum 24-hour average $PM_{2.5}$ concentration recorded between August 2016 and August 2017 at the WBCT air quality station is shown in Table 5-4. This indicates that the 24-hour average $PM_{2.5}$ concentrations are consistently lower than the EPA impact assessment criterion of 25 µg/m³ for the 24-hour maximum. The cases when there have been exceedances are related to the occurrence of a regional event such as bushfire hazard reduction and localised sources of particulate emissions (Port Authority of NSW, 2016-2017).

The annual average $PM_{2.5}$ for this period was 9.5 µg/m³. This is above the NSW criterion of 8 µg/m³. It is considered that emissions from localised domestic wood burning would be the most likely contributor to the elevated measurements.

Specifically, it is highlighted that the WBCT air quality station (located at Grafton Street, Balmain), unlike OEH's air quality monitoring station at Rozelle, has not been sited to be an urban background site. Rather, the WBCT collects data for a specific purpose and should not be evaluated as representative of an urban background site (i.e. they are likely to be impacted by a number of local sources including domestic wood burning, periodic vehicle emissions, etc.). It is also noted that OEH operate a different type of Beta Attenuation Monitor (BAM) at their Rozelle site than at the WBCT site. Whilst both are approved instruments, there are inherent differences in the ways in which they operate that can result in material differences when looking at long term data (e.g. annual averages).

Table 5-4: Summary of the maximum $PM_{2.5}$ concentrations at WBCT between August 2016- August 2017.

Month	Maximum $PM_{2.5}$ 24-hour concentration ($\mu g/m^3$)	Month	Maximum $PM_{2.5}$ 24-hour concentration ($\mu g/m^3$)
EPA Criterion	**25**	**EPA Criterion**	**25**
Aug-16	19	Mar-17	13
Sep-16	16	Apr-17	15
Oct-16	31	May-17	24
Nov-16	18	Jun-17	20
Dec-16	15	Jul-17	21
Jan-17	11	Aug-17	48
Feb-17	13	Mar-17	13

Note: The data presented in this table is a summary of the results presented in the monthly reports for the WBCT air quality station (Port Authority of NSW, 2016-2017).

5.5 Sulfur Dioxide (SO_2)

Sulfur dioxide (SO_2) data is available from the nearby White Bay Cruise Terminal (WBCT) monitoring station. Data from this site have been used to establish background SO_2 concentrations.

A summary of the SO_2 data measured between August 2016 and August 2017 at the WBCT (Ports Authority of NSW, 2016-2017) monitoring station and are presented in Table 5-3. These data show that existing concentrations of SO_2 are below the EPA impact assessment criterion for all averaging periods.

The annual average SO_2 for this period was 1.0 $\mu g/m^3$. This is well below the NSW criterion of 60 $\mu g/m^3$.

Table 5-5: Summary of maximum SO_2 concentrations recorded at WBCT monitoring station

Month	Maximum 10-minutes ($\mu g/m^3$)	Maximum 1-hour ($\mu g/m^3$)	Maximum 24-Hour ($\mu g/m^3$)
EPA Criterion	**712**	**570**	**228**
August – December 2016	86	51	18
January – August 2017	146	71	9

5.6 Deposited dust

Measurements of deposited dust are not available as part of the available monitoring datasets. Therefore a conservative upper limit of 2g/m²/month can be used to estimate the likely background deposition levels in the area.

5.7 Summary of background data

The background concentrations adopted for the assessment are based on the available representative monitoring data measured during 2015-2016 and are presented in Table 5-6.

Table 5-6 Summary of adopted background data

Air quality parameter	Averaging period	EPA criterion	Adopted background concentration
NO_2	Annual	62 µg/m³	21 µg/m³
	1 hour	246 µg/m³	123 µg/m³
Sulfur dioxide (SO_2)	10-minute	712 µg/m³	146 µg/m³
	1-hour	570 µg/m³	71 µg/m³
	24-hour	228 µg/m³	18 µg/m³
	Annual	60 µg/m³	1.0 µg/m³
PM_{10}	Annual	25 µg/m³	17 µg/m³
	24 hour	50 µg/m³	44 µg/m³ (a)
$PM_{2.5}$	Annual	8 µg/m³	7 µg/m³
	24 hour	25 µg/m³	19 µg/m³ (a)
Deposited Dust (b)	Annual	4 g/m² month	2 g/m² month (b)

Notes: (a) Adopted background is based on the highest measurement below the criterion to evaluate the potential for additional exceedances in accordance with the Approved Methods

(b) No background data available.

6 Emission estimation

6.1 Overview

The following section provides detailed information on the calculation of the three key emission sources that would be released in local air environment as a result of the proposed Project's operations and include:

- Particulate emission from operations of the Project – these are considered fugitive dust source emissions from vehicle movements, material handling and bag house emissions.
- Emissions from vehicle exhaust – these emissions would be a result of diesel combustion emissions from trucks visiting the site.
- Emissions from ships – these emissions would arise from use of the auxiliary engine and auxiliary boiler while at berth delivering aggregate to the site.

6.2 Particulate emission from operations of the Project

The model requires estimates of particulate matter (TSP, PM_{10} and $PM_{2.5}$) emission rates for each activity associated with operating the plant. The relevant operations and dust sources will include:

- haulage of raw materials onto the site
- haulage of product off the site
- unloading sand to storage pits via conveyor
- unloading aggregate from ships to storage silos via conveyor
- residual dust from unloading cement and fly ash

The modelling has been based on the use of three particle-size categories: 0 to 2.5 µm – referred to as $PM_{2.5}$ or 'FP' (fine particles), 2.5 to 10 µm – referred to as 'CM' (coarse matter) and 10 to 30 µm – referred to as 'Rest'. Various combinations of these particle size groups make up those being modelled, as follows:

- $PM_{2.5}$ = FP
- PM_{10} = FP + CM
- TSP (including dust deposition) = FP + CM + Rest

The distribution of particles for aggregate and wind erosion has been derived from measurements in Appendix B of the US EPA AP-42 revised document (US EPA, 1995). The particle size distribution for the residual dust collected from the unloading of cement and fly ash, is different as it consists only of PM_{10} and none of the more coarse material (Rest). Suitable distributions for the FP and CM fractions for these sources were established by evaluating the particle size distribution before passing through the fabric filter (HORIBA, 2008), and then using an assumption about the efficiency of the fabric filter to determine the final size distribution of the particles post-bag house (US EPA, 1995).

The particle size distribution of the residual dust from unloading cement and fly ash is considered to be 100% PM_{10}, distributed as follows:

- $PM_{2.5}$ (FP) is 5.6% of TSP.
- $PM_{2.5-10}$ (CM) is 94.4% of TSP.
- PM_{10-30} (Rest) is 0% of TSP.

Individual TSP, PM_{10} and $PM_{2.5}$ emission equations were used for vehicle movements and material handling.

As noted above, the assessment is based on both an average annual production and a peak operational (worst-case) 24-hour operating scenario. These scenarios are modelled assuming the production rates outlined in Table 2-1 and Table 2-2.

For the peak operational 24 hour assessment it is assumed that the peak production rates will occur for every day of the year. This is not achievable in practice and therefore this assumption is only used for short-term average assessment purposes.

Emissions from all these sources have been determined using information on emission factors developed in the United States (US EPA, 1995). Particle size distributions described above were used to determine the emission rates for TSP, PM_{10} and $PM_{2.5}$. The details of how particulate emissions were estimated are shown in Appendix B. Table 6-1 summarises the estimated PM emission rates for the proposed concrete batching plant.

Table 6-1: Summary of estimated particulate matter emissions for each activity

Activity	Normal Day (kg/year)			Peak operational Day (kg/year)		
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Number of sand delivery trucks onsite	1,789	343	83	5,783	1,110	269
Number of fly ash and cement delivery trucks onsite	711	137	33	1,077	207	50
Number of concrete product trucks onsite	10,042	1,928	466	13,890	2,666	645
Material handling - ships to conveyor	13	6	1	56	26	4
Material handling - Conveyor to aggregate storage bin	13	6	1	56	26	4
Residual from de-dusted air loading cement and fly-ash	510	510	29	772	772	43
Total	**13,078**	**2,930**	**613**	**21,633**	**4,808**	**1,015**

6.3 Vehicle exhaust emissions

The annual and daily truck numbers for both the normal day and peak operational day scenarios are shown in Table 6-2. Emissions from light passenger vehicles and the on-site forklift and two loaders have not been included as emissions from these sources are not considered to be material to the assessment outcomes.

Truck numbers have been estimated for the normal day based on the total annual volumes of material to be processed by the proposed project based on the truck payloads detailed in Appendix B.

For the peak operational day scenario, the maximum hourly truck numbers have been provided by the client and have been weighted by hour of the day in accordance with an hourly profile considered representative of the proposed operations. The hourly profile for each track type is shown in Figure 6-1.

Table 6-2: Estimate of truck numbers

	Peak operational Day		Normal Day	
Activity	Trucks per year	Trucks per day	Trucks per year	Trucks per day
Concrete trucks	181,818	7,576	251,485	689
Cement tanker trucks	8,439	352	12,775	35
Sand trucks	27,211	1,134	87,965	241

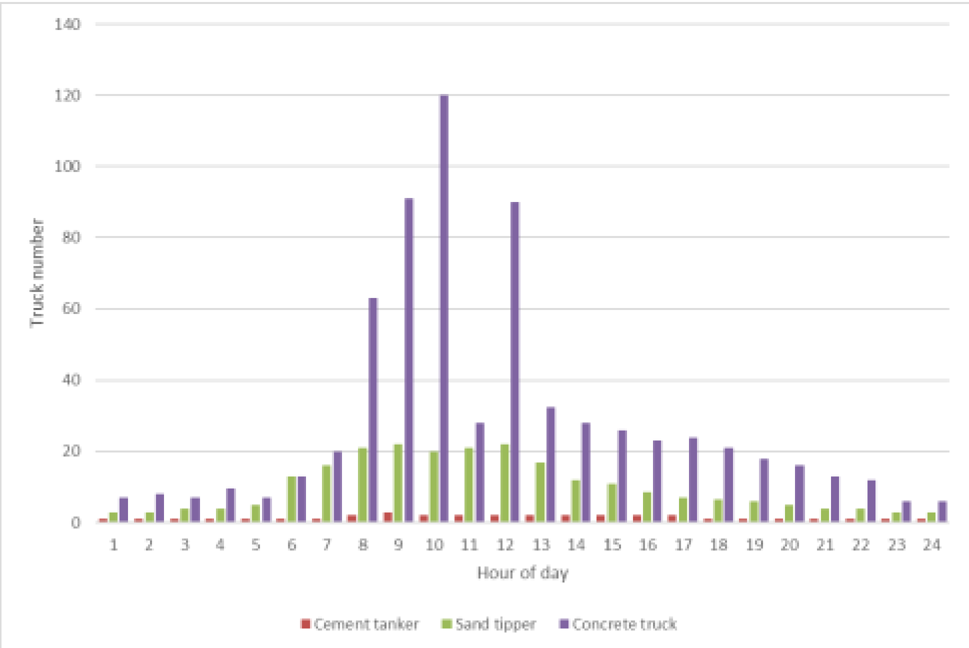


Figure 6-1: Hourly truck profile for the peak operational day scenario

This assessment of heavy duty vehicles (HDV) also requires an emission factor (g/km) for each vehicle type and pollutant. NSW-specific emission factors have been based on the Australian traffic emission data developed by PIARC (2012), rather than the default National Pollutant Inventory values. The calculated mass emissions for each pollutant investigated as part of this assessment are provided in Table 6-3.

Table 6-3: Estimate of vehicle exhaust

Emission	Unit	PM_{10}	$PM_{2.5}$	NO_x	SO_2
Emission factor (10km/hr)	Average g/vehicle-km	0.50	0.44	12.27	0.02
Normal Day	(kg/year)	3	3	83	0.1
Peak operational Day	(kg/year)	44	38	1,071	2

Emissions have been based on vehicle speeds of 10 km/h for all internal access roads. The 10 km/h speed applied reflects an average speed, and hence incorporates an allowance for emissions associated with idling, starting and manoeuvring.

6.4 Emissions from ships

While it is understood that two to three ships would potentially deliver to the site each week, for the annual calculations the number of ships to visit the site is based on the 12,000t payload capacity of the ship assuming that all aggregate is delivered to site via this method.

For the peak operational day scenario it has been assumed that one ship would deliver to the site on any particular day and be at berth for 12 hours.

Emissions from ships have been assumed to include emissions from the auxiliary engine and auxiliary boiler while the ship is at berth at GLB1. Emissions from the main engine have not been included as this would only be engaged intermittently, and on approach / departure from the site. It is thus considered beyond the geographic scope of the assessment of the Project.

For conservatism, emission estimation for the auxiliary engine and auxiliary boiler are assumed to be operating using residual oil (RO). It is noted however that the CSL ships proposed to service the facility can run off heavy fuel oil or marine gas oil (MGO). If compressed natural gas is available they can operate as dual fuel; MGO or gas.

It is understood that the type of ship that would be delivering material to the Project would be a CSL self-unloader ship that discharges rapidly, reduces infrastructure and labour requirements and minimises environmental impacts. Examples of such craft are CSL Elbe, CSL Rhine or CSL Tertnes. As source specific information on these ship types was limited, it has been assumed that a bulk carrier ship (as defined by ICF (2009)) would be representative of these ships and therefore used as the basis for the emissions calculations.

Table 6-4: Emissions from auxiliary engine

Parameter	Value	Units	Source
Capacity	1,776	kW	IFC (2009)
Load factor	0.1	-	IFC (2009)
Exhaust temperature	332	°C	2MW CAT Diesel Gen Set
Diameter	0.75	m	Estimate of CSR ship
Exhaust velocity	3.5	m/s	2MW CAT Diesel Gen Set
Stack height	25	m	Estimate of CSR ship
Emissions	**Emission factor (g/kWh**	**Mass emission rate (g/s)**	
NO_x	14.70	0.73	ICF (2009)
PM_{10}	1.44	0.07	ICF (2009)
$PM_{2.5}$	1.32	0.07	ICF (2009)
SO_2	11.98	0.59	ICF (2009)

Table 6-5: Emissions from auxiliary boiler

Parameter	Value	Units	Source
Capacity	109	kW	ICF (2009)
Exhaust temperature	150	°C	Assumption
Diameter	0.3	m	Estimate of CSR ship
Exhaust velocity	1.4	m/s	Calculated based on 10% stack heat loss
Stack height	25	m	Estimate of CSR ship
Emissions	**Emission factor (g/kWh**	**Mass emission rate (g/s)**	
NO_x	1.10	0.033	NPI (2012)
PM_{10}	0.10	0.003	NPI (2012)
$PM_{2.5}$	0.10	0.003	NPI (2012)
SO_2	4.70	0.142	NPI (2012)

6.5 Source information

The fugitive particulate emissions described in Section 6.2 and the truck exhaust emissions described in Section 6.3 were modelled as a series of volume sources according to the site layout and are shown in Figure 6-2.

The source parameters for the point source emission from ships have already been provided in Section 6.4.

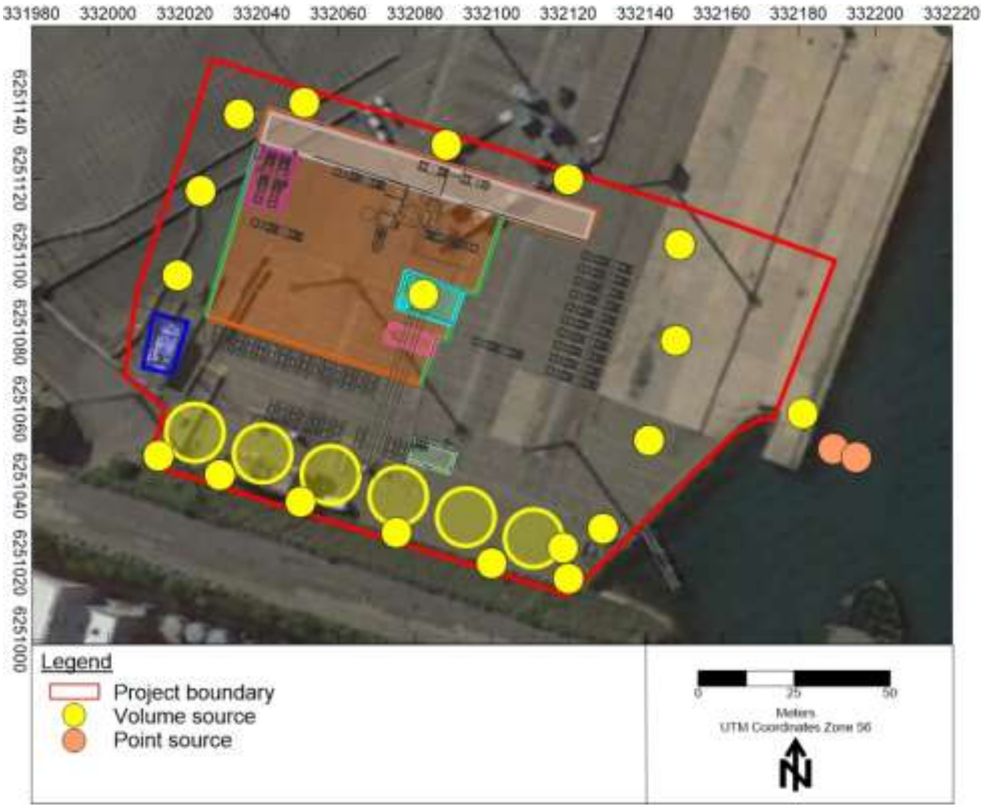


Figure 6-2: Modelling source locations

7 Modelling approach

The overall approach to the assessment has followed the Approved Methods using the Level 2 assessment methodology. The Approved Methods specify how assessments based on the use of air dispersion models should be completed. They include guidelines for the preparation of meteorological data to be used in dispersion models and the relevant air quality criteria for assessing the significance of predicted concentration and deposition rates from the Project. The approach taken in this assessment has followed as closely as possible the approaches provided within the Approved Methods.

7.1 Dispersion model

AERMOD was chosen as a suitable dispersion model due to the source type, location of nearest receiver and nature of local topography. AERMOD is the US EPA's recommended steady-state plume dispersion model for regulatory purposes. AERMOD replaced the Industrial Source Complex (ISC) model for regulatory purposes in the US in December 2006. Ausplume, a steady state Gaussian plume dispersion model developed by the Victorian EPA and frequently used in Australia for simple near-field applications is based on ISC, which has now been replaced by AERMOD.

The AERMOD model was developed, and is supported by the US EPA and is now the model of choice for nearfield (less than 50 km from an emission source) applications in the United States (US EPA, 2017).

7.1.1 AERMOD model inputs

A significant feature of AERMOD is the Pasquil-Gifford stability based dispersion is replaced with a turbulence-based approach that uses the Monin-Obukhov length scale to account for the effects of atmospheric turbulence based dispersion.

The AERMOD system includes AERMET, used for the preparation of meteorological input files and AERMAP, used for the preparation of terrain data. Ground level concentrations were modelled across a 5 km by 5 km domain at 50 m resolution. The size of the modelling domain is considered adequate to capture the maximum predicted ground level concentrations associated with the Project's activities.

Terrain data was sourced from NASA's Shuttle Radar Topography Mission Data (3 arc second [~30m] resolution) and processed to create the necessary input files.

AERMET requires surface and upper air meteorological data as input. Wind speed, wind direction, temperature, relative humidity and sea level pressure were sourced from the OEH Rozelle meteorological station. Cloud cover and cloud height were sourced from the BoM Sydney Airport AWS. In the absence of upper air sounding data for the area, upper air parameters were calculated using the upper air estimator (UAE) within the Lakes Environmental AERMODView software package.

7.1.2 Building Wake Effects

Wind flow is often disrupted in the immediate vicinity of buildings. Plumes emitted nearby are assumed to be unaffected by building wakes if they manage to reach building height plus 1.5 times the lesser of building height or projected building width. If this is not the case, pollutants can be brought to ground within a highly turbulent, generally recirculating cavity region in the immediate lee of the building and/or be subject to plume downwash and enhanced dispersion in a turbulent region which extends further downwind behind the building.

A simplified building geometry was incorporated for simulation of building wake effects, modelled using BPIP-PRIME model, as shown in Figure 7-1. BPIP-PRIME uses heights and corner locations of buildings in the vicinity of the plume to simulate the effective height and width of the structures. The downwash algorithm calculates effective building dimensions relative to the plume, resolved down to ten degree intervals. AERMOD then calculates the impact of these buildings on plume dispersion and consequently on predicted ground level concentrations.

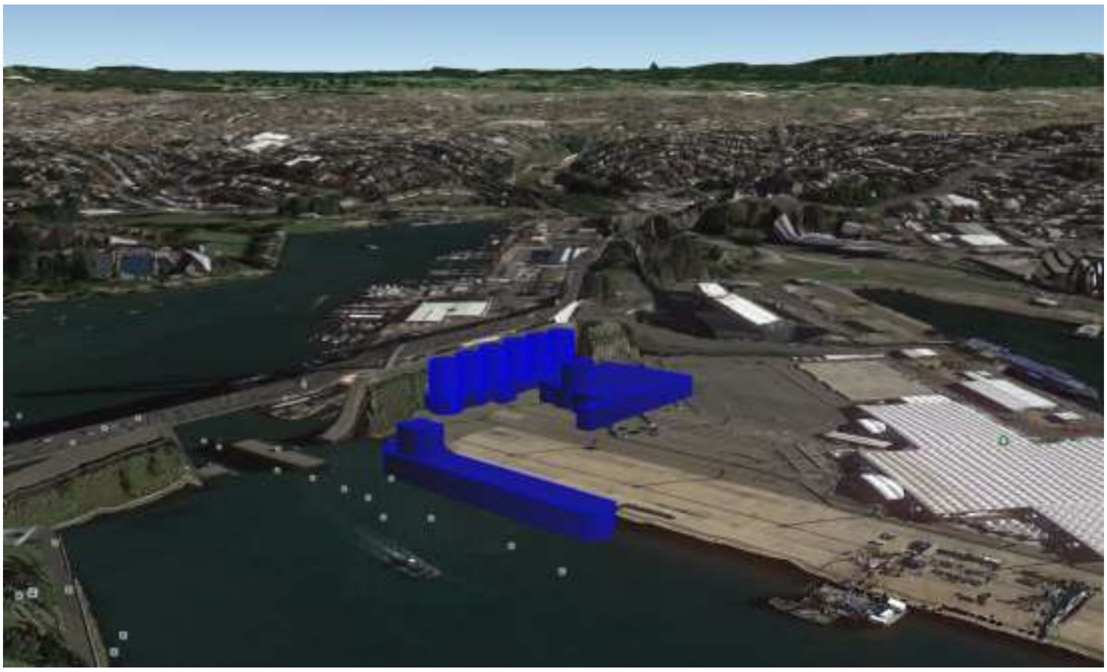


Figure 7-1: Visualisation of the incorporation of building wake effects

7.1.3 Short term averaging periods

For short-term maxima where no monitoring data existed, such as the 15-minute and 10-minute averaging periods for CO and SO_2 respectively, values were obtained using the power-law formula from Borgas (2000) to estimate short-term peak values from longer-term average concentrations. For example, to determine a 10-minute peak value from a one-hour value the formula is:

$$C_{10} = C_{60} \times (60/10)^{0.21}$$

C_{10} is the estimated peak value and C_{60} is the average one-hour value.

7.1.4 Treatment of Emissions of oxides of nitrogen (NO_x)

Nitrogen oxides (NO_x) emitted from combustion are comprised mainly of nitric oxide (NO) and nitrogen dioxide (NO_2). Typically, at the point of emission, NOx would consist of approximately 90-95% of NO and 5-10% of NO_2. The dominant mechanism for short-term conversion of NO to NO_2 is through oxidation with atmospheric ozone (O_3) as an exhaust plume travels from source. Therefore, to predict the ground-level concentration of NO_2

(regulated oxide of nitrogen) it is important to account for the transformation of NO_x to NO_2. Ultimately, all NO emitted into the atmosphere will be oxidised to NO_2 and to other higher oxides of nitrogen. The rate at which this oxidation takes place depends on prevailing atmospheric conditions including temperature, humidity and the presence of other substances in the atmosphere such as O_3. It can vary from a few minutes to many hours. If the dispersion is sufficient to have diluted the plume to the point where the concentration is very low, it is unimportant that the oxidation has taken place. However, if the oxidation is rapid then high concentrations of NO_2 can occur when inadequate dispersion / dilution conditions exist.

A level 1 assessment was completed using the Ozone Limiting Method (OLM). The OLM is based on the assumption that approximately 10% of the NOx emissions are generated as NO_2 (Alberta Environment, 2003). The majority of the NO_X emission is in the form of NO, which reacts with ambient levels of ozone to form additional NO_2. If the ozone concentration is greater than 90% of the predicted NO_x concentration, all the NO_x is assumed to be converted to NO_2, otherwise NO_2 concentrations are calculated using the equation below, which assumes total conversion of the ozone and adds the 10% of the NO_x that was emitted as NO_2:

$$NO_2 = O_3 + 0.1 \times NO_X$$

The predicted NO_2 concentration is then added to the background NO_2 concentration.

To apply the OLM, annual average and annual maximum background concentrations of O_3 and NO_2 in 2015 were obtained from the NSW EPA monitoring station at Rozelle. The NO_2 concentration at each receptor was calculated using the above equation for the 100th percentile prediction, and then added to the maximum annual or annual average background value from the Rozelle site. The maximum hourly NO_2 concentration and annual mean concentration were then determined from the results.

7.2 Dispersion meteorology

7.2.1 Review of available meteorological stations

Air quality impacts are influenced by meteorological conditions, primarily in the form of gradient wind flow regimes, and by local conditions generally driven by topographical features and interactions with coastal influences, such as the sea breeze. The local dispersion meteorology for the site, in relation to wind speed and direction, has been reviewed based on the data available at nearby meteorological stations.

The closest weather station is operated by OEH and is located in Rozelle and is approximately 2 km north-west of the project.

7.2.2 Representative year for modelling

As specified in the Approved Methods, five years of meteorological data are required to be reviewed so that a representative year of meteorological conditions can be selected. Appendix C provides an additional of four years of meteorological data from the OEH Rozelle station. Data from this station was used to analyse the prevailing wind conditions on a seasonal and annual basis. The review identified 2015 as a representative year for dispersion modelling with no anomalous wind patterns compared to the other years examined and is therefore considered representative year for dispersion modelling.

The wind rose for the annual period 2015 presented in Figure 7-2 indicates that winds from the south were dominant and the percentage of occurrence of calm wind conditions (wind speeds less than 0.5 m/s) was 22.5%.

In terms of the seasonal behaviour, winds from the south were dominant during all seasons but winter, when dominant winds came from the north-west. Spring, summer and autumn had an occurrence of calm wind conditions of 15.4%, 16.9% and 24% respectively, while the percentage during winter went up to 33.5%.

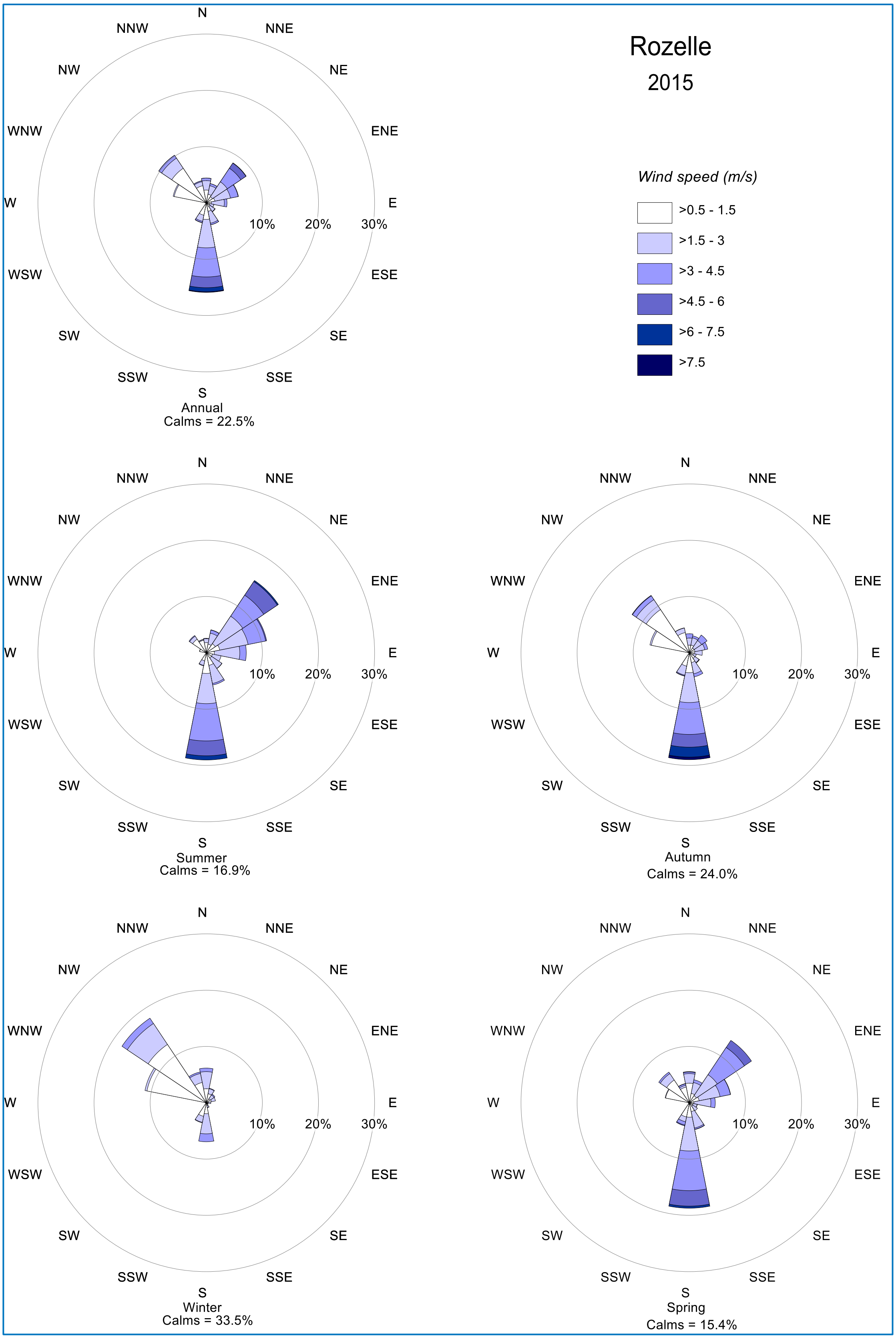


Figure 7-2: Annual and seasonal wind roses for Rozelle (2015)

7.2.3 Atmospheric Stability

An important aspect of pollutant dispersion is the level of turbulence in the lowest 1 km or so of the atmosphere, known as the planetary boundary layer (PBL). Turbulence controls how effectively a plume is dispersed into the surrounding air and hence diluted. It acts by increasing the cross-sectional area of the plume due to random motions. With stronger turbulence, the rate of plume dispersion increases. Weak turbulence limits dispersion and contributes to high plume concentrations downwind of a source.

Turbulence is generated by both thermal and mechanical effects to varying degrees. Thermally driven turbulence occurs when the surface is being heated, in turn transferring heat to the air above by convection. Mechanical turbulence is caused by the frictional effects of wind moving over the earth's surface, and depends on the roughness of the surface as well as the flow characteristics.

Turbulence in the boundary layer is influenced by the vertical temperature gradient, which is one of several indicators of stability. Plume models use indicators of atmospheric stability in conjunction with other meteorological data to estimate the dispersion conditions in the atmosphere.

Stability can be described across a spectrum ranging from highly unstable through neutral to highly stable. A highly unstable boundary layer is characterised by strong surface heating and relatively light winds, leading to intense convective turbulence and enhanced plume dispersion. At the other extreme, very stable conditions are often associated with strong temperature inversions and light winds, which commonly occur under clear skies at night and in the early morning. Under these conditions plumes can remain relatively undiluted for considerable distances downwind. Neutral conditions are linked to windy and/or cloudy weather, and short periods around sunset and sunrise, when surface rates of heating or cooling are very low.

The stability of the atmosphere plays a large role in determining the dispersion of a plume and it is important to have it correctly represented in dispersion models. Current air quality dispersion models (such as AERMOD and CALPUFF) use the Monin-Obukhov Similarity Theory (MOST) to characterise turbulence and other processes in the PBL. One of the measures of the PBL is the Monin-Obukhov length (L), which approximates the height at which turbulence is generated equally by thermal and mechanical effects (Seinfeld and Pandis 2006). It is a measure of the relative importance of mechanical and thermal forcing on atmospheric turbulence.

Because values of L diverge to + and - infinity as stability approaches neutral from the stable and unstable sides, respectively, it is often more convenient to use the inverse of L (i.e., 1/L) when describing stability.

Figure 7-3 shows the hourly averaged 1/L for the Project site computed from all data in the AERMET surface file. Based on Figure 7-3, this plot indicates that the PBL is stable overnight and becomes unstable as radiation from the sun heats the surface layer of the atmosphere and drives convection. The changes from positive to negative occur at the shifts between day and night. This indicates that the diurnal patterns of stability are realistic.

Table 7-1: Inverse of the Monin-Obukhov length L with respect to Atmospheric stability

1/L	Atmospheric Stability
Negative	Unstable
Zero	Neutral
Positive	Stable

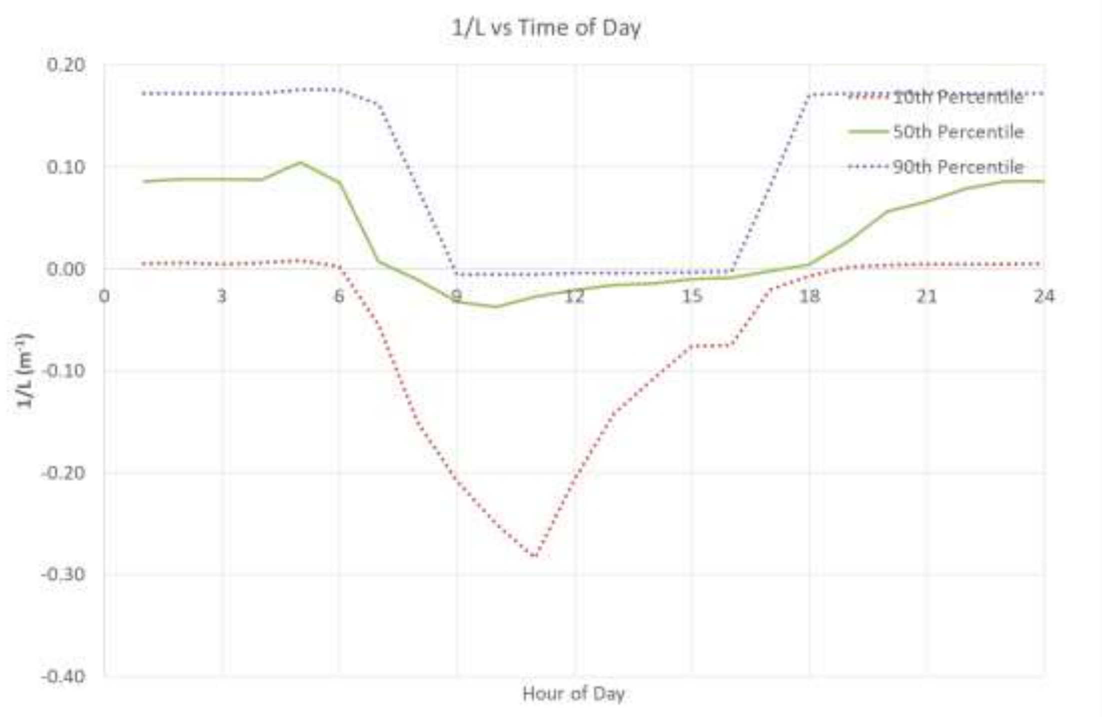


Figure 7-3: Annual statistics of 1/L by hour of the day

Figure 7-4 shows the variations in stability over the year by hour of the day, with reference to the widely known Pasquill-Gifford classes of stability. The relationship between L and stability classes is based on values derived by Golder (1972) set out in NSW EPA (2016). Note that the reference to stability categories here is only for convenience in describing stability. The model uses calculated values of L across a continuum.

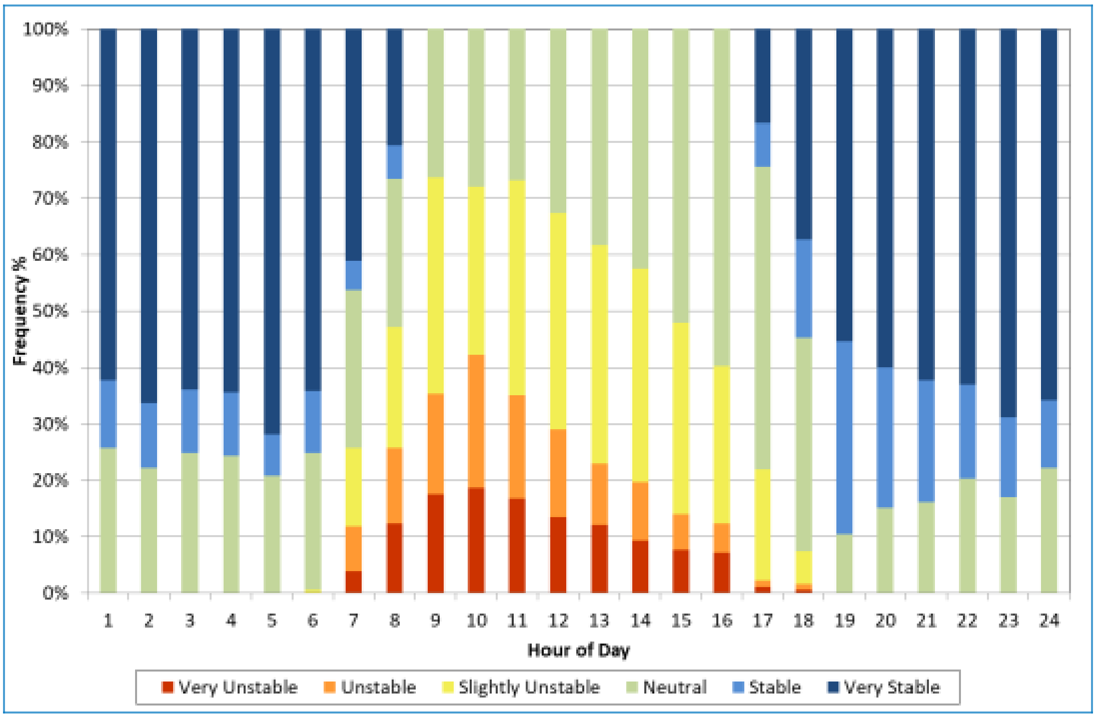


Figure 7-4: Annual distribution of stability type by hour of the day

Figure 7-4 shows that stable and very stable conditions occur for about 30% of the time, which is typical for inland locations that regularly still experience coastal sea breeze influences Atmospheric instability increases during the day and reaches a peak around noon as solar-driven convective energy peaks. A stable atmosphere is prevalent during the night. These profiles indicate that pollutant dispersion is most effective during the daytime and least effective at night.

Values of surface roughness, albedo and Bowen ratio were determined based on a review of aerial photography for a radius of 3 km centred on the OEH Rozelle weather station. Default values for 'urban area' was chosen across this area. The default values for these three surface characteristics required for AERMET are as follows:

- Surface roughness, which is the height at which the mean horizontal wind speed approaches zero, based on a logarithmic profile. Values adopted = 1.0 (urban).
- Albedo, which is an indicator of reflectivity of the surface. Values adopted = 0.2075 (urban).
- Bowen ratio, which is an indicator of surface moisture. Values adopted = 1.625 (urban).

8 Assessment of impacts

The concentrations of the air quality parameters estimated in this study were assessed for 35 discrete receptors across the modelling domain.

Long term averaging period results have been presented for the Normal day operations, as the emissions have been estimated over the course of a year. The shorter term averaging (10-minute, 1-hour and 24-hour) have been presented for the Peak Operational Day only as the emissions represent the worst case emissions on any particular day.

Contour plots have also been prepared to show the spatial distribution of the assessed pollutants. It is important to note that the contour figures are presented to provide a visual representation of the predicted (worst-case) impacts spatially. To produce the contours it is necessary to make interpolations, and as a result the contours will not always match exactly with predicted impacts at any specific location. The actual predicted pollutant concentrations at nearby receivers are presented in tabular form.

All contour plots have been provided for the cumulative scenario only and are provided in Appendix D.

Results have been presented on both an incremental and cumulative basis (i.e. including background), in order to understand both the scale of model predictions and allow comparison with the impact assessment criteria outlined in Section 4.

8.1 Normal day

The section presents the modelling results for Project operating under the normal day conditions. Table 8-1 considers the incremental predictions and Table 8-2 considers the cumulative predictions, combining the incremental predictions with the relevant adopted background concentration (for backgrounds see Table 5-6).

The incremental results (presented in Table 8-1) conservatively show NO_2 as 100% NO_x, when in reality, the percentage of NO_2 in total oxides of nitrogen would be 10% to 20%. The results show that during Normal Day operations the Project is compliant with annual air quality criteria for NO_2.

The cumulative results (presented in Table 8-2) have adopted the OLM methodology for NO_2 assessment described in Section 7.1.4.

The model predictions demonstrate compliance with all of the impact assessment criteria for all relevant averaging periods.

Table 8-1: Predicted ground level concentrations for Normal Day – incremental

ID	NOx ($\mu g/m^3$) Annual	PM_{10} ($\mu g/m^3$) Annual	$PM_{2.5}$ ($\mu g/m^3$) Annual	SO_2 ($\mu g/m^3$) Annual	TSP Deposition g/m^2/month Month
Criterion:	n/a	n/a	n/a	n/a	2
R1	4.5	0.8	0.3	0.1	<0.1
R2	7.3	1.3	0.5	1.2	0.1
R3	6.2	1.1	0.4	1.0	0.1
R4	15.5	2.7	1.0	0.5	0.2
R5	6.0	1.1	0.4	0.3	0.1
R6	8.2	1.5	0.6	0.2	0.1
R7	11.7	2.1	0.8	0.6	0.2
R8	10.7	1.9	0.7	0.5	0.2
R9	2.0	0.4	0.1	0.1	<0.1
R10	1.4	0.3	0.1	<0.1	<0.1
R11	1.5	0.3	0.1	<0.1	<0.1
R12	1.4	0.3	0.1	0.1	<0.1
R13	2.2	0.4	0.1	0.1	<0.1
R14	0.7	0.1	<0.1	<0.1	<0.1
R15	1.5	0.3	0.1	0.1	<0.1
R16	2.9	0.5	0.2	0.2	<0.1
R17	0.3	0.1	<0.1	0.1	<0.1
R18	2.3	0.4	0.2	0.2	<0.1
R19	1.7	0.3	0.1	0.1	<0.1
R20	1.0	0.2	0.1	0.1	<0.1
R21	1.2	0.2	0.1	0.3	<0.1
R22	1.5	0.3	0.1	<0.1	<0.1
R23	3.1	0.6	0.2	0.1	<0.1
R24	0.5	0.2	<0.1	0.2	<0.1
R25	1.4	0.3	0.1	0.2	<0.1
R26	0.5	0.1	<0.1	<0.1	<0.1
R27	0.6	0.1	<0.1	<0.1	<0.1
R28	1.3	0.2	0.1	0.1	<0.1
R29	1.5	0.3	0.1	0.2	<0.1
R30	0.4	0.1	<0.1	0.1	<0.1
R31	0.1	<0.1	<0.1	<0.1	<0.1
R32	0.1	<0.1	<0.1	<0.1	<0.1
R33	0.3	0.1	<0.1	0.1	<0.1
R34	0.3	0.1	<0.1	0.1	<0.1
R35	0.9	0.2	0.1	0.1	<0.1

Table 8-2: Predicted ground level concentrations for Normal Day – cumulative

ID	NO_2 (µg/m^3) Annual	PM_{10} (µg/m^3) Annual	$PM_{2.5}$ (µg/m^3) Annual	SO_2 (µg/m^3) Annual	TSP Deposition g/m^2/month Month
Criterion:	62	25	8	62	4
R1	27.1	17.8	7.3	1.1	2.0
R2	29.8	18.3	7.5	2.2	2.1
R3	28.8	18.1	7.4	2.0	2.1
R4	38.0	19.7	8.0	1.5	2.2
R5	28.6	18.1	7.4	1.3	2.1
R6	30.8	18.5	7.6	1.2	2.1
R7	34.2	19.1	7.8	1.6	2.2
R8	33.3	18.9	7.7	1.5	2.2
R9	24.5	17.4	7.1	1.1	2.0
R10	24.0	17.3	7.1	1.0	2.0
R11	24.1	17.3	7.1	1.0	2.0
R12	23.9	17.3	7.1	1.1	2.0
R13	24.8	17.4	7.1	1.1	2.0
R14	23.3	17.1	7.0	1.0	2.0
R15	24.1	17.3	7.1	1.1	2.0
R16	25.5	17.5	7.2	1.2	2.0
R17	22.8	17.1	7.0	1.1	2.0
R18	24.8	17.4	7.2	1.2	2.0
R19	24.2	17.3	7.1	1.1	2.0
R20	23.6	17.2	7.1	1.1	2.0
R21	23.8	17.2	7.1	1.3	2.0
R22	24.1	17.3	7.1	1.0	2.0
R23	25.6	17.6	7.2	1.1	2.0
R24	23.1	17.2	7.0	1.2	2.0
R25	23.9	17.3	7.1	1.2	2.0
R26	23.1	17.1	7.0	1.0	2.0
R27	23.2	17.1	7.0	1.0	2.0
R28	23.9	17.2	7.1	1.1	2.0
R29	24.1	17.3	7.1	1.2	2.0
R30	23.0	17.1	7.0	1.1	2.0
R31	22.6	17.0	7.0	1.0	2.0
R32	22.6	17.0	7.0	1.0	2.0
R33	22.8	17.1	7.0	1.1	2.0
R34	22.9	17.1	7.0	1.1	2.0
R35	23.4	17.2	7.1	1.1	2.0

8.2 Peak operational day

This section presents the modelling results for the Project operating under the peak operational day scenario. Table 8-3 presents the incremental predictions and Table 8-4 presents the cumulative predictions, combining the incremental predictions with the relevant adopted background concentration (for backgrounds see Table 5-6).

The incremental results (presented in Table 8-3) conservatively show NO_2 as 100% NO_x, when in reality, the percentage of NO_2 in total oxides of nitrogen would be 10% to 20%.

Adopting this highly conservative approach resulted in a predicted exceedance of the maximum 1-hour NO_2 criterion (246 µg/m^3) at receptor R2.

Application of the (more realistic, albeit conservative) OLM methodology described in Section 7.1.4 however demonstrates that maximum concentrations of NO_2 at this location, inclusive of background NO_2 (i.e. cumulative evaluation) is anticipated to be less than 40% of the 1-hour criterion.

Consistent with the commentary provided in Section 8.1, the cumulative results (presented in Table 8-4) have adopted the OLM methodology for NO_2 assessment described in Section 7.1.4.

As noted in Section 5.7, for the assessment of cumulative 24-hour average PM_{10}, a background value (44 µg/m^3) has been adopted based on the highest 24-hour measurement below the criterion to evaluate the potential for additional exceedances.

Adopting this conservative approach resulted in a predicted exceedance (peak operational day combined with worst-case dispersion meteorology) at receptors R2, R4, R7 and R8.

A contemporaneous assessment of cumulative 24-hour PM_{10} concentrations combines observed PM_{10} concentrations (in this case taken from OEH Rozelle during the calendar year 2015) with paired-in-time model predictions.

Adoption of such a contemporaneous assessment for these four receptors (R2, R4, R7 and R8) demonstrates that maximum 24-hour concentrations of PM_{10} at these locations are anticipated to meet the assessment criterion.

In view of the above discussion, model predictions demonstrate compliance with all of the impact assessment criteria for all relevant averaging periods.

Table 8-3: Predicted ground level concentrations for Peak operational Day – incremental

ID	NOx (µg/m³) 1-hour	PM_{10} (µg/m³) 24-hour	$PM_{2.5}$ (µg/m³) 24-hour	SO_2 (µg/m³) 10-min	SO_2 (µg/m³) 1-hour	SO_2 (µg/m³) 24-hour
Criterion:	n/a	n/a	n/a	n/a	n/a	n/a
R1	64	3	1	24	17	2
R2	92 (a)	8	3	143	100	13
R3	151	4	2	135	94	13
R4	197	9	4	113	79	6
R5	84	4	1	93	65	4
R6	106	5	2	98	69	4
R7	137	7	3	94	66	8
R8	132	7	2	114	80	8
R9	41	1	0	58	41	2
R10	29	1	0	36	25	1
R11	30	1	0	37	26	1
R12	109	2	1	59	41	2
R13	28	1	1	56	39	2
R14	19	1	0	22	16	1
R15	22	1	0	27	19	1
R16	51	2	1	57	40	3
R17	37	1	0	41	29	2
R18	42	1	1	60	42	4
R19	48	1	0	73	51	3
R20	42	1	0	58	40	3
R21	43	1	0	55	38	4
R22	21	1	0	39	27	2
R23	42	2	1	25	17	1
R24	107	2	1	47	33	3
R25	162	2	1	59	42	3
R26	7	0	0	9	7	0
R27	9	0	0	12	8	1
R28	25	1	0	25	17	1
R29	64	2	1	59	41	2
R30	47	1	0	36	25	2
R31	34	1	0	24	16	1
R32	23	0	0	23	16	1
R33	44	0	0	50	35	2
R34	42	1	0	45	31	2
R35	35	1	0	49	34	2

Notes: (a) Cumulative NO_2 concentration evaluated using the OLM method has been reported at this receptor.

Table 8-4: Predicted ground level concentrations for Peak operational Day – cumulative

ID	NO_2 (µg/m^3) 1-hour	PM_{10} (µg/m^3) 24-hour	$PM_{2.5}$ (µg/m^3) 24-hour	SO_2 (µg/m^3) 10-min	SO_2 (µg/m^3) 1-hour	SO_2 (µg/m^3) 24-hour
Criterion:	246	50	25	712	570	228
R1	62	47	20	170	88	20
R2	92	46 (a)	22	289	171	31
R3	70	48	21	281	165	31
R4	75	48 (a)	23	259	150	24
R5	64	48	20	239	136	22
R6	66	49	21	244	140	22
R7	69	47 (a)	22	240	137	26
R8	69	47 (a)	21	260	151	26
R9	59	45	19	204	112	20
R10	51	45	19	182	96	19
R11	53	45	19	183	97	19
R12	66	46	20	205	112	20
R13	51	45	20	202	110	20
R14	42	45	19	168	87	19
R15	45	45	19	173	90	19
R16	60	46	20	203	111	21
R17	59	45	19	187	100	20
R18	60	45	20	206	113	22
R19	60	45	19	219	122	21
R20	60	45	19	204	111	21
R21	60	45	19	201	109	22
R22	43	45	19	185	98	20
R23	60	46	20	171	88	19
R24	66	46	20	193	104	21
R25	72	46	20	205	113	21
R26	30	44	19	155	78	18
R27	31	44	19	158	79	19
R28	47	45	19	171	88	19
R29	62	46	20	205	112	20
R30	60	45	19	182	96	20
R31	57	45	19	170	87	19
R32	45	44	19	169	87	19
R33	60	44	19	196	106	20
R34	60	45	19	191	102	20
R35	58	45	19	195	105	20

Notes: (a) A contemporaneous assessment of cumulative PM_{10} concentrations was adopted at these receptors.

8.3 Management and mitigation

There are a number of mitigation measures proposed in relation to reducing fugitive particulate emissions from the Project that are detailed in Table 8-5.

The performance of the mitigation and control measures identified in Table 8-5 shall be monitored by on site personnel. Table 8-6 provides a summary of the measures and their relevant performance indicators and timing.

Table 8-5: Dust management measures by activity

Activity	Control and mitigation measure
Aggregate receival, transfer and storage	• Receival bins located inside enclosed building to minimise exposure to wind • Enclosed conveyors and transfer points to move aggregate to holding hoppers • Fully enclosed holding hoppers
Cement and fly ash delivery	• Enclosed loading bay • Use of an enclosed pneumatic transfer system when filling cement and fly ash silos and loading agitator trucks • Automatic silo fill system that shuts the fill pipe near the tanker connection if the silo becomes full • Fully enclosed cement hoppers • Use of bag filters for dry dust collection and filtering
General site	• All internal roads sealed and kept clean • Limit vehicle speed on site • Covering of loads • Wash down area for agitator trucks and raw material delivery trucks •

Table 8-6: Dust management practices and performance metrics

Action	Method	Timing	Performance metric	Responsibility for implementation
Dust suppression sprays during aggregate delivery	Activate misting system during unloading process	All deliveries	No visible dust from storage bays	Site manager
Enclosed conveyors, transfer points and hoppers	Visual inspection for leakages	Ongoing	Conveyors and transfer points remain enclosed	Site manager
Enclosed loading bay	Ensure automatic doors are closed prior to loading	All loading periods	Door closed and no visible dust from building	Drivers, relevant staff
Pneumatic transfer	Ensure connections are sealed prior to transfer between the trucks and silos	All transfer periods	No visible dust inside the building	Drivers, relevant staff
Automatic silo fill system	Test system is functioning appropriately	Ongoing	Tests show alarm system is working correctly	Site manager
Enclosed cement hoppers	Visual inspection	Ongoing	Cement hoppers have no cracks or potential weak points	Site manager
Use of bag filters	Ensure bag filters are maintained in optimal operating condition	Ongoing	No visible dust from building	Site manager
Limiting speeds onsite	Visual inspection	Ongoing	Vehicles are travelling at or below 10 km/h	Site manager and entrance operator
Maintain clean road surfaces	Visual inspection	Ongoing	No visible dust above wheel arches	Site manager
Covering of loads	Visual inspection	Ongoing	100% of loads are covered	Entrance / weighbridge operator
Vehicle wash down	Visual inspection	Ongoing	Vehicles are clean	Wash down area operator and drivers

9 Construction dust assessment

This section outlines the potential impacts of the construction stage of the project. The main air quality and amenity issues at any construction site are:

- Annoyance due to dust deposition (soiling of surfaces)
- Visible dust plumes / visual amenity
- Elevated PM_{10} concentrations due to dust-generating activities
- Exhaust emissions from diesel-powered construction equipment

Exhaust emissions from on-site construction plant and site traffic are unlikely to have a significant impact on local air quality and in the majority of cases they will not need to be quantitatively assessed (IAQM, 2014).

Particulate emissions can occur during the preparation of the land (e.g. demolition and earth moving) and during construction itself, and can vary substantially from day to day depending on the level of activity, the specific operations being undertaken, and the weather conditions. A significant portion of the emissions results from site plant and road vehicles moving over temporary roads and open ground. If mud is allowed to get onto local public roads, dust emissions can occur at some distance from the construction site (IAQM, 2014).

9.1 Assessment methodology

A full technical description of the assessment methodology and outcomes is provided in Appendix E. The activities considered are:

- Demolition
- Earthworks
- Construction
- Track out

The following provides an overview of the construction assessment.

The risk assessment process firstly identified if there were sensitive receptors that were at risk of dust impacts from construction activities from the Proposal.

The potential for dust emissions were then defined by allocating each construction stage a level of risk, as ‘small’, ‘medium’ or ‘large’ based on the detailed information about the construction activities, such as the number of heavy duty vehicles that would enter the site per day and the quantity of material to be handled during earthworks. The next step was to identify the sensitivity of the area based on the nature of sensitive receptors, such as ‘human’ or ‘ecological’ and then by the number and distance of these sensitive receptors to the proposed Proposal’s construction activities.

9.2 Results

The results for the construction risk assessment are provided in Table 9-1. Overall the assessment is classified as “low risk”. Where the demolition and earthworks activities are categorised as "negligible", while the construction and track out activities are considered as 'low risk'.

Table 9-1: Summary of risk assessment for the Proposal

Type of activity	Step 2a: Potential for dust emissions	Step 2b: Sensitivity of area			Step 2c: Risk of dust impacts		
		Dust soiling	Human health	Ecological	Dust soiling	Human health	Ecological
Demolition	Small	Low	Low	Medium	Negligible	Negligible	Low
Earthworks	Small	Low	Low	Medium	Negligible	Negligible	Low
Construction	Medium	Low	Low	Medium	Low	Low	Medium
Track-out	Medium	Low	Low	Medium	Low	Low	Low

9.3 Mitigation

For those cases where the risk category is 'negligible', no mitigation measures beyond those required by legislation will be required.

The proposed construction mitigation activities are shown in Table 9-2 to Table 9-7. Most of the recommended measures are routinely employed as 'good practice' on construction sites. Whilst all measures contained in the following tables are encouraged to be adopted within a construction environmental management plan (CEMP), in the event that they prove impracticable, they should be read as guidelines as opposed to requirements.

A CEMP, that includes dust management, should be produced to cover the construction period. This should contain details of the site-specific mitigation measures to be applied. Additional guidance on the control of dust at construction sites in NSW is provided as part of the NSW EPA Local Government Air Quality Toolkit[1]. Detailed guidance is also available from the UK (GLA, 2006) and the United States (Countess Environmental, 2006).

Table 9-2: Mitigation for all sites: Communications

	Mitigation measure	Recommendation
1	Communication, notification and complaints handling requirements regarding air quality matters will be managed through the Community Communication Strategy (CCS).	Highly recommended

[1] http://www.epa.nsw.gov.au/air/lgaqt.htm

Table 9-3: Mitigation for all sites: Dust Management

	Mitigation measure	Recommendation
2	A Construction Air Quality Management Plan will be developed and implemented to monitor and manage potential air quality impacts associated with the construction for the project. The Plan will be implemented for the duration of construction.	Highly recommended
Site management		
3	Regular communication with sites in close proximity to ensure that measures are in place to manage cumulative dust impacts.	Highly recommended
Monitoring		
4	Regular site inspections will be conducted to monitor for potential dust issues. The site inspection, and issues arising, will be recorded.	Highly recommended
Preparing and maintaining the site		
5	Construction activities with the potential to generate dust will be modified or ceased during unfavourable weather conditions to reduce the potential for dust generation.	Highly recommended
6	Measures to reduce potential dust generation, such as the use of water carts, sprinklers, dust screens and surface treatments, will be implemented within project sites as required.	Highly recommended
7	Unsealed access roads within project sites will be maintained and managed to reduce dust generation.	Highly recommended
8	Where reasonable and feasible, appropriate control methods will be implemented to minimise dust emissions from the project site.	Highly recommended
9	Storage of materials that have the potential to result in dust generation will be minimised within project sites at all times.	Highly recommended
Operating vehicle/machinery and sustainable travel		
10	All construction vehicles and plant will be inspected regularly and maintained to ensure that they comply with relevant emission standards.	Highly recommended
11	Engine idling will be minimised when plant are stationary, and plant will be switched off when not in use to reduce emissions.	Highly recommended
12	The use of mains electricity will be favoured over diesel or petrol-powered generators where practicable to reduce site emissions.	Highly recommended
13	Haul roads will be treated with water carts and monitored during earthworks operations, ceasing works if necessary during high winds where dust controls are not effective.	Highly recommended
14	A Sustainability Plan will be produced to manage the sustainable delivery of goods and materials.	Highly recommended
Construction		
15	Suitable dust suppression and/or collection techniques will be used during cutting, grinding or sawing activities likely to generate dust in close proximity to sensitive receivers.	Highly recommended
16	The potential for dust generation will be considered during the handling of loose materials. Equipment will be selected and handling protocols developed to minimise the potential for dust generation.	Highly recommended
17	All vehicles loads will be covered to prevent escape of loose materials during transport.	Highly recommended

Table 9-4: Mitigation specific to demolition

	Mitigation measure	Recommendation
31	Soft strip buildings before demolition (retaining walls and windows in the rest of the building where possible, to provide a screen against dust).	Desirable
32	Ensure effective water suppression is used during demolition operations. Hand held sprays are more effective than hoses attached to equipment as the water can be directed to where it is needed. In addition high volume water suppression systems, manually controlled, can produce fine water droplets that effectively bring the dust particles to the ground.	Highly recommended
33	Avoid explosive blasting, using appropriate manual or mechanical alternatives.	Highly recommended
34	Bag and remove any biological debris or damp down such material before demolition.	Highly recommended

Table 9-5: Mitigation specific to earthworks

	Mitigation measure	Recommendation
21	Areas of soil exposed during construction will be minimised at all times to reduce the potential for dust generation.	Desirable
22	Exposed soils will be temporarily stabilised during weather conditions conducive to dust generation and prior to extended periods of inactivity to prevent dust generation.	Desirable
23	Exposed soils will be permanently stabilised as soon as practicable following disturbance to minimise the potential for ongoing dust generation.	Desirable

Table 9-6: Mitigation specific to construction

	Mitigation measure	Recommendation
24	Ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place.	Highly recommended
25	Ensure fine materials are stored and handled to minimise dust.	Desirable

Table 9-7: Mitigation specific to track-out of loose material onto roads.

	Mitigation measure	Recommendation
26	Deposits of loose materials will be regularly removed from sealed surfaces within and adjacent to project sites to reduce dust generation.	If required
27	During establishment of project ancillary facilities, controls such as wheel washing systems and rumble grids will be installed at site exits to prevent deposition of loose material on sealed surfaces outside project sites to reduce potential dust generation.	If required

9.4 Significance of risks

Once the risk of particulate impacts has been determined in Step 2C and the appropriate dust mitigation measures identified in Step 3, the final step is to determine whether there are residual significant effects arising from the construction phase of a proposed development. For almost all construction activities, the aim should be to prevent significant effects on receptors through the use of effective mitigation. Experience shows that this is normally possible. Hence the residual effect will normally be ‘not significant’ (IAQM, 2014).

However, even with a rigorous Dust Management Plan in place, it is not possible to guarantee that the dust mitigation measures will be effective all the time. There is the risk that nearby buildings might experience some occasional dust soiling impacts. This does not mean that impacts are likely, or that if they did occur, that they would be frequent or persistent. Overall construction dust is unlikely to represent a serious ongoing problem. Any effects would be temporary and relatively short-lived, and would only arise during dry weather with the wind blowing towards a receptor, at a time when dust is being generated and mitigation measures are not being fully effective. The likely scale of this would not normally be considered sufficient to change the conclusion that with mitigation the effects will be ‘not significant’.

The sensitive receptors are located to the west and east of the nearest construction activities. In view of the prevailing winds originating from both the south and east (see Figure 7-2**)** consideration of construction activities during adverse conditions from these directions should be made to ensure dust impacts during construction are minimised.

10 Greenhouse Gas Assessment

10.1 Relevant legislation

10.1.1 International framework

10.1.1.1 Intergovernmental Panel on Climate Change

The Intergovernmental Panel on Climate Change (IPCC) is a panel established in 1988 by the World Meteorological Organisation (WMO) and the United Nations Environment Programme (UNEP) to provide independent scientific advice on climate change. The panel was originally asked to prepare a report, based on available scientific information, on all aspects relevant to climate change and its impacts and to formulate realistic response strategies. This first assessment report of the IPCC served as the basis for negotiating the United Nations Framework Convention on Climate Change (UNFCCC).

The IPCC also produce a variety of guidance documents and recommended methodologies for GHG emissions inventories, including (for example):

- 2006 IPCC Guidelines for National GHG Inventories; and
- Good Practice Guidance and Uncertainty Management in National GHG Inventories (2000).

Since the UNFCCC entered into force in 1994, the IPCC remains the pivotal source for scientific and technical information relevant to GHG emissions and climate change science.

The IPCC operates under the following mandate: "*to provide the decision-makers and others interested in climate change with an objective source of information about climate change"*. The IPCC does not conduct any research nor does it monitor climate-related data or parameters. Its role is to assess on a comprehensive, objective, open and transparent basis the latest scientific, technical and socio-economic literature produced worldwide, relevant to the understanding of the risk of human-induced climate change, its observed and projected impacts and options for adaptation and mitigation. IPCC reports should be neutral with respect to policy, although they need to deal objectively with policy relevant scientific, technical and socio economic factors. They should be of high scientific and technical standards, and aim to reflect a range of views, expertise and wide geographical coverage" (IPCC, 2011).

The stated aims of the IPCC are to assess scientific information relevant to:

- Human-induced climate change.
- The impacts of human-induced climate change.
- Options for adaptation and mitigation.

IPCC reports are widely cited within international literature, and are generally regarded as authoritative.

10.1.1.2 United Nations Framework Convention on Climate Change

The UNFCCC sets an overall framework for intergovernmental efforts to tackle the challenge posed by climate change. It recognises that the climate system is a shared resource, the stability of which can be affected by industrial and other emissions of CO_2 and other GHGs. The convention has near-universal membership, with 172 countries (parties) having ratified the treaty, the Kyoto Protocol.

Under the UNFCCC, governments:

- Gather and share information on GHG emissions, national policies and best practices.
- Launch national strategies for addressing GHG emissions and adapting to expected impacts, including the provision of financial and technological support to developing countries.
- Cooperate in preparing for adaptation to the impacts of climate change.

10.1.1.3 Kyoto Protocol

The Kyoto Protocol entered into force on 16 February 2005. The Kyoto Protocol built upon the UNFCCC by committing to individual, legally binding targets to limit or reduce GHG emissions. Annex I Parties (which includes Australia) are countries that were members of the Organisation for Economic Co-operation and Development (OECD) in 1992, plus countries with economies in transition such as Russia. The GHGs included in the Kyoto Protocol were:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)
- Sulfur hexafluoride (SF_6)

Each of the above gases has a different effect on the earth’s warming and this is a function of radiative efficiency and lifetime in the atmosphere for each individual gas. To account for these variables, each gas is given a ‘global warming potential’ (GWP) that is normalised to CO_2. For example, CH_4 has a GWP of 28 over a 100 year lifetime (IPCC, 2014). This factor is multiplied by the total mass of gas to be released to provide a CO_2 equivalent mass, termed ‘CO_2-equivalent’.The emission reduction targets were calculated based on a party’s domestic GHG emission inventories (which included land use change and forestry clearing, transportation and stationary energy sectors). Domestic inventories required approval by the Kyoto Enforcement Branch. The Kyoto Protocol required developed countries to meet national targets for GHG emissions over a five year period between 2008 and 2012.

To achieve their targets, Annex I Parties had to implement domestic policies and measures. The Kyoto Protocol provided an indicative list of policies and measures that might help mitigate climate change and promote sustainable development.

Under the Kyoto Protocol, developed countries could use a number of flexible mechanisms to assist in meeting their targets. These market-based mechanisms include:

- Joint Implementation – where developed countries invest in GHG emission reduction projects in other developed countries.
- Clean Development Mechanism – where developed countries invest in GHG emission reduction projects in developing countries.

Annex I countries that failed to meet their emissions reduction targets during the 2008-2012 period were liable for a 30 percent penalty (additional to the level of exceedance). A second commitment period was agreed in 2012 that spans from 2013 to 2020, whereby 37 countries, including Australia, were bound to emissions targets (DFAT, 2015).

10.1.1.4 Paris Agreement

In 2015, a historic global climate agreement was reached under the UNFCCC at the 21st Conference of the Parties (COP21) in Paris (known as the Paris Agreement). The Paris Agreement sets in place a durable and dynamic framework for all countries to take action on climate change from 2020 (that is, after the Kyoto period), building on existing efforts in the period up to 2020. Key outcomes of the Paris Agreement include:

- A global goal to hold average temperature increase to well below 2°C and pursue efforts to keep warming below 1.5°C above pre-industrial levels.
- All countries to set mitigation targets from 2020 and review targets every five years to build ambition over time, informed by a global stocktake.
- Robust transparency and accountability rules to provide confidence in countries' actions and track progress towards targets.
- Promoting action to adapt and build resilience to climate change.
- Financial, technological and capacity building support to help developing countries implement the Paris Agreement.

Australia ratified the Paris Agreement in November 2016. Australia's target under the Paris Agreement is to reduce emissions by 26-28 per cent below 2005 levels by the year 2030, progressing the levels of reduction required to meet the Kyoto Protocol targets.

10.1.2 Australian context

According to the Department of Environment and Energy (DoEE), Australia's GHG emissions have increased by 27.9% since 1990 reaching 534.7 Million tonnes of CO_2-equivalent ($MtCO_2$-e) in 2016 (excluding Land Use, Land Use Change and Forestry - LULUCF) (DoEE, 2016a).

10.1.2.1 National Greenhouse and Energy Reporting Framework

The National Greenhouse and Energy Reporting Act 2007 (Cth) (the NGER Act) establishes a mandatory obligation on corporations which exceed defined thresholds to report GHG emissions, energy consumption, energy production and other related information.

Corporate and facility reporting thresholds for GHG emissions and energy consumption or energy production are provided in Table 2-1.

Table 10-1: NGER reporting thresholds per financial year

Parameter	Reporting Threshold	
	Corporate	Facility
GHG Emissions (Scope 1&2) (kt CO_2-e)	50	25
Energy production (TJ)	200	100
Energy consumption (TJ)	200	100

Source: CER, 2017

If a corporation has operational control over facilities whose GHG emissions or energy use in a given reporting year:

- Individually exceed the relevant facilities threshold; or
- When combined with other facilities under the corporation's operational control, exceed the relevant corporate thresholds.

That corporation must report the relevant GHG emissions or energy use (as the case may be) for that year under the NGER Act. This may include construction or other contractors, for example.

It is anticipated that during construction, there will be multiple parties with operational control over different aspects of the site development. For this reason, while it is anticipated that there is likely to be some reporting requirement under the NGER scheme, this is likely to be apportioned across the NGER reporting corresponding to several corporations.

Once operational, the Project's total GHG emissions are anticipated to be below the 25,000 tonnes CO_2-e in a financial year and not anticipated to report under the NGER scheme.

10.2 Methodology

Quantification of GHG emissions has been performed in accordance with the GHG Protocol (WRI & WBCSD, 2004), IPCC and Australian Government GHG accounting/classification systems.

This GHGA is also guided by the emission estimation methodologies endorsed under the National Greenhouse and Energy Reporting Regulations 2008 (the NGER Regulations). These describe the detailed requirements for reporting under the NGER framework and also provide a basis for estimating emissions from proposed activities.

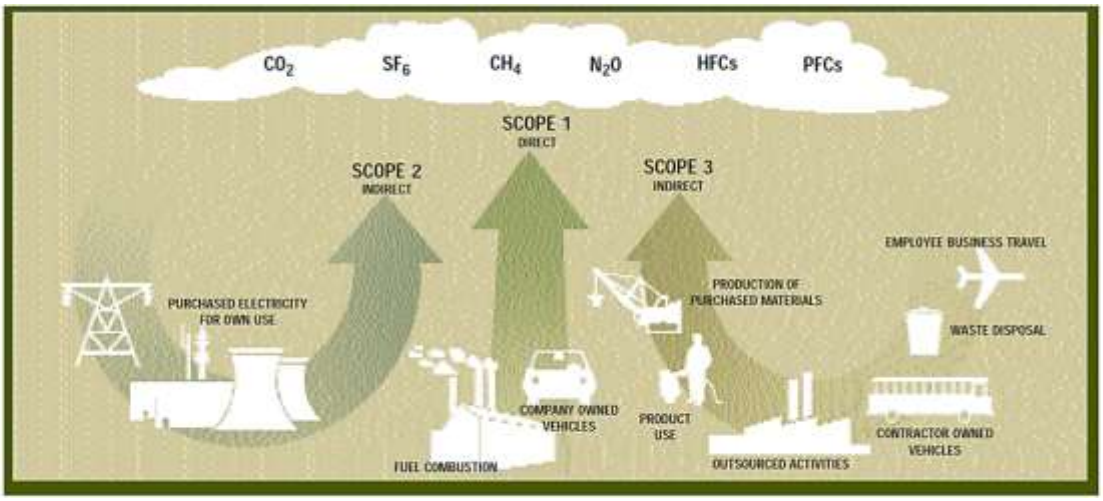
The *Technical Guidelines for the Estimation of Greenhouse Gas Emissions by Facilities in Australia* (the NGER Guidelines) (DoEE, 2016b) support reporting under the NGER Act. They have been designed to assist corporations in understanding and applying the NGER Measurement Determination.

The NGER Guidelines are reporting year specific, and outline calculation methods and criteria for determining GHG emissions, energy production, energy consumption and potential GHG emissions embodied in combusted fuels. The latest published NGER Guidelines (at the time of writing) have been referenced.

10.2.1 The GHG Protocol

The GHG Protocol establishes an international standard for accounting and reporting of GHG emissions. The GHG Protocol has been adopted by the International Organization for Standardisation, endorsed by GHG initiatives (such as the Carbon Disclosure Project) and is compatible with existing GHG trading schemes.

Under this protocol, three "scopes" of emissions (Scope 1, Scope 2 and Scope 3) are defined for GHG accounting and reporting purposes. This terminology has been adopted in Australian GHG reporting and measurement methods and has been employed in this assessment. The definitions for Scope 1, Scope 2 and Scope 3 emissions are provided in the following sections, with a visual representation provided in Figure 10-1.



Source: WRI & WBCSD 2004

Figure 10-1: Overview of Scopes and Emissions across a Reporting Entity

10.2.1.1 Scope 1: Direct Greenhouse Gas Emissions

Direct greenhouse gas emissions are defined as those emissions that occur from sources that are owned or controlled by the reporting entity. Direct greenhouse gas emissions are those emissions that are principally the result of the following types of activities undertaken by an entity and includes:

- Transportation of materials, products, waste and employees. These emissions result from the combustion of fuels in entity owned/controlled mobile combustion sources, e.g., concrete trucks, aggregate tippers, cement tankers, forklift, loaders and bobcats.

10.2.1.2 Scope 2: Energy Product Use Indirect Greenhouse Gas Emissions

Scope 2 emissions are indirect GHG emissions from the generation of purchased energy by the Project. Scope 2 in relation to the Project covers purchased electricity, defined as electricity that is purchased or otherwise brought into the organisational boundary of the entity. Scope 2 emissions physically occur at the facility that generates the electricity, rather than the facility that uses the electricity. This is why they are often referred to as indirect GHG emissions.

10.2.1.3 Scope 3: Other Indirect Greenhouse Gas Emissions

Scope 3 emissions are defined as those emissions that are a consequence of the activities of an entity, but which arise from sources not owned or controlled by that entity. Some examples of Scope 3 activities provided in the GHG Protocol are extraction and production of purchased materials, transportation of purchased fuels, and use of sold products and services. In the case of BIPS, Scope 3 emissions will include emissions associated with fuel cycles.

The GHG Protocol provides that reporting scope 3 emissions is optional. If an organisation believes that Scope 3 emissions are a significant component of the total emissions inventory, these can be reported along with Scope 1 and Scope 2. However, the GHG Protocol notes that reporting Scope 3 emissions can result in double counting of emissions and can also make comparisons between organisations and/or products difficult because reporting is voluntary. Double counting needs to be avoided when compiling national (country) inventories under the Kyoto Protocol. The GHG Protocol also recognises that compliance regimes are more likely to focus on the "point of release" of emissions (i.e. direct emissions) and/or indirect emissions from the purchase of electricity.

Under the NGER Act, facilities triggering greenhouse emission and energy usage thresholds are required to report Scope 1 and Scope 2, but not Scope 3 and therefore have not been considered further.

10.2.2 National Greenhouse and Energy Reporting (Measurement) Determination 2008

The National Greenhouse and Energy Reporting (Measurement) Determination 2008 (the NGER Determination) commenced on 1 July 2008 and is made under subsection 10 (3) of the NGER Act. It provides a framework for the measurement of the following arising from the operation of facilities:

- Greenhouse gas emissions.
- The production of energy.
- The consumption of energy.

The determination addresses Scope 1 and Scope 2 emissions. The methods are presented in a tiered structure with higher tiers producing less uncertain results but requiring more data to employ. In the NGER Determination there are 4 categories of Scope 1 emissions (the code for the IPCC classification is provided in brackets):

- Fuel combustion (UNFCCC Category 1.A).
- Fugitive emissions from fuels, which deals with emissions released from the extraction, production, flaring of fuel, processing and distribution of fossil fuels (UNFCCC Category 1.B).
- Industrial processes emissions (UNFCCC Category 2).
- Waste emissions (UNFCCC Category 6).

It is acknowledged that as the NGER Guidelines are derived from the NGER Determination, where there is a perceived contradiction between the NGER Guidelines and NGER Determination, the NGER Determination has taken precedence.

10.2.3 Assessment approach

GHG emissions have been estimated for the Project based upon the methods outlined in the following documents:

- The National Greenhouse and Energy Reporting (Measurement) Amendment Determination 2008.
- Site specific information.
- The NGER Guidelines.
- The NGA Factors.

10.3 Greenhouse Gas Emission Estimates

Emissions of carbon dioxide (CO_2) and methane (CH_4) would be the most relevant GHGs for the Project. These gases are formed and released during the combustion of fuels used on site.

Inventories of GHG emissions can be calculated using published emission factors. Different gases have different greenhouse warming effects (referred to as global warming potentials) and emission factors take into account the global warming potentials of the gases created during combustion. The GHG assessment has been conducted using the NGA Factors (see

Table 10-2), published by the DoE (2015).

Relevant sources included in the assessment are as follows:

- Scope 1: fuel consumption (diesel) used for concrete agitator trucks, aggregate tippers, forklifts, loaders and bobcat.
- indirect emissions associated with on-site electricity use – scope 2.

Table 10-2: NGA Calculation Factors

NGA Calculation factors		
CO_2-e from electrical energy	Scope 2	0.88 kg CO_2-e/kWh electricity
CO_2-e from diesel usage	Scope 1	70.51 kg CO_2-e/litre diesel

Notes (a) DoE (2015) Table 41.
(b) DoE (2015) Table 4, post 2004 vehicles.

A summary of the annual GHG emissions is provided in Table 10-3.

Table 10-3: Summary of Estimated CO_2-e (tonnes/annum) - All scopes

	Quantity	Units
Diesel used	1,170	l/y
Electrical energy used	2,519,984	kWh
Scope 1 Estimated emissions	3.2	t/y
Scope 2 Estimated emissions	2,167	t/y
Total CO_2-e	**2,170**	**t/y**

Average annual scope 1 and 2 emissions from the Project (2,170 tonnes CO_2-e) would represent approximately 0.0000004% of Australia's 2016 emissions (537.4 Mt CO_2-e) and a extremely small portion of global GHG emissions, given that Australia contributed approximately 1.5% of global GHG emissions in 2005 (Commonwealth of Australia, 2011).

In view of the above, it is anticipated that the Project will not have to report GHG emissions under the NGER scheme at a facility level (see Section 10.1.2.1).

10.3.1 Greenhouse gas mitigation measures

Maximum gains in efficiency, and thus GHG management, can be realised through the choice of best available power generation technology. Less significant efficiencies and greenhouse gas reductions can be realised through operational management and maintenance practices, some of which are presented as follows:

- Development of strong performance indicators based around plant efficiency and greenhouse intensity.
- consideration of energy efficiency in plant and equipment selection/purchase, including the installation of timers on all equipment
- power factor correction on incoming electricity supply and;
- recycling of all concrete, water and aggregates that are returned to the plant. This would indirectly mitigate greenhouse gas emissions by reducing emissions associated with waste disposal and production of supplementary materials.

11 Conclusion

Pacific Environment has been commissioned by Hanson Construction Materials Pty Ltd (Hanson) to undertake an air quality and greenhouse gas assessment for the proposed construction and operation of a concrete batching plant at Glebe Island, within the Bays Precinct, NSW.

This assessment has adopted the use of the computer-based dispersion model, AERMOD, to predict off site dust and gaseous air quality metrics.

Modelling results indicate that potential air quality impacts associated with the Project will be below ambient air quality impact assessment criteria. Further, an assessment of cumulative air quality impacts indicates that the Project would not be anticipated to result in any additional exceedances of the impact assessment criteria.

A semi-quantitative screening assessment of construction phase impacts identified human receptors within 350 m of the boundary of the site. Various measures for limiting the impacts of construction dust have been recommended. Most of the recommended measures are routinely employed as ‘good practice’ on construction sites.

Average annual scope 1 and 2 greenhouse gas emissions from the Project (2,170 tonnes CO_2-e) would represent approximately 0.0000004% of Australia’s 2016 emissions (537.4 Mt CO_2-e). This in turn comprises an extremely small component of global GHG emissions, given that Australia contributed approximately 1.5% to global GHG emissions in 2005 (Commonwealth of Australia, 2011).

A range of mitigation measures have been proposed to manage the Project’s construction, operation and greenhouse gas emissions.

Accordingly, based on the analysis undertaken in this assessment, the potential for the Project to adversely impact air quality is considered to be low and acceptable.

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Appendix A

Sensitive receptors

Table A-1: Selected discrete receptor locations

ID	Description	Easting (m)	Northing (m)	Elevation (m)
R1	Waterfront Park	332453	6251070	8.8
R2	Residential Area	332403	6250960	15.4
R3	Residential Building	332354	6250879	3.3
R4	Harbour Utilities Area	331950	6250988	2.5
R5	State Government Office	331842	6250888	4.3
R6	Harbour Utilities Area	331820	6251092	8.1
R7	Harbour Utilities Area	332087	6251290	2.7
R8	Iron Cove Bridge	332150	6250893	27.0
R9	Harbour Utilities Area	331530	6250803	1.9
R10	White Bay Power Station	331350	6251126	8.0
R11	C3 Church	331459	6251298	12.8
R12	Residential Area	331630	6251424	17.1
R13	Punch Park	331790	6251579	7.3
R14	Residential Area	331134	6250419	12.3
R15	Jubilee Park	331592	6250541	4.4
R16	Blackwattle Bay Park	332088	6250665	3.6
R17	St Scholastica’s College	331675	6250097	30.9
R18	Residential area	331773	6250602	8.6
R19	Residential Area	332234	6250438	3.1
R20	Sydney Secondary College Blackwattle Bay Campus	332396	6250221	9.5
R21	Sydney Fish Market	332844	6250499	6.9
R22	Pirrama Park	332676	6251452	9.3
R23	Cadi Park	332525	6251212	7.5
R24	Children’s Education and Care Centre	332796	6251026	27.9
R25	KU Maybanke Preschool	332892	6250886	23.0
R26	Illoura Reserve	333134	6251915	8.1
R27	Residential Area	332825	6251951	3.0
R28	Residential	332348	6251875	11.4
R29	Birrung Park	332030	6251804	18.3
R30	Balmain Care for Kids	332039	6252180	34.0
R31	Balmain Cove Children’s Centre	330681	6251794	37.6
R32	Rozelle Public School	330756	6251519	47.0
R33	Balmain Public School	331947	6251965	42.2
R34	Father John Therry Catholic Primary School	331996	6252010	40.6
R35	Wentworth Park	332723	6250244	6.0

Appendix B

Estimation of emissions and assumptions

B1.1 Introduction

The most significant sources of dust for the existing concrete batching plant will be:

- dust emissions from vehicle movements on paved areas
- residual dust emissions from de-dusted air used in materials conveying operations
- dust from unloading of sand and aggregate
- wind erosion from exposed areas

Estimates of dust emissions from these sources for a peak operational and a normal day have been estimated using operations information supplied by Hanson and emission factors from the US EPA's AP-42 document.

B1.2 Vehicle movements

TSP emissions from vehicle movements on paved roads were estimated using the US EPA emission factor equation given in Equation 1 (US EPA, 1995).

Equation 1

E_{TSP} = 3.23 x (sL)0.91 x [(GVM x 1.1023)1.02] / 1000 kg/VKT

where,

sL = silt loading of the surface (g/m2)

GVM = gross vehicle mass (t)

The PM_{10} and $PM_{2.5}$ emission factor equations are variations of Equation 1, as follows:

E_{PM10} = 0.62 x (sL)0.91 x [(GVM x 1.1023)1.02] / 1000 kg/VKT

$E_{PM2.5}$ = 0.15 x (sL)0.91 x [(GVM x 1.1023)1.02] / 1000 kg/VKT

For this project, a silt loading of 0.4 g/m^2 has been used for road that have < 5,000 vehicles per day. No cleaning and sweeping controls on the road have been accounted for.

B1.3 Material Handling

Each tonne of material unloaded would generate a quantity of TSP that would depend on the wind speed and the moisture content. Equation 2 (US EPA, 1995) shows the relationship between these variables.

Equation 2

$E_{TSP} = 0.74 \times 0.0016 \times [(U/2.2)^{1.3} / (M/2)^{1.4}]$ kg/t

where, ,

U = wind speed (m/s),

M – moisture content (%).

The PM_{10} and $PM_{2.5}$ emission factor equations are variations of Equation 2 as follows:

$EF_{PM10} = 0.35 \times 0.0016 \times [(U/2.2)^{1.3} / (M/2)^{1.4}]$ kg/t

B1.4 Residual dust from de-dusted air used for loading cement and fly ash to silos

Estimated dust emissions due to loading fly-ash and cement to the silo can be made by assuming the concentration of dust in the air discharged after de-dusting the conveying air and dry dust collection system when dry concrete mix is loaded to trucks is 50 mg/Nm3 (the EPA licence limit). The volume of air handled is approximately 34 Nm3/minute.

Approximately 300,000 t of cement and fly-ash will be required during a on an annual average basis, equating of 821 tonnes per day. This takes approximately one minute per tonne to load so the total number of minutes per peak operational day is 821 minutes for unloading cement and fly-ash to the silos. This gives a daily dust emission of 1.397 kg/day or 510 kg/y [(360 minutes x 34 Nm^3/minute x 0.050 g/Nm^3 / 1000].

Based on the information presented in Section 6.2, 100% of this is PM_{10} and 5.6% is $PM_{2.5}$.

Appendix C

Meteorological analysis

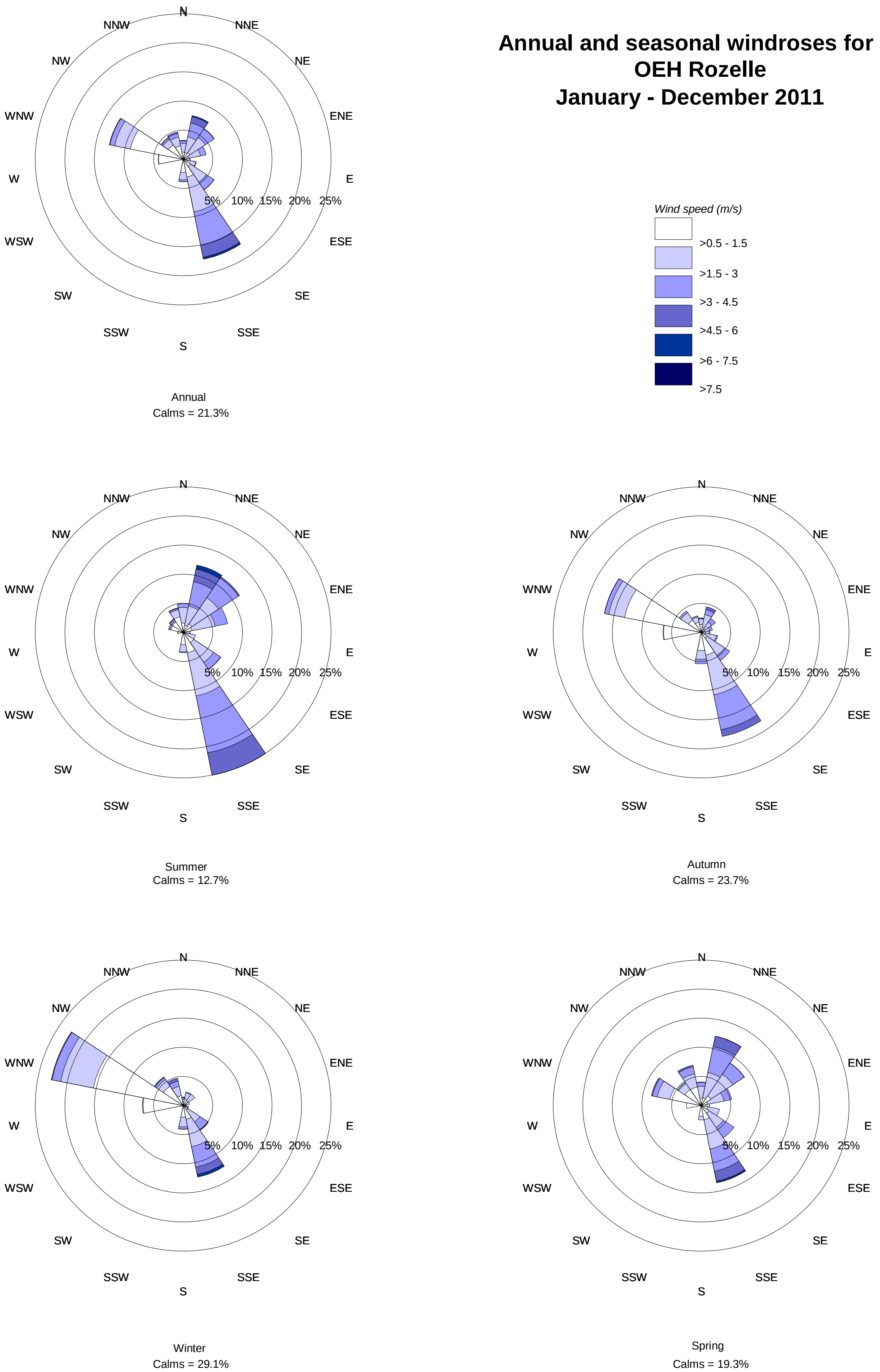


Figure 12-1: Annual and seasonal wind roses for Rozelle (2011).

Figure 12-2: Annual and seasonal wind roses for Rozelle (2012)

Figure 12-3: Annual and seasonal wind roses for Rozelle (2013)

Figure 12-4: Annual and seasonal wind roses for Rozelle (2014)

Appendix D

Contour plots

D1 Normal Day contour plots

Species: NO_2	**Location:** Glebe Island	**Scenario:** Normal Day – cumulative	**Percentile:** Annual	**Averaging Time:** 1 year
Model Used: AERMOD	**Units:** µg/m³	**Criterion:** 62	**Met Data:** Rozelle 2015	**Plot:** J. Firth

Figure D 1: Predicted cumulative annual average NO_2 concentration

Species: PM_{10}	Location: Glebe Island	Scenario: Normal Day - cumulative	Percentile: Annual	Averaging Time: 1 year
Model Used: AERMOD	**Units:** µg/m³	**Criterion:** 25	**Met Data:** Rozelle 2015	**Plot:** J. Firth

Figure D 2: Predicted cumulative annual average PM_{10} concentration

Species:	Location:	Scenario:	Percentile:	Averaging Time:
$PM_{2.5}$	Glebe Island	Normal Day - cumulative	Annual	1 year
Model Used:	**Units:**	**Criterion:**	**Met Data:**	**Plot:**
AERMOD	µg/m³	8	Rozelle 2015	J. Firth

Figure D 3: Predicted cumulative annual average $PM_{2.5}$ concentration

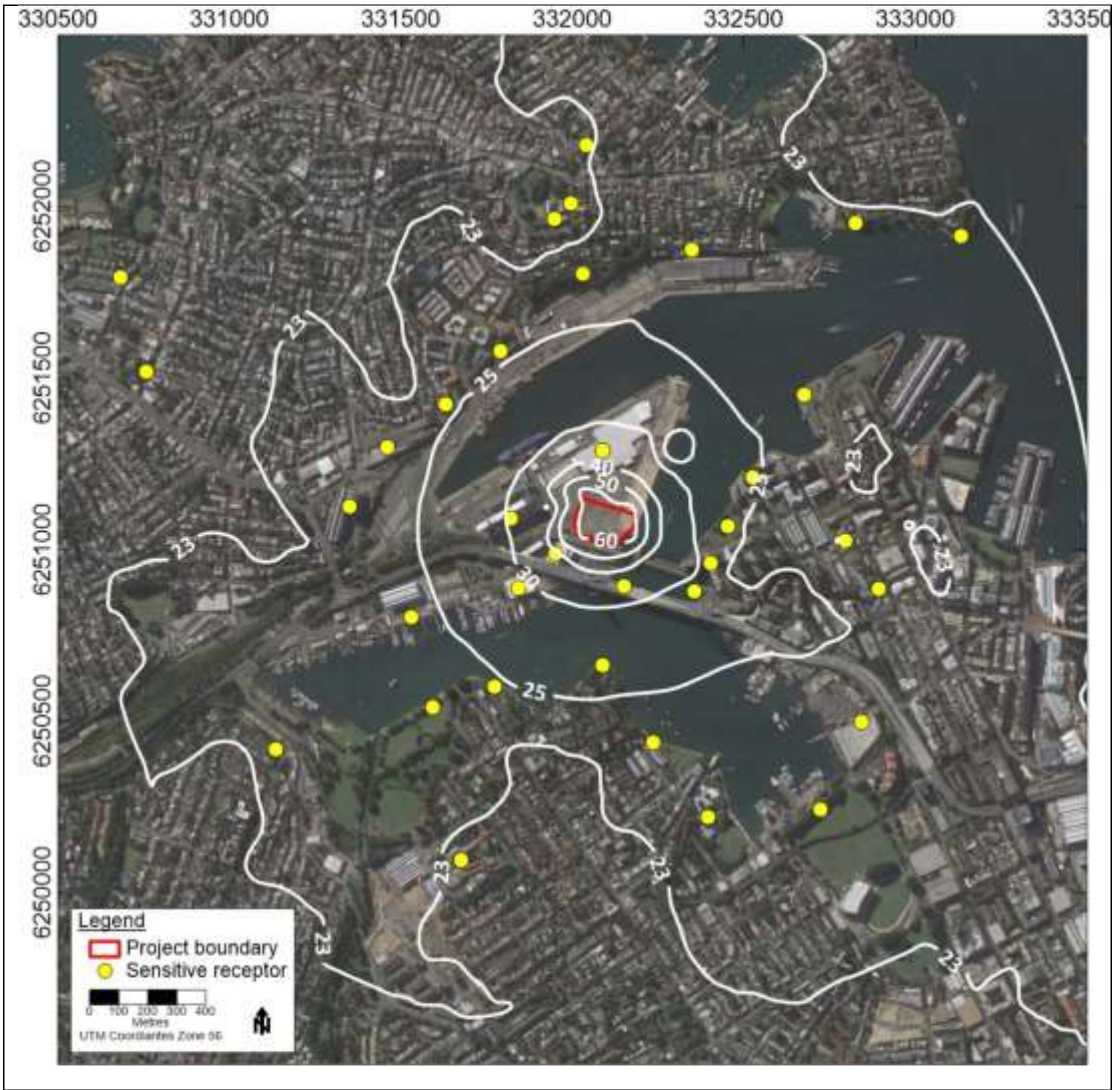
Species: SO_2	Location: Glebe Island	Scenario: Normal Day - cumulative	Percentile: Annual	Averaging Time: 1 year
Model Used: AERMOD	**Units:** µg/m³	**Criterion:** 62	**Met Data:** Rozelle 2015	**Plot:** J. Firth

Figure D 4: Predicted cumulative annual average SO_2 concentration

Species: Dust deposition	Location: Glebe Island	Scenario: Normal Day - cumulative	Percentile: 100th	Averaging Time: 1 month
Model Used: AERMOD	**Units:** g/m^2/month	**Criterion:** 4	**Met Data:** Rozelle 2015	**Plot:** J. Firth

Figure D 5: Predicted cumulative annual average dust deposition

D2 Peak operational Day contour plots



Species: NO$_2$	Location: Glebe Island	Scenario: Peak operational Day - cumulative	Percentile: 100th	Averaging Time: 1-hour
Model Used: AERMOD	**Units:** µg/m³	**Criterion:** 246	**Met Data:** Rozelle 2015	**Plot:** J. Firth

Figure D 6: Predicted cumulative maximum 1-hour NO_2 concentration

Species: PM_{10}	Location: Glebe Island	Scenario: Peak operational Day - cumulative	Percentile: 100th	Averaging Time: 24-hour
Model Used: AERMOD	**Units:** µg/m³	**Criterion:** 50	**Met Data:** Rozelle 2015	**Plot:** J. Firth

Figure D 7: Predicted cumulative maximum 24-hour PM_{10} concentration

Species: PM2.5	Location: Glebe Island	Scenario: Peak operational Day - cumulative	Percentile: 100th	Averaging Time: 24-hour
Model Used: AERMOD	**Units:** µg/m³	**Criterion:** 25	**Met Data:** Rozelle 2015	**Plot:** J. Firth

Figure D 8: Predicted cumulative maximum 24-hour $PM_{2.5}$ concentration

Species: SO_2	Location: Glebe Island	Scenario: Peak operational Day - cumulative	Percentile: 100th	Averaging Time: 10-minute
Model Used: AERMOD	**Units:** µg/m³	**Criterion:** 772	**Met Data:** Rozelle 2015	**Plot:** J. Firth

Figure D 9: Predicted cumulative maximum 10-minute SO_2 concentration

Species: SO2	Location: Glebe Island	Scenario: Peak operational Day - cumulative	Percentile: 100th	Averaging Time: 1-hour
Model Used: AERMOD	**Units:** µg/m³	**Criterion:** 570	**Met Data:** Rozelle 2015	**Plot:** J. Firth

Figure D 10: Predicted cumulative maximum 1-hour SO_2 concentration

Species: SO_2	Location: Glebe Island	Scenario: Peak operational Day - cumulative	Percentile: 100th	Averaging Time: 24-hour
Model Used: AERMOD	**Units:** µg/m³	**Criterion:** 60	**Met Data:** Rozelle 2015	**Plot:** J. Firth

Figure D 11: Predicted cumulative maximum 24-hour SO_2 concentration

Appendix E

Construction Dust Assessment Methodology

E1 Overview

The risk of dust impacts from a demolition/construction site causing loss of amenity and/or health or ecological impacts is related to the following (**IAQM, 2014**):

- The nature of the activities being undertaken.
- The duration of the activities.
- The size of the site.
- The meteorological conditions (wind speed, direction and rainfall). Adverse impacts are more likely to occur downwind of the site and during drier periods.
- The proximity of receptors to the activities.
- The sensitivity of the receptors to dust.
- The adequacy of the mitigation measures applied to reduce or eliminate dust.

It is very difficult to quantify dust emissions from construction activities. Due to the variability of the weather it is impossible to predict what the weather conditions would be when specific construction activities are undertaken. Any effects of construction on airborne particle concentrations would also generally be temporary and relatively short-lived. Moreover, mitigation should be straightforward, as most of the necessary measures are routinely employed as 'good practice' on construction sites. It is therefore usual to provide a qualitative assessment of potential construction dust impacts. A largely qualitative approach has also been used here, and the impacts of construction have not been specifically modelled. The approach used for Proposal was based on that described by IAQM (2014). The aim is to identify risks and to recommend appropriate mitigation measures.

The IAQM guidance is designed primarily for use in the UK, although it may be applied elsewhere. Here, the guidance has been adapted for use in NSW, taking into account factors such as the assessment criteria for ambient PM_{10} concentrations.

E2 Assessment procedure

The IAQM assessment procedure for assessing risk is shown in Figure E 1: Steps in an assessment of construction dust (IAQM, 2014). Professional judgement is required in some steps, and where justification cannot be given a precautionary approach should be adopted.

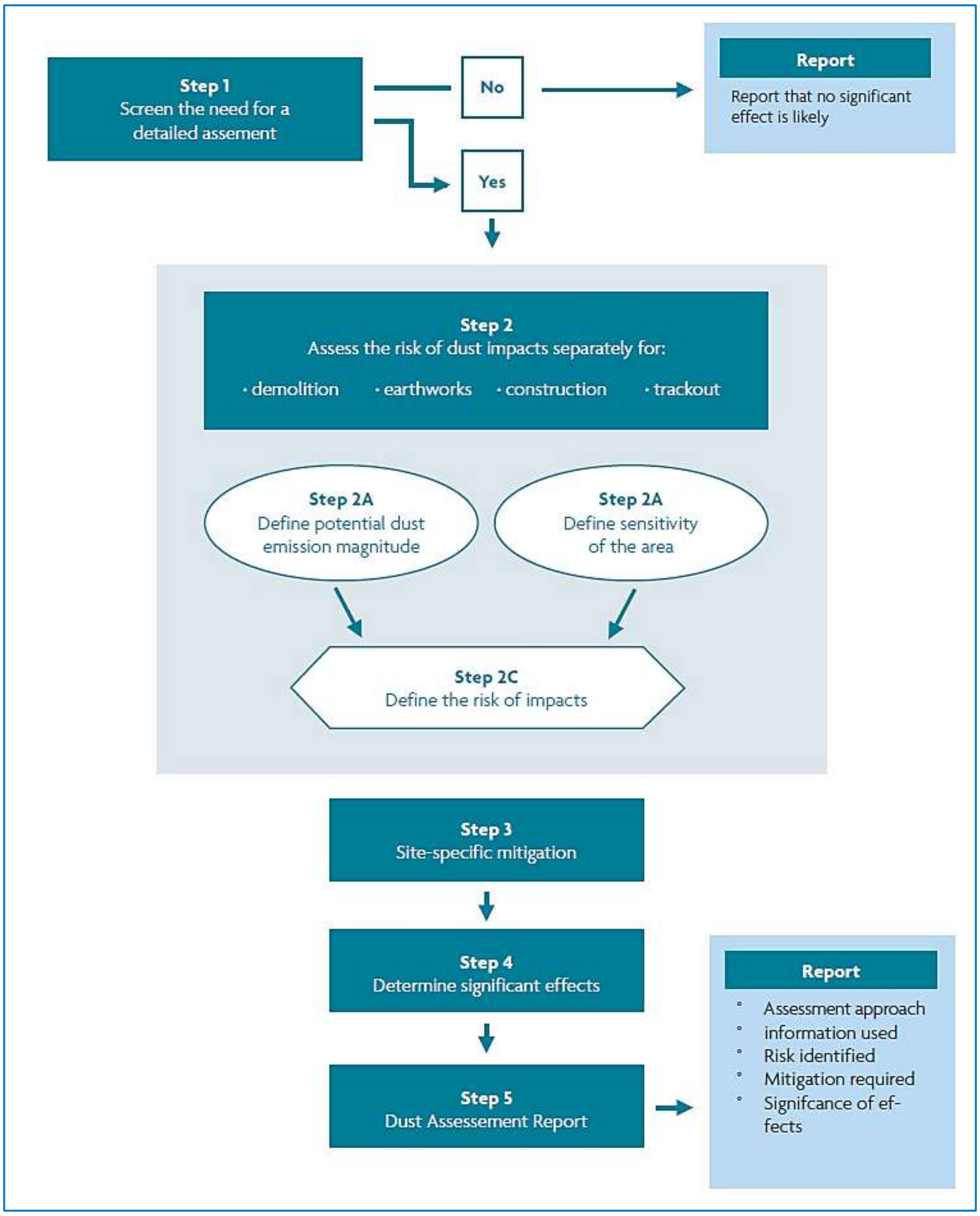


Figure E 1: Steps in an assessment of construction dust (IAQM, 2014)

Activities on construction sites can be divided into four types to reflect their different potential impacts, and the potential for dust emissions is assessed for each activity that is likely to take place. These activities are:

- *Demolition*. Demolition is any activity that involves the removal of existing structures. This may also be referred to as de-construction, specifically when a building is to be removed a small part at a time.
- *Earthworks*. This covers the processes of soil stripping, ground levelling, excavation and landscaping. Earthworks will primarily involve excavating material, haulage, tipping and stockpiling.

- *Construction*. Construction is any activity that involves the provision of new structures, modification or refurbishment. A structure will include a residential dwelling, office building, retail outlet, road, *etc*.

- *Track-out.* This involves the transport of dust and dirt by HDVs from the construction/demolition site onto the public road network, where it may be deposited and then re-suspended by vehicles using the network.

The assessment methodology considers three separate dust impacts:

- Annoyance due to dust soiling.

- The risk of health effects due to an increase in exposure to PM_{10}.

- Harm to ecological receptors

The assessment is used to define appropriate mitigation measures to ensure that there will be no significant effect.

The assessment steps, as they were applied to the mine, are summarised in the following Sections.

E2.1 Step1: Screening

Step 1 is a screening assessment. A construction dust assessment will normally be required where:

- There are human receptors within 350 m of the boundary of the site and/or within 50 m of the route(s) used by construction vehicles on the public highway, up to 500 m from the site entrance(s).

- There are ecological receptors within 50 m of the boundary of the site and/or within 50 m of the route(s) used by construction vehicles on the public highway, up to 500 m from the site entrance(s).

A 'human receptor', refers to any location where a person or property may experience the adverse effects of airborne dust or dust soiling, or exposure to PM_{10} over a time period relevant to air quality standards and goals. In terms of annoyance effects, this will most commonly relate to dwellings, but may also refer to other premises such as buildings housing cultural heritage collections (e.g. museums and galleries), vehicle showrooms, food manufacturers, electronics manufacturers, amenity areas and horticultural operations (e.g. salad or soft-fruit production). An 'ecological receptor' refers to any sensitive habitat affected by dust soiling. This includes the direct impacts on vegetation or aquatic ecosystems of dust deposition, and the indirect impacts on fauna (e.g. on foraging habitats) (IAQM, 2014).

In this screening stage the construction area was assumed to be limited to the Project boundary. It can be seen from Figure E 2: Screening assessment - sensitive receptors near the construction that there are sensitive receptors (project-related residences) within 350 metres of the boundaries of the project boundary.

Little information was available on the ecological sensitivity for the study area. However, it is acknowledged that the marina surrounding Glebe Island is habitat for local aquatic species and as a result, it has been assumed that the receptor sensitivity is medium within 50m of the construction activities

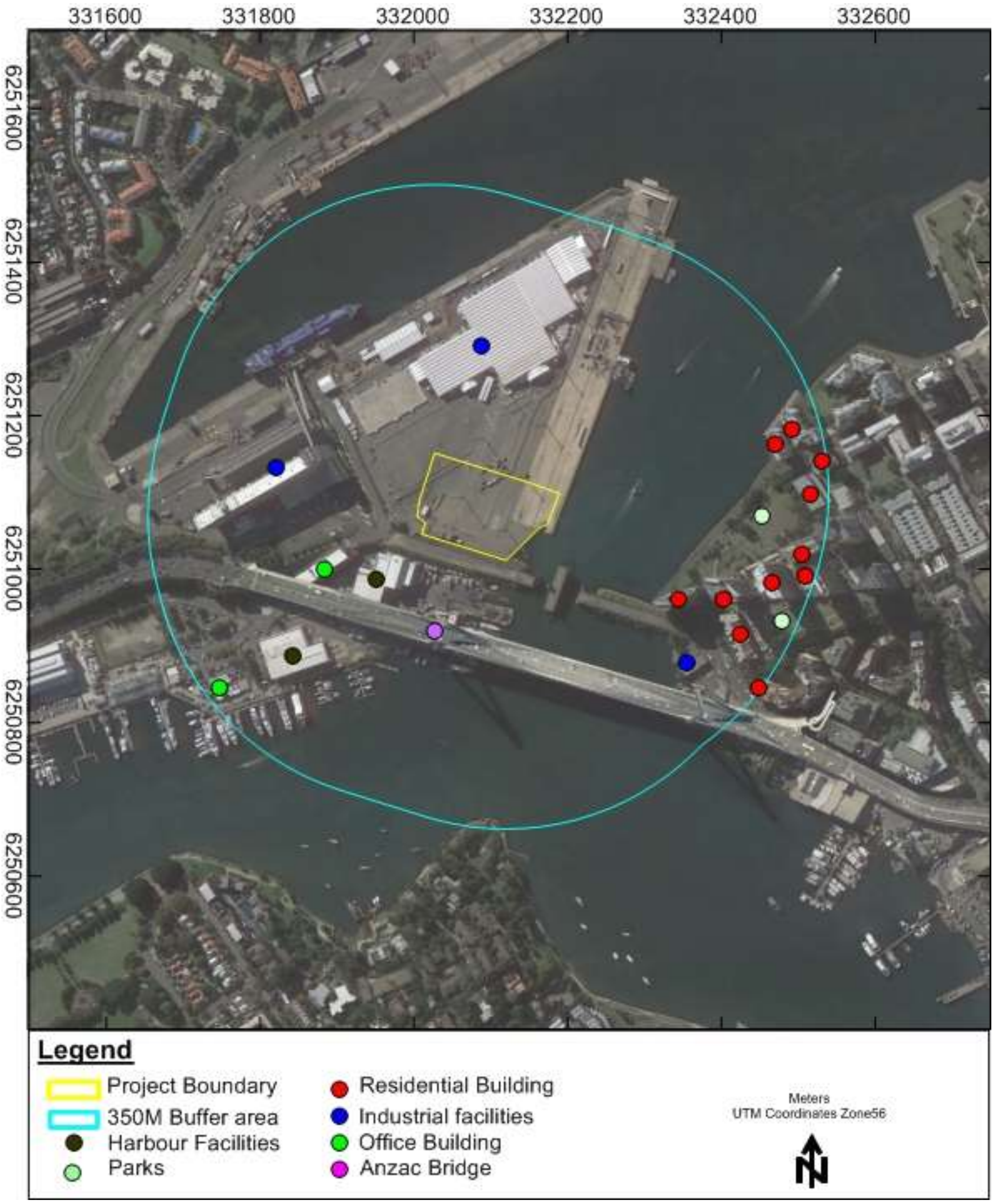


Figure E 2: Screening assessment - sensitive receptors near the construction

Step 2: Risk assessment

In Step 2 the risk of dust arising in sufficient quantities to cause annoyance and/or health effects was determined separately for each scenario and each of the four activities (demolition, earthworks, construction, and track-out). Risk categories were assigned to the site based on two factors:

- The scale and nature of the works, which determines the magnitude of potential dust emissions. This is assessed in Step 2A.
- The sensitivity of the area, including the proximity of sensitive receptors (i.e. the potential for effects). This is assessed in Step 2B.

These factors are combined in Step 2C to give the risk of dust impacts. Risks are categorised as low, medium or high for each of the four separate potential activities. Where there is risk of an impact, then site-specific mitigation will be required in proportion to the level of risk.

E2.2 Step 2A: Potential for dust emissions

The criteria for assessing the potential scale of emissions based on the scale and nature of the works are shown in Table E 1. Based on these criteria and construction assumptions provided, the appropriate categories for the Proposal are shown in Table E 2**.**

Table E 1: Site categories (scale of works) (From IAQM, 2014)

Type of activity	Site category		
	Large	Medium	Small
Demolition	Building volume >50,000 m^3, potentially dusty construction material (e.g. concrete), on-site crushing and screening, demolition activities >20 m above ground level.	Building volume 20,000–50,000 m^3, potentially dusty construction material, demolition activities 10-20 m above ground level.	Building volume <20,000 m^3, construction material with low potential for dust release (e.g. metal cladding, timber), demolition activities <10 m above ground and during wetter months.
Earthworks	Site area >10,000 m^2, potentially dusty soil type (e.g. clay, which will be prone to suspension when dry due to small particle size), >10 heavy earth-moving vehicles active at any one time, formation of bunds>8 m in height, total material moved >100,000 tonnes.	Site area 2,500-10,000 m^2, moderately dusty soil type (e.g. silt), 5-10 heavy earth moving vehicles active at any one time, formation of bunds 4-8 m in height, total material moved 20,000-100,000 tonnes.	Site area <2,500 m^2, soil type with large grain size (e.g. sand), <5 heavy earth moving vehicles active at any one time, formation of bunds <4 m in height, total material moved <20,000 tonnes, earthworks during wetter months.
Construction	Total building volume >100,000 m^3, piling, on site concrete batching; sandblasting	Building volume 25,000-100,000 m^3, potentially dusty construction material (e.g. concrete), piling, on site concrete batching.	Total building volume <25,000 m^3, construction material with low potential for dust release (e.g. metal cladding or timber).
Track-out	>50 HDV (>3.5t) outward movements in any one day, potentially dusty surface material (e.g. high clay content), unpaved road length >100 m.	10-50 HDV (>3.5t) outward movements in any one day, moderately dusty surface material (e.g. high clay content), unpaved road length 50–100 m.	<10 HDV (>3.5t) outward movements in any one day, surface material with low potential for dust release, unpaved road length <50 m.

Table E 2: Site categories for the Proposal

Type of activity	Activity assumptions	Category
Demolition	Advised by client	Low
Earthworks	Advised by client	Medium
Construction	Advised by client	Medium
Track-out	Advised by client	Low

E2.2.1 Step 2B: Sensitivity of area

The sensitivity of the area takes into account the specific sensitivities of local receptors, the proximity and number of the receptors, and the local background PM_{10} concentration. Dust soiling and health impacts are treated separately.

E2.3 Sensitivity of area to dust soiling effects on people and property

The criteria for determining the sensitivity of an area to dust soiling effects are shown in Table E 3.

Table E 3: Criteria for sensitivity of area to dust soiling effects (from IAQM, 2014)

Receptor sensitivity	Number of receptors	Distance from source (m)			
		<20	<50	<100	<350
High	>100	High	High	Medium	Low
	10-100	High	Medium	Low	Low
	1-10	Medium	Low	Low	Low
Medium	>1	Medium	Low	Low	Low
Low	>1	Low	Low	Low	Low

The number of nearby receptors was estimated from site plans (see Figure E 2). The exact counting of the number of 'human receptors' is not required by the IAQM guidance. Instead it is recommended that judgement is used to determine the approximate number of receptors within each distance band. For receptors which are not dwellings professional judgement should be used to determine the number of human receptors.

The numbers of receptors for each scenario and activity, and the resulting outcomes are shown in Table E 4.

Table E 4: Results - sensitivity to dust soiling effects

Activity	Receptor sensitivity	Number of receptors by distance from source				Sensitivity of area
		<20 m	20-50 m	50-100 m	100-350 m	
Demolition	High	0	0	10	1485-	Low
Earthworks	High	0	0	10	1485	Low
Construction	High	0	0	10	1485	Low
Track-out	High	0	0	N/A	N/A	Low

E2.4 Sensitivity of area to human health impacts

The criteria for determining the sensitivity of an area to human health impacts caused by construction dust are shown in Table E 5. Based on the IAQM guidance[2] the receptor sensitivity was assumed to be 'High'. The numbers of receptors for each scenario and activity, and the resulting outcomes are shown in Table E 6.

Table E 5: Criteria for sensitivity of area to health impacts

Receptor sensitivity	Annual mean PM_{10} conc. ($\mu g/m^3$) (a)	Number of receptors	Distance from source (m)				
			<20	<50	<100	<200	<350
High	>24	>100	High	High	High	Medium	Low
		10-100	High	High	Medium	Low	Low
		1-10	High	Medium	Low	Low	Low
	21-24	>100	High	High	Medium	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	High	Medium	Low	Low	Low
	18-21	>100	High	Medium	Low	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	Medium	Low	Low	Low	Low
	<18	>100	Medium	Low	Low	Low	Low
		10-100	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
Medium	-	>10	High	Medium	Low	Low	Low
		1-10	Medium	Low	Low	Low	Low
Low	-	>1	Low	Low	Low	Low	Low

(a) Scaled for Sydney, according to the ratio of NSW and UK annual mean standards (30 $\mu g/m^3$ and 40 $\mu g/m^3$ respectively).

Table B- 1: Results - sensitivity to health impacts

Activity	Receptor sensitivity	Annual mean PM_{10} conc. ($\mu g/m^3$)	Number of receptors by distance from source					Sensitivity of area
			<20 m	20-50 m	50-100 m	100-200 m	100-350 m	
Demolition	High	<18	0	0	10	300	1185	Low
Earthworks	High	<18	0	0	10	300	1185	Low
Construction	High	<18	0	0	10	300	1185	Low
Track-out	High	<18	0	0	n/a	n/a	n/a	Low

[2] The sensitivity of people to the health effects of PM10 is based on exposure to elevated concentrations over a 24-hour period. High sensitivity receptors relate to locations where members of the public are exposed over a time period relevant to the air quality objective for PM10 (in the case of the 24-hour objectives, a relevant location would be one where individuals may be exposed for eight hours or more in a day). Indicative examples include residential properties. Hospitals, schools and residential care homes should also be considered as having equal sensitivity to residential areas for the purposes of this assessment.

E2.5 Sensitivity of ecological impacts

The criteria for determining the sensitivity of an area to ecological impacts caused by construction dust are shown in Table E 6. Based on the IAQM guidance[3] the receptor sensitivity was assumed to be 'Medium'. The distance of the receptors for each scenario and activity, and the resulting outcomes are shown in Table E 7.

Table E 6: Criteria for sensitivity of ecological impacts

Receptor Sensitivity	Distance from source (m)	
	<20	20-50
High	High	Medium
Medium	Medium	Low
Low	Low	Low

Table E 7: Results - sensitivity to ecological impacts

Type of activity	Receptor Sensitivity	Distance from Source (m)	Sensitivity
Demolition	Medium	<20	Medium
Medium	Medium	<20	Medium
Low	Medium	<20	Medium
Track-out	Medium	<20	Medium

E3 Risk of dust impacts

The dust emission potential determined in Step 2A is combined with the sensitivity of the area determined in Step 2B to give the risk of impacts with no mitigation applied. The criteria are shown in Table E 8.

[3] Professional judgement is used to identify where on the spectrum between high and low sensitivity a receptor lies. Medium sensitivity receptors are found in locations where there may be important species, where dust sensitivity is uncertain or unknown.

Table E 8: Criteria for sensitivity of area to health impacts (from IAQM, 2014)

Type of activity	Sensitivity of area	Dust emission potential		
		Large	Medium	Small
Demolition	High	High Risk	Medium Risk	Medium Risk
	Medium	High Risk	Medium Risk	Low Risk
	Low	Medium Risk	Low Risk	Negligible
Earthworks	High	High Risk	Medium Risk	Low Risk
	Medium	Medium Risk	Medium Risk	Low Risk
	Low	Low Risk	Low Risk	Negligible
Construction	High	High Risk	Medium Risk	Low Risk
	Medium	Medium Risk	Medium Risk	Low Risk
	Low	Low Risk	Low Risk	Negligible
Track-out	High	High Risk	Medium Risk	Low Risk
	Medium	Medium Risk	Low Risk	Negligible
	Low	Low Risk	Low Risk	Negligible

E4 Final results

The results for the construction risk assessment are provided in Table E 9. Overall the assessment is classified as “low risk”. Where the demolition and earthworks activities are categorized as “negligible”, while the construction and track out activities are considered as ‘low risk’

Table E 9: Summary of risk assessment for the Project

Type of activity	Step 2a: Potential for dust emissions	Step 2b: Sensitivity of area			Step 2c: Risk of dust impacts		
		Dust soiling	Human health	Ecological	Dust soiling	Human health	Ecological
Demolition	Small	Low	Low	Medium	Negligible	Negligible	Low
Earthworks	Small	Low	Low	Medium	Negligible	Negligible	Low
Construction	Medium	Low	Low	Medium	Low	Low	Medium
Track-out	Medium	Low	Low	Medium	Low	Low	Low