Chapter 10.0 - Climate and Air Quality

Document No.: 60047441_EAR_RP_010_1
J:\Projects\60047441\6. Draft Docs\6.1 Reports\Environment\EAR_FinalDraft_PublicRelease\60047441_EAR_RP_010_1.doc

Table of Contents

List of Tables

List of Figures

10.0 Climate and Air Quality

10.1 Overview

This chapter describes the potential impact of the KBP on air quality within the study area. Given its relevance to the topic, the climate of the area is also described here. The existing environmental values for the area are described, potential impacts of the KBP assessed and potential mitigation strategies presented that may be used to eliminate or reduce the impacts.

10.2 Approach and Methodology

10.2.1 Climate

An assessment of the climate was made from observations at the Australian Bureau of Meteorology (BoM) site at Archerfield. The data was compiled to show average trends in temperature, rainfall, and wind speed and direction.

10.2.2 Air Quality Assessment Methodology

An Air Quality Report for the KBP was prepared by ENSR Australia Pty Ltd (ENSR). The report is based on geometric modelling of the KBP alignment (AECOM 2008) and anticipated traffic numbers (DMR 2007) using established techniques for estimating vehicle emissions and modelling their disbursement in the air around the KBP. It should be noted that the road impacts were assessed outside the existing road corridors and without the presence of noise barriers in the model.

Estimated vehicle emissions for 2016 and 2026 have been determined as part of this assessment. As funding for the construction of the KBP has not been allocated and as such an opening date is yet to be determined. Therefore, the estimation of vehicle emissions for 5 and 10 years after opening has not been calculated. For the purpose of this assessment, 2016 and 2026 are considered appropriate and are consistent with the traffic modelling and noise assessments undertaken to date.

Models are compiled using as much available data as possible concerning characteristics of traffic emissions and their dispersion characteristics and validating them with real world observations. The validation process is complex and detailed, requiring a considerable volume of data. Such models are compiled to simulate real world situations.

Once a model has been compiled and tested as acceptable for use for a particular class of issues, the modeller can use the model with confidence, provided they can define the required range of parameters. This requires sophisticated estimations of the future situation to be modelled. The dispersion model CAL3QHCR was used for this study, with particular attention to the context and scope of the model to the KBP.

The concentration of a pollutant at any defined location is the combination of a number of factors including the relative locations of sources of emission and climatic factors. It is therefore necessary to undertake an analysis of available pollution data to ascertain levels that may be attributable to certain sources and what the background levels are for the location. For this study the data from a number of sites in the Brisbane area were used to estimate the background level of pollutants in the project area. The dispersion modelling results include this assessment of background levels for the KBP.

The broad objective of this chapter is to assess the impact on air quality due to the expected outcomes of the KBP. Consequentially, it is possible to assess whether the project is likely to alter the number of exceedances of air quality standards at sensitive locations, as set by the *National Environment Protection (Ambient Air Quality) Measure* (NEPM (Air)) and *Environmental Protection (Air) Policy 2008* (*EPP (Air)*).

The following steps were undertaken:

- establish baseline conditions and create the model;
- input the adjusted horizontal and vertical alignments and new connections and ramps;

- adjust fleet volumes and composition for the anticipated usage in the target year 2026;
- calculate fleet emissions in the target year in model dispersion in the study area; and
- quantify expected impacts:
  - using an expected concentration contour; and
  - estimating the impact on a list of sensitive receptors identified in the study area.

10.2.3 Ambient Air Quality Criteria

The *EPP (Air*), which commenced on 1 January 2009, is subordinate legislation under the *Environmental Protection Act 1994*. The *EPP (Air)* aims to achieve the objectives of the Act in relation to Queensland's air environment by specifying:

- the environmental values to be protected;
- the air quality indicators or goals to protect the environmental values;
- a framework for making consistent and fair decisions about management of the air environment; and
- involving the community in achievement of the air quality goals.

Goals for the relevant air quality indicators (air pollutants) that are contained in the *EPP (Air)* are summarised in Table 10.1.

Table 10.1: *EPP (Air)* Ambient Air Quality Standards and Goals

Pollutant	Goal	Averaging Period
Criteria Pollutants:		
Carbon Monoxide	8 ppm or 10 mg/m^3	8 hour maximum
Nitrogen Dioxide	0.16 ppm or 320 µg/m^3	1 hour maximum
PM_{10}	150 µg/m^3	24 hour maximum
	50 µg/m^3	Annual Average
$PM_{2.5}$	25 µg/m^3	24 hour maximum
	8 µg/m^3	Annual Average
Air Toxics:		
1,3-Butadiene	2.4µg/m^3	Annual Average
Benzene	0.003 ppm	Annual Average
Benzo(a)pyrene	0.3 ng/m^3	Annual Average
Formaldehyde	0.04 ppm	24 hour maximum
Toluene	4.1 mg/m^3	24 hour maximum
Xylenes	0.25 ppm	24-hour maximum
	0.2 ppm	Annual Average

The National Environment Protection Council defines national ambient air quality standards and goals in consultation, and with agreement from, all State governments. These standards and goals were first published in 1998 in the NEPM (Air). Compliance with the NEPM (Air) standards is assessed via ambient air quality monitoring undertaken at locations prescribed by the NEPM (Air) that are representative of large urban populations. The goal of the NEPM (Air) is for the ambient air quality standards to be achieved at the designated monitoring stations within ten years of its commencement (i.e. in 2008). Although located in urban environments, it should be noted that these stations are not immediately adjacent to major roads.

The standards are not intended to be used to assess the air quality at locations adjacent to major roads and industrial premises. Consequently, the NEPM (Air) Advisory Reporting Standard is a very strict measure and one that is commonly exceeded in urban areas, particularly in close proximity to roads. Improvements in motor vehicle emission standards and fuel quality are key initiatives that have been implemented in Australia that will reduce fine particle levels in the air-shed and particularly in close proximity to roads.

The NEPM standard is expected to be a measure of air quality levels likely to experienced by the general population in a region or sub-region, rather than a limit for any given specific location.

10.3 Description of Existing Environmental Values

10.3.1 Climate

BoM collects meteorological data from sites in the Brisbane area. The closest BoM site to the study area is at Archerfield Airport, approximately six kilometres to the southeast of the KBP. The meteorological data collected from the Archerfield Airport site includes hourly records of temperature, wind speed and direction. A range of long term average data collected from this station is provided in Table 10.2.

The coastal siting and sub-tropical climate of Brisbane result in late morning and afternoon winds dominated by sea-breezes (even on many days in winter for the coastal strip). Although situated on relatively flat ground, Brisbane is a city surrounded by complex terrain, with the D'Aguilar Range to the northwest, Flinders Peak to the southwest and Tambourine Mountain to the south, all situated within 40 kilometres of the city. To the east lies a complex coastline, with several major islands within 20 kilometres of the coast. This topography is known to lead to complex wind patterns. The terrain and the Brisbane River have the potential to lead to both channelling and blocking of local winds.

Temperature

The project area is typical of the region with respect to temperatures, reaching average daily maxima of 29.5°C to 30.3°C in summer and 21.1°C to 22.4°C in winter. Table 10.2 shows the monthly average maximum and minimum temperatures at Archerfield.

Surface Winds

Table 10.3 shows the monthly wind roses at the Archerfield weather station taken over 990 readings in each month in the years from 1939 to 2006 for morning (9am) and afternoon (3pm). Typically the area reflects the coastal trend for lighter breezes in the morning, which pick up to stronger winds in the afternoon. Throughout most of the year the predominant winds are from the eastern sector from north easterlies through to south easterlies, however winter westerly winds can commence in May and continue through to September.

Table 10.2: Climate Statistics Archerfield

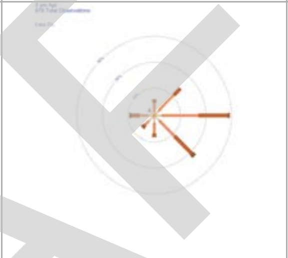
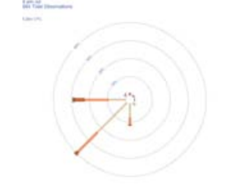
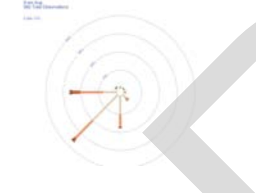
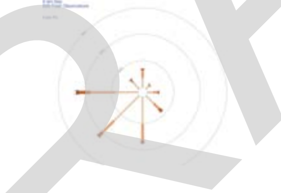
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Temperature													
Mean maximum temperature (°C)	30.3	29.6	28.7	26.4	23.9	21.4	21.1	22.4	25	26.9	28.2	29.5	26.1
Highest temperature (°C)	43.3	41.8	38.7	34.9	31.3	28.9	28.3	32.2	37.8	39.4	40.5	39.8	43.3
Lowest maximum temperature (°C)	21.1	21.1	19.8	17.1	16.4	13.5	11.2	12.3	14.8	17.5	18	19.4	11.2
Decile 1 maximum temperature (°C)	27	26.3	25.7	23.7	21.1	18.4	18.3	19.4	21.6	23.1	24.5	26	
Decile 9 maximum temperature (°C	33.8	33.1	31.6	29.3	26.4	24.1	23.8	25.6	28.9	31.3	32.2	33.3	
Mean number of days >= 30°C	16.4	12.2	8	1.8	0.1	0	0	0.2	1.7	4.9	7.8	13	66.1
Mean number of days >= 35°C	1.4	0.7	0.2	0	0	0	0	0	0.1	0.5	0.6	1.3	4.8
Mean number of days >= 40°C	0.2	0.1	0	0	0	0	0	0	0	0	0	0	0.3
Mean minimum temperature (°C)	20.2	20	18.2	15	11.9	9.2	7.4	7.9	10.9	14.3	16.9	19	14.2
Lowest temperature (°C)	13.7	14.2	10.7	5.3	0.6	-0.8	-2.5	-1.8	-0.4	4.2	7.2	9.8	-2.5
Highest minimum temperature (°C)	27.8	27.1	25.5	22.5	21.7	18.8	19.5	17.3	20.3	22.6	24.3	24.9	27.8
Decile 1 minimum temperature (°C)	16.9	17.2	15.3	11.6	7.3	4.4	3.1	4	6.6	10	13.3	15.6	
Decile 9 minimum temperature (°C)	23.3	23	21.3	18.5	16.4	13.7	12.3	12.6	15.1	18.3	20.1	22.2	
Mean number of days <= 2°C	0	0	0	0	0.1	0.6	2	0.7	0.3	0	0	0	3.7
Mean number of days <= 0°C	0	0	0	0	0	0.1	0.3	0.2	0.1	0	0	0	0.7
Mean daily ground minimum temperature (°C)	17.6	17.6	15.8	12.8	9.5	4.9	3.2	4.2	7.1	10.9	14.1	17.1	11.2
Lowest ground temperature (°C)	10.5	9	7	1.9	-1.8	-6.4	-4.5	-4.3	-1.9	3	4.8	8.5	-6.4
Mean number of days ground min. temp. <= -1°C	0	0	0	0	0.2	2	5.5	2.3	0.4	0	0	0	10.4
Rainfall													
Mean rainfall (mm)	135	152	125	78.7	73.5	66.4	50.3	38.1	35.9	78.1	99.4	125.5	1059.1
Highest rainfall (mm)	622.5	600.2	458	461.6	550.6	494.4	375.1	137.8	114.7	394.6	391.6	444	1964.2
Lowest rainfall (mm)	10.4	17	3.6	5.2	3.8	0.8	0	0	0.4	1.3	1.3	16.1	510.7
Decile 1 monthly rainfall (mm)	32.6	41.9	19.6	16.5	12	7	4.3	8.9	3.4	25.1	23	38.8	665
Decile 5 (median) monthly rainfall (mm)	118.3	113.9	116.4	51.1	45.6	39.6	33.1	29.2	27	69.1	78.6	105.6	1036.6
Decile 9 monthly rainfall (mm)	262.2	322	243	166.8	169.2	187	118.1	79.6	73.9	143	192.4	238	1456.5
Highest daily rainfall (mm)	186	343.7	192	163.1	182.6	174.8	158.8	66.8	57.7	117.9	161	113.8	343.7

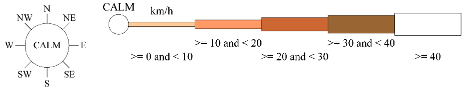
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Mean number of days of rain	11.5	12.3	12.9	9.9	9.1	7.1	6.2	5.9	5.9	8.6	9.7	10.8	109.9
Mean number of days of rain >= 1 mm	9.1	9.8	9.7	7.6	6.6	5	4.5	4.3	4.3	6.5	7.8	8.7	83.9
Mean number of days of rain >= 10 mm	3.7	3.5	3.2	2	1.8	1.4	1.3	1.1	1.2	2.4	2.8	3.8	28.2
Mean number of days of rain >= 25 mm	1.6	1.6	1.5	0.7	0.6	0.6	0.4	0.3	0.2	0.8	1.1	1.6	11
Sun, Wind Cloud													
Mean daily wind run (km)													
Maximum wind gust speed (km/h)	95	76	72	76	68	97	82	97	85	102	115	143	143
Mean daily solar exposure (MJ/(m*m))	23.9	21.1	19.7	16.6	13.3	11.9	13.2	16	19.7	21.7	23.5	24.5	18.8
Mean number of clear days	5.4	3.4	6.4	9.4	10.7	13.2	15.9	15.8	16.5	11.1	7.6	6.2	121.6
Mean number of cloudy days	11.4	12.5	10.4	9.6	8.7	7.7	5.7	5.6	4.3	7.7	9.6	11.2	104.4
Mean 9am temperature (°C)	25.7	25.1	23.7	20.8	17.4	14.3	13.3	15	18.7	21.8	23.7	25	20.4
Mean 9am wet bulb temperature (°C)	21.4	21.4	20.2	17.7	14.9	12	10.8	12	14.6	17.2	18.9	20.5	16.8
Mean 9am dew point temperature (°C)	19.1	19.2	18	15.8	13.2	9.7	8.3	8.9	11	13.7	15.3	17.6	14.2
Mean 9am relative humidity (%)	66	69	70	72	75	74	71	67	62	60	61	64	68
Mean 9am cloud cover (oktas[1])	4.9	5.2	4	3.8	3.3	3.1	2.6	2.4	2.6	3.6	4.2	4.7	3.7
Mean 9am wind speed (km/h)	11.6	11	10.7	10.4	9.8	10.3	10.2	10.4	10.7	11.3	12	11.5	10.8
Mean 3pm temperature (°C)	28.8	28.2	27.1	25	22.8	20.5	20.3	21.3	23.6	25.1	26.3	27.7	24.7
Mean 3pm wet bulb temperature (°C)	22.4	22.3	21.2	18.8	16.8	14.7	13.7	14.3	16.2	18.4	19.8	21.4	18.3
Mean 3pm dew point temperature (°C)	18.8	18.7	17.3	14.6	12.2	9.1	7.1	7.4	9.8	13.1	15	17.3	13.4
Mean 3pm relative humidity (%)	55	57	56	54	53	50	45	44	44	50	52	54	51
Mean 3pm cloud cover (oktas)	4.6	5.3	4.7	4.3	3.9	3.6	3.1	3.2	2.9	3.6	4	4.3	4
Mean 3pm wind speed (km/h)	20.8	19.2	18.7	16.9	14.1	14.2	15.1	18.1	21.4	22.2	22.2	21.9	18.7

---

[1] Cloud cover is measured visually by estimating the fraction (in eighths or oktas) of the dome of the sky covered by cloud. A completely clear sky is recorded as zero okta, while a totally overcast sky is 8 oktas. The presence of any trace of cloud in an otherwise blue sky is recorded as 1 okta, and similarly any trace of blue in an otherwise cloudy sky is recorded as 7 oktas.

Table 10.3: Monthly Wind Conditions at Archerfield

	January	February	March	April	May	June
Morning Averages (9am)						
Afternoon Averages (3pm)						
	July	**August**	**September**	**October**	**November**	**December**
Morning Averages (9am)						
Afternoon Averages (3pm)						



Rainfall

Table 10.2 shows the rainfall data for Archerfield. It indicates the rainy season through the summer months commencing in late November and sometimes persisting through to March. Rain in this period is characterised by afternoon storm events, often with significant downpours. Through the rainy season (November to March) rainfall events happen on less than one day out of three. Through the drier months of July and August on average there are only 4-5 rain events per month.

In recent years, there has been a period of drought with drier than usual rainy seasons; however, in the summer of 2007/8, there was a return to more normal rain patterns as shown in Table 10.4. This increased rainfall through the recent summer months has been associated with what has become to be known as the La Nińa (as opposed to El Nińo) effect. Global indicators such as the Southern Oscillation Index suggest that these conditions are likely to continue for the foreseeable future.

Table 10.4: Rainfall in the 2007/8 Summer Months at Archerfield

Month	Recorded Rainfall 2007/2008 (mm)	Recorded Rainfall 2008/2009 (mm)	Long Term Monthly Average (mm)
November	81.6	264	99.4
December	54.8	95.8	125.5
January	182.2	37.4	135.0
February	155.6	>118[2]	152.0
March	53.4		125.0

10.3.2 Traffic Emissions and Impact in South East Queensland

In the SEQ Region, motor vehicles have been estimated to contribute 62% of oxides of nitrogen, 68% of carbon monoxide and 67% of volatile organic compounds (VOC)[3] from anthropogenic sources (EPA & BCC, 2003). Motor vehicles also contribute 27% of all anthropogenic particles (as PM_{10})[4] with a disproportionately high contribution (75%) being due to heavy diesel vehicles. The total amount of air pollutants emitted depends in part on the total number of kilometres travelled by motor vehicles (vehicle kilometres travelled, VKT) and the amount of pollutants that each vehicle emits. VKT in the SEQ Region was estimated to increase by between 10%-17% in the years from 2000 to 2005 and by 30%-60% by 2011 (DMR 2007).

As the vehicle fleet gradually modernises, an ever-increasing proportion of vehicles will comply with the tighter vehicle emissions standards that have recently been implemented in Australia (Australian Design Rule (ADR) 79/01 for light vehicles and ADR 80/01 for heavy vehicles). This shift towards a more modern fleet will lead to a substantial reduction in emissions over time. However, it is possible that the reductions in total vehicle emissions achieved will be matched and perhaps overtaken by the increase in total vehicle emissions associated with a growing VKT and the expansion of the motor vehicle fleet. From a public health perspective, regional air quality monitoring in Brisbane indicates that the last ten years have seen a small improvement or stabilisation in air quality, with fewer regional events likely to affect people who are sensitive to pollution (Katestone 2004).

High pollution events tend to occur on days with particular meteorological conditions, the frequency of which can change dramatically from year to year. The air quality monitoring data from Brisbane suggest that meteorological variability and particularly the inland penetration of sea-breezes is very important to the occurrence of pollution-conducive days. If the changing traffic emission control technologies do not keep pace with the increase in traffic use in Brisbane or if congestion worsens, then the past 10 years may not be a good predictor of the future (Katestone 2004).

---

[2] Complete data for February and March 2009 were not available at the time of reporting.

[3] Volatile Organic Compounds (VOC) are a group of chemicals that exist in the air as trace vapours. In vehicle emissions they result from incomplete combustion of fuels in engines.

[4] PM_{10} are suspended aerosol particles or droplets with a specific diameter of 10 microns or less.

On a local level, within 100 metres of busy roads, air pollution hotspots may exist particularly during the morning and afternoon peak hours. These are more likely for locations in close proximity to congested intersections with queuing traffic or where a significant proportion of the traffic is heavy diesel vehicles. In the mid 1990s, Neale and Wainwright (2001) found high concentrations of carbon monoxide and PM_{10} at monitoring points between one and 20 metres from the edge of various roads and intersections in Brisbane. Existing road corridors (within land boundaries) are not included in this air quality reporting.

10.3.3 Air Pollutants of Concern Associated with Motor Vehicles

The major air pollutants associated with motor vehicles are summarised in Table 10.5. The main pollutants of concern are nitrogen dioxide and benzene and particulate matter, both PM_{10} and its sub component $PM_{2.5}$. The importance of benzene is likely to decrease in the next few years as the benzene content of fuel is reduced nationally. Table 10.5 lists the emission rates in SEQ in tonnes/year. The relationship between VKT and pollutant emissions has been considered by vehicle type in Figure 10.1 (Neale & Wainwright 2001).

Table 10.5: Traffic Air Pollutants of Concern in SEQ

Air pollutant	Emission rate[5] (tonnes/annum)
Nitrogen dioxide	60,579
Carbon monoxide	417,317
Sulphur dioxide	1,871
PM_{10}	2,249
$PM_{2.5}$	Not available
Total VOC	83,167
Benzene	2,277
Toluene	3,583
1,3-Butadiene	415

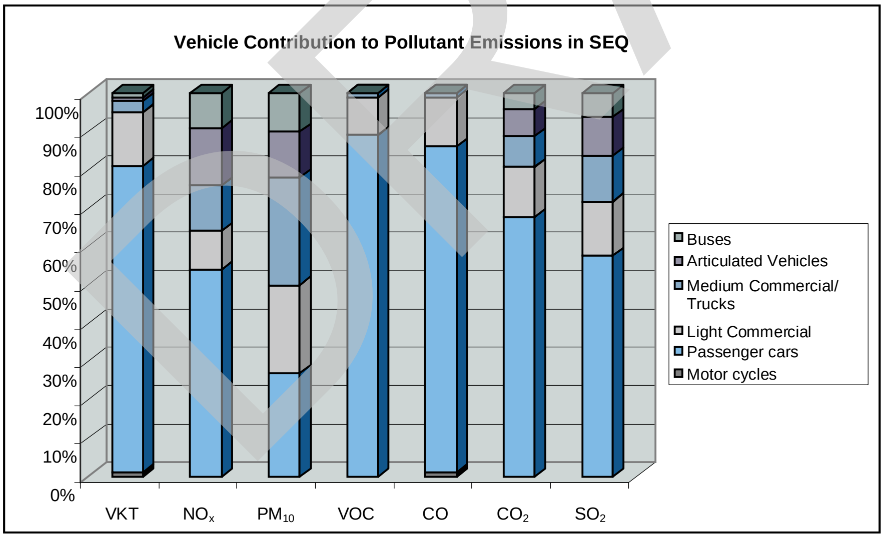


Figure 10.1: Vehicle Contribution to Pollutant Emissions in SEQ

---

[5] Emission rate from SEQ Inventory.

10.3.4 Background Air Quality

The major factors of the existing environment that can influence the level of air pollutants adjacent to a roadway include:

- location or proximity of sensitive receptors to the roadway;
- existing air quality due to regional sources of air pollution;
- elevated ambient concentrations of air pollutants, which reduce the capacity of the area to absorb additional air pollutants;
- elevated levels of reactive pollutants such as ozone, which will increase the rate of transformation of nitric oxide to nitrogen dioxide;
- climatic conditions;
- terrain features; and
- presence of other air pollutant sources such as service stations or commercial and industrial facilities that can emit the same air pollutants as motor vehicles.

Air quality at receptor locations will depend on the proximity to roads and industry. For receptors close to main roads during peak hours vehicle emissions will be the primary source of air pollution. Air quality at locations more than 500 metres from existing roads will be dominated by any local activities (e.g. industrial sources) or by the mix of regional air pollutant sources.

The EPA operates ambient air monitoring stations as part of the SEQ air monitoring network. The closest EPA monitoring station to the study area is in Rocklea, approximately eight kilometres to the southeast. The Rocklea station was established as part of the original monitoring network in 1978. The site is located in an open area of the former Department of Primary Industries and Fisheries' Animal Husbandry Research Farm and is surrounded by light industry and residential areas, which could be considered as representative of regional air quality. A variety of pollutants are monitored at Rocklea station, including the pollutants of concern in this study such as nitrogen oxides, PM_{10}, and $PM_{2.5}$.

Carbon monoxide is not measured at Rocklea but this and other pollutants emitted from motor vehicles are measured at the EPA monitoring station at South Brisbane. This station is located adjacent to the Southeast Freeway and was established in 2001. This site provides information on air quality typically experienced at the boundary of major traffic corridors in SEQ. Air pollutant concentrations collected at this station need to be considered carefully when used for impact assessments. Using this data could result in overestimates of cumulative pollutant concentration since the measured ambient data may have levels of vehicle pollutants higher than what could be considered as normal regional background. This, in effect, could result in double counting of vehicle pollutants when cumulative concentrations are calculated. However, as a screening approach this methodology is considered appropriate as it results in conservative estimates of cumulative concentrations.

Summary data for 2006 from the two monitoring stations discussed above is provided in Table 10.6.

Table 10.6: Collation of Air Quality Parameters from Relevant EPA Monitoring Sites

Pollutant	Averaging period	South Brisbane	Rocklea
Nitrogen dioxide (µg/m³)	1 hour (95th percentile)	N/A	41
	Annual average	N/A	16
Carbon monoxide (ppm)	8 hour (95th percentile)	1.0	N/A
PM_{10} (µg/m³)	24 hour (95th percentile)	31	27
	Annual average	20	16
$PM_{2.5}$ (µg/m³)	24 hour (95th percentile)	N/A	11
	Annual average	N/A	6

Based on the summarised data listed above, the background pollutant concentrations used by this impact assessment are as follows:

- NO_2 1 hour maximum – 41 µg/m³
- CO 8 hour maximum – 1 ppm
- PM_{10} 24 hour maximum – 27 µg/m³
- PM_{10} annual average – 16 µg/m³
- $PM_{2.5}$ 24 hour maximum – 11 µg/m³
- $PM_{2.5}$ annual average – 6 µg/m³

No background pollutant concentrations have been used for the air toxics; their baseline concentrations are assumed to be zero.

10.4 Air Modelling

10.4.1 Project Alignment

The current alignment design at the time of modelling (dated October 2008) was used to estimate the potential air quality impacts of the KBP.

10.4.2 Road and Traffic Data

Traffic usage of the KBP was extracted from the 2007 DMR report entitled ‘*Kenmore Bypass Traffic Need/Benefit Assessment’*.

A total of 70 links were modelled in the assessment, including 35 inbound and 35 outbound. A link is a segment that may represent an entire road or a portion of the road that has a break in it (thereby defining a new link segment) due to the presence of a stoplight, an intersection, a bend in the road or a significant change in the road gradient.

Surface elevations provided by AECOM were used to estimate the gradient for all links included in the modelling.

10.4.3 Receptor Grids

In order to describe the impacts of an emission source on a surrounding area it is usual to describe a number of locations around it as potential receptors. The model then calculates the concentrations of the studied pollutants at each receptor. It is important to remember that although they are described as receptors they are merely designated locations in proximity to the source, as opposed to sensitive receptors, which are specifically designed to determine impacts at defined properties.

A grid of receptors that follows the length of the study area was applied over seven sections of the roadway. Receptors were situated on a 25 metre grid spacing with a total of 7,200 receptors. Figure 10.2 shows the receptor grids.

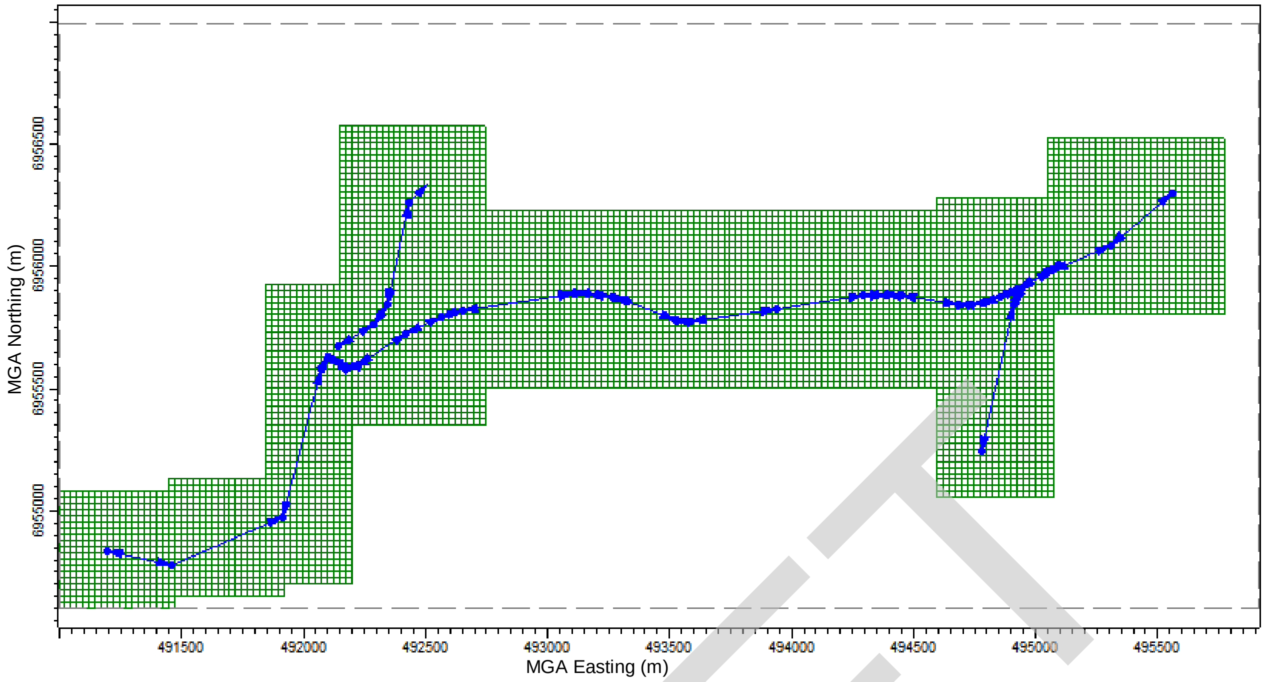


Figure 10.2: Receptor Grids

10.4.4 Sensitive Receptors

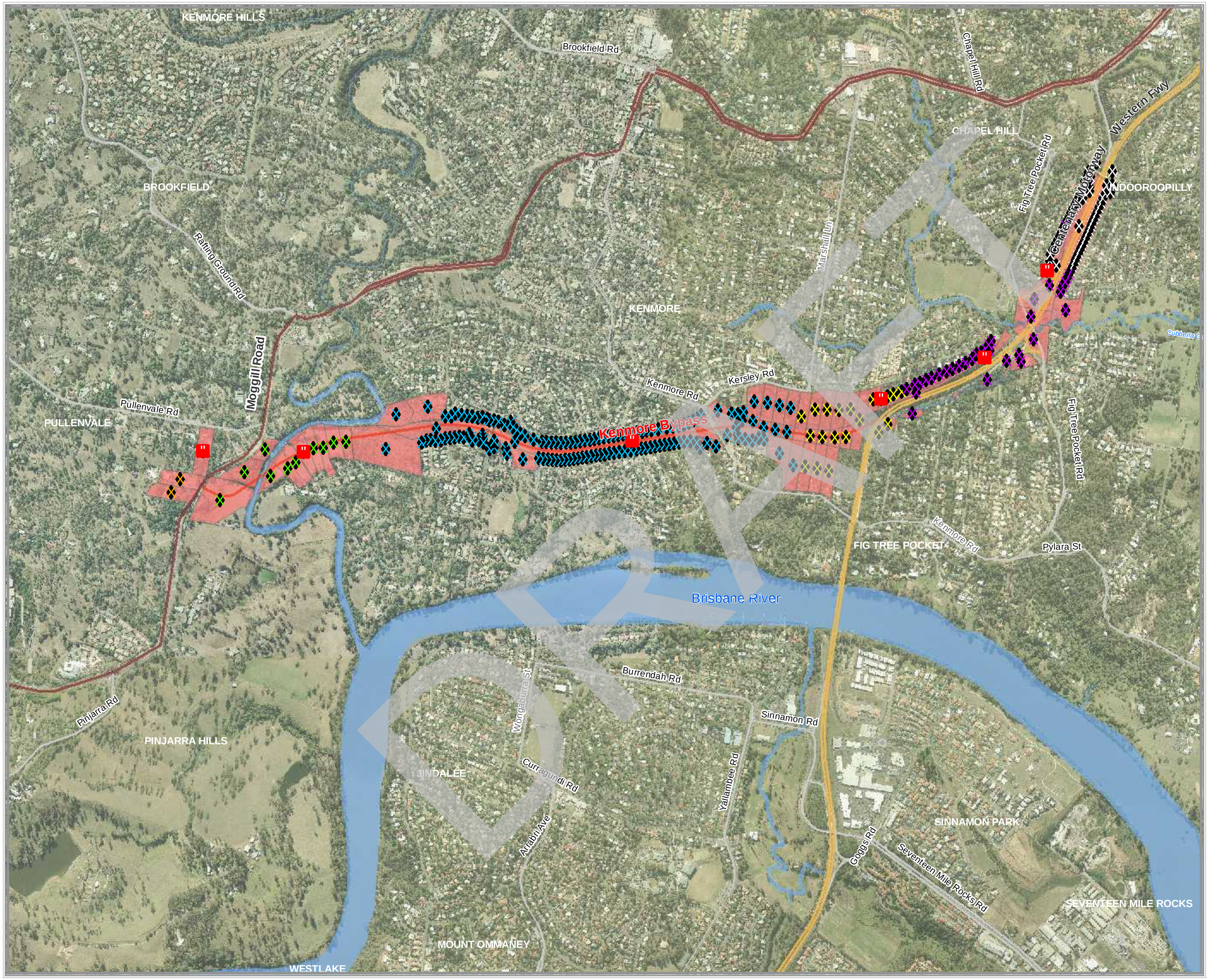
For this study, sensitive receptors have been defined as any property adjacent to the corridor and locations of public gathering or interest within 300 meters of the centreline. Two hundred and sixty three (263) sensitive receptors were defined for the corridor. The point used to characterise a sensitive receptor in the model is the geometric centroid of the lot, which may not always correlate exactly with the location of buildings.

For the purposes of reporting, the sensitive receptors were combined into six groups, based on their clustering around the alignment. A description of each group is given in Figure 10.3.

Table 10.7: Receptor Groups

Sensitive Receptor Group	Description
Group 1	Western End – Moggill Road
Group 2	Moggill Creek Floodplain
Group 3	Central group (most of the alignment)
Group 4	Kersley Road/Kenmore Road
Group 5	Centenary Motorway to Fig Tree Pocket interchange
Group 6	Centenary Motorway north of Fig Tree Pocket

J:\Projects\60047441\4. Tech Work Area\4.7 GIS\GIS data\Workspaces\Map_Edits_May_09_SB\60047441_Fig7_2_SB.mxd



AECOM

1:15,000 (when printed at A3)

Date - 13 May 2009

GDA
MGA94 Zone 56

Legend

Data sources:
Roads, railway, rivers etc - Copyright 2006, MapData Sciences PTY LTD, PSMA

Aerial Imagery:
Copyright Qasco Surveys Pty Limited (2005).

Air Quality Information provided by ENSR Australia, Brisbane for the Kenmore Bypass Environmental Study.

KENMORE BYPASS
AIR QUALITY

Sensitive Receptor Groups

Figure 10.3

10.4.5 Emissions Estimation

10.4.5.1 Overview

The primary factors that influence emissions from vehicles include the mode of travel, the grade of the road and the mix or type of vehicles on the road. It is important to estimate pollutant emissions using as much information as is known about these factors.

The general approach to derive total pollutant emissions from a road section is simply to multiply the total number of vehicles on the road section by the pollutant emission per vehicle (the emission factor). Pollutant emission factors are typically provided in units of grams/kilometre or sometimes as grams/hour. There are a number of sources of these emission factors.

10.4.5.2 Fleet Composition

The fleet composition used for emissions estimation was based on the Australian Bureau of Statistics (ABS), *Motor Vehicle Census – 2001* and *Motor Vehicle Census – 2005*. Inherent in the future year scenarios is the fleet composition in terms of vehicle type, vehicle vintage and fuel type and its change, which is expected to occur over time. The change in fleet composition was derived from future year scenarios projected in the SEQ Air Emissions Inventory and based on the ABS information accounting for a take up rate of new vehicles of 3.5%/annum and the reduction in the existing vehicles reported in the ABS data.

10.4.5.3 Criteria Pollutants

Emission factors for this project have been derived from the *Emission Factors in Road Tunnels: Vehicle Emissions and Air Demand for Ventilation*, published by the Permanent International Association of Road Congress (PIARC 2004). These emission factors, which account for the effect of road gradients, vehicle speeds and emission standards, have been modified according to Australian Design Standards and the SEQ region air emissions inventory in accordance with the methodology employed by Holmes (2004).

Changes in fleet emissions between 2008 and 2026 were accounted for by estimating the gradual loss of older vehicles from the fleet, which have relatively high emissions (and conform to old ADR), and the up take of new vehicles into the fleet, which have lower emissions and conform to current ADR. No account has been taken of the additional reductions in fleet emissions that could occur due to the tightening of ADR after 2006. It was assumed that 6% of all vehicles were diesel vehicles.

Vehicle types were defined as follows:
- passenger cars using petrol;
- passenger cars using diesel; and
- heavy goods vehicles using diesel.

Ageing factors for vehicles with catalytic converters have been included in the calculations. Also, the assumed weight of heavy vehicles has been taken to be 20 tonne, which is used for adjustment of heavy vehicle emission factors.

PM_{10} from brake and tyre wear has been taken to be 0.0089 g/km (Carnovale & Tilly 1995).

Table 10.8 presents an average of the emission factors for PM_{10}, NO_x and CO derived for the KBP for 2016 and 2026. This data represents the average emission factors per pollutant derived for a total of 70 inbound and outbound KBP links (or sections) each year accounting for the effect of road gradients and vehicle speeds combined with emission standards and projected Queensland fleet composition. For comparison, those generated by the SEQ Region Air Emissions Inventory for 2011 are provided.

Table 10.8: Comparison of SEQ Emissions and PIARC

	Year	CO	NO_x	PM_{10}
SEQ Emissions Inventory (EPA & BCC 2004) Vehicle running mode at average speed of 50 km/hr (g/veh.mile)	2011	5.54	1.58	0.07
Calculated emissions using PIARC Vehicle running mode at average speed of 80 km/hr (g/veh.mile)[6]	2016	4.6	1.6	0.07
	2026	3.7	0.7	0.05

It is noted that, due to the availability of data, there is a difference in the years and vehicle speeds that the data were derived for. However, it can be seen that average emission factors calculated using PIARC are generally close to the SEQ Emissions Inventory data with only NO_x being slightly higher.

The emission rate of $PM_{2.5}$ has been calculated from PM_{10} assuming that 50% of PM_{10} is in the form of $PM_{2.5}$. This is slightly higher than the ratio of 44% for the EPA monitoring data from the Rocklea site but considered by ENSR to be a suitable ratio erring on the side of conservatism.

10.4.5.4 Air Toxics

Emission factors for the air toxics were calculated using the same methodology used in the North-South Bypass Tunnel air quality study (Holmes 2004). The approach to assessing these pollutant concentrations has been based on the assumption that there is an association between carbon monoxide and volatile organic compound emissions in the exhaust. Speciation factors based on the National Pollutant Inventory data for volatile organic compounds have then been applied to derive likely emissions of the air toxics considered.

Table 10.9: Speciation Factors for Air Toxics

Substance	Fraction of CO emission
1,3-Butadiene	4.6×10^{-4}
Benzene	4.66×10^{-3}
Benzo(a)pyrene	3.46×10^{-7}
Formaldehyde	1.56×10^{-3}
Toluene	7.42×10^{-3}
Xylenes	5.37×10^{-3}

10.4.6 Dispersion Modelling

10.4.6.1 Overview

The air dispersion modelling conducted for this assessment has been based on the modelling approach using The Air Pollution Model (TAPM) and CALMET as a meteorological pre-processor to the air dispersion model, Cal3QHCR. The data that was available for this project and the data processing methodologies that were required in order to implement Cal3QHCR is discussed below.

The concentration of any air quality parameter estimated at a given point is the sum of influences from a variety of sources and activities that occur within a given region or air-shed. As such it is a challenge to model the influences of one particular activity and predict concentrations at a given point.

It should be noted that the actual air quality parameters experienced within the modelled area at any given time can vary noticeably from the estimated levels. This is due to natural fluctuations caused by factors such as temperature, surface winds, rainfall as well as seasonal variations in traffic flows and composition.

---

[6] This data has been adopted for this study.

In order to allow for these combined influences the modeller will use baseline data which reflects the environment, in this case baselines from a busy urban environment (Rocklea) has been used. Further, the modelling undertaken here attempts to take into account other activities such as movements on other roads, to best reflect the impacts at specific locations in the context of the other influences in the air shed.

10.4.6.2 TAPM

TAPM is a three-dimensional meteorological and air pollution model developed by the CSIRO Division of Atmospheric Research.

TAPM solves the fundamental fluid dynamics and scalar transport equations to predict meteorology and (optionally) pollutant concentrations. It consists of coupled prognostic meteorological and air pollution concentration components. The model predicts airflow important to local scale air pollution, such as sea breezes and terrain induced flows, against a background of larger scale meteorology provided by synoptic analyses.

Upper air data were generated over the study region using TAPM. The TAPM generated upper air data and observed surface meteorological data were entered into the CALMET diagnostic meteorological model, which is discussed below.

Data assimilation ensures that as much observational data as possible is used to produce this numerical generated data in order to guide the model towards accurate predictions of the meteorological conditions in areas where observational data is available. This data assimilation process attempts to minimise potential errors and to give confidence in numerical output used to represent meteorological conditions at points within the domain that are not represented by field stations as part of an existing monitoring network.

10.4.6.3 CALMET

CALMET is a meteorological pre-processor that provides the meteorological inputs suitable for running in the Cal3QHCR dispersion model (Scire et al 2000b). It creates a fine resolution, three-dimensional meteorological field and includes a wind field generator that takes into account slope flows and terrain channelling and 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.

Prognostic data produced by TAPM at upper level was input into CALMET. Observational data from regional meteorological sites operated by the BoM and the EPA were used in deriving CALMET input. The BoM observational stations at Archerfield and Brisbane Airport were used in conjunction with wind speed and direction data collected by the EPA at Rocklea.

10.4.6.4 Cal3QHCR

Cal3QHCR is one of a number of models in the CALINE series that are steady-state dispersion models that can determine pollutant concentrations at receptor locations downwind of ‘at grade’, ‘fill’, ‘bridges’ and ‘cut section’[7] roads located in relatively uncomplicated terrain. It requires a range of input data including meteorology, road layout, queuing information, hourly traffic load estimates, hourly emission rates, signal light sequencing and road gradients.

Meteorological data used as input into Cal3QHCR includes wind speed, wind direction, stability class, ambient temperature and mixing height. Stability classification is a measure of the atmospheric turbulence where Class A represents very unstable atmospheric conditions that may typically occur on a sunny day. Class F represents very stable atmospheric conditions which typically occur during light wind conditions at night. During unstable conditions (stability class A to C) atmospheric turbulence caused by solar heating of the ground is greater and is responsible for the degree of dispersion. Dispersion processes for the most frequently occurring Class D conditions are dominated by

---

[7] The term “at grade” means that the road is at the same level as the surrounding terrain, roads “in cut” are below ground level and “in fill” above it.

mechanical turbulence generated as the wind passes over irregularities in the local surface. The higher wind speeds associated with Class D conditions generally result in lower ground-level concentrations than classes A to C. During the night, the atmospheric conditions are predominantly stable (Class E and F). Table 10.10 shows the frequency of stability classes determined from the Cal3QHCR meteorological file.

Table 10.10: Frequency of Occurrence (%) of Surface Atmospheric Stability Conditions

Pasquill-Gifford Stability Class	Frequency (%)	Classification
A	0.01	Extremely unstable
B	8.2	Unstable
C	14.5	Slightly unstable
D	50.0	Neutral
E	15.9	Slightly stable
F	11.4	Stable

Other model parameters

In addition to the input data discussed in the previous sections, other values of the parameters used in Cal3QHCR are given in Table 10.11.

Table 10.11: Other Modelling Parameters

Parameter	Value
Surface roughness (cm)	100
Urban/Rural Setting	Urban
Receptor height (m)	1.8
Source height (m)	0
Mixing zone width – free lane	3 metres/lane + an additional 6 metres

Modelling Outcomes

In order to represent the outcomes of the modelling with respect to the sensitive receptors, which were grouped as per Figure 10.3, the highest expected concentration for each parameter was recorded in each group with the receptor at which it is expected. This information is summarised in Table 10.12.

It is important to note that the dispersion modelling results that are presented are based on the maximum concentration of each air pollutant as predicted at the receptors over a one year period and thus represent a worst-case scenario. The contour plots are constructed such that at each point in the domain the maximum value is obtained and stored. As these maximum values may occur at different times for receptors at different locations these figures do not represent a single snapshot of conditions at any given time.

Table 10.12: Air Modelling Outcomes – 2016

	Averaging Period	Units	Standard / Goal	Receptor Group 1		Receptor Group 2		Receptor Group 3		Receptor Group 4		Receptor Group 5		Receptor Group 6	
Air Quality Parameters				Reading	Location[8]	Reading	Location[8]	Reading	Location[8]	Reading	Location[8]	Reading	Location[8]	Reading	Location[8]
NO_2	1 hour	µg/m^3	250	48	492106, 6955778	50	492528, 6955774	58	493907; 6955850	92	494951, 6955997	83	495387, 6956169	43	495647, 6956534
NO_2	annual	µg/m^3	62	18	492106, 6955778	18	492281, 6955689	19	494164, 6955906	34	494951, 6955997	31	495409, 6956200	16	495647, 6956534
CO	8 hour	ppm	9	1.0	n.a.[9]	1.0	n.a[9]	1.0	n.a. [9]	1.2	494918; 6955856	1.3	495387, 6956169	1.0	n.a. [9]
PM_{10}	24 hour	µg/m^3	50 [10]	28	492106, 6955778	27	492281, 6955689	28	493907, 6955820	32	494951, 6955997	32	495387, 6956169	27	495647, 6956534
$PM_{2.5}$	24 hour	µg/m^3	25	11	492106, 6955778	11	492281, 6955689	12	493907, 6955820	13	494951, 6955997	14	495387, 6956169	11	495647, 6956534
$PM_{2.5}$	annual	µg/m^3	8	6.1	492012, 6955660	6.1	492528, 6955774	6.4	493907, 6955820	7.2	494951, 6955997	7.5	495387, 6956169	6	495647, 6956534
Air Toxics															
1,3 butadiene	annual	µg/m^3	2.4	0.008	492106, 6955778	0.05	492281, 6955689	0.02	493123, 6955923	0.06	494951, 6955997	0.07	495387, 6956169	0.001	495647, 6956534
benzene	annual	µg/m^3	10	0.07	492106, 6955778	0.05	492281, 6955689	0.2	493123, 6955923	0.6	494951, 6955997	0.5	495387, 6956169	0.014	495647, 6956534
toluene	24 hour	µg/m^3	4100	0.3	492106, 6955778	0.13	492528, 6955774	0.5	493123, 6955923	1.8	494951, 6955997	1.9	495387, 6956169	0.04	495647, 6956534
toluene	annual	µg/m^3	410	0.1	492106, 6955778	0.08	492281, 6955689	0.3	493123, 6955923	0.9	494951, 6955997	1.1	495387, 6956169	0.02	495647, 6956534
xylenes	24 hour	µg/m^3	1200	0.19	492106, 6955778	0.09	492528, 6955774	0.4	493123, 6955923	1.3	494951, 6955997	1.4	495387, 6956169	0.03	495647, 6956534
xylenes	annual	µg/m^3	950	0.09	492106, 6955778	0.06	492281, 6955689	0.2	493123, 6955923	0.6	494951, 6955997	0.8	495387, 6956169	0.02	495647, 6956534
formaldehyde	24 hour	µg/m^3	54	0.05	492106, 6955778	0.02	492654, 6955813	0.11	493123, 6955923	0.4	494951, 6955997	0.4	495387, 6956169	0.009	495647, 6956534
benzo(a)pyrene	annual	µg/m^3	0.3	0.006	492106, 6955778	0.004	492281, 6955689	0.014	493123, 6955923	0.04	494951, 6955997	0.05	495387, 6956169	0.001	495647, 6956534

Table 10.13: Air Modelling Outcomes – 2026

	Averaging Period	Units	Standard / Goal	Receptor Group 1		Receptor Group 2		Receptor Group 3		Receptor Group 4		Receptor Group 5		Receptor Group 6	
Air Quality Parameters				Reading	Location [8]	Reading	Location [8]	Reading	Location [8]	Reading	Location [8]	Reading	Location [8]	Reading	Location [8]
NO_2	1 hour	µg/m^3	250	44	492106, 6955778	45	492528, 6955774	48	493907; 6955850	65	494951, 6955997	61	495387, 6956169	42	495647, 6956534
NO_2	annual	µg/m^3	62	17	492106, 6955778	17	492281, 6955689	17	494164, 6955906	25	494951, 6955997	23	495409, 6956200	16	495647, 6956534
CO	8 hour	ppm	9	1.0	n.a. [9]	1.0	n.a. [9]	1.0	n.a. [9]	1.0	494918; 6955856	1.7	495387, 6956169	1.0	n.a. [9]
PM_{10}	24 hour	µg/m^3	50 [10]	27	492106, 6955778	27	492281, 6955689	28	493907, 6955820	30	494951, 6955997	31	495387, 6956169	27	495647, 6956534
$PM_{2.5}$	24 hour	µg/m^3	25	11	492106, 6955778	11	492281, 6955689	12	493907, 6955820	13	494951, 6955997	13	495387, 6956169	11	495647, 6956534
$PM_{2.5}$	annual	µg/m^3	8	6.1	492012, 6955660	6.1	492528, 6955774	6.4	493907, 6955820	6.9	494951, 6955997	7.1	495387, 6956169	6	495647, 6956534
Air Toxics															
1,3 butadiene	annual	µg/m^3	2.4	0.003	492106, 6955778	0.03	492281, 6955689	0.009	493123, 6955923	0.02	494951, 6955997	0.02	495387, 6956169	0.001	495647, 6956534
benzene	annual	µg/m^3	10	0.03	492106, 6955778	0.04	492281, 6955689	0.13	493123, 6955923	0.2	494951, 6955997	0.2	495387, 6956169	0.005	495647, 6956534
toluene	24 hour	µg/m^3	4100	0.1	492106, 6955778	0.09	492528, 6955774	0.15	493123, 6955923	0.7	494951, 6955997	0.64	495387, 6956169	0.02	495647, 6956534
toluene	annual	µg/m^3	410	0.05	492106, 6955778	0.06	492281, 6955689	0.1	493123, 6955923	0.3	494951, 6955997	0.4	495387, 6956169	0.008	495647, 6956534
xylenes	24 hour	µg/m^3	1200	0.07	492106, 6955778	0.08	492528, 6955774	0.08	493123, 6955923	0.5	494951, 6955997	0.5	495387, 6956169	0.01	495647, 6956534
xylenes	annual	µg/m^3	950	0.003	492106, 6955778	0.04	492281, 6955689	0.07	493123, 6955923	0.3	494951, 6955997	0.3	495387, 6956169	0.006	495647, 6956534
formaldehyde	24 hour	µg/m^3	54	0.02	492106, 6955778	0.02	492654, 6955813	0.03	493123, 6955923	0.14	494951, 6955997	0.14	495387, 6956169	0.003	495647, 6956534
benzo(a)pyrene	annual	µg/m^3	0.3	0.002	492106, 6955778	0.002	492281, 6955689	0.005	493123, 6955923	0.02	494951, 6955997	0.02	495387, 6956169	0.0004	495647, 6956534

---

[8] MGA Easting (m) - MGA Northing (m). This receptor location is where the highest concentration within the sensitive receptor group occurred.

[9] Not applicable. All CO concentrations at the sensitive receptors modelled in these receptor groups were predicted to be very similar (i.e. approximately 1 ppm or background).

[10] Not to be exceeded more than five days each year.

10.5 Potential Impacts and Mitigation Measures

10.5.1 Construction Impacts

Potential air quality impacts during construction include airborne dust and exhaust fumes from the construction plant. Airborne dust would be generated from a number of sources:

- clearing of vegetation and topsoil;
- excavation and transport of materials;
- loading and unloading of trucks;
- refuelling of plant and equipment;
- re-entrainment of deposited dust by vehicle movements; and
- wind erosion from stockpiles and unsealed roads.

High wind conditions would increase the emission rates of airborne dust from stockpiles and exposed areas, while reducing the concentration of vehicle fumes. During high wind conditions particular attention should be paid to dust suppression. Fugitive dust may be an issue, due to the proximity of the KBP to residences.

10.5.2 Operation Impacts

10.5.2.1 General Impacts on the Study Area

The highest concentration for all pollutants modelled occurs in the vicinity of the Centenary Motorway, as would be expected. It should be noted that the modelling does not include a “do nothing” scenario for the project; therefore it is difficult to determine the precise contribution of the KBP on those elevated concentrations.

The study area is defined as those areas outside the existing road corridors, it should also be noted that the modelling does not include the inclusion of sound barriers in the design; the effect of barriers would be to elevate the effective point of emission, which would lower the ground level concentrations experienced in the near vicinity of the KBP.

The background concentrations included in the modelling for each pollutant are detailed in Section 10.3.4.

Nitrogen dioxide – 1-hour average

Table 10.12 and Table 10.13 show that the maximum predicted concentrations of NO_2 are predicted to be lower than the *EPP (Air)* impact criteria as a 1 hour average (250 µg/m³) and annual average (62 µg/m³) for the 2016 and 2026 scenarios. In addition, there are no exceedances of the guideline predicted at any of the sensitive receptors modelled.

Carbon monoxide – 8-hour average concentration

Carbon monoxide levels modelled in the corridor are well below the 8ppm minimum required by the *EPP (Air) Guideline*.

Particulate matter as PM_{10} – 24-hour average concentration

No areas within the modelling domain are predicted to exceed the *EPP (Air)* goal of 150 µg/m³ for the 24-hour average ground-level concentration of PM_{10}.

Particulate matter as PM_{10} – annual average concentration

There are no exceedances predicted of the *EPP (Air)* goal of 50 µg/m³ in the study area for either of the modelled scenarios (2016 and 2026).

Particulate Matter $PM_{2.5}$ - 24 hour maxima

There are no exceedances of the *EPP (Air)* goal of 25 µg/m³ for the 24 hour maxima.

Particulate Matter $PM_{2.5}$ - annual average concentration

There are no exceedances of the *EPP (Air)* goal of 8 µg/m³.

10.5.2.2 Interpretation of Site-Specific Impacts - Criteria Pollutants Summary

The following interpretations are derived from the dispersion modelling results for the concentrations of the criteria pollutants:

- There are no exceedances of the relevant *EPP (Air)* goals predicted at any of the sensitive receptors modelled including background for CO, NO_2, PM_{10} or $PM_{2.5}$.

It is noted that the greatest impacts predicted by the modelling all occur in close proximity to the existing Centenary Motorway. In those cases a model for the Centenary Motorway without the KBP has not been constructed to isolate KBP contributions.

10.5.2.3 Air Toxics

Modelling included the prediction of the concentrations of organic compounds that are commonly associated with traffic. There are six volatiles - benzene, xylenes, toluene, formaldehyde, 1,6-butadiene and benzo(a)pyrene, which is more closely aligned with diesel fumes. None of the volatile compounds were found to exceed the limits quoted in Table 10.1.

10.5.3 Mitigation

Design

The key features of the design, which pertain to air emissions, are the even grades and the absence of on/off ramps and intersections that would necessitate acceleration and deceleration. Should those elements alter in future design, it would be necessary to revisit their impact.

Modelling for the KBP has been based on ground level emissions and does not include provision for sound barriers to be in place. The provision of sound barriers will mitigate dispersion of the road emissions to all sensitive receptors.

Construction

Air quality management planning should consider the following measures:

- applying water by truck sprays on all exposed areas as required to minimise dust emissions;
- restricting dust-generating activities such as blasting or topsoil removal during high winds or where winds are blowing toward nearby residences during more stable conditions;
- siting the construction compounds away from residences;
- establishing and policing procedures for refuelling of plant and equipment;
- avoiding spillages and ensuring prompt cleanup;
- covering haul vehicles moving outside the construction site;
- restricting speed of construction vehicles;
- visually checking particulate emissions from diesel vehicles and regular maintenance of vehicles;
- prohibiting burning or incineration on site; and
- dust monitoring adjacent to residential properties that are close to high activity areas during construction. Monitoring should include dust gauges, high volume sampling or other ambient monitoring techniques to determine whether controls are being applied appropriately. Dust gauges should be adequate for areas where impact is likely to be low. If levels approaching air quality guidelines are found, more frequent high-volume sampling is recommended.

On-site concrete batching plants, bitumen or asphalt plants can be a source of dust, odour and other air pollutants. If they are located near sensitive receptors a tailored air quality assessment should be undertaken. These monitoring and control methods should be formalised in a detailed Environmental Management Plan prior to the commencement of construction.

All of the above activities should also take into account the likelihood and seasonal direction of strong wind events as depicted in Table 10.3.

Traffic control planning should avoid congestion and steep gradients as much possible to minimise emissions by traffic egress during construction of the interchanges.

Operation

Maintenance activities should follow the same basic procedures outlined for construction.

The list of receptors has been developed, based on existing properties and will need to be reviewed once the land acquisitions for the KBP are finalised.

A summary of all the potential impacts and proposed mitigation measures can be found in Table 10.14.

Table 10.14: Potential Impacts and Mitigation Measures

Reference Code	Project Phase	Potential Impact	Trigger	Potential Mitigation Measures
AQ 01	Design	Changes to modelled levels of pollutants at sensitive receptors due to alterations in gradient or the addition of intersections or interchanges.	Design changes from those proposed.	Re-model the emissions and dispersion characteristics to re-assess impacts on sensitive receptors.
AQ 02				Design to avoid steep gradients and acceleration/deceleration.
AQ 03	Construction	Dust from earthmoving and construction activities carrying to sensitive receptors.	Construction activities.	An adequate dust suppression program needs to be maintained.
AQ 04				Careful scheduling of activities to be planned around known prevailing wind conditions.
AQ 05				Establishing speed limits and regulations for vehicle movement around the site.
AQ 06				Suitable stabilisation of spoil heaps.
AQ 07				Covering haul vehicles bringing fill on or off site.
AQ 08				Maintaining a dust monitoring program and suspending activities pending procedure review if dust levels exceed DMR Guidelines.
AQ 09	Construction	Fumes from plant and equipment on site impact on sensitive receptors.	Construction activities.	Ensure suitable maintenance of all vehicles and motorised plant.
AQ 10				Ensure motorised equipment is operated in optimum regimes for the tasks they are undertaking (i.e. idle cycles etc.).
AQ 11	Construction	Fumes from refuelling activities.	Construction activities.	Designate refuelling areas.
AQ 12				Define refuelling procedures.
AQ 13				Define and promulgate spill response procedures.
AQ 14	Operation	Air pollution at nearby residences.	Vehicles using the KBP.	Although all air pollutants are expected to be within acceptable limits noise barriers will further minimise the impact on residents of air pollution from the roadway.