BaT project

Chapter 10
Air quality

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10. Air quality

The purpose of this chapter is to assess the potential air quality impacts from the Project. It provides an overview of existing air quality and meteorology, the emission sources during construction and operation of the Project, and assesses the potential for impacts on sensitive receptors. Strategies to manage potential impacts are also recommended, where required.

This chapter addresses section 11.4 to section 11.7 of the Terms of Reference (ToR).

This chapter summarises the key findings of the air quality impact assessment undertaken for the Project. The more detailed assessment report can be found in **Technical Report 2 – Air quality**.

10.1 Methodology

The chapter assesses the potential air quality impacts within the study corridor as described in **Chapter 1 – Introduction**.

The methodology used to undertake the air quality assessment involved:

- identifying the emissions to air during construction and operation
- reviewing the Australian air quality legislation including the *Environmental Protection (Air) Policy 2008* and National Environment Protection Measure (NEPM) for Ambient Air Quality
- describing the dispersion meteorology of the study area by reviewing meteorological data from the Bureau of Meteorology (BoM) and developing wind fields using air quality modelling tools (e.g. TAPM and CALMET)
- describing the existing air quality environment by identifying the major sources of air emissions and reviewing air quality data from Department of Environment and Heritage Protection (DEHP)
- estimating dust emissions from each worksite by combining information on the proposed construction activities with National Pollutant Inventory (NPI) emission factors
- estimating ventilation outlet emissions from each portal and station sites
- modelling construction and operational emissions with the air dispersion model known as CALPUFF and comparing results with the ambient air quality guidelines and other relevant objectives
- describing potential air quality impacts resulting from construction and operation of the Project
- identifying suitable mitigation measures to minimise or avoid potential air quality impacts.

10.2 Legislative and policy framework

The *Environmental Protection Act 1994* (EP Act) provides for the management of the air environment in Queensland. Air quality objectives are specified by the DEHP in the Queensland Environmental Protection (Air) Policy 2008 (EPP (Air)). The purpose of the EPP (Air) is to protect the air quality environment for human health and wellbeing, the health and biodiversity of ecosystems, the aesthetics of the environment and for agricultural use.

The air quality objectives in the EPP (Air) relevant to the Project are presented in **Table 10-1**.

Table 10-1 Air quality objectives relevant to the Project

Pollutant	Air quality objective	Averaging period	Allowable exceedances
Total Suspended Particulates (TSP)	90µg/m^3	Annual	Nil
Particulates as PM_{10} (<10µm)	50µg/m^3	24 hours	5 per year
Particulates as $PM_{2.5}$ (<2.5µm)	25µg/m^3	24 hours	Nil
	8µg/m^3	Annual	Nil
Nitrogen dioxide (NO_2)	250µg/m^3	1 hour	1 day each year
	62µg/m^3	1 year	Nil
Carbon monoxide (CO)	11,000µg/m^3	8 hours	1 day each year

The National Environment Protection Measure (NEPM) for Ambient Air Quality was released in 2003 by the National Environment Protection Council (NEPC, 2003). The NEPM sets national standards for the six key air pollutants; carbon monoxide, ozone, sulphur dioxide, nitrogen dioxide, lead and particles. The EPP (Air) has adopted the NEPM (Air) standards as air quality objectives.

The NEPM also provides advisory reporting standards for $PM_{2.5}$. These are 25µg/m^3 for a maximum 24 hour average period and 8µg/m^3 as an annual averaging period. Both of these standards are consistent with the objectives for $PM_{2.5}$ set out in the EPP (Air).

During construction the generation of dust can result in an increase in concentration and deposition of coarse particulates (>10 µm), which have the potential to cause nuisance or amenity impacts. The EPP(Air) does not provide specific objectives for the nuisance impact of particulates. The following objectives are adopted for the management of potential nuisance impacts for the Project:

- dust deposition rate of 4 g/m^2/30 days or 130 mg/m^2/day averaged over a 30 day period[1]
- TSP concentration of 90 µg/m^3 (annual average) (EPP (Air)).

10.3 Existing environment

10.3.1 Regional air quality

The air quality of the study corridor is influenced by both regional and local air pollution sources. The ambient air quality within the study corridor has been described with consideration of:

- the regional influences on air quality in South East Queensland
- ambient air quality data recorded by the DEHP and other available sources
- localised sources of air emissions in the study corridor
- background air quality levels for the study corridor.

[1] Adopted from DEHP guidance for the management of coal dust - http://www.ehp.qld.gov.au/management/coal-dust/index.html.

Regional influences on air quality

In 2004 the then Queensland Environmental Protection Agency (EPA) and Brisbane City Council prepared an air emissions inventory for South East Queensland and identified the following key regional influences on air quality:

- particulate matter from dust storms (infrequent)
- particulate matter from bushfires and controlled burns (occurs once or twice per year in cooler months). Vehicle exhausts emissions including nitrogen oxide (NO_x), PM_{10}, $PM_{2.5}$, CO and sulphur dioxide (SO_2)
- the main source of SO_2 in the air is industrial activity that processes materials containing sulphur (e.g. petroleum refineries). It is also present in motor vehicle emissions. However, since the introduction of national fuel quality standards in 2002, 2008 and 2009 which reduced the maximum allowable sulphur content in fuel, emissions of SO_2 from vehicles are no longer a concern in Australia and have not been addressed further in this assessment.biogenic emissions of volatile organic compounds (VOCs) which can be a precursor to the formation of photochemical smog.

The air quality in the study corridor was described by analysing monitoring data collected by the DEHP (formerly known as EPA) at the Brisbane Central Business District (CBD) (Queensland University of Technology (QUT) Gardens Point), South Brisbane, Woolloongabba and Rocklea (refer **Figure 10-6**).

Brisbane CBD Queensland University of Technology monitoring station

The Brisbane CBD Queensland University of Technology (QUT) monitoring station is located in an elevated position at the QUT Gardens Point campus. The site measures PM_{10} concentrations and meteorological data. Statistics for daily PM_{10} concentrations from 2008 to 2012 are summarised in **Table 10-2**. PM_{10} concentrations recorded at the station were below the air quality goal of less than five exceedances per year of the daily concentration of 50µg/m^3, except in 2009 when major regional dust storms resulted in seven exceedances.

Table 10-2 Ambient air quality monitoring data at Brisbane CBD (QUT), 2008-2012

Pollutant	Air quality objective	Averaging period	Pollutant concentrations (µg/m^3)				
			Average	70th percentile	95th percentile	99th percentile	Maximum
PM_{10}	50µg/m^3	24 hours	18	19	33	57	6,459 (10)

Data in parenthesis represent the number of exceedances of the objectives during the five year period.

South Brisbane monitoring station

The South Brisbane monitoring station is located nearby the Pacific Motorway between Vulture Street and Stanley Street in Woolloongabba. The site measures PM_{10}, $PM_{2.5}$, CO and NO_2 concentrations and meteorological data. Summary statistics for air quality monitoring data from the South Brisbane monitoring station from 2008 to 2014 are provided in **Table 10-3**.

Table 10-3 Ambient air quality monitoring data at South Brisbane, 2008-2012

Pollutant	Air quality objective	Averaging period	Pollutant concentrations (µg/m³)				
			Average	70th percentile	95th percentile	99th percentile	Maximum
PM_{10}	50µg/m³	24 hours	19	20	31	54	5,969 (18)
$PM_{2.5}$	25µg/m³	24 hours	7.8	8.6	15	21	59 (4)
CO	11,000µg/m³	8 hours	240	260	640	1,240	2,070
NO_2	250µg/m³	1 hour	30	38	59	73	100

Data in parenthesis represent the number of exceedances of the objectives during the five year period.

Rocklea monitoring station

The Rocklea monitoring station was established in 1978 and is located in an open area surrounded by industry and residential uses. The Rocklea monitoring station measures PM_{10}, $PM_{2.5}$, nitrogen dioxide (NO_2), ozone (O_3) and meteorological data. Air quality monitoring data from Rocklea monitoring station from 2008 to 2012 are summarised in **Table 10-4**.

Measurement data recorded at the Rocklea station are below the air quality goals for PM_{10} and NO_2 concentrations, except in 2009 when major dust storms resulted in ten exceedances of the PM_{10} goal of 50µg/m³. Exceedances of the 24 hour ambient air quality goal for $PM_{2.5}$ were recorded in 2008 and 2009. The annual goal for $PM_{2.5}$ was exceeded on eight occasions in 2009 due to major dust storms.

Table 10-4 Ambient air quality monitoring data at Rocklea, 2008-2012

Pollutant	Air quality objective	Averaging period	Pollutant concentrations (µg/m³)				
			Average	70th percentile	95th percentile	99th percentile	Maximum
PM_{10}	50µg/m³	24 hours	18	20	33	51	455 (11)
$PM_{2.5}$	25µg/m³	24 hours	7.8	9	26	24	159
NO_2	250µg/m³	1 hour	15	19	39	55	96 (11)

Data in parenthesis represent the number of exceedances of the objectives during the five year period.

Woolloongabba monitoring station

The Woolloongabba monitoring station has been operating since 1998 and is situated very close to the kerb of a busy main road to monitor air pollution from traffic sources. Measurement data at this station is heavily influenced by traffic emissions and above what may be classified as representative of the general urban background. In addition, the station is situated next to the side of a building which may cause discrepancies in measured winds and air quality monitoring data. Data from this station have therefore not been included in the estimation of background for the Project. Air quality monitoring data from the Woolloongabba monitoring station from 2008 to 2012 are summarised in **Table 10-5**.

Table 10-5 Ambient air quality monitoring data at Woolloongabba, 2008-2012

Pollutant	Air Quality Objective	Averaging Period	Pollutant concentrations (µg/m^3)				
			Average	70th percentile	95th percentile	99th percentile	Maximum
PM_{10}	50µg/m^3	24 hours	16	19	33	35	851 (11)
$PM_{2.5}$	25µg/m^3	24 hours	8.4	9.5	15.4	21.2	110 (11)
CO	10,000µg/m^3	8 hours	280	336	964	1,355	3,375
NO_2	250µg/m^3	1 hour	34	41	65	82	137

10.3.2 Local air quality

This section identifies air emissions within the study corridor and establishes background air quality levels for the air quality impact assessment. Localised air emissions sources in the study corridor include:

- motor vehicle emissions from major roads including the Inner City Bypass, Lutwyche Road, Riverside Expressway, the Pacific Motorway and Ipswich Road
- transport infrastructure
- local construction activities.

Due to the absence of major industrial activity within or near to the study corridor, the regional air quality monitoring data has been used to establish the local background air quality. The adopted background air quality concentrations for the study corridor are provided in **Table 10-6**.

A 70th percentile concentration as measured across the regional air quality monitoring stations is adopted for the assessment of background air quality. This approach is consistent with the approach suggested by the Victorian EPA (VEPA), where the 70th percentile of background data is used to determine the potential for the relevant assessment objectives to be exceeded (VEPA 2006). This VEPA approach has been adopted due to a lack of a DEHP approach to determine an assessment concentration. For the assessment of annual average model predictions, the background levels were based on annual average measurement data.

The adopted background air quality concentrations in **Table 10-6** are considered conservative levels. That is, on most days in most parts of the study corridor, concentrations would be expected to be lower than these values.

Table 10-6 Adopted background air quality concentrations

Pollutant	Averaging period	Air quality objective	Adopted background concentration
TSP	1 year	90µg/m^3	36µg/m^3
PM_{10}	24 hours	50µg/m^3	20µg/m^3
$PM_{2.5}$	24 hours	25µg/m^3	9µg/m^3
	1 year	8µg/m^3	7.8µg/m^3
Dust deposition	1 year	130mg/m^2/day	60mg/m^2/day
NO_2	1 hour	250µg/m^3	19µg/m^3
	1 year	62µg/m^3	15µg/m^3
CO	8 hours	11,000µg/m^3	260µg/m^3

10.3.3 Meteorology

The dispersion of air emissions following release from a source varies depending on the local terrain, surrounding built environment and prevailing meteorological conditions. This assessment has considered the existing meteorology and climatic data as recorded by two BoM meteorological monitoring stations at:

- Brisbane Airport (located 10km to the north-east of the northern section of the study corridor)
- Archerfield Airport (located 3km to the south-west of the southern section of the study corridor).

The two BoM meteorological monitoring stations were selected because:

- both had automatic weather stations installed which record meteorological data every minute
- the locations covered the extents of the modelling domain
- they are sited in accordance with AS 3580.14-2011 - Meteorological monitoring for ambient air quality monitoring applications.

The locations of these meteorological stations, as well as air quality monitoring stations are presented in **Figure 10-6**.

Existing meteorological conditions (Brisbane airport)

The Brisbane Airport meteorological station is located approximately 12km northeast of the Northern Connection. Wind patterns for the Brisbane Airport for 2009 to 2013 are shown in **Figure 10-1**. The key Project related aspects of the dispersion meteorology at Brisbane Airport are:

- the dominant wind directions throughout the year are from the south-west/south-southwest and north/ north-northeast
- winds during summer are predominantly from the east-southeast and the north-northeast with an average wind speed of 4.1m/s
- winds during autumn and winter are predominantly from the south-west/ south-southwest with an average wind speed of 3.8m/s in autumn winter
- winds during spring are predominantly from the north/north-northeast with an average wind speed of 4.6m/s
- strong winds are most frequent from the north and north-northeast during spring and summer
- calm conditions (wind speed less than 0.5m/s) occur 1.6 per cent of the year and are most common during winter (1.7 per cent).

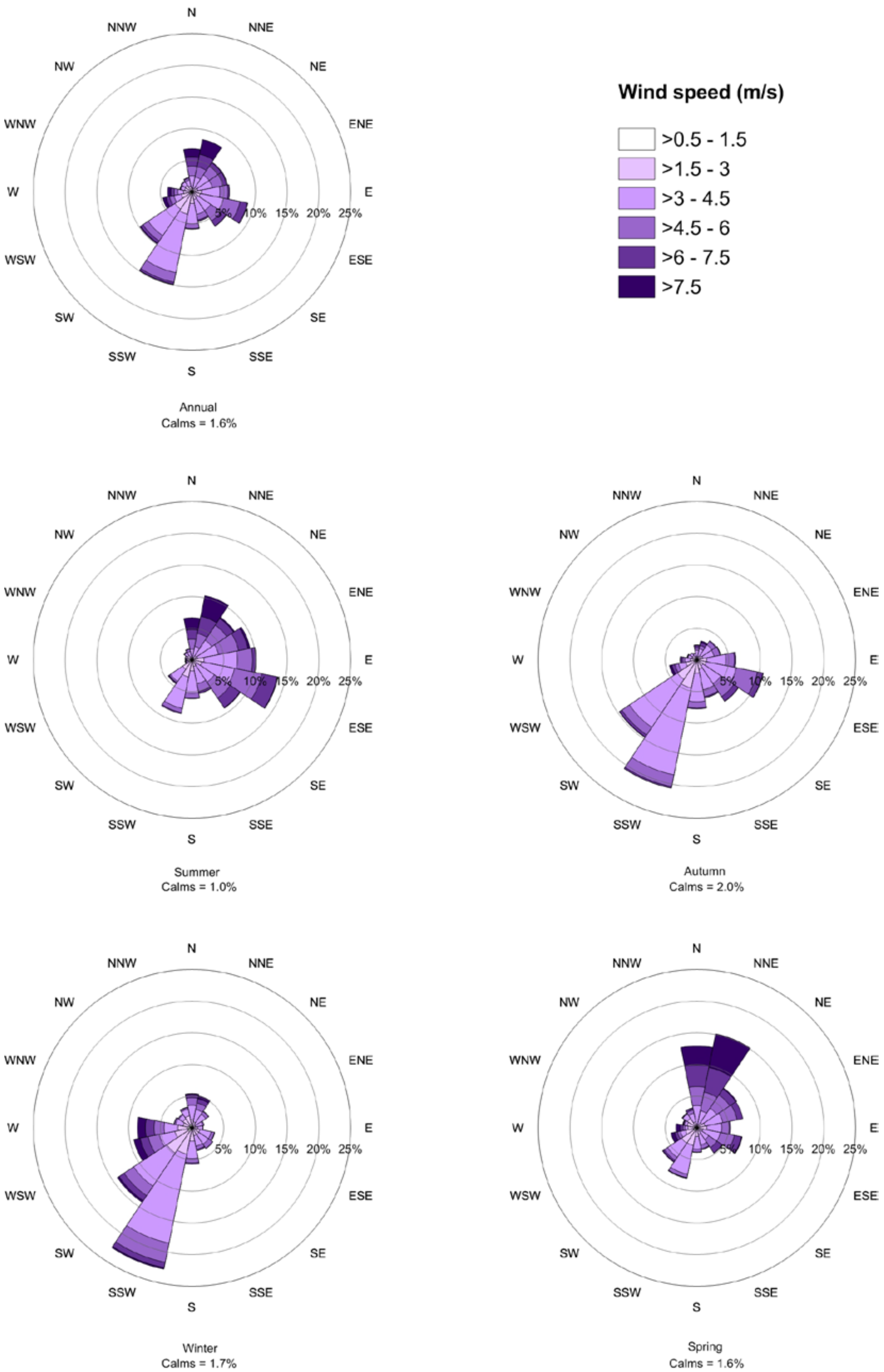
Table 10-7 provides a summary of the temperature, humidity and rainfall data for the Brisbane Airport meteorological station from 1994 to 2014.

Brisbane Airport typically has warm days during summer with average maximum daytime temperatures around 29°C in January and February, falling to 21°C in June and July. Temperatures overnight are mild during summer and cool during the winter months, with average minimum daily temperatures of 9°C in July, rising to 21°C in January and February. The highest rainfall is generally recorded during summer months with monthly rain averaging above 90mm/ month from November to February and also in May. Mean monthly rainfall is low from July to September with average monthly rainfall less than 40mm.

Table 10-7 Climatic data for Brisbane Airport, 1994-2014

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Mean daily maximum temperature (°C)	29	29	28	26	24	21	21	22	24	25	27	28	25
Mean daily minimum temperature (°C)	21	21	19	16	13	11	9	10	13	16	18	20	16
Mean rainfall (mm)	139	126	100	79	107	69	31	39	33	76	96	131	1016
Number of rain days	13	13	13	11	10	9	7	5	6	9	11	12	118
Mean 9am air temp (°C)	26	26	25	22	19	16	15	17	21	23	24	26	22
Mean 9am relative humidity (%)	66	68	67	67	68	70	65	60	59	59	62	64	65
Mean 3pm air temp (°C)	27	28	26	25	22	20	20	20	23	24	25	27	24
Mean 3pm relative humidity (%)	63	63	61	58	56	55	50	50	55	58	61	62	58

Figure 10-1 Annual and seasonal windroses for Brisbane Airport, 2009-2013



Existing meteorological conditions (Archerfield airport)

The Archerfield Airport meteorological station is located 8km to the south-west of the Southern Connection and is representative of conditions in the southern part of the study corridor. Wind patterns for Archerfield Airport form 2009 to 2013 are shown in **Figure 10-2**. The key features of the dispersion meteorology at Archerfield Airport are:

- the dominant wind directions throughout the year are from the south, east-southeast and north-northeast
- winds during summer are predominantly from the east-southeast and the north-northeast with an average wind speed of 4.0m/s
- winds during autumn and winter are predominantly from the south-southwest/ southwest with an average wind speed of 3.1m/s in autumn and 3m/s in winter
- winds during spring are predominantly from the north/ north-northeast with an average wind speed of 3.7m/s
- strong winds are most frequent from the north and north-northeast during spring and summer although strong westerly winds occur during winter
- calm conditions (wind speed less than 0.5m/s) occur 10.2 per cent of the year and are most common during winter (12.6 per cent).

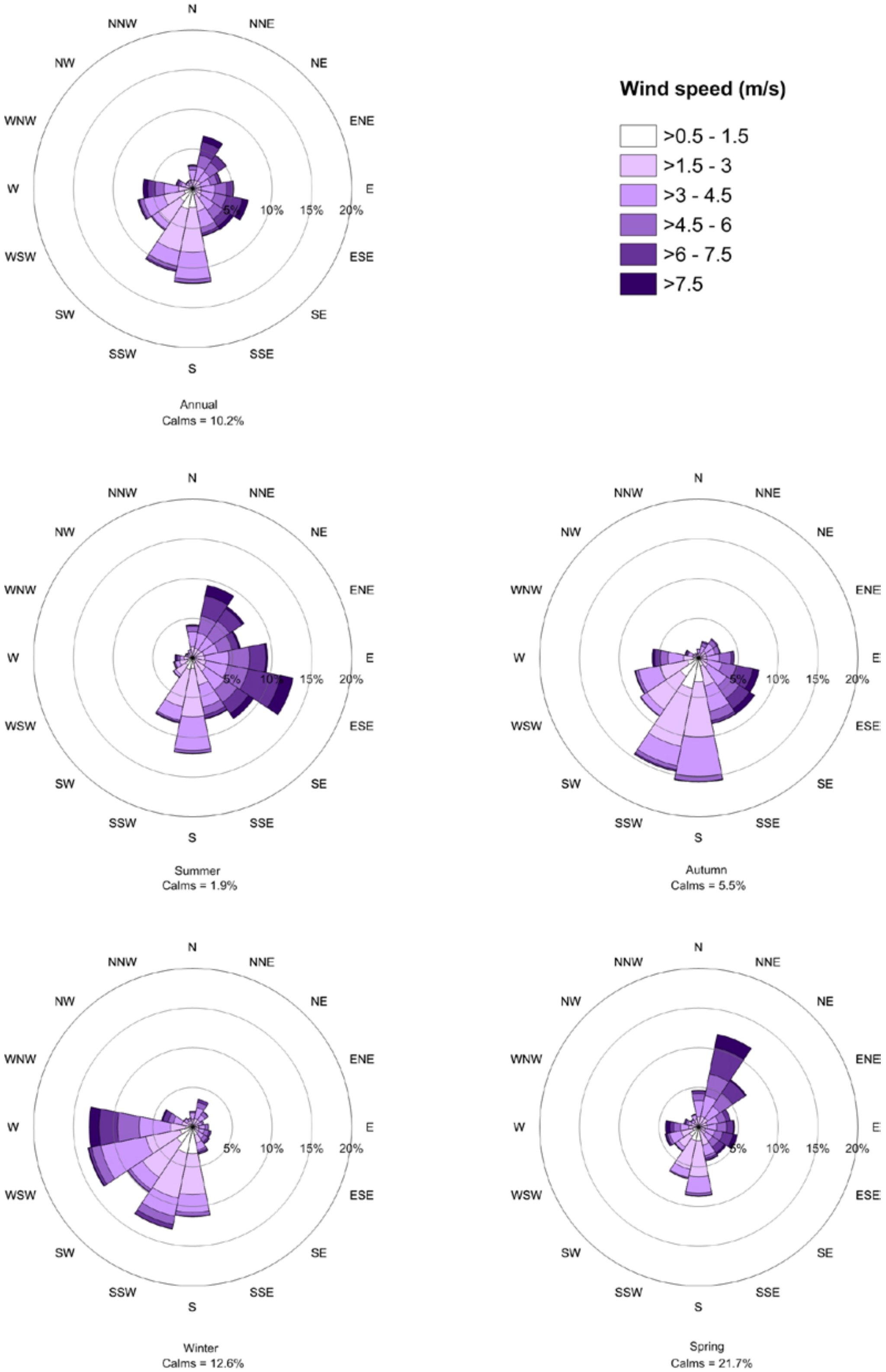
Table 10-8 provides a summary of the temperature, humidity and rainfall data for the Archerfield Airport meteorological station from 1939 to 2013.

Archerfield Airport typically has warm days during summer with average maximum daytime temperatures around 30°C in January and February falling to 21°C in June and July. Overnight temperatures are mild during summer and cool during the winter months, with average minimum daily temperatures of 8°C in July, rising to almost 20°C in January and February.

Table 10-8 Climatic data for Archerfield Airport, 1939-2013

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Mean daily maximum temperature (°C)	30	30	29	26	24	21	21	23	25	27	28	30	26
Mean daily minimum temperature (°C)	20	20	18	15	12	9	8	8	11	14	17	19	14
Mean rainfall (mm)	138	153	124	81	74	66	49	37	36	78	100	127	1064
Number of rain days	11	12	13	10	9	7	6	6	6	9	10	11	110
Mean 9am air temp (°C)	26	25	24	21	17	14	13	15	19	22	24	25	20
Mean 9am relative humidity (%)	66	70	70	71	74	74	71	67	62	60	61	64	67
Mean 3pm air temp (°C)	29	28	27	25	23	21	20	21	24	25	26	28	25
Mean 3pm relative humidity (%)	55	58	56	54	53	51	45	43	45	50	53	54	51

Figure 10-2 Annual and seasonal wind roses for Archerfield 2009 to 2013



Dispersion modelling meteorology

A three dimensional meteorological field was required for the air dispersion modelling that includes a wind field generator accounting for slope flows, terrain effects and terrain blocking effects . CALMET produces fields of wind components, air temperature, relative humidity, mixing height and other micro-meteorological variables for each hour of the modelling period. In the absence of site specific meteorological data for the project site, provided three years of meteorological datasets (2011, 2012 and 2013) were prepared using the CALMET meteorological model and compared to the Bureau of Meteorology observations for selection of the year representative of local conditions and to provide further information on the local meteorological influences. The comparison demonstrated that there is little variation in wind patterns from year to year. The 2012 dataset from the CALMET model was selected. Details of the modelling approach and dataset are provided **Technical Report 2 – Air quality**. Outputs from the CALMET derived meteorological dataset for the Project adopted to describe the local meteorology are wind speed and wind direction; mixing height; stability class.

Wind speed and direction

The annual and seasonal wind roses for the CALMET derived dataset for 2012 are provided in **Figure 10-4**. The wind roses for the dataset show the prevailing winds for the Project location as south-east to south-west during the autumn and winter months and northeast to southeast during summer and spring which are consistent with the data measured at the Brisbane Airport and Archerfield Airport BoM stations. In addition, the strongest wind speeds (i.e. >4.5m/s) are from the south to south-east direction.

Mixing height

Mixing height is the depth of the atmospheric surface layer beneath an elevated temperature inversion. Vertical diffusion or mixing of a plume is generally limited by the mixing height, as the air above this layer tends to be stable, with restricted vertical motion.

The diurnal variation of mixing height is summarised in **Figure 10-3**. On average, mixing heights are lower during the night and early morning hours (<500m), increasing after sunrise to a maximum of 2,100m by mid-afternoon and generally decreasing sharply with sunset.

Figure 10-3 Diurnal variation in mixing height for the CALMET derived data

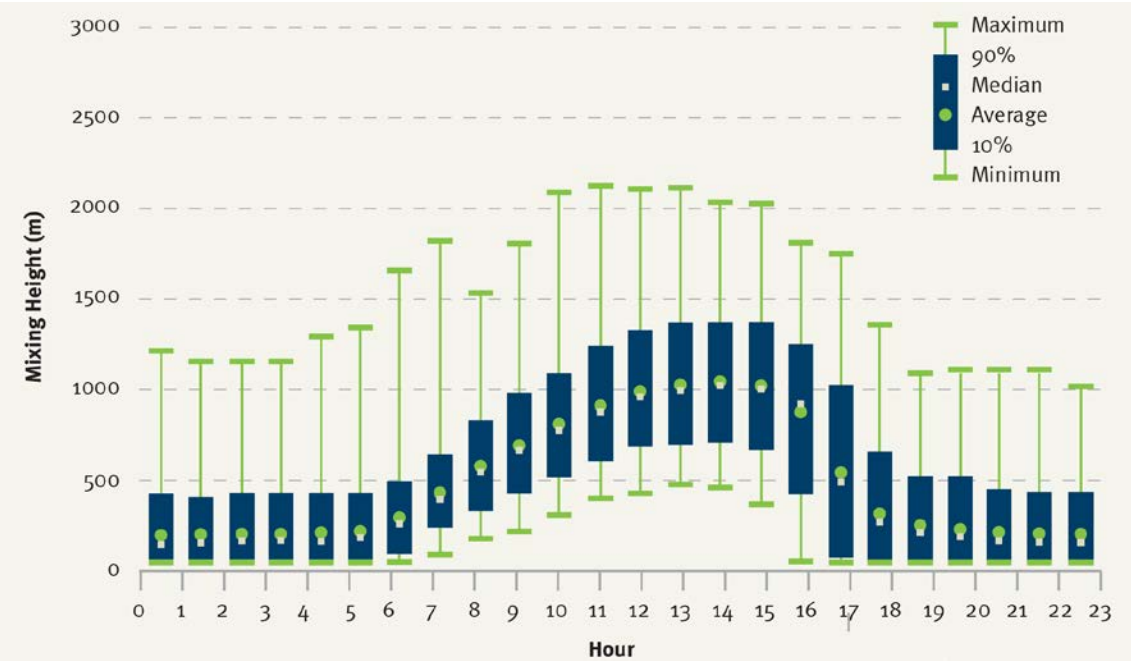


Figure 10-4 Annual and seasonal windroses for CALMET derived dataset for 2012

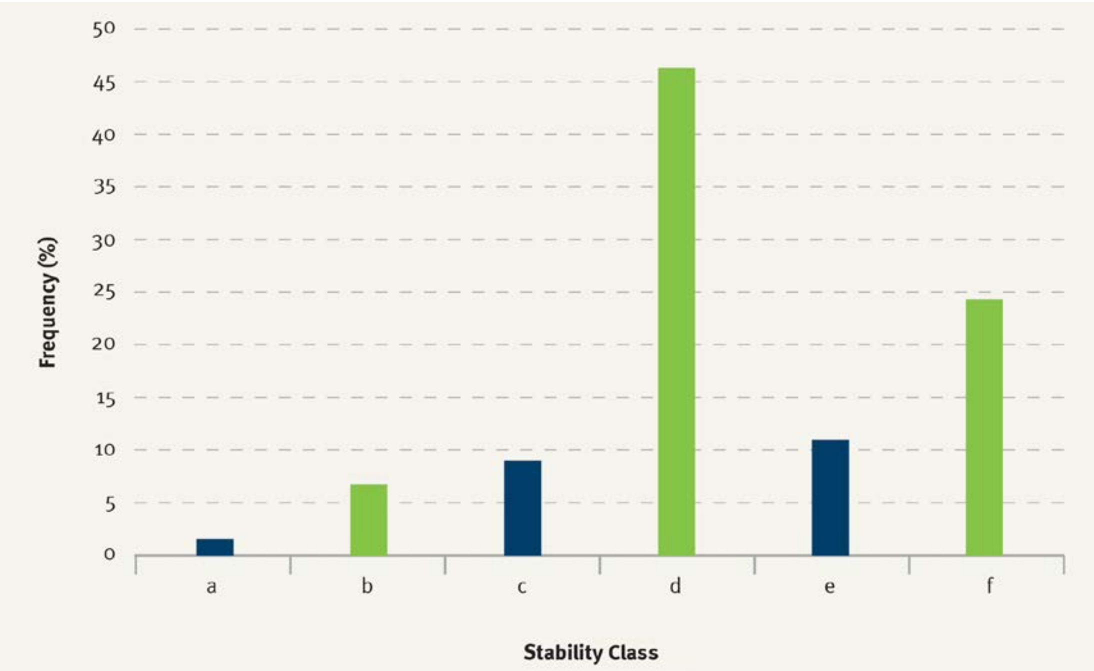
Stability class

The Pasquill-Gifford stability classification scheme denotes six stability classes from A to F. Class A is described as highly unstable and occurs during the day in association with strong surface heating and light winds, leading to intense convective turbulence and much enhanced plume dilution. At the other extreme, class F denotes very stable conditions associated with strong temperature inversions and light winds, which commonly occur under clear skies at night and in the early morning. Intermediate stability classes grade from moderately unstable (B), through neutral (D) to slightly stable (E). Whilst classes A and F are strongly associated with clear skies, class D is linked to windy and/or cloudy weather, and short periods around sunset and sunrise when surface heating or cooling is small.

As a general rule, unstable (or convective) conditions dominate during the daytime and stable flows are dominant at night. This diurnal pattern is most pronounced when there is relatively little cloud cover and light to moderate winds.

The stability class percentages from the CALMET derived meteorological data for the Project is shown in **Figure 10-5**. Neutral to stable atmospheric conditions associated with light to moderate winds are shown by the high percentage of D (46 per cent) and F classes (24 per cent). These stability class percentages are consistent with expectations for the Project location.

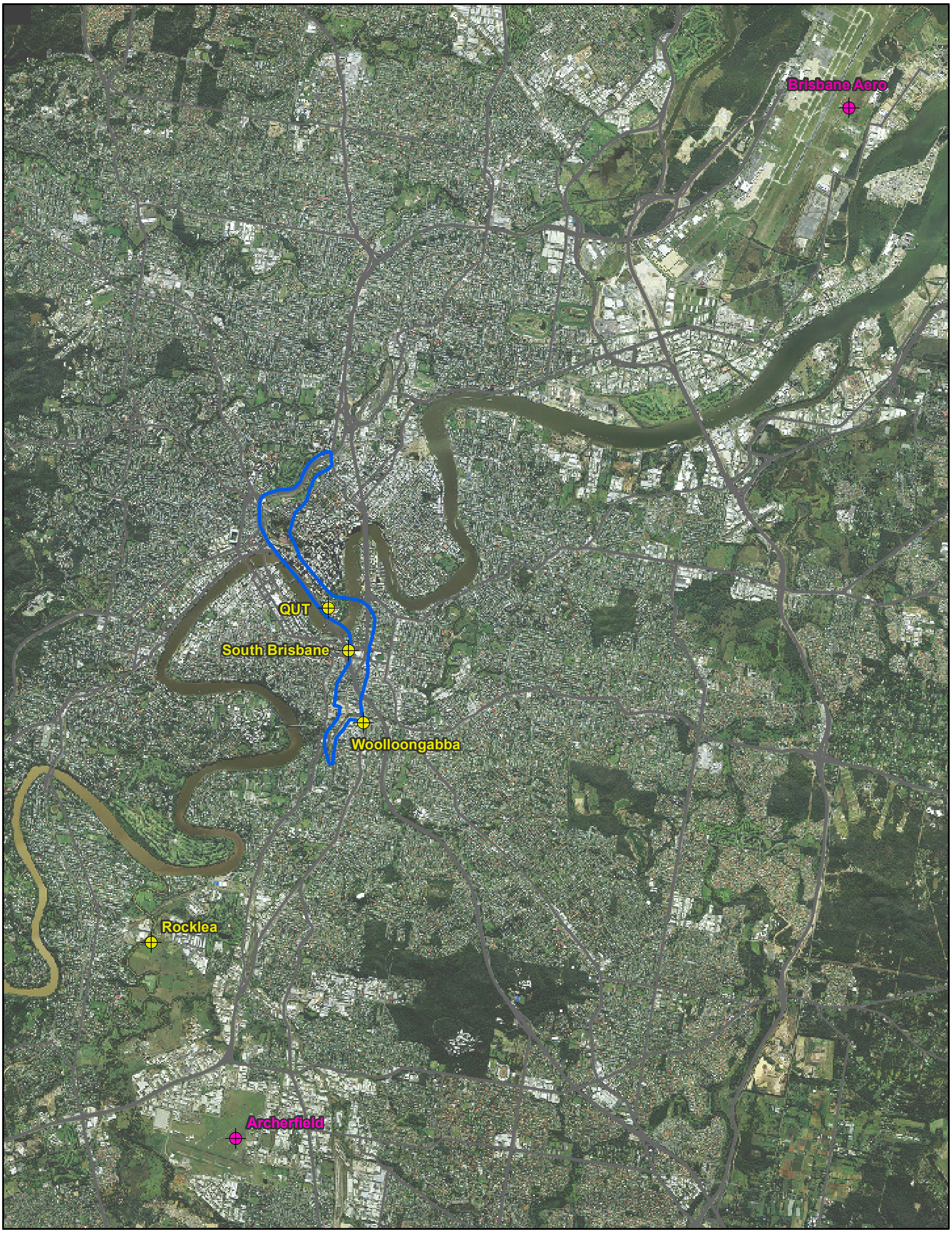
Figure 10-5 Stability class parameters for CALMET derived data



10.3.4 Terrain and land use

Terrain information was extracted from the NASA Shuttle Research Topography Mission (SRTM) database, which has global coverage at approximately 90m resolution. Land use data were extracted from aerial imagery.

The impact of building wake effects on plume dispersion has also been included in the modelling for buildings and structures located around the work sites in the vicinity of the ventilation outlets. The heights and locations of these structures were entered into the Building Profile Input Program (BPIP) utility. The wind direction-specific building widths and heights calculated by BPIP for each ventilation outlet were then entered into the CALPUFF model.



LEGEND

- BoM meteorological station
- DEHP monitoring station
- Highway/main road
- Study corridor

Aerial Photo: AusImage 2009

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 10-6

Locations of BoM meteorological stations and DEHP monitoring stations

N

0 1 2
Kilometres
1:100,000 (at A4)
Projection: GDA 1994 MGA56

G:\QENV2\Projects\QE06863\Spatial\ArcGIS\Figures\Final_EIS_Figures\10_AirQuality\AirQuality_Figure10-6_BOM_Meteorological_Stations.mxd Date: 12/08/2014

10.4 Impact assessment

This section summarises the model predictions (inclusive of background) at the nearest or most affected sensitive receptors from the Project's construction and operational emissions.

Air quality impacts were modelled using the CALPUFF (version 6.42) air dispersion model. It is the preferred model of the United States Environmental Protection Agency for the long-range transport of pollutants and for complex terrain (TRC 2007).

The results of the modelling are provided for the worst affected (or greatest predictions) of the sensitive receptors in each direction. In addition, particularly sensitive receptors such as hospitals and schools were also included. Where relevant, a selection of sensitive receptors closest to the ventilation outlets at George Street Station and Roma Street Station were modelled at different heights above ground (e.g. 10m, 20m, 30m, 40m and 50m) representing apartments or workplaces within tall buildings.

The purpose of the EPP (Air) is to protect the air quality environment for human health and wellbeing, the health and biodiversity of ecosystems, the aesthetics of the environment and for agricultural use. To determine the potential impacts to health and amenity, the combined pollutant levels of background and the Project (cumulative impacts) have been compared with the air quality objectives of EPP (Air).

Contour plots showing the spatial distribution of impacts from the construction emissions are displayed in **Figure 10-7** to **Figure 10-21**. The figures present the results of modelling at a general grid spacing, with the levels between each grid spacing being determined through interpolation. Whilst the figures provide useful information as to the overall dispersion patterns, some caution should be used when interpreting results from the contour mapping at specific locations. The assessment has been based on upon modelling results at specific receptor locations (i.e. **Table 10-14** to **Table 10-21**).

For operational emissions, the contribution from the Project is very low compared to background and the relevant air quality objectives. Consequently, contour plots were not developed.

10.4.1 Construction

The major components of construction that may generate emissions to air include:

- worksite establishment and demolition activities
- tunnelling activities and associated excavation
- shaft excavation
- spoil removal
- surface road and bridge works
- emissions from construction equipment, generators and other plant equipment.

As a result, the pollutants of interest from the construction phase of the Project are:

- Total Suspended Particulate (TSP)
- Particulate Matter 10 (PM_{10})
- deposited dust.

Deposited dust and TSP have the potential to cause nuisance impacts, rather than impacts on human health. Dust emissions from construction vary with the intensity of construction activity.

Two scenarios have been modelled in the assessment based on the maximum anticipated activity:

- Scenario 1 – where primary excavation activities would be performed by excavators, rock hammers, front end loaders and piling rigs. This scenario was modelled for all stations.
- Scenario 2 – included the general activities from Scenario 1, plus drill and blast activities for primary excavation. This scenario was modelled for Woolloongabba Station, George Street Station and Roma Street Station.

Dust emission rates from these 'worst-case' scenarios have been calculated for each worksite based upon forecast maximum activities (i.e. multiple activities operating concurrently across the site). Emission rates were estimated using factors from the 'Emission Estimation Technique Manual for Mining version 3.1' (NPI, 2012) due to the similarity of tunnelling and surface earthworks to that of mining activities. The uncontrolled emission factors used in this assessment are provided in **Table 10-9.**

Table 10-9 Uncontrolled emissions factors used in the construction assessment

Construction activity	Unit	TSP	PM_{10}
Base Case			
Excavators/FEL on spoil	kg/tonne	0.025	0.0012
Bulldozers on spoil/excavated material	kg/hour	1.63	0.33
Wheel generated dust	kg/vkt	4.23	1.26
Wind erosion	kg/ha/hour	0.4	0.2
Loading trucks	kg/tonne	1 x 10-4	5 x 10-5
Unloading trucks (deliveries)	kg/tonne	1 x 10-4	5 x 10-5
Rock breakers	kg/tonne	1.63	0.33
Piling rigs	kg/tonne	1.63	0.33
Scenario 2			
Drilling	kg/hole	0.59	0.31
Blasting	kg/blast	0.22	0.11

Source: NPI, 2012

Preliminary modelling of air quality impacts (with basic mitigation only) at a selection of work sites indicated impacts from dust deposition and PM_{10} would exceed air quality objectives at some receptors. Preliminary predictions and potential exceedances at worst affected receptors are shown in **Table 10-10**.

Table 10-10 Summary of preliminary modelling exceedances

Work site	Exceedances modelled without specific controls		
	24 hr PM_{10}	TSP	Dust Deposition
Objective	**50 µg/m^3**	**90 µg/m^3**	**130 mg/m^2/day**
Southern Connection	64 (**14**)	-	280 (**150**)
George Street Station	58 (**8**)	-	451
Roma Street Station	55 (**5**)	155 (**65**)	1424 (**1296**)

As a result, a potential mitigation regime was developed for each site to control emissions to meet air quality objectives. The mitigation options modelled included a selection of:

- acoustic enclosures or sheds at areas with higher intensity of activity (load out areas/shaft excavations)
- hoardings around general work areas
- hardstand on roads
- basic standard controls.

The specific modelled mitigation regime for each worksite is outlined in **Table 10-11**. The Project has to ability to increase the level of dust control depending on the specific activity and prevailing weather (temperature, wind and precipitation) conditions. A more comprehensive range of the potential control options is provided in **section 10.5** and **Chapter 18 - Outline EMP**.

While the controls modelled are extensive, they are not the only method by which dust control can be achieved for the project. Should an alternative construction approach, or mitigation regime become preferred (such as more intensive water spraying, activity specific extraction hoods, covering or sealing exposed surfaces) dust control would be required to meet air quality objectives. Effectiveness of any mitigation regime could be confirmed through air quality monitoring proposed in **Section 10.5.1**.

Table 10-11 Modelled mitigation options

Potential mitigation and control factors (per cent reduction)	Construction worksites/areas						
	Dutton Park south	Dutton Park north	Woolloongabba	George Street	Roma Street	Spring Hill south	Spring Hill north
Enclosure/shed (70%)	Yes	Yes	Yes	-	-	-	-
Enclosure equipped with fabric filters (99%)	-	-	-	Yes	Yes	-	-
Sealed/hardstand roads (100%)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hoardings (30%)	-	-	-	-	-	Yes	Yes
Base standard dust controls (e.g. water spraying, wheel wash-down)	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The following limitations should also be considered when interpreting the construction air quality assessment:

- the construction scenario assessed is a snapshot of typical activities that could be expected to occur during maximum (i.e. worst case) worksite activities
- emission factors are generally long-term averages, whereas actual emissions would vary on a short-term time scale.

The estimated TSP and PM_{10} emissions in kg/day for the various construction activities with the potential mitigation regimes in place controls at each worksite are provided in **Table 10-12** and **Table 10-13**.

Table 10-12 Estimated TSP emissions (kg/day) from worksites with mitigation applied

	Dutton Park South	Dutton Park North	Woolloongabba	George Street	Roma Street	Spring Hill South	Spring Hill North
Scenario 1							
Excavators/FEL on spoil[1]	0.05	0.11	3.20	0.003	0.004	-	0.06
Bulldozers on excavated material[1]	4.6	4.6	-	-	-	10.8	-
Wheel generated dust[1]	-	-	-	-	-	-	-
Wind erosion	10.14	9.60	13.92	0.88	1.14	8.54	33.60
Loading trucks[1]	0.56	0.12	0.11	0.004	0.003	0.01	-
Unloading trucks (deliveries)[1]	0.03	-	0.04	0.06	0.06	0.17	-
Rock breakers	4.6	4.6	4.6	0.08	0.15	5.4	-
Piling rigs	4.6	4.6	4.6	0.08	0.15	5.4	-
Total	**24.58**	**23.13**	**26.47**	**1.19**	**1.51**	**30.32**	**33.66**
Scenario 2							
Drilling[1]	-	-	3.20	3.20	3.20	-	-
Blasting[1]	-	-	3.20	3.20	3.20	-	-
Total (Scenario 2)			**32.87**	**7.59**	**7.91**		

Note 1 No emissions were modelled where controls of 100% (e.g. activities under total enclosure and sealed roads) are applied.

Table 10-13 Estimated PM_{10} emissions (kg/day) from worksites with mitigation applied

	Dutton Park South	Dutton Park North	Woolloongabba	George Street	Roma Street	Spring Hill South	Spring Hill North
Scenario 1							
Excavators/FEL on spoil[1]	0.02	0.05	0.06	0.06	0.002	-	0.03
Bulldozers on excavated material[1]	0.94	0.94	-	-	-	2.19	-
Wheel generated dust[1]	-	-	-	-	-	-	-
Wind erosion	5.10	4.84	7.00	0.44	0.57	4.27	16.8
Loading trucks[1]	0.29	0.06	0.05	0.06	0.001	0.01	-
Unloading trucks (deliveries)[1]	0.02	-	0.03	0.002	0.04	0.12	-
Rock breakers	0.94	0.94	0.94	0.02	0.04	1.1	-
Piling rigs	0.94	0.94	0.94	0.02	0.04	1.1	-
Total	**8.25**	**7.77**	**9.02**	**0.60**	**0.69**	**8.79**	**16.83**

	Dutton Park South	Dutton Park North	Woolloongabba	George Street	Roma Street	Spring Hill South	Spring Hill North
Scenario 2							
Drilling[1]	-	-	1.73	1.73	1.73	-	-
Blasting[1]	-	-	1.64	1.64	1.64	-	-
Total			**12.39**	**3.4**	**3.43**		

Note 1 No emissions were modelled where controls of 100% (e.g. activities under total enclosure and sealed roads) are applied.

The following sections report predictions of impacts at the worst affected receptors surrounding each worksite. The modelling has considered the maximum level of emissions anticipated at each worksite (i.e. Scenario 1 for the Southern Connection and Northern Connection, and Scenario 2 for Woolloongabba, George Street and Roma Street Stations).

The modelling results presented in **Figure 10-7** to **Figure 10-21** are based on Scenario 1 as this scenario is expected to occur at all sites. Generally impacts from Scenario 1 and 2 are expected to be very similar at sensitive receptors under the modelled controls regime.

Greater detail on the modelling methodology and results for all scenarios is provided in the **Technical Report 2 – Air quality**.

Southern Connection

Two major worksites are proposed for the construction of the Southern connection (including dive structure, portal and surface works) and removal of spoil from the TBM tunnelling operation. The construction activities have been modelled using scenarios that reflect maximum activity levels expected onsite, not typical conditions. This approach represents a conservative assessment as typical activity levels would result in lower impacts.

The results for the nearest sensitive receptors in the vicinity of the Southern Connection worksite are presented in **Table 10-14**. While modelling considered all sensitive receptors within the study corridor, the results from the nearest sensitive receptors (representing worst case conditions) has been the focus of the assessment.

The model predictions of cumulative air quality impacts from the southern connection worksite (including background) are predicted to be below air quality objectives for all airborne particulate pollutants, at all modelled sensitive receptors.

During construction the loading out of spoil to trucks from the TBM operation would be approximately 40m from the metropolitan linen services, general energy services and general support services buildings within the Princess Alexandra Hospital (PA Hospital) campus. For this activity, spoil would likely be transported via conveyors and unloaded within an acoustic enclosure, which would also provide significant dust mitigation. With controls, levels are predicted to be close to but below the dust deposition air quality objectives at the general support services building. Given the proximity of this receptor and the sensitivity of the broader PA Hospital campus, potential management measures include ongoing dust monitoring to support adaptive management and application of additional controls.

This is particularly useful where meteorological monitoring suggests adverse wind conditions or dust monitoring indicates levels at or near to exceeding air quality objectives. Additional management strategies may include increased watering regime on roads, stockpiles and haul truck load out areas.

Table 10-14 Predicted particle concentrations and dust deposition at the closest sensitive receptors to Southern connection (Scenario 1 – without blasting)

Sensitive receptors		Cumulative model predictions				
		TSP (µg/m^3)	24 hour PM_{10} (µg/m^3)		Monthly dust (mg/m^2/day)	
		Annual	Max	5th	Max	Average
ID	**Objectives**	**90**	**n/a**	**50**	**130**	**n/a**
SC1	Ecoscience Building - commercial	36.6	23.7	21.8	71	67
SC2	PA Hospital (General support services building)	38.9	34.7	30.9	128	83
SC3	Rawnsley Street – residential	39.4	30.8	26.2	90	77
SC4	Annerley Road – residential	36.6	24.0	21.7	64	62
SC5	Dutton Park Primary School	36.4	22.1	21.2	65	63
SC6	Leukaemia Foundation ESA Village (ESA Village)	36.6	24.2	21.8	81	76

The modelled cumulative dust deposition levels, 24 hour average PM_{10} and TSP concentrations (including existing background contributions) for Scenario 1 are shown in **Figure 10-7**, **Figure 10-8** and **Figure 10-9**.

LEGEND

Sensitive receptor

Construction worksite

Air Quality Contours

Dust deposition 1 month

Air quality objective (130 mg/m²/day)

Aerial Photo: Brisbane City Council 2012

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 10-7

Monthly dust deposition model predictions of cumulative impacts Southern Connection construction worksite – scenario 1

N

0 0.05 0.1
Kilometres
1:5,000 (at A4)
Projection: GDA 1994 MGA56

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LEGEND

Sensitive receptor

Construction worksite

Air Quality Contours

PM_{10} 24 hour average

Air quality objective (50 μg/m^3)

Aerial Photo: Brisbane City Council 2012

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 10-8

24 hour average PM_{10} model predictions of cumulative impacts
Southern Connection construction worksite – scenario 1

N

0 0.05 0.1
Kilometres
1:5,000 (at A4)
Projection: GDA 1994 MGA56

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LEGEND

Sensitive receptor

Construction worksite

Air Quality Contours

TSP 1 year

Air quality objective (90 µg/m^3)

Aerial Photo: Brisbane City Council 2012

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 10-9

Annual average TSP model predictions of cumulative impacts Southern Connection construction worksite – scenario 1

N

0 0.05 0.1
Kilometres
1:5,000 (at A4)
Projection: GDA 1994 MGA56

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Woolloongabba Station

The air quality modelling results combined with background (cumulative predictions) at each of the nearest sensitive receptors surrounding the Woolloongabba Station worksite are presented in **Table 10-15** and **Table 10-16**. The modelled scenarios considered the anticipated maximum activity levels (including blasting for Scenario 2) and focussed on the nearest sensitive receptors. This approach represents a conservative assessment as typical activity levels would result in lower impacts. With the application of controls outlined in **Table 10-11**, no exceedances of air quality objectives are predicted under any of the modelled scenarios, at any of the sensitive receptors surrounding the Woolloongabba Station worksites. The contribution of the Project's construction emissions are approximately an order of magnitude lower than the background levels.

Table 10-15 Predicted particle concentrations and dust deposition at the closest sensitive receptors to Woolloongabba (Scenario 1-without blasting)

Sensitive receptors		Cumulative model predictions				
		TSP (µg/m^3)	24 hour PM_{10} (µg/m^3)		Monthly dust (mg/m^2/day)	
		Annual	Max	5th	Max	Ave
ID	**Objectives**	**90**	**n/a**	**50**	**130**	**n/a**
W1	Vulture Street – residential	37.5	25.8	23.9	74	68
W2	Vulture Street – commercial	37.8	27.4	25.0	78	71
W3	Main Street – residential	36.9	25.5	22.5	68	64
W4	St Nicholas Cathedral	37.6	25.9	24.3	75	68
W5	Main Street – commercial	38.1	27.2	26.7	95	72
W6	Stanley Street – commercial	37.4	28.3	25.7	78	68
W7	St Joseph's Primary School	36.7	23.7	22.5	67	64

Table 10-16 Predicted particle concentrations and dust deposition at the closest sensitive receptors to Woolloongabba Station (Scenario 2-with blasting)

Sensitive receptors		Cumulative model predictions				
		TSP (µg/m3)	24 hour PM10 (µg/m3)		Monthly dust (mg/m2/day)	
		Annual	Max	5th	Max	Average
ID	**Objectives**	**90**	**n/a**	**50**	**130**	**n/a**
W1	Vulture Street – residential	37.7	26.7	24.8	76	69
W2	Vulture Street – commercial	38.0	28.7	25.6	80	72
W3	Main Street – residential	37.0	26.3	22.9	69	65
W4	St Nicholas Cathedral	36.8	24.4	22.9	78	70
W5	Main Street – commercial (Lands Centre)	38.7	29.2	29.0	105	75
W6	Stanley Street – commercial	38.2	29.2	26.5	94	74
W7	St Joseph's Primary School	36.8	24.4	22.9	68	65

The modelled cumulative monthly dust deposition levels and 24 hour average PM_{10} and TSP concentrations (including existing background contributions) for Scenario 1 are shown in **Figure 10-10, Figure** 10-11 and **Figure 10-12**.

LEGEND

Sensitive receptor

Construction worksite

Air Quality Contours

Dust deposition 1 month

Air quality objective (130 mg/m²/day)

Aerial Photo: Brisbane City Council 2012

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 10-10

Monthly dust deposition model predictions of cumulative impacts Woolloongabba construction worksite – scenario 1

N

0 0.025 0.05
Kilometres
1:2,500 (at A4)
Projection: GDA 1994 MGA56

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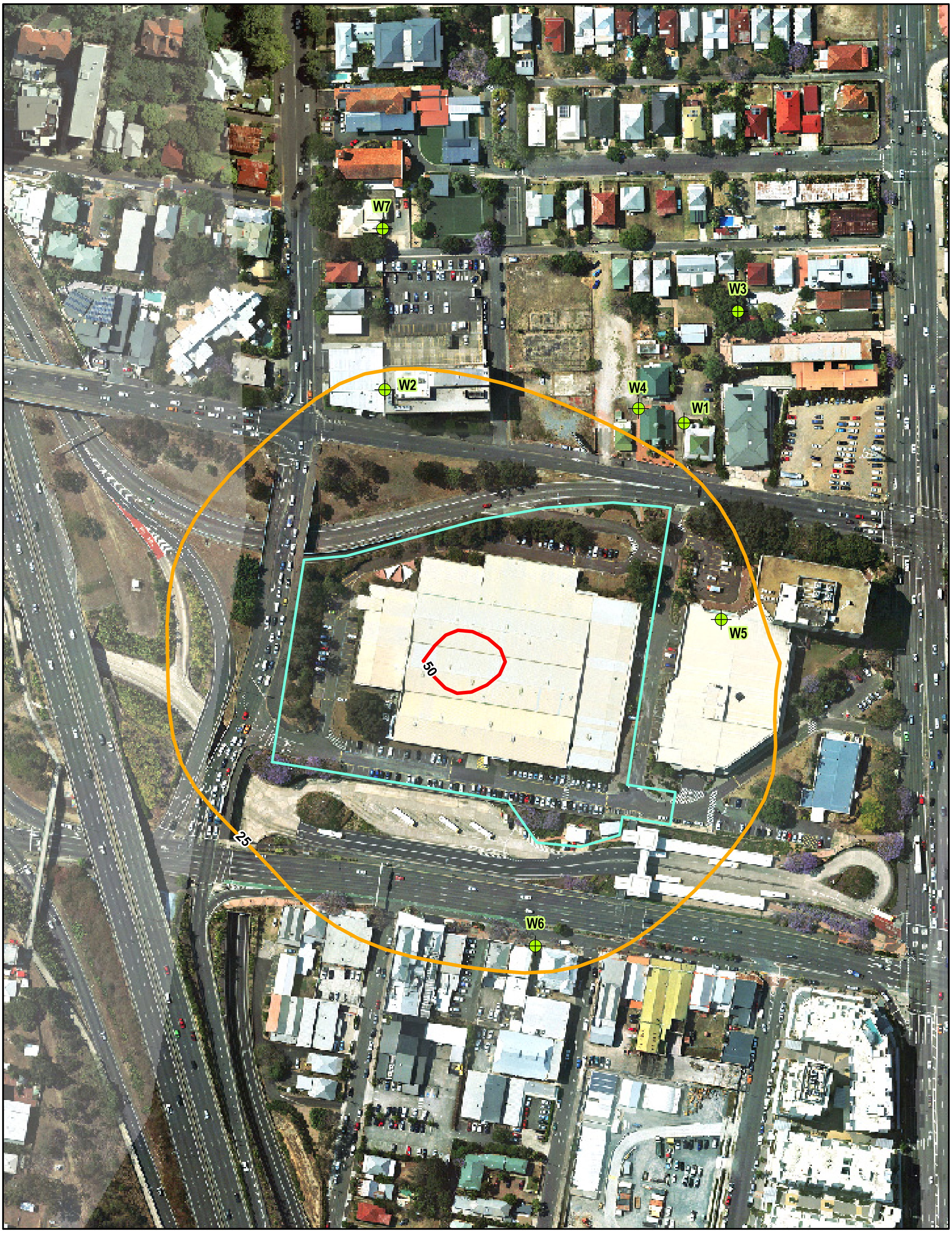

LEGEND

Sensitive receptor

Construction worksite

Air Quality Contours

PM_{10} 24 hour average

Air quality objective (50 µg/m^3)

Aerial Photo: Brisbane City Council 2012

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 10-11

24 hour average PM_{10} model predictions of cumulative impacts Woolloongabba construction worksite – scenario 1

N

0 0.025 0.05
Kilometres
1:2,500 (at A4)
Projection: GDA 1994 MGA56

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LEGEND

Sensitive receptor

Construction worksite

Air Quality Contours

TSP 1 year

Air quality objective (90 µg/m³)

Aerial Photo: Brisbane City Council 2012

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 10-12

Annual average TSP model predictions of cumulative impacts Woolloongabba construction worksite – scenario 1

N

0 0.025 0.05
Kilometres
1:2,500 (at A4)
Projection: GDA 1994 MGA56

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George Street Station

The modelling results at the nearest sensitive receptors surrounding the George Street Station worksite are presented in **Table 10-17** and **Table 10-18**. The results relate to the ground level receptors, with impacts reducing as the building height and source separation distance increases. The modelled scenarios considered maximum anticipated activity levels (including blasting) and has focussed on the nearest sensitive receptors. This approach represents a conservative assessment as typical activity levels would result in lower impacts.

There are no exceedances of the TSP and PM_{10} air quality objectives predicted by the modelling at the nearest sensitive receptors. Coarse particulates (>10µm) have the potential to generate nuisance primarily as deposited dust and are not considered a health issue. No exceedances of the dust deposition objective are predicted at the modelled nearest sensitive receptors.

The modelling has incorporated various dust mitigation measures including the installation of an acoustics shed or enclosure equipped with a fabric filter for the removal of airborne particulate matter and dust at the George Street Station worksite. Further measures proposed for the control and management of the dust emissions at the George Street Station worksite are discussed in **section 10.5**.

Due to the proximity of the worksite to sensitive receptors, the potential management measures include ongoing dust monitoring at a location representative of the worst-affected sensitive receptors. This would allow adaptive management strategies to be implemented where meteorological monitoring suggests adverse wind conditions or dust monitoring indicates levels at or near to exceeding air quality objectives. Additional management strategies may include an intensified watering regime on roads, stockpiles and haul truck load out areas.

Table 10-17 Predicted particle concentrations and dust deposition at the closest sensitive receptors to George Street (Scenario 1 – without blasting)

Sensitive receptors		Cumulative model predictions				
		TSP (µg/m^3)	PM_{10} (µg/m^3)		Dust (mg/m^2/day)	
		Annual	Max	5th	Max	Ave
ID	**Objectives**	**90**	**n/a**	**50**	**130**	**n/a**
GS1	Mary Street – residential	38.0	26.1	24.5	99	74
GS2	Mary Street – commercial	36.9	22.1	21.9	75	66
GS3	Mary Street – commercial	36.8	21.5	21.3	69	65
GS4	George Street – commercial	38.5	26.6	23.9	94	77
GS5	George Street – commercial	37.5	22.8	22.0	81	71
GS6	George Street – residential	36.4	21.2	20.7	66	63
GS7	George Street – commercial	37.2	23.4	21.9	74	68
GS8	Synagogue	36.5	21.8	21.5	71	63

Table 10-18 Predicted particle concentrations and dust deposition at the closest sensitive receptors to George Street Station (Scenario 2 – with blasting)

Sensitive receptors		Cumulative model predictions				
		TSP (μg/m³)	PM_{10} (μg/m³)		Monthly dust (mg/m²/day)	
		Annual	Max	5th	Max	Average
ID	**Objectives**	**90**	**n/a**	**50**	**130**	**n/a**
GS1	Mary Street – residential	38.4	28.0	25.6	109	77
GS2	Mary Street – commercial	37.0	22.7	22.4	80	67
GS3	Mary Street – commercial	36.9	22.0	21.6	72	66
GS4	George Street – commercial	39.1	29.6	25.6	105	81
GS5	George Street – commercial	37.9	23.7	22.9	87	74
GS6	George Street – residential	36.5	21.4	20.9	67	64
GS7	George Street – commercial	36.9	22.0	21.6	72	66
GS8	Synagogue	26.6	22.3	21.9	74	64

The modelled cumulative monthly dust deposition levels, 24 hour average PM_{10} and TSP concentrations (including existing background contributions) for Scenario 1 are shown in **Figure 10-13, Figure 10-14** and **Table 10-15**.

LEGEND

Sensitive receptor

Construction worksite

Air Quality Contours

Dust deposition 1 month

Air quality objective (130 $mg/m^2/day$)

Aerial Photo: Brisbane City Council 2012

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 10-13

Monthly dust deposition model predictions of cumulative impacts George Street construction worksite – scenario 1

N

0 0.025 0.05
Kilometres
1:2,500 (at A4)
Projection: GDA 1994 MGA56

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LEGEND

Sensitive receptor

Construction worksite

Air Quality Contours

PM_{10} 24 hour average

Air quality objective (50 μg/m³)

Aerial Photo: Brisbane City Council 2012

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 10-14

24 hour average PM_{10} model predictions of cumulative impacts George Street construction worksite – scenario 1

N

0 0.025 0.05
Kilometres
1:2,500 (at A4)
Projection: GDA 1994 MGA56

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LEGEND

Sensitive receptor

Construction worksite

Air Quality Contours

TSP 1 year

Air quality objective (90 µg/m³)

Aerial Photo: Brisbane City Council 2012

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 10-15

Annual average TSP model predictions of cumulative impacts
George Street construction worksite – scenario 1

N

0 0.025 0.05
Kilometres
1:2,500 (at A4)
Projection: GDA 1994 MGA56

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Roma Street Station

The results of modelling at the sensitive receptors surrounding the Roma Street Station worksite are presented in **Table 10-19** and **Table 10-20**. The results relate to the ground level receptors, with impacts reducing as the building height and source separation distance increases. The modelled scenarios considered maximum anticipated activity levels (Scenario 2 includes blasting) and focussed on the nearest sensitive receptors. This approach represents a conservative assessment as typical activity levels would result in lower impacts.

There are no exceedances of the TSP, PM_{10} or dust deposition objectives predicted by the modelling at the sensitive receptors. Similar to George Street Station, the modelling has incorporated various dust mitigation measures including the installation of an acoustics shed or enclosure equipped with a fabric filter for the removal of airborne particulate matter and dust.

Further potential measures proposed for the control and management of dust emissions at the Roma Street Station worksite are discussed in **section 10.5**. Considering the proximity of the worksite to sensitive receptors, potential measures include ongoing dust monitoring at locations representative of the worst-affected sensitive receptors (the Parkland Crescent residential building). This allows adaptive management strategies to be implemented when meteorological monitoring suggests adverse wind conditions or dust monitoring indicates levels at or near to exceeding air quality objectives. Additional management strategies may include increased watering of roads, stockpiles and haul truck load out areas.

Table 10-19 Predicted particle concentrations and dust deposition at the closest sensitive receptors to Roma Street (Scenario 1 – without blasting)

Sensitive receptors		Cumulative model predictions				
		TSP (µg/m^3)	24 hour PM_{10} (µg/m^3)		Dust (mg/m^2/day)	
		Annual	Max	5th	Max	Ave
ID	**Objectives**	**90**	**n/a**	**50**	**130**	**n/a**
RS1	Wickham Terrace – residential	36.1	20.3	20.2	61	60.3
RS2	Brisbane Private Hospital	36.0	20.1	20.1	60.2	60.1
RS3	Brisbane Dental Hospital	36.0	20.1	20.1	60.1	60
RS4	Roma Street station – commercial	36.1	20.6	20.4	60.9	60.5
RS5	Holiday Inn – residential	36.0	20.2	20.1	60.2	60.1
RS6	Parkland Crescent – residential facing east	37.9	23.6	22.5	85	73

Table 10-20 Predicted particle concentrations and dust deposition at the closest sensitive receptors to Roma Street Station (Scenario 2 – with blasting)

Sensitive receptors		Cumulative model predictions				
		TSP (μg/m^3)	24 hour PM_{10} (μg/m^3)		Dust (mg/m^2/day)	
		Annual	Max	5th	Max	Average
ID	**Objectives**	**90**	**n/a**	**50**	**130**	**n/a**
RS1	Wickham Terrace – residential	36.1	20.3	20.3	61	60.4
RS2	Brisbane Private Hospital	36.0	20.2	20.1	60.3	60.1
RS3	Brisbane Dental Hospital	36.0	20.1	20.1	60.1	60
RS4	Roma Street Station – commercial	36.1	20.8	20.5	61.2	60.6
RS5	Holiday Inn – residential	36.0	20.2	20.1	60.2	60.1
RS6	Parkland Crescent – residential	38.3	24.4	23.3	91	76

The modelled cumulative dust deposition levels, 24 hour average PM_{10} and TSP concentrations (including existing background contributions) for Scenario 1 are shown in
Figure 10-16, **Figure 10-17** and **Table 10-18**.

LEGEND

Sensitive receptor

Construction worksite

Air Quality Contours

Dust deposition 1 month

Air quality objective (130 mg/m²/day)

Aerial Photo: Brisbane City Council 2012

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 10-16

Monthly dust deposition model predictions of cumulative impacts Roma Street construction worksite – scenario 1

N

0 0.05 0.1
Kilometres
1:5,000 (at A4)
Projection: GDA 1994 MGA56

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LEGEND

Sensitive receptor

Construction worksite

Air Quality Contours

PM_{10} 24 hour average

Air quality objective (50 µg/m³)

Aerial Photo: Brisbane City Council 2012

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 10-17

24 hour average PM_{10} model predictions of cumulative impacts Roma Street construction worksite – scenario 1

N

0 0.05 0.1
Kilometres
1:5,000 (at A4)
Projection: GDA 1994 MGA56

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LEGEND

Sensitive receptor

Construction worksite

Air Quality Contours

TSP 1 year

Air quality objective (90 µg/m³)

Aerial Photo: Brisbane City Council 2012

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 10-18

Annual average TSP model predictions of cumulative impacts
Roma Street construction worksite – scenario 1

N

0 0.05 0.1
Kilometres
1:5,000 (at A4)
Projection: GDA 1994 MGA56

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Northern Connection

The results of modelling at sensitive receptors surrounding the Northern Connection construction worksite are presented in **Table 10-21**. The modelled cumulative dust deposition levels, 24 hour average PM_{10} and TSP concentrations (including existing background contributions) for Scenario 1 are shown in **Figure 10-19, Figure 10-20** and **Figure 10-21**.

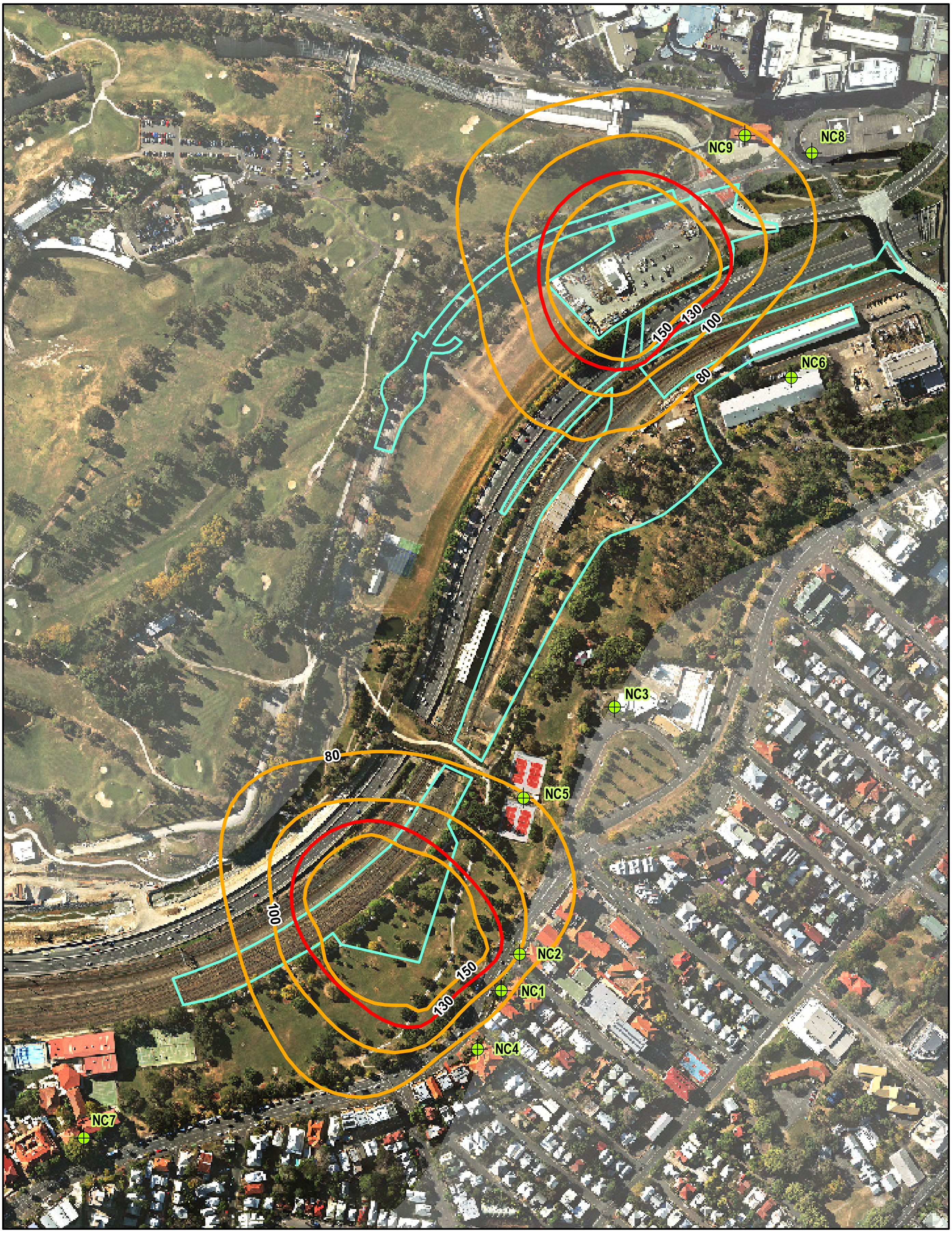
The modelled scenario considered maximum anticipated activity levels (excluding blasting) and has focussed on the nearest sensitive receptors. This approach represents a conservative assessment as typical activity levels would result in lower impacts.

The model predictions of cumulative impacts on air quality from the construction activities at the sensitive receptors are below air quality objectives for all of the pollutants modelled from the Northern Connection worksite. As shown in **Figure 10-20**, impacts are predicted to exceed the objectives for PM_{10} and dust deposition beyond the boundary of the TBM retrieval worksite, but not at any of the modelled worst affected receptors.

Table 10-21 Predicted particle concentrations and dust deposition at the closest sensitive receptors to Northern Connection worksites (Scenario 1 – without blasting)

Sensitive receptors		Cumulative model predictions				
		TSP (µg/m^3)	24 hour PM_{10} (µg/m^3)		Monthly dust (mg/m^2/day)	
		Annual	Max	5th	Max	Average
ID	**Objectives**	**90**	**n/a**	**50**	**130**	**n/a**
NC1	Gregory Terrace – residential	37.2	33.4	29.3	79	66
NC2	St Joseph's College	37.5	34.9	30.3	85	68
NC3	Centenary Aquatic Centre	36.7	24.8	23.4	68	64
NC4	Gregory Terrace – residential	37.0	30.7	26.8	73	65
NC5	Gregory Terrace – commercial	37.7	30.0	25.9	81	69
NC6	Bowen Bridge Road – commercial	36.6	25.6	24.1	69	63
NC7	Brisbane Girls Grammar School	36.3	24.8	22.1	64	62
NC8	Royal Brisbane Hospital	37.2	28.0	24.3	77	66
NC9	Mental Illness Fellowship	38.0	30.4	25.8	85	71

While there is potential for construction dust to impact the amenity of Victoria Park in close proximity to active worksites, no health effects are anticipated. Vegetation in Victoria Park is primarily well established semi-mature to mature trees and not considered to be highly sensitive to dust. With the proposed controls and natural precipitation, potential impacts are expected to be minimal. Further detail of ecological values and impacts is provided in **Chapter 8 - Ecology**.



LEGEND

Sensitive receptor

Construction worksite

Air Quality Contours

Dust deposition 1 month

Air quality objective (130 mg/m²/day)

Aerial Photo: Brisbane City Council 2012

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

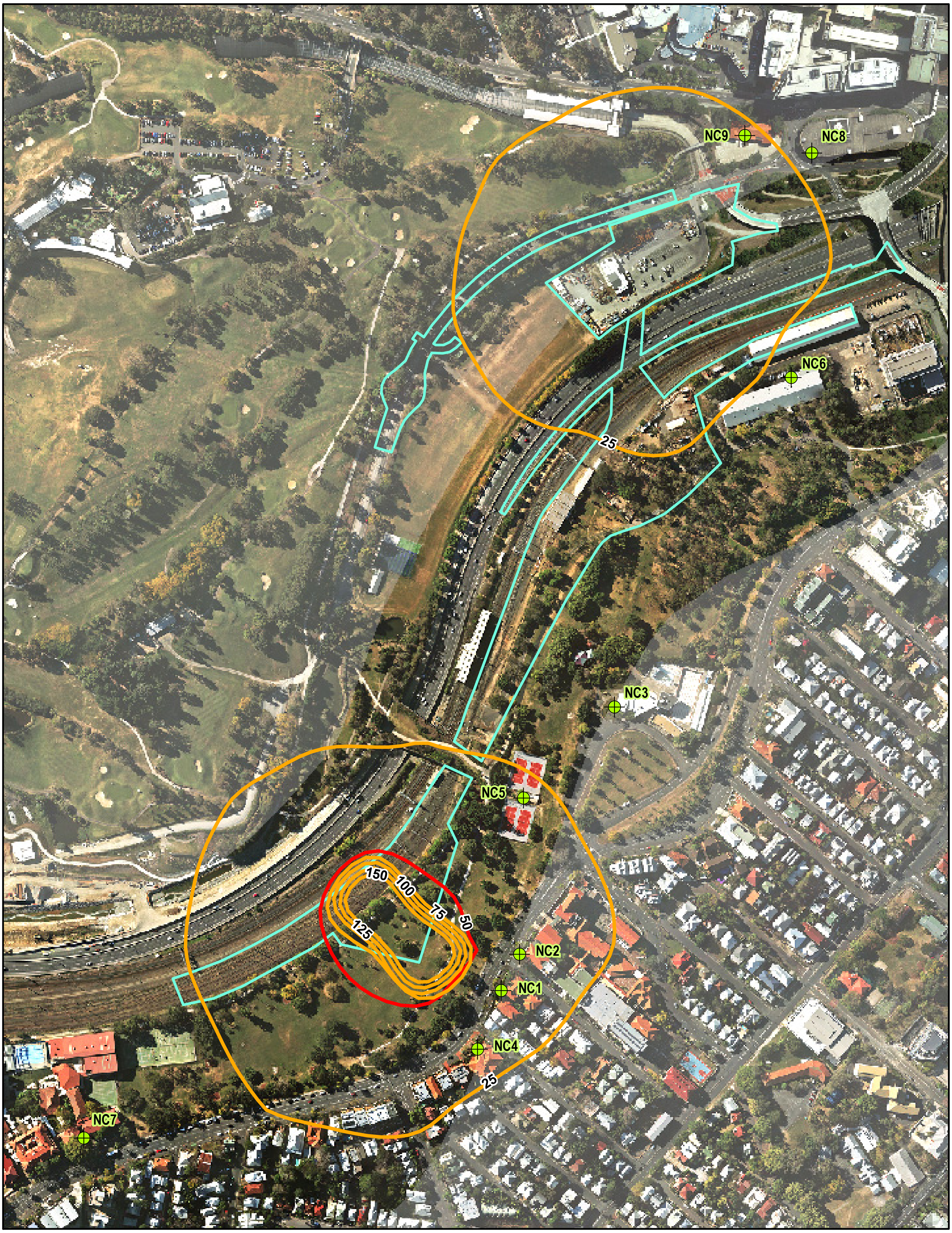
FIGURE 10-19

Monthly dust deposition model predictions of cumulative impacts Northern Connection construction worksite – scenario 1

N

0 0.05 0.1
Kilometres
1:5,000 (at A4)
Projection: GDA 1994 MGA56

G:\QENV2\Projects\QE06863\Spatial\ArcGIS\Figures\Final_EIS_Figures\10_AirQuality\AirQuality_Figure10-X_DustDeposition_MapBk.mxd Date: 12/08/2014



LEGEND

Sensitive receptor

Construction worksite

Air Quality Contours

PM_{10} 24 hour average

Air quality objective (50 µg/m^3)

Aerial Photo: Brisbane City Council 2012

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 10-20

24 hour average PM_{10} model predictions of cumulative impacts Northern Connection construction worksite – scenario 1

N

0 0.05 0.1
Kilometres
1:5,000 (at A4)
Projection: GDA 1994 MGA56

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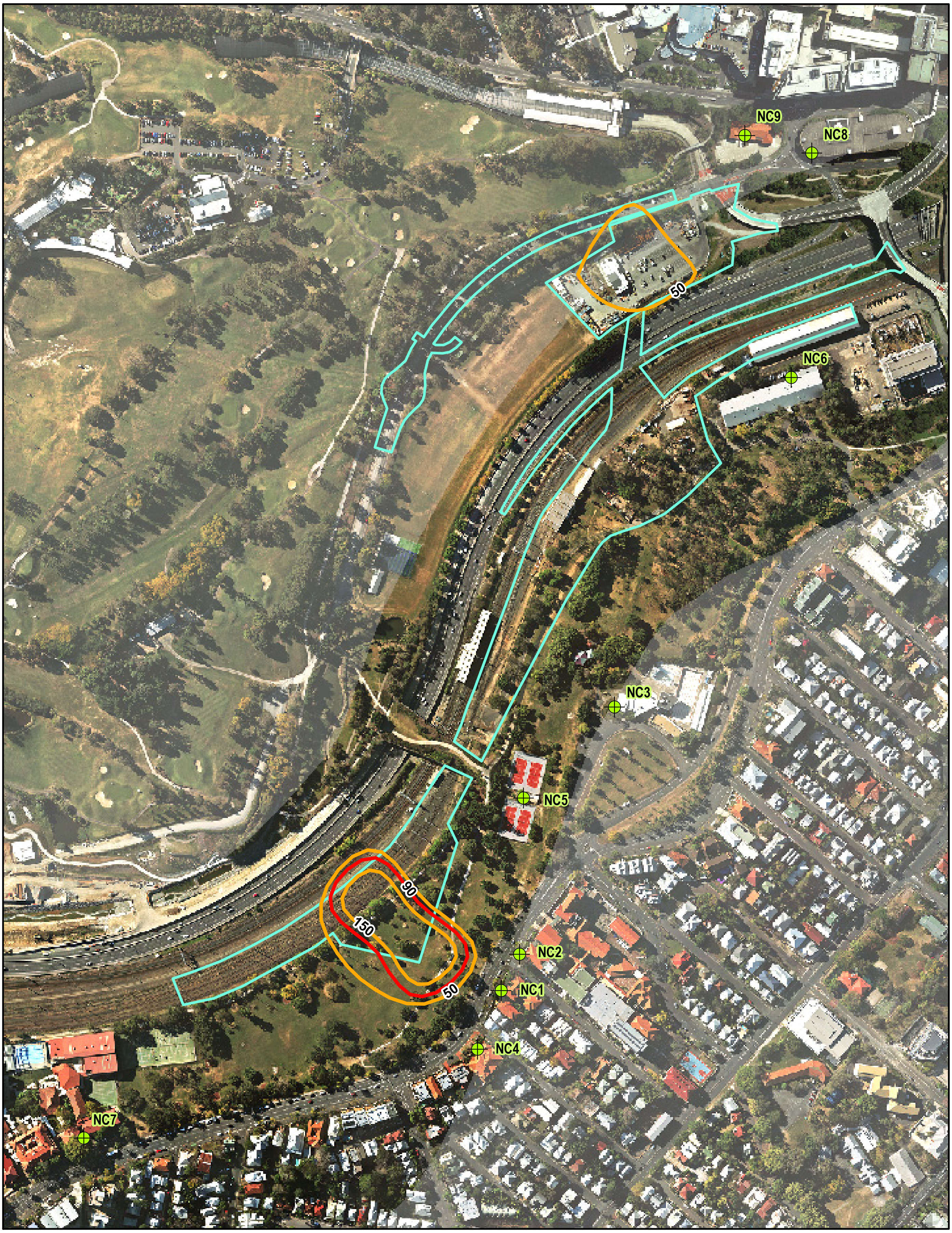

LEGEND

Sensitive receptor

Construction worksite

Air Quality Contours

TSP 1 year

Air quality objective (90 µg/m³)

BUS AND TRAIN PROJECT
ENVIRONMENTAL IMPACT STATEMENT

FIGURE 10-21

Annual average TSP model predictions of cumulative impacts Northern Connection construction worksite – scenario 1

N

0 0.05 0.1
Kilometres
1:5,000 (at A4)

Projection: GDA 1994 MGA56

Aerial Photo: Brisbane City Council 2012

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10.4.2 Operations

Air within the tunnel and stations would be refreshed and exhausted to the surface through five ventilation outlets located in close proximity to the stations and portals. The location of ventilation outlets are shown in **Chapter 3 – Project description** and in **Technical Report 2 – Air quality**.

The ventilation system also provides the ability to confine and extract smoke in the event of an incident. The likelihood of a major incident involving a bus fire is 'rare' to 'very low' from a risk perspective. Due to the infrequency, short duration and unpredictability of the location and smoke characteristics of an incident, specific air quality modelling has not been conducted. However, should an incident occur, the operators' integrated emergency response procedures would be implemented to mitigate the impact of the incident on the community and the Project's infrastructure. These procedures would be developed in consultation with the Department of Emergency Services (DES) prior to operation. During the unlikely event of a fire, the agreed procedures would be followed along with any site specific, above ground requirements of the DES's operational units.

Ventilation exhaust air would contain the emissions from buses operating within the tunnel. The air would be similar in quality to station and tunnel air and contain:

- oxides of nitrogen
- carbon monoxide
- particulate matter as PM_{10}
- particulate matter as $PM_{2.5}$
- ultrafine particles (i.e. particles smaller than 0.1µm)
- volatile organic compounds (VOC) including (but not necessarily limited to): benzene, toluene, xylene, 1,3-butadiene.

The NEPM classifies benzene, formaldehyde, toluene and xylene as air toxics. Air toxics are defined as gaseous, aerosol or particulate pollutants and exist at relatively low concentrations in urban air sheds, with significantly elevated levels only occurring near specific sources such as industrial sites, heavily trafficked roads and areas impacted by wood smoke (NEPC, 2003). Most of the air toxics from vehicles arise from the by-products of the combustion process when fuel is burnt in the engine and then emitted via the exhaust system, and from evaporation of the fuel itself. The approach to assessing air toxics from exhaust emissions is based on the assumption that there is an association between CO and VOC emissions in the exhaust. Speciation factors for VOCs provided in the NPI database are applied to derive likely emissions of the air toxics based on data. In diesel exhaust, for example these speciation factors range from 0.01 for benzene to 0.0147 for toluene. As the predicted contribution of the operation of the Project to CO impacts is very low, the contribution of the operation of the Project to air toxic levels will also a result also be very low. As a result they have not been modelled or assessed further in this report.

As a subset of volatile organic compounds, air toxics also have the potential to cause nuisance odour at elevated concentrations. When concentrations reach or exceed odour thresholds, they have general aromatic and sweet smelling odour characteristics. Typically these aromatic hydrocarbons produce their most pungent odour when in liquid form (as a laboratory solvent) and not as the by-product of combustion. The concentration of air toxics as a result of the Project are expected to be significantly lower than each compound's odour detection or recognition threshold, and are very unlikely to result in nuisance odour complaints.

While not a pollutant, there is also potential for small increases in temperature in close proximity to the extraction points of the ventilation outlets. Heat is primarily generated by the vehicle exhaust in the tunnel and is directly proportional to the vehicle density within the tunnel.

The key features of the ventilation outlets relevant for the air quality modelling are outlined in **Table 10-22**. Further details on the ventilation outlet characteristics are provided in **Chapter 3 – Project description**.

Table 10-22 Modelled ventilation outlet characteristics

Site	Height (m above ground level)	Diameter (m)	Aperture (m^2) (internal)	Temp (°C)	Flowrate (m^3/s)
Southern Connection	11	4.4	$15m^2$	24.9	60
Woolloongabba Station	24	5.6	$35m^2$	24.9	340
George Street Station	25	5.6	$35m^2$	24.9	340
Roma Street Station	8	5.6	$35m^2$	24.9	340
Northern Connection	11	4.4	$15m^2$	24.9	60

Emissions during the forecast peak operations are likely to generate the maximum impacts. To provide a conservative assessment of the potential impacts, this has been the focus of the assessment. The estimated pollutant emission rates during peak operation of the Project, at each of ventilation outlets, is shown in **Table 10-23**. The estimate of particulate emissions have been conservative as they have considered all particles emitted from the ventilation outlets as $PM_{2.5}$.

Table 10-23 Ventilation outlet emissions data for peak operation

Site	Emission rate (g/s)		
	NO_x	CO	$PM_{2.5}$
Southern Connection	0.038	0.038	0.038
Woolloongabba Station	0.090	0.090	0.090
George Street Station	0.093	0.093	0.093
Roma Street Station	0.065	0.065	0.065
Northern Connection	0.025	0.025	0.025

The estimated emissions from the operational phase of the Project are based upon the following assumptions:

- as a conservative estimate, all particles emitted from the ventilation outlets are $PM_{2.5}$
- emissions are estimated during peak bus operations and air pollutant levels (i.e. maximum emissions) for comparison with short term average objectives (i.e. one hour NO_2 and 24 hour $PM_{2.5}$)
- emissions are estimated during normal tunnel air pollutant levels for comparison with annual average objectives (i.e. annual average NO_2 and $PM_{2.5}$)
- bus speeds within the tunnel and entering and exiting the tunnel portals are 60km/h.

Impacts from a range of ventilation outlet height and locations were modelled as part of the air quality assessment. The purpose of modelling these multiple scenarios was to inform the design process of any risks or opportunities associated with the location of the ventilation outlets relevant to air quality impacts.

As the Project's emissions provide a relatively small contribution to existing air pollution levels, the selection of outlet locations was based primarily on creating separation distance sufficient to allow ventilated air to return to ambient temperature. Should future development be proposed that could reduce the separation distance from outlet to receptor, consideration would be required to mitigate potential impacts.

Southern Connection

The model predictions for the operational stage of the Project at the sensitive receptors in the vicinity of the proposed ventilation outlet at the Southern connection are presented in **Table 10-24**.

Model predictions of cumulative (including background) air quality impacts from the ventilation outlets at heights of 11m are predicted to be below air quality objectives for all pollutants modelled. Annual average $PM_{2.5}$ are predicted to be just below the objective of 8µg/m^3 at the sensitive receptors. The contribution to $PM_{2.5}$ levels from the operation of the Project is predicted to be much lower (approximately 0.02µg/m^3) than the regional background levels (7.8µg/m^3) adopted for the modelling.

Table 10-24 Predicted particle and gas concentrations at the closest sensitive receptors to Southern Connection

Sensitive receptors		Cumulative model predictions				
		$PM_{2.5}$ (µg/m^3)		NO_2 (µg/m^3)		CO (µg/m^3)
		24 hour	Annual	1 hour	Annual	8 hour
ID	**Objectives**	**25**	**8**	**250**	**62**	**11,000**
SC1	Ecoscience building – commercial	9.6	7.81	23.2	15.03	270
SC2	PA Hospital	9.1	7.80	20.6	15.00	262.0
SC3	Rawnsley Street – residential	9.6	7.82	22.1	15.04	267.8
SC4	Annerley Road – residential	9.4	7.81	21.3	15.02	266.1
SC5	Dutton Park Primary School	9.4	7.81	21.7	15.03	265.3
SC6	ESA Village	9.6	7.82	22.8	15.04	271.3

Woolloongabba Station

The model predictions for the operational stage of the Project at the sensitive receptors in the vicinity of the proposed ventilation outlet at Woolloongabba Station are presented in **Table 10-25**.

Model predictions of cumulative (including background) air quality impacts from the ventilation outlets are predicted to be below air quality objectives for all pollutants modelled. Annual average $PM_{2.5}$ levels are predicted to be just below the objective of 8µg/m^3 at the sensitive receptors. The contribution to $PM_{2.5}$ levels from the operation of the Project is predicted to be much lower (approximately 0.1µg/m^3) than the regional background levels (7.8µg/m^3) adopted for the modelling.

Table 10-25 Predicted particle and gas concentrations at the closest sensitive receptors to Woolloongabba Station

Sensitive receptors		Cumulative model predictions				
		$PM_{2.5}$ (µg/m^3)		NO_2 (µg/m^3)		CO (µg/m^3)
		24 hour	Annual	1 hour	Annual	8 hour
ID	**Objectives**	**25**	**8**	**250**	**62**	**11,000**
W1	Vulture Street - residential	9.26	7.85	26.42	15.12	265.9
W2	Vulture Street - commercial	9.21	7.84	25.16	15.11	264.7
W3	Main Street - residential	9.22	7.83	21.09	15.07	265.5
W4	St Nicholas Cathedral	9.21	7.84	25.16	15.11	264.7
W5	Main Street - commercial	9.96	7.90	24.67	15.25	275.7
W6	Stanley Street - commercial	9.82	7.89	22.61	15.23	270.7
W7	St Joseph's Primary School	9.28	7.85	21.07	15.12	263.8

George Street Station

The model predictions for the operational stage of the Project at the sensitive receptors in the vicinity of the proposed ventilation outlet at George Street Station are presented in **Table 10-26**. To understand the potential impacts on all floors of the surrounding apartment buildings, modelling has considered a range of receptor heights.

Model predictions of cumulative air quality impacts from the operational emissions from the ventilation outlet (including background) at George Street Station are predicted to be well below air quality objectives for 24 hour average $PM_{2.5}$ and CO and NO_2. Annual average $PM_{2.5}$ levels are predicted to be just below the objective of 8µg/m^3 at the sensitive receptors. The contribution to air quality levels from the operation of the Project is predicted to be much lower (approximately 0.13µg/m^3) than the regional background levels (7.8µg/m^3) adopted for the modelling.

Table 10-26 Predicted particle and gas concentrations at the closest sensitive receptors to George Street Station

Sensitive receptors		Cumulative model predictions				
		$PM_{2.5}$ (µg/m^3)		NO_2 (µg/m^3)		CO (µg/m^3)
		24 hour	Annual	1 hour	Annual	8 hour
ID	**Objectives**	**25**	**8**	**250**	**62**	**11,000**
GS1	Mary Street - residential at ground level	10.0	7.87	33.9	15.16	278.7
GS1	Mary Street - residential at 25m	10.0	7.87	34.4	15.16	278.7
GS1	Mary Street - residential at 50m	11.3	7.92	54.4	15.29	315.6
GS2	Mary Street - commercial at ground level	10.4	7.93	72.9	15.31	298.5
GS2	Mary Street - commercial at 25m	10.4	7.93	73.4	15.31	298.8
GS2	Mary Street - commercial at 50m	10.4	7.93	73.9	15.31	299.1
GS3	Mary Street - commercial at 0m	9.8	7.83	39.5	15.07	274.1
GS3	Mary Street - commercial at 25m	9.8	7.83	40.2	15.07	274.2

Sensitive receptors		Cumulative model predictions				
		$PM_{2.5}$ (µg/m³)		NO_2 (µg/m³)		CO (µg/m³)
		24 hour	Annual	1 hour	Annual	8 hour
GS3	Mary Street - commercial at 50m	9.8	7.83	40.9	15.07	274.6
GS4	George Street - commercial at ground level	9.9	7.85	26.5	15.10	274.5
GS4	George Street - commercial at 25m	9.9	7.85	26.5	15.10	274.5
GS4	George Street - commercial at 50m	11.1	7.85	52.0	15.13	306.0
GS5	George Street - commercial at ground level	10.3	7.87	25.5	15.16	279.0
GS5	George Street - commercial at 25m	10.3	7.87	25.5	15.16	279.0
GS5	George Street - commercial at 50m	10.3	7.87	25.5	15.16	279.0
GS6	George Street - commercial at ground level	10.30	7.89	25.7	15.21	279.8
GS6	George Street - commercial at 25m	10.30	7.89	25.7	15.21	279.8
GS6	George Street - commercial at 50m	10.30	7.90	25.7	15.23	279.8
GS7	Synagogue at ground level	9.9	7.85	38.1	15.11	278.0
GS7	Synagogue at 25m	9.9	7.85	38.6	15.11	278.0
GS7	Synagogue at 50m	9.9	7.85	39.2	15.12	278.0

Roma Street Station

The model predictions for the operational stage of the Project at the sensitive receptors in the vicinity of the proposed ventilation outlet at Roma Street Station are presented in **Table 10-27**. To understand the potential impacts on all floors of the surrounding apartment buildings, modelling has considered a range of receptors heights.

Model predictions of cumulative air quality impacts from the operational emissions from the ventilation outlet (including background) at Roma Street Station are predicted to be below air quality objectives at the sensitive receptors for all pollutants modelled. Annual average $PM_{2.5}$ levels are predicted to be just below the objective of 8µg/m^3 at the sensitive receptors. The contribution from the operation of the Project it is predicted to be much lower (approximately 0.05µg/m^3) than the regional background levels (7.8µg/m^3) adopted for the modelling.

Table 10-27 Predicted particle and gas concentrations at the closest sensitive receptors to Roma Street Station

Sensitive receptors		Cumulative model predictions				
		$PM_{2.5}$ (µg/m^3)		NO_2 (µg/m^3)		CO (µg/m^3)
		24 hour	Annual	1 hour	Annual	8 hour
ID	**Objectives**	**25**	**8**	**250**	**62**	**11,000**
RS1	Wickham Terrace - residential	9.3	7.81	21.1	15.02	267.4
RS2	Brisbane Private Hospital	9.1	7.80	20.2	15.01	262.6
RS3	Brisbane Dental Hospital	9.1	7.80	20.4	15.00	262.8
RS4	Roma Street Station - commercial	9.3	7.81	23.5	15.02	266.6
RS5	Holiday Inn - residential	9.5	7.81	24.6	15.01	270.4
RS6	Parkland Crescent - residential east at ground level	10.0	7.85	25.1	15.12	277.5
RS6	Parkland Crescent - residential east at 10m	10.0	7.85	25.1	15.12	277.8
RS6	Parkland Crescent - residential east at 20m	10.0	7.85	25.1	15.12	277.8
RS6	Parkland Crescent - residential east at 30m	10.0	7.85	25.1	15.12	277.8
RS6	Parkland Crescent - residential east at 40m	10.0	7.85	25.1	15.12	277.8
RS7	Parkland Crescent - residential south at ground level	9.5	7.83	21.5	15.07	268.5
RS7	Parkland Crescent - residential south at 10m	9.5	7.83	21.5	15.07	268.5
RS7	Parkland Crescent - residential south at 20m	9.5	7.83	21.5	15.07	268.5
RS7	Parkland Crescent - residential south at 30m	9.5	7.83	21.5	15.07	268.5
RS7	Parkland Crescent - residential south at 40m	9.5	7.83	23.0	15.07	268.5

Northern Connection

The model predictions for the operational stage of the Project at the sensitive receptors in the vicinity of the proposed ventilation outlet at the Northern Connection are presented in **Table 10-28**.

Model predictions of cumulative air quality impacts from the operational emissions from the ventilation outlet (including background) are well below air quality objectives at the sensitive receptors for all pollutants modelled. With regards to the contribution to $PM_{2.5}$ levels from the operation of the Project is predicted to be much lower (approximately 0.05µg/m^3) than the regional background levels (7.8µg/m^3) adopted for the modelling.

Table 10-28 Predicted particle and gas concentrations at the nearest sensitive receptors to the Northern Connection

Sensitive receptors		Cumulative model predictions				
		$PM_{2.5}$ (µg/m³)		NO_2 (µg/m³)		CO (µg/m³)
		24 hour	Annual	1 hour	Annual	8 hour
ID	**Objectives**	**25**	**8**	**250**	**62**	**11,000**
NC1	Gregory Terrace - residential	9.31	7.82	20.5	15.04	264.9
NC2	St Joseph's College	9.26	7.81	20.7	15.02	263.5
NC3	Centenary Aquatic Centre	9.11	7.81	20.3	15.02	261.9
NC4	Gregory Terrace - residential	9.11	7.81	20.2	15.02	262.8
NC5	Gregory Terrace - commercial	9.24	7.82	20.7	15.05	265.3
NC6	Bowen Bridge Road - commercial	9.05	7.80	19.5	15.01	261.4
NC7	Brisbane Girls Grammar School	9.25	7.82	20.6	15.05	264.9
NC8	Royal Brisbane Hospital (RBWH)	9.03	7.80	19.3	15.01	260.8
NC9	Mental Illness Fellowship	9.03	7.80	19.3	15.01	260.7

The Legacy Way tunnel ventilation outlet (currently under construction) will be located to the north-west of the ventilation outlet for the Project's Northern Connection and the Inner City Bypass (ICB). The Northern Link EIS (SKM-Connell Wagner JV, 2008) prepared for Legacy Way included detailed air quality modelling of emissions from each ventilation outlet. At the eastern outlet, the maximum contribution to ground level concentrations of $PM_{2.5}$ were predicted to be less than 0.07µg/m^3 (assuming all PM_{10} particulates as $PM_{2.5}$). When combined with the conservatively estimated background (7.8µg/m^3) and the Project's predicted $PM_{2.5}$ emission (0.02µg/m^3), the combined $PM_{2.5}$ concentration would remain below the 8µg/m^3 air quality objective.

10.4.3 Evaluation of significance

Construction impacts

Particles generated through construction works (e.g. excavation and materials handling) are predominantly due to the crushing or abrasion of rock, and most of the emission particle size will be larger than $PM_{2.5}$, of which are most concern in terms of health impacts.

Air quality objectives for the modelling assessment were adopted primarily from the EPP (Air). The purpose of the EPP (Air) is to protect the air quality environment for human health and wellbeing, the health and biodiversity of ecosystems, the aesthetics of the environment and for agricultural use. There are no exceedances of the TSP and PM_{10} air quality objectives predicted by the modelling at each of the sensitive receptors for the Project's construction scenarios modelled. The potential for an increase in human health risk due to the construction of the Project at nearby sensitive receptors is considered to be low.

Coarse particulates (>10µm) have the greater potential to generate potential nuisance primarily as deposited dust and are not considered a health issue. The EPP (Air) does not provide specific objectives for nuisance impacts of particulates. A dust deposition objective of 130mg/m^2/day as a maximum monthly average has been adopted for the management of potential nuisance impacts for the Project. No exceedances of the dust deposition objective are predicted for the Project's construction modelling scenarios at the sensitive receptors.

Operational impacts

Particles size generated through combustion and exhausted to the atmosphere by ventilation systems are likely small to fine but much less concentrated because of the large volumes of exhaust air. The predicted $PM_{2.5}$ and gaseous pollutant concentrations during the operation of the Project are generally well below the ambient air quality objectives in the EPP (Air). The exceptions to this are cumulative predictions of annual $PM_{2.5}$ which are just below the EPP (Air) objective of 8µg/m^3 and includes a background level of 7.8µg/m^3. The contribution to air quality levels from the operation of the Project is predicted to be much lower (to a maximum of approximately 0.2µg/m^3) than the regional background levels adopted for the modelling. As the cumulative impacts from the Project are predicted to be below the relevant air objectives, the health risk due to the operation of the Project is considered to be low.

10.4.4 Benefits of the Project

With the Project in place, the transport modelling forecasts that the north-bound bus services during the peak hour across the Brisbane River remains stable to 2021 (442), with a small increase to 462 in 2031. The most significant growth in bus and rail is in the tunnel itself, with reductions (compared to today) on the Merivale Bridge (rail), Victoria Bridge (bus) and Captain Cook Bridge (bus).

Above the tunnel, the air quality is expected to be better than if an open air road section was situated at the same location. Emissions from vehicles travelling on surface roads are released at ground-level closer to the sensitive receptors than those emissions from a ventilation outlet that are typically released at height. Therefore, the point of emission from the tunnel (at the outlet height) allows a greater potential for the dispersion of the pollutants and reduction of ground level pollutant concentrations because of the distance of the receptors from the source.

Compared to current bus travel on the Victoria Bridge and Captain Cook Bridge, the Project would result in a reduction in the ground level emissions and improvement in air quality at these locations. Air dispersion modelling of the emissions from the ventilation outlets during the operation of the Project has predicted that impacts from the Project are negligible compared with existing background levels of all pollutants modelled. An overall (slight) improvement in regional air quality would be expected from the Project compared to a 'without' Project scenario.

10.5 Impact management

This section identifies mitigation measures which have been regularly and successfully applied to similar large scale projects in order to minimise the potential impacts. Impacts and potential mitigation are listed in **Table 10-29.**

Table 10-29 Impacts and potential mitigation

Impact	Project phase	Management measure
All construction worksite locations	Construction	Prepare and implement an Air Quality Management Plan, as a sub-plan to the overarching Environmental Management Plan (EMP), to achieve environmental outcomes for the duration of construction. Establish baseline air quality data prior to construction, particularly around the Northern Connection (Victoria Park), Woolloongabba, Boggo Road, George Street and Roma Street construction worksites. Installation of hoardings or barriers on worksite perimeters, where appropriate, to help mitigate dust impacts. Installation of worksheds or enclosures for the primary excavation activities. Handle excavated spoil within enclosed work areas, where possible. Work sheds would cover the excavated areas and would allow access and egress of trucks and truck loading operations and stockpiling of excavated tunnel material. Regular watering of exposed areas within the worksites. Sealing of access roads, as much as is practicable, within the construction worksites and ensuring sealed access roads into worksites are kept relatively dust free by regular sweeping and washing, wherever needed. Monitoring meteorological conditions at worksites and spoil placement sites, particularly wind speed and direction. Where winds approach threshold speeds, take measures to avoid impacts on adjacent properties. Ensure adequate ventilation is installed and operated in underground construction works. Conducting demolition activities using appropriate dust controls, such as water sprays. Installing truck wheel wash stations in worksites where space allows or using water blasting, as required, to control the spread of materials from construction worksites. Covering trucks transporting excavated material, to minimise wind-blown dust during transport. Cleaning down loaded trucks prior to exiting worksites, to ensure loose material is not tracked onto the adjacent road network. Implementation of measures for the control of dust (e.g. vacuum and watering) during the removal of equipment in particular, the worksheds at the construction worksites. Develop and implement a complaints management system for capturing and responding to complaints relating to air quality matters. Reasonable and practicable measures to address the potential impact of odour on adjacent properties should be implemented as part of the construction EMP. These include: • identifying and determining the potential for odour impacts at off-site sensitive receptors • conducting works with odorous soils when wind directions are unlikely to affect sensitive receptors • covering odorous, excavated soil stockpiled either on a worksite or a spoil placement site to reduce odour impacts.

Impact	Project phase	Management measure
		The effects of diesel exhaust emissions would be minimised by the following measures: • avoiding queuing of the construction traffic vehicle fleet in the streets adjacent to the worksites which would in turn minimise the amount of exhaust emissions generated during the construction works • marshalling and queuing for trucks and worksite vehicles away from residential areas and other sensitive receptors, where possible • directing exhaust emissions from mobile and stationary plant away from the ground and sensitive receptors, where possible • as much as practicable, minimise the use and intensity of use of diesel engines • for stationary plant and equipment, ensuring all diesel motors are fitted with emission control measures and are regularly maintained to manufacturers' specifications.
	Operation	In the event of an incident, detailed emergency response procedures would be implemented including minimising the impact of any fire and smoke to the community and infrastructure. More detail is in provided in **Chapter 16 - Hazard and risk.**
Greenhouse gas emissions	Construction	Maintain construction plant and equipment and haul trucks in good working order to maximise the fuel efficiency of equipment. Procure energy efficient construction equipment, when appropriate. Use appropriately sized equipment for construction activities. Minimise waste from construction by procuring pre-fabricated products. Where feasible, use low energy intensity materials instead of high energy intensity building materials.
Southern Connection	Construction	Installation of an acoustic shed and enclosure, above the TBM workbox, within the northern worksite. Model predictions were below air quality objectives at all sensitive receptors modelled in close proximity to the Dutton Park Station worksite. However, given the sensitivity of the receiving environment, additional monitoring measures are proposed for this site include: • ongoing dust monitoring at locations adjacent to the worst affected sensitive receptors (further details are discussed in the paragraphs proceeding this table). • acoustic enclosure over the spoil load out facility.
Woolloongabba Station	Construction	Installation of a workshed within the Woolloongabba Station construction worksite. Model predictions were below air quality objectives at all sensitive receptors modelled in close proximity to the Woolloongabba Station worksite. However, ongoing dust deposition sampling will be conducted in each direction from the construction worksite.

Impact	Project phase	Management measure
George Street Station	Construction	Installation of an acoustic shed equipped with a fabric filter for the removal of airborne particulate matter and dust from the primary excavation activities at the George Street worksite. Model predictions were below air quality objectives at all sensitive receptors modelled in close proximity to the George Street worksite. Additional monitoring measures proposed for this site include: • maintaining as far as practical distance from the receptor and any soil disturbance activities • ongoing dust monitoring at a location adjacent to the worst affected sensitive receptors • community consultation and complaints response procedures.
Roma Street Station	Construction	Installation of an acoustic shed equipped with a fabric filter for the removal of airborne particulate matter and dust from the primary excavation activities at the Roma Street construction worksite. Model predictions were below air quality objectives at all sensitive receptors modelled in close proximity to the Roma Street worksite, in particular to the closest residential receptor on Parkland Crescent. Additional management and monitoring measures proposed for this site include: • maintaining as far as practical distance from the receptor and any soil disturbance activities (e.g. vehicle movements) • ongoing dust monitoring at a location adjacent to the Parkland Crescent sensitive receptor • community consultation and complaints response procedures.
Northern Connection	Construction	Model predictions were below air quality objectives at all sensitive receptors modelled in close proximity to the Woolloongabba Station worksite. However, ongoing dust deposition sampling will be conducted in each direction from the worksite.

10.5.1 Monitoring of air quality impacts

Regular monitoring of TSP, PM_{10} and dust deposition levels at the worst affected sensitive receptors adjacent to worksites (or representative locations) would provide a basis for compliance with appropriate objectives. In addition, ongoing monitoring allows adaptive management strategies to be implemented when meteorological monitoring suggests adverse wind conditions or dust monitoring at sensitive receptors indicates levels are near to exceeding air quality objectives. Monitoring requirements are also outlined in **Chapter 18 – Draft Outline EMP**.

Indicative dust sampling and dust monitoring locations around the main construction worksites are provided in **Table 10-30**.

Table 10-30 Indicative dust monitoring locations

Worksite	Indicative dust monitoring locations
Southern Connection	Ongoing dust and meteorological monitoring at the PA Hospital and ESA Village Dust deposition sampling in each direction from the worksite
Woolloongabba Station	Dust deposition sampling in each direction from the worksite
George Street Station	Ongoing dust and meteorological monitoring at the worst affected George Street commercial location Dust deposition sampling in each direction from the worksite
Roma Street Station	Ongoing dust and meteorological monitoring at the Parkland Crescent residential building Dust deposition sampling in each direction from the worksite
Northern Connection	Dust deposition sampling in each direction from the worksite

Air quality monitoring data used to characterise the existing air environment in the study corridor is summarised in **section 10.1**. As shown in **Figure 10-6**, three air quality monitoring stations (QUT Gardens Point, South Brisbane and Woolloongabba) are currently operated as part of the South East Queensland Air Monitoring network within the study corridor. In addition, monitoring of external air in the vicinity of the CLEM7 tunnel is undertaken at four stations adjacent to the CLEM7 tunnel northern and southern ventilation outlets. The continued operation of the monitoring stations from these two networks will provide sufficient information to identify and quantify changes to ambient air quality in the study corridor resulting from the operation of the Project.

10.6 Summary

This chapter describes the existing air quality within the study corridor and assesses the potential benefits and impacts on air quality attributable to the Project. The primary emissions from the construction of the Project are expected to be dust related as airborne and deposited particulate matter. The operation of the tunnel has the potential to generate air quality impacts associated with emissions from buses including combustion related gases and particulate matter.

An air dispersion modelling assessment of the impacts from the construction and operation of the Project has been undertaken. The air dispersion modelling conducted for this assessment has been based on the modelling approach using a combination of TAPM and CALMET as a meteorological pre-processor to the air dispersion model, known as CALPUFF. The CALPUFF model, through the CALMET meteorological processor, simulates complex meteorological patterns that exist in a particular region. The effects of local topography and changes in land surface characteristics are accounted for by this model.

Two scenarios were modelled for the construction phase of the Project representing activities at the five primary worksites (Southern Connection, Woolloongabba Station, George Street Station, Roma Street Station and Northern Connection):

- Scenario 1 **–** where primary excavation activities would be performed by excavators, rock hammers, front end loaders and piling rigs. This scenario was modelled for all stations.
- Scenario 2 **–** included the activities from Scenario 1 plus drill and blast activities for primary excavation. This scenario was modelled for Woolloongabba Station, George Street Station and Roma Street Station.

Concentrations and deposition levels for the primary pollutants associated with the construction and operation of the Project were compared with EPP (Air) objectives for an assessment of human health and nuisance effects. The predicted air quality levels from the construction of the Project were below objectives at the five worksites, with the application of specified mitigation regime. The contribution to air quality levels from the operation of the Project was predicted to be much lower than the conservative regional background levels adopted for the modelling for all five proposed ventilation outlet sites and is therefore not considered a risk to human health. An overall (slight) improvement in regional air quality would be expected from the Project compared to a without Project scenario due to the shift to more effect public transport.

Mitigation measures are also proposed for managing potential impacts, including the establishment of monitoring, communication and complaints systems. Further details are provided in **Chapter 18 – Draft Outline EMP**.