10. Air environment

This section presents the results of an air quality assessment of the Moura Link - Aldoga Rail Project that has been undertaken by Katestone Environmental. The following air quality issues have been addressed:

- Climate, meteorology and existing air quality in the study region have been characterised
- Quantifying the potential impact of emissions associated with the Moura Link - Aldoga Rail Project and in particular:
  – Coal dust emissions from coal trains in transit on the Moura Link and by-pass tracks of the Aldoga Rail Yard
  – Oxide of nitrogen and particulate matter emissions from the combustion of diesel fuel by locomotives
- Identifying potential impacts from construction activities
- Estimating greenhouse gas emissions
- Detailing of mitigation measures and commitments

10.1 Existing environment

10.1.1 Climate

Meteorological data

Data from the EPA monitoring station at Aldoga as well as from the Bureau of Meteorology (BoM) sites at the Gladstone Airport and Radar Hill have been used to characterise important meteorological conditions in the Gladstone region (refer Figure 10.1).

Table 10.1 summarises the meteorological parameters that are measured at the Aldoga, Gladstone Airport and Radar Hill monitoring stations. Gladstone Airport has been chosen as the most representative monitoring station for the Gladstone region as the measurement period is for twelve continuous years (1996-2007), with a suite of parameters measured. These parameters include temperature, wind speed, wind direction, relative humidity and atmospheric pressure. The Aldoga monitoring station dataset represents a five-year period (2002-2007), that includes a period of four months during 2006 when the station was relocated, during which data was not recorded. The monitoring station at Radar Hill has been operating since 1957 and has been used for rainfall averages in this assessment.

Table 10.1 Location of Bureau of Meteorology monitoring sites and parameters used

Agency	Site	Easting AMG	Northing AMG	Record Period	Parameters
BoM	Gladstone Airport	318895	7359053	01/96 – 12/07	½ hourly measurements of temperature, relative humidity, wind speed, wind direction, pressure – converted to 1-hour averages
	Radar Hill	323092	7360700	12/57 – 02/08	Daily total rainfall
EPA	Aldoga			04/02 – 02/08	½ hourly measurements of wind speed, wind direction – converted to 1-hour averages

Wind

Wind speed and direction play an important role in the transport and dispersion of air pollutants. The influence of the coastal environment plays a key role in determining the direction in which pollutants will be transported, as sea breezes will result in an inland displacement of air pollutants.

Figure 10.2 illustrates the wind rose for all 30-minute average measurements of wind speed and direction from the Gladstone Airport site from 1 January 1996 to 31 December 2007. The frequency distribution of wind speed and wind direction is given in Table 10.2.

Based on the information provided in Table 10.2, wind speeds greater than 10 m/s were recorded with winds from the east and east-southeast and occurred for 41% of the time. The majority of the wind speeds greater than 5 m/s were recorded with winds from the east to east-southeast.

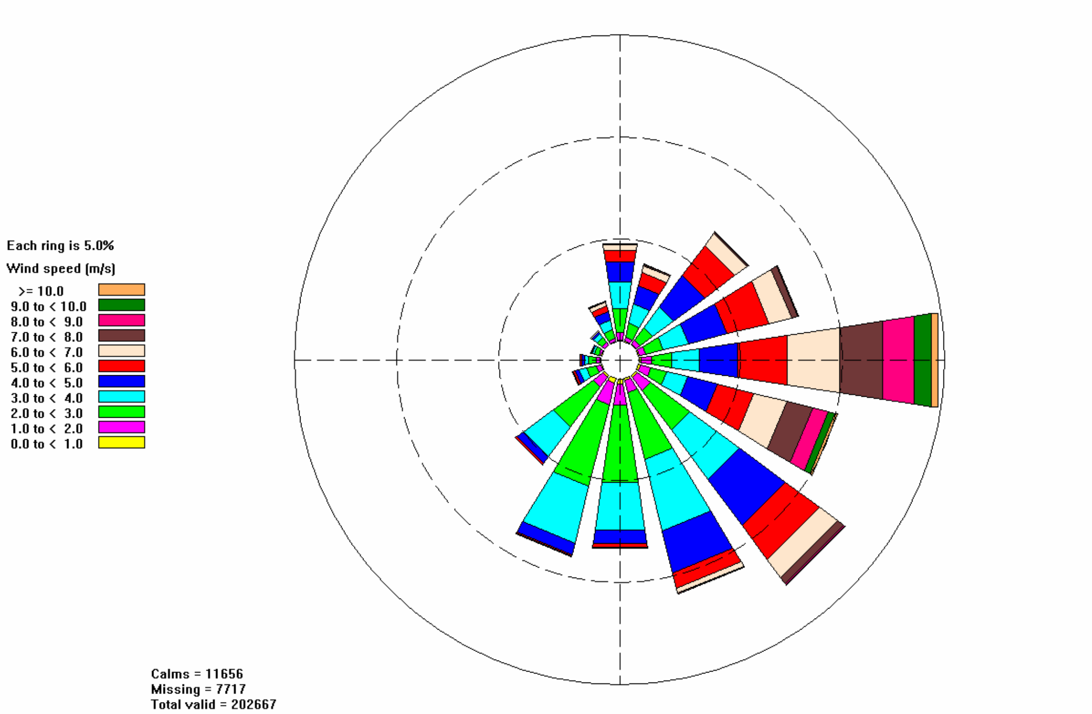

Figure 10.2 Wind rose for all 30-minute average measurements of wind speed and direction at Gladstone Airport, 1 January 1996 to 31 December 2007

Table 10.2 Frequency distribution (%) of the wind speed as a function of wind direction using 30-minute average data from the Gladstone Airport

Wind Speed (m/s)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
0 - 1	0.09	0.05	0.06	0.06	0.13	0.12	0.12	0.10	0.23	0.25	0.14	0.05	0.05	0.04	0.03	0.04	1.6
1 - 2	0.36	0.18	0.22	0.30	0.50	0.51	0.80	0.59	1.05	1.08	0.58	0.21	0.19	0.12	0.14	0.16	7.0
2 - 3	1.17	0.69	0.75	0.87	0.97	0.80	2.35	3.37	3.76	4.07	2.41	0.50	0.37	0.22	0.30	0.41	23.0
3 - 4	1.29	0.99	1.25	1.27	1.37	1.04	2.99	3.55	2.33	2.81	1.76	0.35	0.21	0.10	0.23	0.48	22.0
4 - 5	0.97	0.88	1.91	1.93	1.88	1.50	2.78	2.08	0.67	0.57	0.42	0.21	0.14	0.05	0.09	0.41	16.5
5 - 6	0.58	0.68	1.81	2.08	2.42	1.81	2.04	0.79	0.20	0.09	0.08	0.09	0.06	0.03	0.05	0.31	13.1
6 - 7	0.26	0.33	0.71	1.13	2.56	1.64	1.09	0.23	0.03	0.02	0.02	0.03	0.01	0.01	0.02	0.17	8.3
7 - 8	0.07	0.06	0.11	0.31	2.11	1.28	0.35	0.04	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.05	4.4
8 - 9	0.01	0.00	0.01	0.04	1.55	0.77	0.09	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	2.5
9 - 10	0.00	0.00	0.00	0.00	0.85	0.34	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.2
Above 10	0.00	0.00	0.00	0.00	0.28	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.4
Total	4.8	3.9	6.8	8.0	14.6	9.9	12.6	10.8	8.3	8.9	5.4	1.4	1.0	0.6	0.9	2.0	

The temporal dependence of the wind speed is highlighted in Figure 10.3. The 1-hour average wind speed is relatively light in the early morning (midnight to 6.00 am), steadily increasing through the morning hours through until 3.00 pm in the afternoon, then decreasing till 9.00 pm, with lighter wind conditions observed during the night.

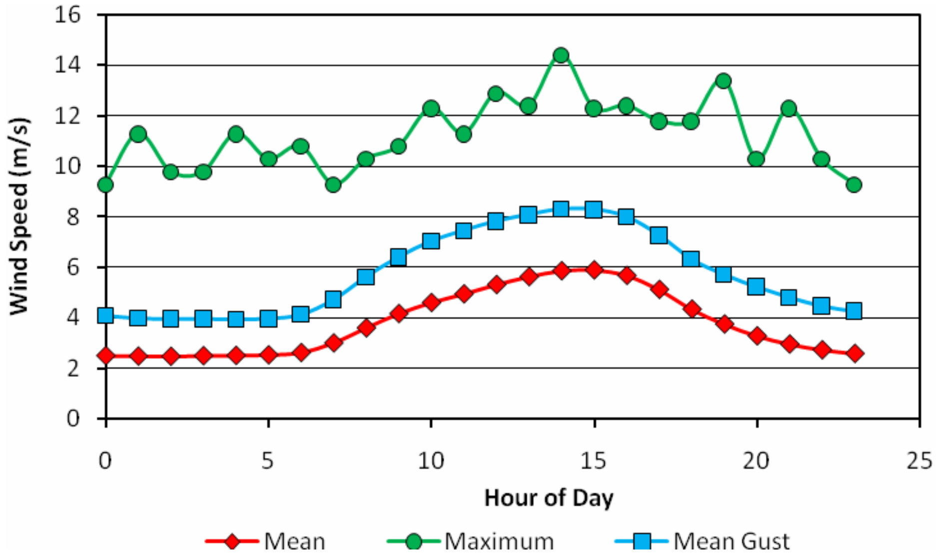

Figure 10.3 Maximum and average 1-hour average wind speeds (m/s), and the average hourly wind gust at Gladstone Airport, 1 January 1996 to 31 December 2007

This temporal dependence is further highlighted in the wind roses of Figure 10.4. Lighter wind conditions are observed during the early morning hours suggesting that, in general, calmer southerly dominated flow conditions are experienced over night. Strong wind conditions from the east (in the direction of the coast) dominate during the afternoon hours, indicative of the development of a significant sea breeze.

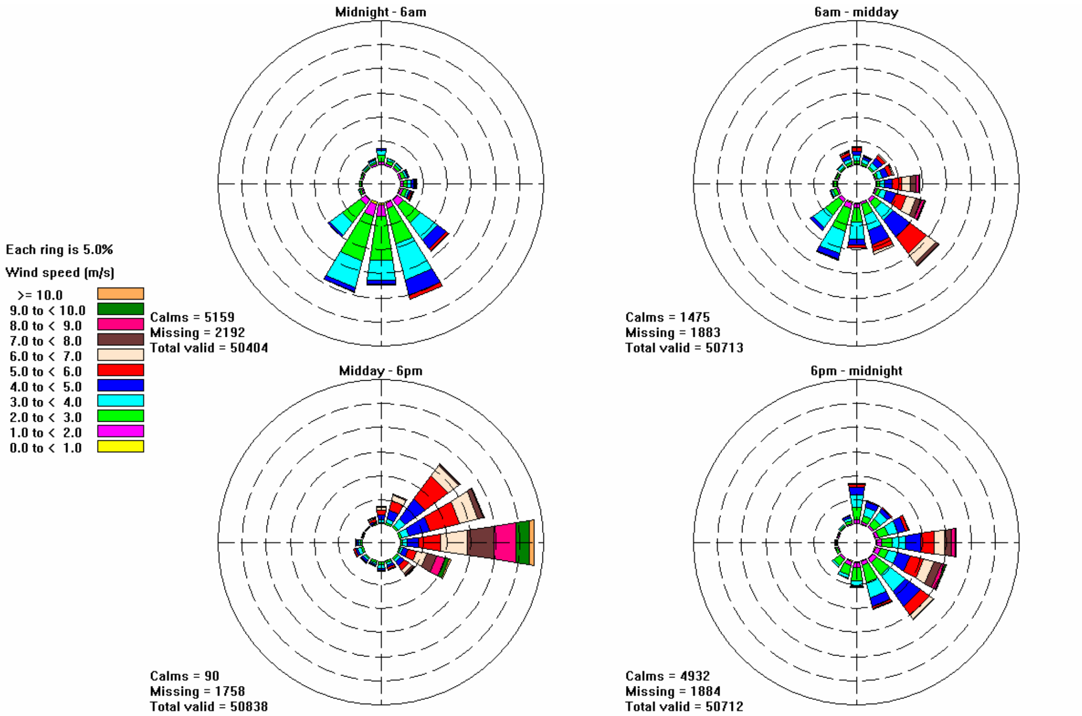

Figure 10.4 Wind roses for times of the day at Gladstone Airport, 1 January 1996 to 31 December 2007

Plotted in Figure 10.5 are wind roses illustrating the seasonal dependence of both wind speed and direction.

The maximum wind speeds are found to occur from the easterly direction at all times of the year and most frequently in the summer.

During the summer, the winds are dominated by easterly flows while during autumn, the winds are predominantly southeast. Winds are generally lighter during winter and dominated by a southwest to southeast flow. Spring wind fields are dominated by east to northeast winds.

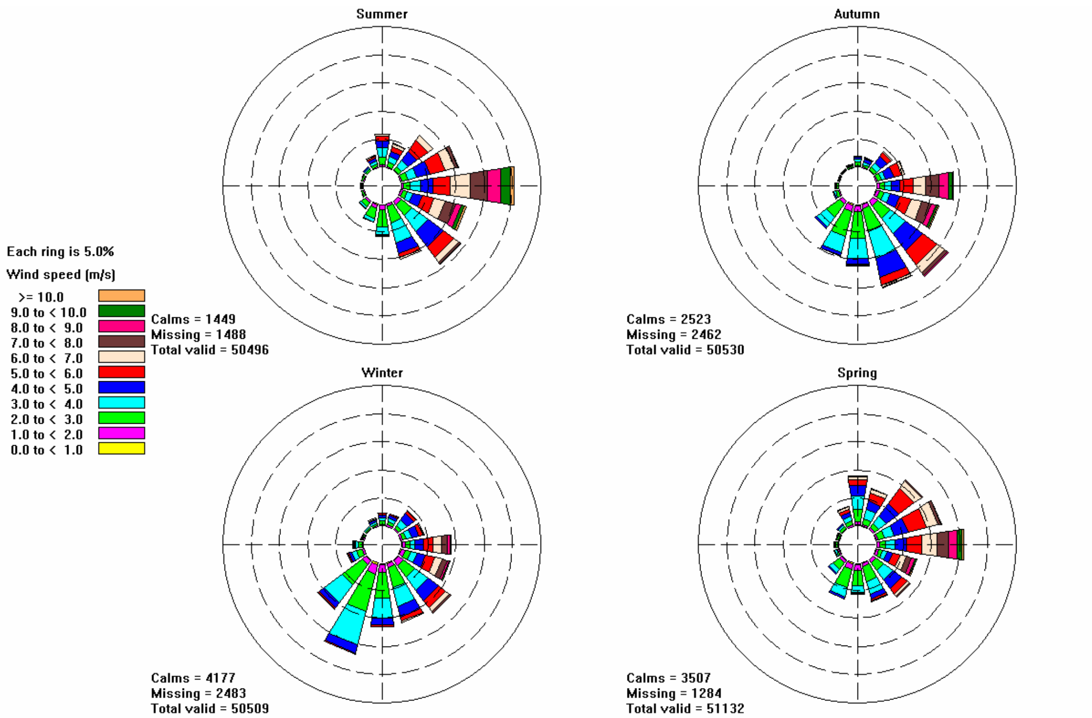

Figure 10.5 Seasonal wind roses at Gladstone Airport, 1 January 1996 to 31 December 2007

The annual distribution of winds measured at the EPA monitoring station at Aldoga for the period 1 January 2003 to 31 December 2007 are presented in Figure 10.6. This distribution indicates a similar dominance of winds from the east and southeast to that at Gladstone Airport. However, there is a greater frequency of winds below 2 m/s. This is likely to be a result of the site being situated further from the coast, and influenced to a greater extent by terrain features and land uses such as forests.

There is also a greater frequency of winds from the north and northwest. Figure 10.7 and Figure 10.8 show that these winds tend to occur at night and during spring and summer, indicating that terrain features are likely to produce these night time drainage flows. Figure 10.7 also illustrates the daytime sea breeze, with winds tending to blow from the southeast in the morning and from the east and northeast in the afternoon.

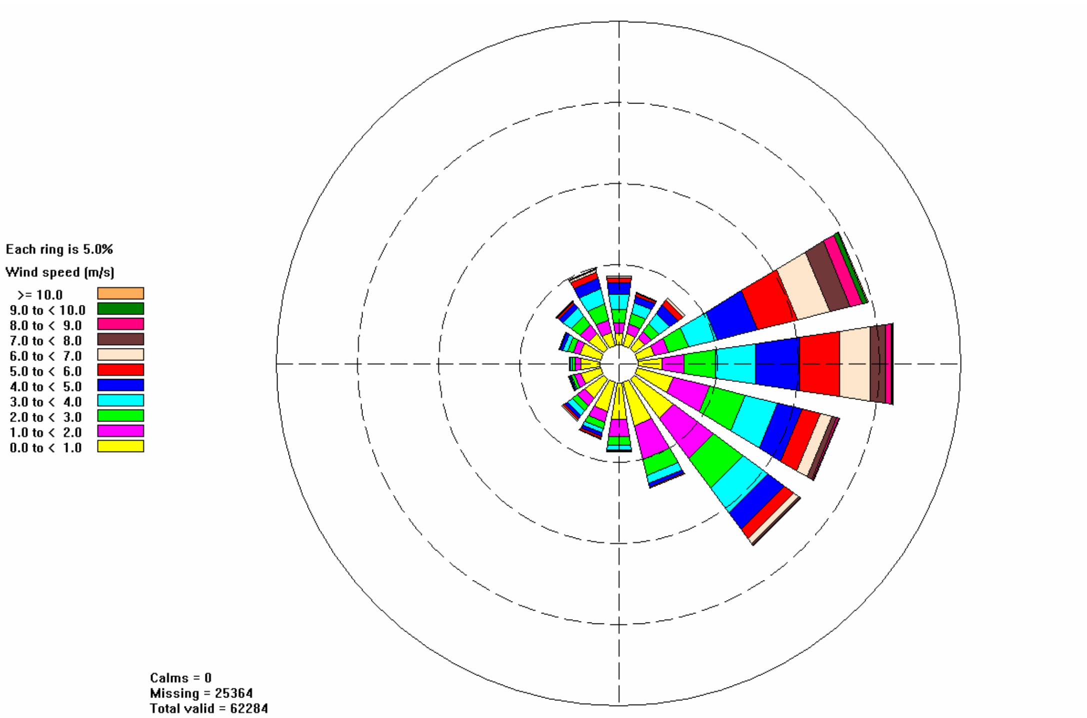

Figure 10.6 Wind rose for all 30-minute average measurements of wind speed and direction at Aldoga, 1 January 2003 to 31 December 2007

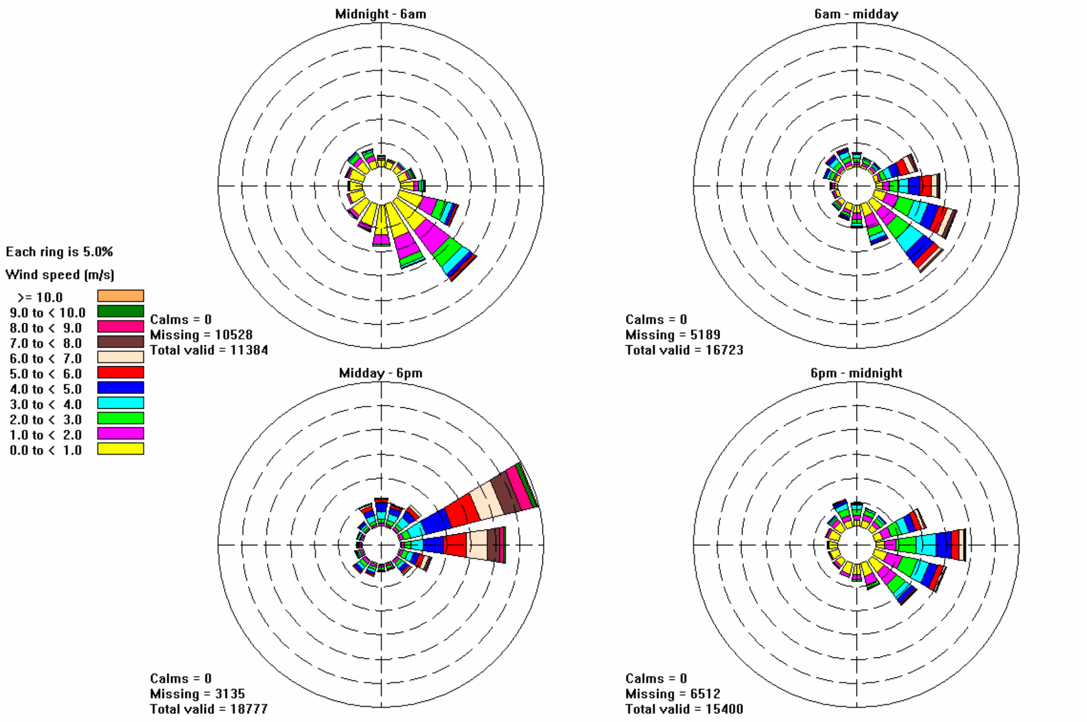

Figure 10.7 Wind roses for times of the day at Aldoga, 1 January 2003 to 31 December 2007

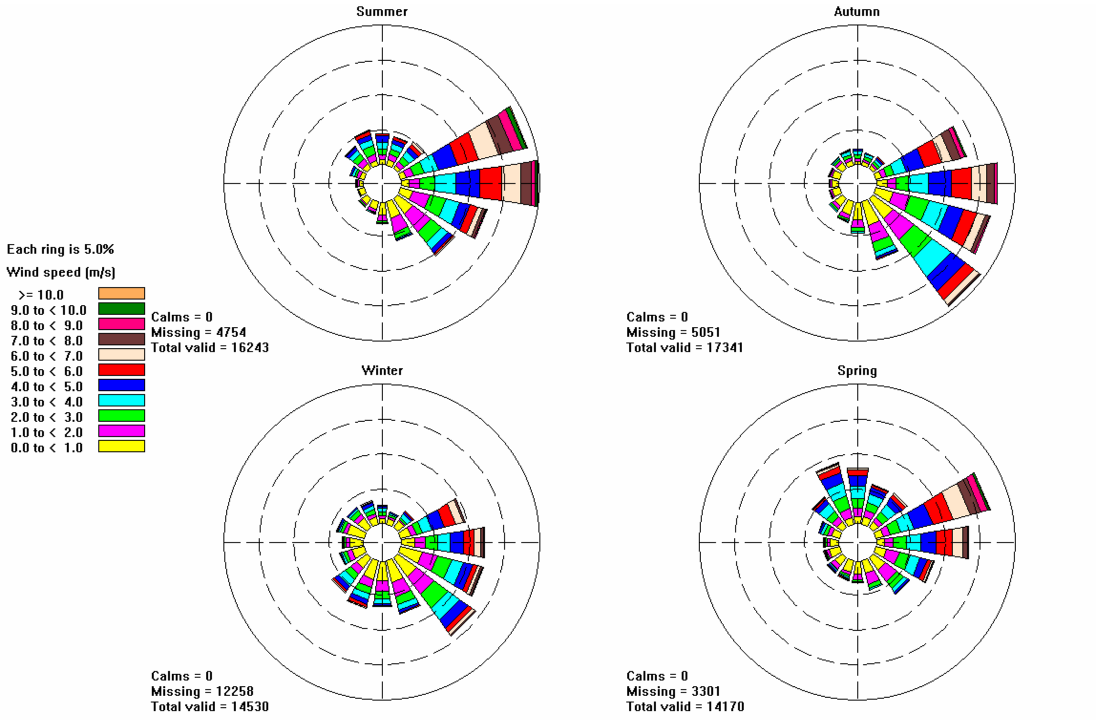

Figure 10.8 Seasonal wind roses at Aldoga, 1 January 2003 to 31 December 2007

Rainfall

Presented in Table 10.3 is the average monthly rainfall over the 50-year period from December 1957 to February 2008 at the Radar Hill site. The annual average rainfall at Radar Hill is 881 mm/year. The maximum annual rainfall was 1,732 mm in 1971.

Consistent with a sub-tropical climate, the summer months are wetter and the winter months are dryer. In particular, the months of December, January and February account for 47.2% of the average annual rainfall, while the months of June through September total only 15.0%. Scheduling of major earthworks will need to consider the seasonality of heavy rainfall periods where practically possible.

Table 10.3 Minimum, average and maximum, monthly averaged rainfall at Gladstone Radar Hill site, December 1957 to February 2008

Month	Minimum (mm)	Maximum (mm)	Average (mm)	Average rainfall (%)
January	0.4	640.1	144.2	16.4
February	7.2	709.8	141.5	16.1
March	2.4	311.6	83.5	9.5
April	3.8	250.4	46.3	5.3
May	0.2	316.4	60.9	6.9
June	0	220.3	40	4.5
July	0	170.2	32.7	3.7
August	0	141.6	33	3.7
September	0	89.6	26.6	3.0
October	0.4	276.8	62.9	7.1
November	1.4	218.1	73.6	8.4
December	2.8	508.9	129.8	14.7

Temperature

Figure 10.9 presents the 1-hour averaged monthly mean daily maximum temperature, the monthly mean temperature, and monthly averaged daily 1-hour minimum temperature, using data from the Gladstone Airport monitoring site for the period 1 January 1996 through 31 December 2007.

During the summer months, the monthly averaged daily temperatures range by approximately 7°C. During the winter months, the monthly averaged daily temperatures have a greater diurnal variation of around 11°C.

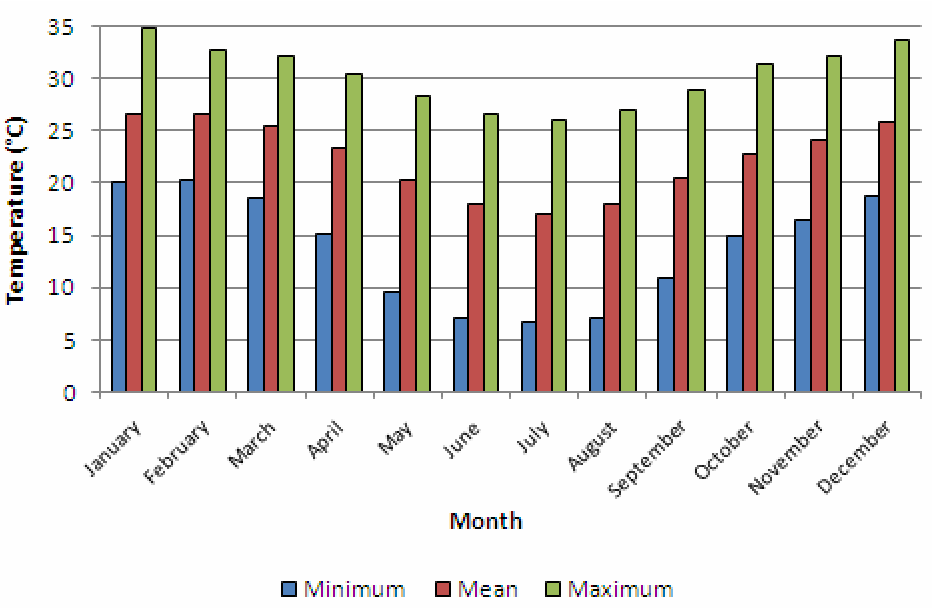

Figure 10.9 Monthly average, minimum and maximum daily temperatures (in °C) at Gladstone Airport, 1 January 1996 to 31 December 2007

Relative humidity

The monthly averaged relative humidity at 9.00 am and 3.00 pm at Gladstone Airport for the period from January 1996 to February 2008 is presented in Figure 10.10.

There is no significant trend identified with morning values of the monthly averaged relative humidity showing little variation throughout the year. The monthly averaged relative humidity at 3.00 pm indicates slightly drier afternoon conditions during the winter months.

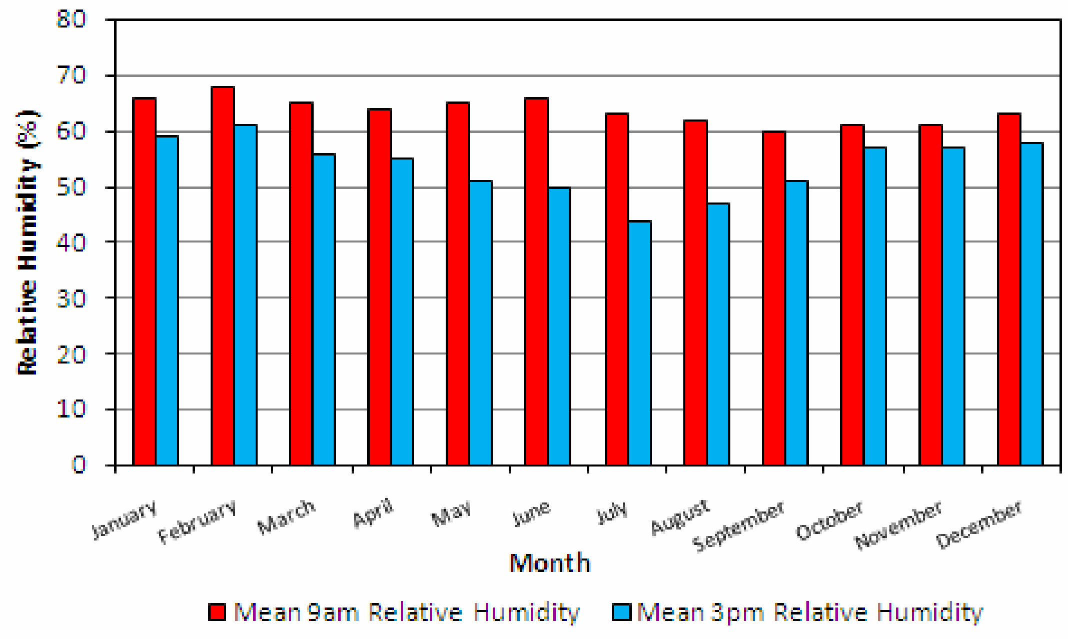

Figure 10.10 Monthly averaged 9.00 am and 3.00 pm measurements of relative humidity at Gladstone Airport, January 1996 to February 2008

Surface pressure

The monthly averaged surface pressure from the Gladstone Airport is presented in Figure 10.11. The biannual pattern of peaks and troughs in the monthly averaged pressure field indicates that the months of January and July are dominated by low pressure features that are typically associated with either wetter (summer) and/or colder (winter) conditions. The months of April and October are dominated by high pressure features that are typically associated with clear, drier and warmer conditions.

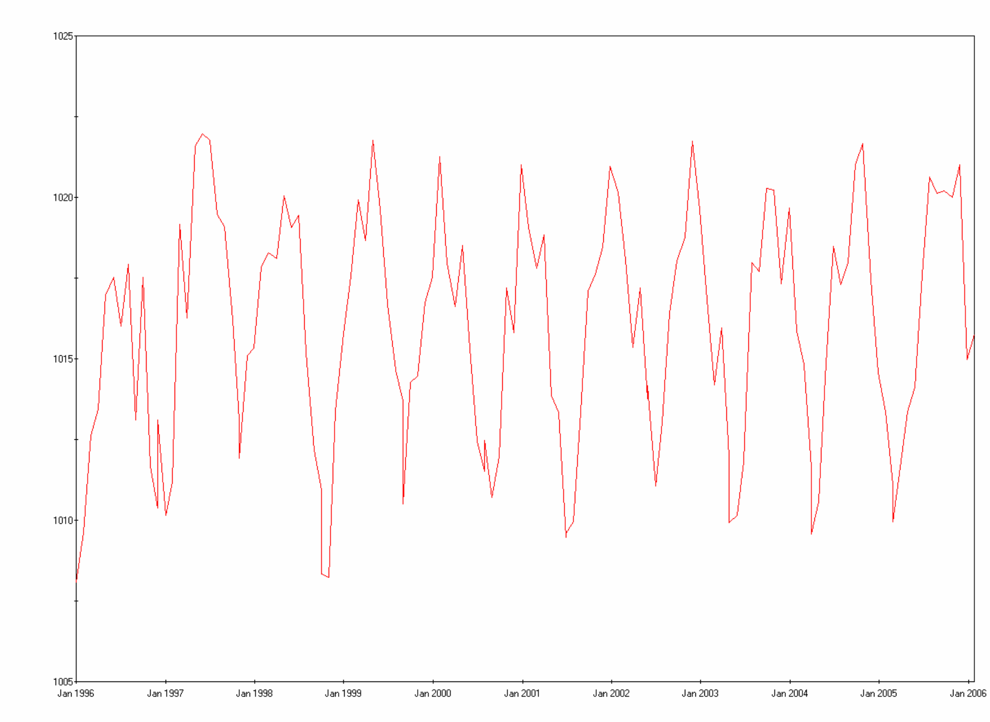

Figure 10.11 Monthly averaged surface pressure (mb) at Gladstone Airport, January 1996 to December 2007

Frequency of droughts, thunderstorms, lightning and tropical cyclones

The BoM reports the following frequencies of thunder, lightning and cyclones in the Gladstone region (based on data available up to 1999):

- Fifteen days of thunderstorms per year (based on ten years of data from 1990 to 1999)
- One ground strike of lightning per square kilometre per year (based on approximately 5 years of data)
- Two to four cyclones every 10 years (based on 30 years of data from 1969 to 1999)

Areas of the former Calliope Shire were declared drought affected in January 2007.

10.1.2 Air quality

The following air quality issues have been addressed:

- A general description of the local air quality and existing influences on air quality such as industry.
- A discussion of the available air quality monitoring data with particular reference to particulates with an aerodynamic diameter less than 10 microns (PM_{10}), nitrogen dioxide (NO_2) and dust deposition rate.

Air quality criteria

The *Environmental Protection Act 1994* (EP Act) gives the Environment Minister the power to create Environmental Protection Policies that identify and aim to protect environmental values of the atmosphere that are conducive to the health and well-being of humans and biological integrity. The *Environmental Protection (Air) Policy* (EPP(Air)) was gazetted in 1997. The administering authority must consider the requirements of the EPP(Air) when it decides an application for a development permit, amendment of a licence or approval of a draft Environmental Management Plan. Schedule 1 of the EPP(Air) specifies air quality indicators and goals for Queensland. Indicators and goals that are relevant for this Project are reproduced in Table 10.4.

Health impacts are normally assessed by comparing airborne concentrations of dust with air quality standards and goals. Recent measurements that were commissioned by QR indicate that concentrations of coal dust within the proximity to railway lines carrying coal trains were well below air quality standards and goals and unlikely to cause adverse health impacts (Connell Hatch 2008a).

The National Environment Protection Council (NEPC) defines national ambient air quality standards and goals in consultation, and with agreement from, all State governments. These were first published in 1998 in the National Environment Protection (Ambient Air Quality) Measure (NEPM(Air)). Compliance with the NEPM(Air) standards is assessed via ambient air quality monitoring undertaken at locations prescribed by the NEPM(Air) and representative of large urban populations. The goal of the NEPM(Air) is for the ambient air quality standards to be achieved at these monitoring stations within ten years of commencement due in 2008. The EPA operates one monitoring station in Gladstone for assessing compliance against the NEPM(Air). This monitoring station is located at South Gladstone.

In 2003, the NEPC amended the NEPM(Air) to incorporate Advisory Reporting Standards for particulate matter with an aerodynamic diameter of less than 2.5 microns ($PM_{2.5}$) and monitoring requirements to be implemented by each jurisdiction. The goal for $PM_{2.5}$ is to gather sufficient data nationally to facilitate a review of the Advisory Reporting Standards as part of the review of the NEPM(Air) to establish an appropriate $PM_{2.5}$ standard. The review of the NEPM (Air) commenced in 2005 with the release of an issues scoping paper. The review is scheduled for completion in 2008 and as such, the Advisory Reporting Standards for $PM_{2.5}$ are unlikely to be suitable for application to this Project.

The NEPM standard for PM_{10} and the Advisory Reporting Standard for $PM_{2.5}$ are based on studies of exposure to urban air pollutants that includes the very fine particles associated with motor vehicles. Consequently, the application of these standards to particulate matter from coal stockpiles and rail transport activities is likely to overestimate the potential for adverse impact.

The EPP(Air) goals are used to assess impacts at sensitive locations (such as residential areas and isolated dwellings) that are located near industrial sites and major traffic routes. The EPP(Air) goals and the NEPM(Air) standards are both, therefore, applicable to the Gladstone area. The NEPM(Air) standards were developed to protect against health impacts in populated areas such as in Gladstone but the standards do not apply to isolated residences in close proximity to industrial areas. However, the EPP(Air) goals do apply to isolated residences in close proximity to industrial activities.

Dust nuisance can occur due to the deposition of larger dust particles in residential areas. Coal dust has the potential to cause annoyance due to soiling of material surfaces and reduced visibility as a result of dust particles in the atmosphere. Annoyance and nuisance caused by soiling of surfaces can be difficult to quantify since the perceived level of annoyance may depend on physical and social factors. Community surveys have been used to develop the annoyance thresholds that are currently recognised in Queensland (NERDDC 1988). Table 10.4 shows the dust deposition guideline commonly used in Queensland as a benchmark for minimising amenity impacts due to dust. The dust deposition guideline is not defined in the EPP(Air) and is therefore not enforceable by legislation, but was recommended by the EPA as a design goal (pers. comm. Dr David Wainwright, Qld EPA Air Services Manager). Whilst this guideline was originally defined as an annual average, the EPA has recently advised that it is to be interpreted as a monthly average.

Table 10.4 Existing ambient air quality goals and standards

Pollutant	Standard or Goal	Units	Averaging Period	Source
Dust deposition rate	120	$mg/m^2/day$	Month	Recommended EPA
Particulates as PM_{10}	150	$\mu g/m^3$	24-hour	EPP(Air)
	50	$\mu g/m^3$	24-hour	NEPM(Air)
	50	$\mu g/m^3$	Annual	EPP(Air)
Nitrogen dioxide	0.16	ppm	1-hour	EPP(Air)
	0.12	ppm	1-hour	NEPM(Air)
	0.03	ppm	Annual	NEPM(Air)

Emission sources within the Gladstone Region

The coastal town of Gladstone is located approximately 525 km north of Brisbane in central Queensland. It is situated in a sub-tropical region comprising a flat coastal plain bordered by a mountain range with a peak elevation of 630 m.

Industries in the Gladstone regional airshed currently include a major coal fired power station, two large alumina refineries, an aluminium smelter, an ammonium nitrate plant, coal handling and port facilities and cement manufacturing plants. General sources of dust in the region include landfills, trains, exposed areas of land and traffic.

Gladstone is highly industrialised with a number of industries reporting to the National Pollutant Inventory (NPI), including QR. For the purposes of the air quality assessment of the Project, the focus is on particulate emissions and emissions of oxides of nitrogen, as an indicator of nitrogen dioxide. The major emitters of PM_{10} and oxides of nitrogen are listed in Table 10.5 for the 2006-2007 NPI reporting year. The location of these sources is depicted in Figure 10.12.

Airborne emissions may be introduced into the local airshed as a result of stack emissions (as is the case for the NRG Power Station and the QAL and Rio Tinto alumina refineries) or they may be fugitive emissions (ie associated with advection by the wind field of particulates originating from land-based stockpiles). The power station and alumina refineries also have fugitive dust emissions from stockpiles.

Table 10.5 Existing sources of PM_{10} and oxides of nitrogen emissions for 2006 to 2007 and their location

Source	Easting AMG	Northing AMG	Total PM_{10} (kg/year)	Total Oxides of Nitrogen (kg/year)
NRG Gladstone Operating Services (Gladstone Power Station)	318592	7360478	870,000	45,000,000
Queensland Alumina Ltd (QAL)	325907	7359571	530,000	8,800,000
Cement Australia (Queensland) Pty Ltd, Gladstone	312196	7366554	32,000	3,900,000
Central Queensland Ports Authority, Coal Storage	323640	7362278	1,000,000	370,000
Boyne Smelters Ltd	330871	7353162	290,000	120,000
Cement Australia (Queensland) Pty Ltd, Mount Larcom	294262	7365263	320,000	17,000
Rio Tinto Aluminium Ltd, Yarwun	311633	7363070	100,000	700,000
Orica Australia Pty Ltd, Yarwun	312705	7367236	930	230,000
Queensland Rail Callemondah Rail Yard	319236	7361556	340	18,000
Austicks Pty Ltd	319765	7361064	10,000	4,600

Monitoring sites

For the purposes of the EIS, ambient air quality monitoring data from the EPA has been acquired and analysed (refer Table 10.6). The location of the EPA air quality monitoring sites and their proximity to existing sources is depicted in Figure 10.12.

Continuous monitoring of PM_{10} is undertaken using TEOMs at three locations in and around Gladstone. There are currently no known studies of the breakdown of the type of dust (ie coal dust, cement dust) that contributes to the ambient levels of PM_{10} in the Gladstone airshed.

Nitrogen dioxide monitoring data from six sites in the Gladstone area have been analysed for this study. Monitoring at three of these sites, Barney Point, Mount Miller and Targinie (Stupkin Lane), were discontinued in 2003, 2004 and 2007, respectively. There is no monitoring data for PM_{10} and NO_2 available at the site of the Project with the closest station located at Targinie. Details of the monitoring stations are summarised in Table 10.6.

The South Gladstone monitoring station is located near to QAL, within the South Gladstone State Primary School grounds. The EPA recommends using this station as an upper-end indicator for the NEPM standards. The other monitoring stations are located close to industries and are remote from residences, therefore the EPP(Air) guidelines are applicable.

Table 10.6 Location and data obtained from the monitoring sites

EPA Monitoring Site	Easting AMG	Northing AMG	Record Period	Parameters
Clinton	318914	7359008	02/01 – 02/08	PM_{10}, NO_2
South Gladstone	323742	7359988	01/01 – 02/08	PM_{10}, NO_2
Targinie (Stupkin Lane)	307169	7367541	01/01 – 02/08	PM_{10}, NO_2
Barney Point	323697	7361183	01/97 – 08/03	NO_2
Mount Miller	313676	7358344	03/01 – 12/04	NO_2
Targinie (Swans Road)	306949	7369454	01/97 – 02/08	NO_2

Table note:
PM_{10} measurements are undertaken at Clinton, South Gladstone and Targinie (Stupkin Lane) by TEOM
NO_2 (nitrogen dioxide) measurements are undertaken at all of the above monitoring sites by chemiluminescence techniques

The Targinie (Stupkin Lane) monitoring site is considered to be most representative of the existing air quality at the site of the Project. None of the monitoring sites match the topography of the site of the Project, however, the Targinie (Stupkin Lane) site is sufficiently removed from major industrial and diffuse sources to be considered a proxy for the Project's existing air quality.

The monitoring data from this site has been used to develop the background levels for the Project.

Particulate matter as PM_{10}

24-hour average concentration of PM_{10}

Included in Table 10.7 is the maximum 24-hour average concentration of PM_{10} from measurements at three of the EPA monitoring sites, between 2001 and 2007.

Table 10.7 Maximum 24-hour average concentration of PM_{10} ($\mu g/m^3$)

Year	Clinton	South Gladstone	Targinie (Stupkin Lane)
2001	64.7	66.6	93.1
2002	185.1	197.0	203.5
2003	42.6	41.2	49.8
2004	41.5	42.7	50.4
2005	221.5	196.6	222.1
2006	53.0	53.1	78.6
2007	29.3	38.8	36.4

Figure 10.13 to Figure 10.15 are plots of the cumulative frequency distribution of 24-hour average concentrations of PM_{10} for each station for each year that data is available. The years 2002 and 2005 were exceptional with relatively high peak concentrations of PM_{10} recorded at all sites. These high events were attributed to bushfires that occurred in 2002 and dust storms that occurred for 2-3 days over a significant portion of Queensland in 2005. In the longer term, the concentration of PM_{10} recorded at each site is relatively similar and is less than 40 $\mu g/m^3$ for 98% of the time.

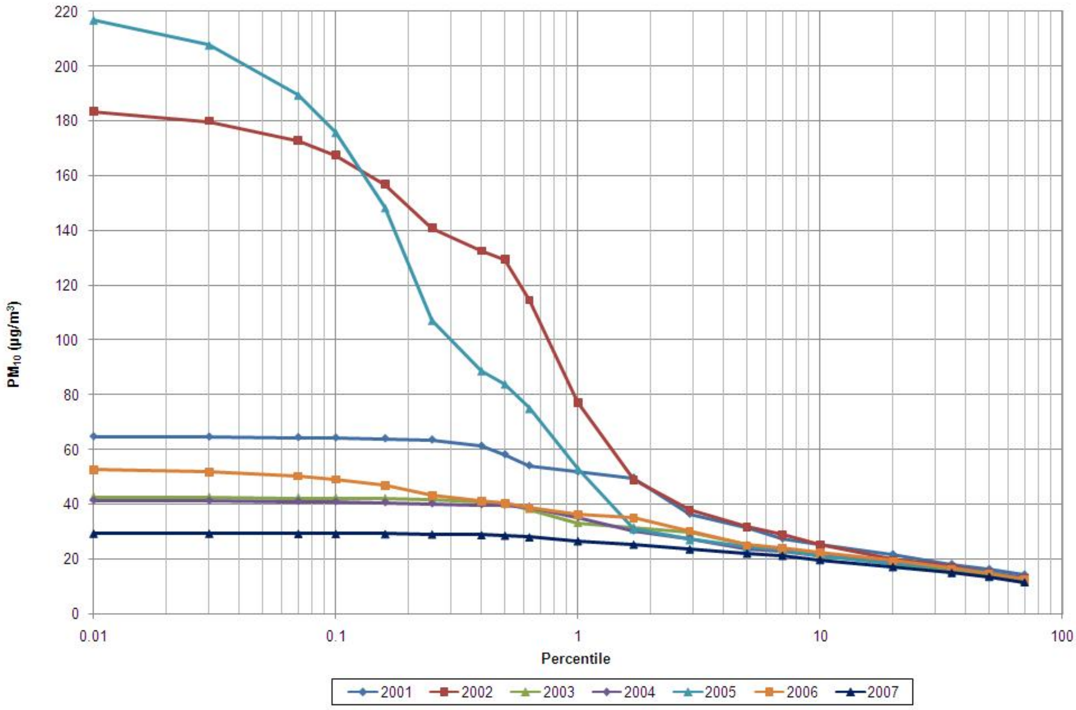

Figure 10.13 Cumulative frequency distribution of 24-hour average concentrations of PM_{10} ($\mu g/m^3$) at Clinton, 2001-2007

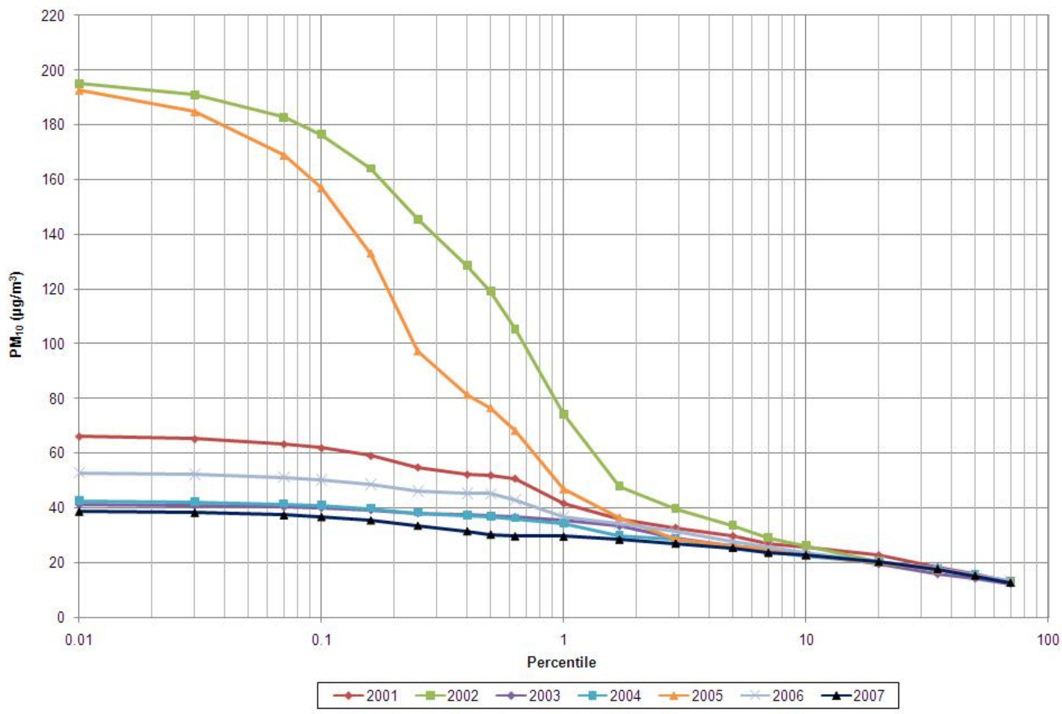

Figure 10.14 Cumulative frequency distribution of 24-hour average concentrations of PM_{10} ($\mu g/m^3$) at South Gladstone, 2001-2007

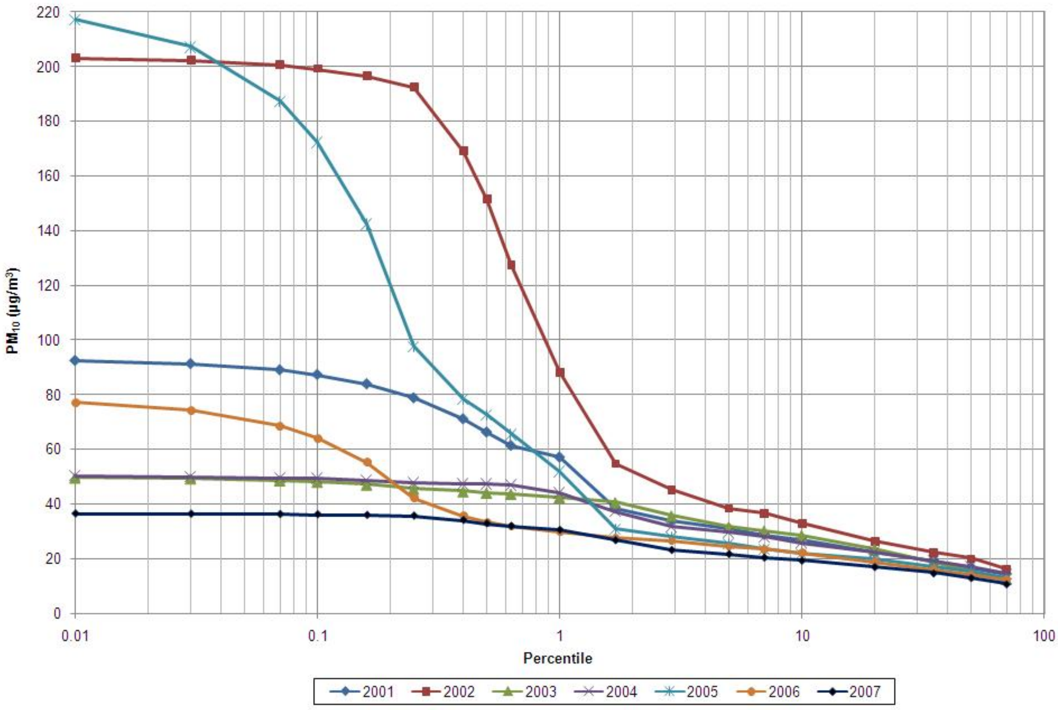

Figure 10.15 Cumulative frequency distribution of 24-hour average concentrations of PM_{10} ($\mu g/m^3$) at Targinie (Stupkin Lane), 2001-2007

Exceedances of the NEPM(Air) standard

The NEPM(Air) standard is applicable for the South Gladstone monitoring site. The other monitoring sites are isolated from populated areas and are close to industry. The EPP(Air) is applicable at these sites. Exceedances of the NEPM(Air) standard for 24-hour average concentrations of PM_{10} of 50 $\mu g/m^3$ occurred at South Gladstone in 2001, 2002 and 2005. Dates on which these exceedances occurred and possible causes are included in Table 10.8.

Table 10.8 Number of exceedances of the NEPM(Air) standard for the 24-hour average concentration of PM_{10} of 50 $\mu g/m^3$ at South Gladstone

Year	Number of exceedances	Date of exceedance	Possible cause
2001	3	31 October 1-2 November	Regional dust storm event
2002	5	4 July 24-26 October 7 December	Regional dust Bushfires Regional dust
2003	0	-	-
2004	0	-	-
2005	4	3-6 February	Regional dust storm event
2006	1	16 November	Regional dust storm event
2007	0	-	-

Exceedances of the EPP(Air) goal

Exceedances of the EPP(Air) goal for 24-hour average concentrations of PM_{10} of 150 $\mu g/m^3$ occurred at Clinton and Targinie (Stupkin Lane) on 26 October 2002 and on 3 February 2005. PM_{10} levels also exceeded EPP(Air) goals on the 24 October 2002 at Targinie (Stupkin Lane) (refer Table 10.9).

As noted previously, it is likely that high PM_{10} levels from 24 to 26 October 2002 were due to bushfires and those occurring on 3 February 2005 were associated with widespread dust storms.

Table 10.9 Exceedances of the 24-hour average concentration of PM_{10} EPP(Air) goal of 150 $\mu g/m^3$

Year	Date of exceedance	
	Clinton	Targinie (Stupkin Lane)
2002	26 October	24 and 26 October
2005	3 February	3 February

Annual average of PM_{10}

The EPP(Air) goal for annual average concentrations of PM_{10} is 50 $\mu g/m^3$. Table 10.10 summarises the annual average concentrations of PM_{10} from data obtained from each site for each year. There were no exceedances of the EPP(Air) goal for annual average concentrations of PM_{10}.

Table 10.10 Annual average concentration of PM_{10} ($\mu g/m^3$), 2001 to 2007

Year	Clinton	South Gladstone	Targinie (Stupkin Lane)
2001	18.0	17.3	18.4
2002	17.8	18.1	22.3
2003	14.9	15.3	17.4
2004	15.8	16.2	18.2
2005	16.1	16.7	16.4
2006	15.4	16.6	15.1
2007	13.6	17.3	13.2

The Targinie (Stupkin Lane) monitoring site is considered to be most representative of the existing air quality at the site of the Project. Based on this an annual average background level at Aldoga of 22 $\mu g/m^3$ for PM_{10} has been adopted.

From this, a background concentration of total suspended particulates (TSP) has been inferred, 44 $\mu g/m^3$ (ie within rural areas 50% of TSP is in the of PM_{10}).

Background levels of PM_{10}

The background dust level is generally defined as the level of dust that would exist in the absence of anthropogenic sources. The EPA recommends using the 95th percentile of the 24-hour average concentration to represent the background level of PM_{10} for air quality assessments. Presented in Table 10.11 is the 95th percentile of 24-hour average PM_{10} concentrations for each site for each year.

The range of the 95th percentile of 24-hour average PM_{10} concentrations for Clinton is 22.0 $\mu g/m^3$ to 31.8 $\mu g/m^3$, for South Gladstone it is 25.2 $\mu g/m^3$ to 33.5 $\mu g/m^3$ and for Targinie (Stupkin Lane) it is 21.6 $\mu g/m^3$ to 38.5 $\mu g/m^3$.

Table 10.11 Annual 95th percentile of 24-hour average PM_{10} concentrations ($\mu g/m^3$) for each site, 2001 to 2007

Year	Clinton	South Gladstone	Targinie (Stupkin Lane)
2001	31.4	29.8	31.0
2002	31.8	33.5	38.5
2003	25.2	26.1	31.5
2004	23.6	25.2	29.7
2005	24.4	26.2	25.3
2006	25.0	27.7	24.3
2007	22.0	25.3	21.6

The Targinie (Stupkin Lane) monitoring site is considered to be most representative of the existing air quality at the site of the Project. Based on this a 24-hour average background at Aldoga of 38.5 $\mu g/m^3$ for PM_{10} has been adopted.

Nitrogen dioxide

1-hour average concentration of nitrogen dioxide

Included in Table 10.12 is the maximum 1-hour average concentration of NO_2 from measurements at each of the monitoring sites, for each year that data is available.

Table 10.12 Maximum 1-hour average concentration of nitrogen dioxide (ppm)

Year	Clinton	South Gladstone	Targinie (Stupkin Lane)	Barney Point	Mt Miller	Targinie (Swans Road)
1997	-	0.031	-	0.042	-	0.038
1998	-	0.022	-	0.092	-	0.044
1999	-	0.034	-	0.036	-	0.042
2000	-	0.031	-	0.062	-	0.038
2001	0.069	0.048	0.047	0.041	0.055	0.038
2002	0.036	0.036	0.048	0.034	0.068	0.039
2003	0.032	0.035	0.041	0.027	0.047	0.035
2004	0.038	0.042	0.044	-	0.052	0.030
2005	0.036	0.035	0.047	-	-	0.039
2006	0.035	0.034	-	-	-	0.041
2007	0.038	0.035	-	-	-	0.036

Figure 10.16 to Figure 10.21 are plots of the cumulative frequency distribution of 1-hour average concentrations of NO_2 for each site for each year that data is available. Levels are low at all sites.

Exceedances of the NEPM(Air) standard

The NEPM(Air) standard is applicable for the South Gladstone monitoring station. The other monitoring stations are isolated from populated areas and are close to industry and therefore the EPP(Air) goal is applicable at these sites. The 1-hour average NO_2 concentrations measured at South Gladstone did not exceed the NEPM(Air) standard of 0.12 ppm between 1997 and 2006.

Exceedances of the EPP(Air) goal

The 1-hour average NO_2 concentrations measured did not exceed the EPP(Air) goal of 0.16 ppm at any of the monitoring sites for the years for which NO_2 data is available.

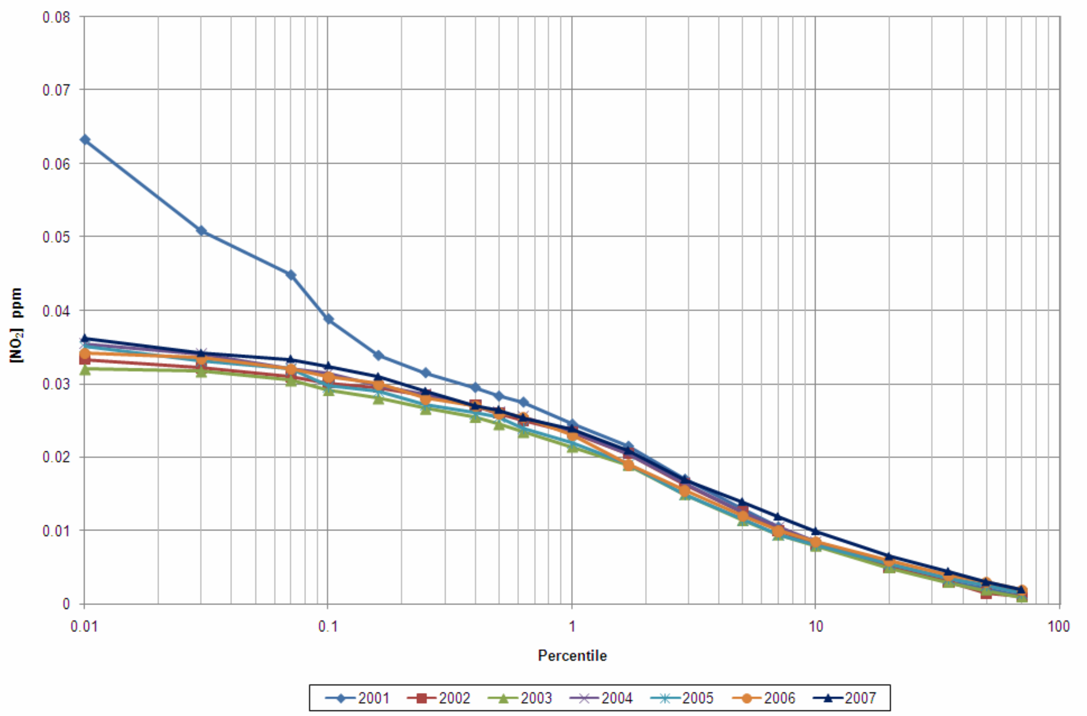

Figure 10.16 Cumulative frequency distribution of 1-hour average concentrations of nitrogen dioxide (NO_2) (ppm) at Clinton, 2001-2007

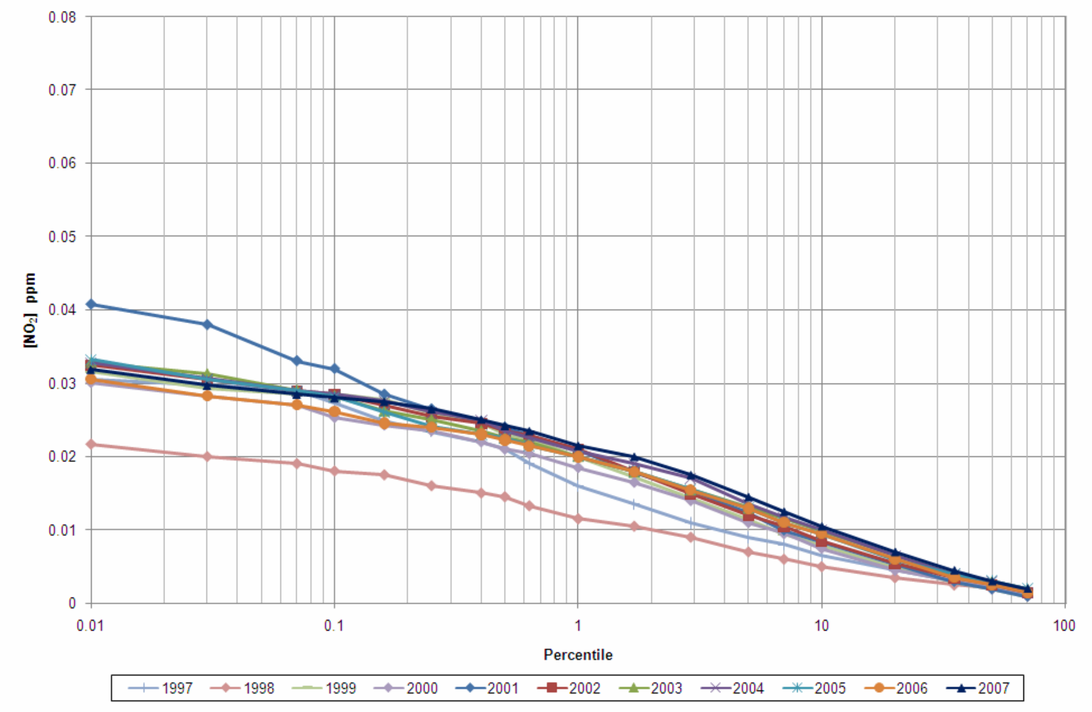

Figure 10.17 Cumulative frequency distribution of 1-hour average concentrations of nitrogen dioxide (NO_2) (ppm) at South Gladstone, 1997-2007

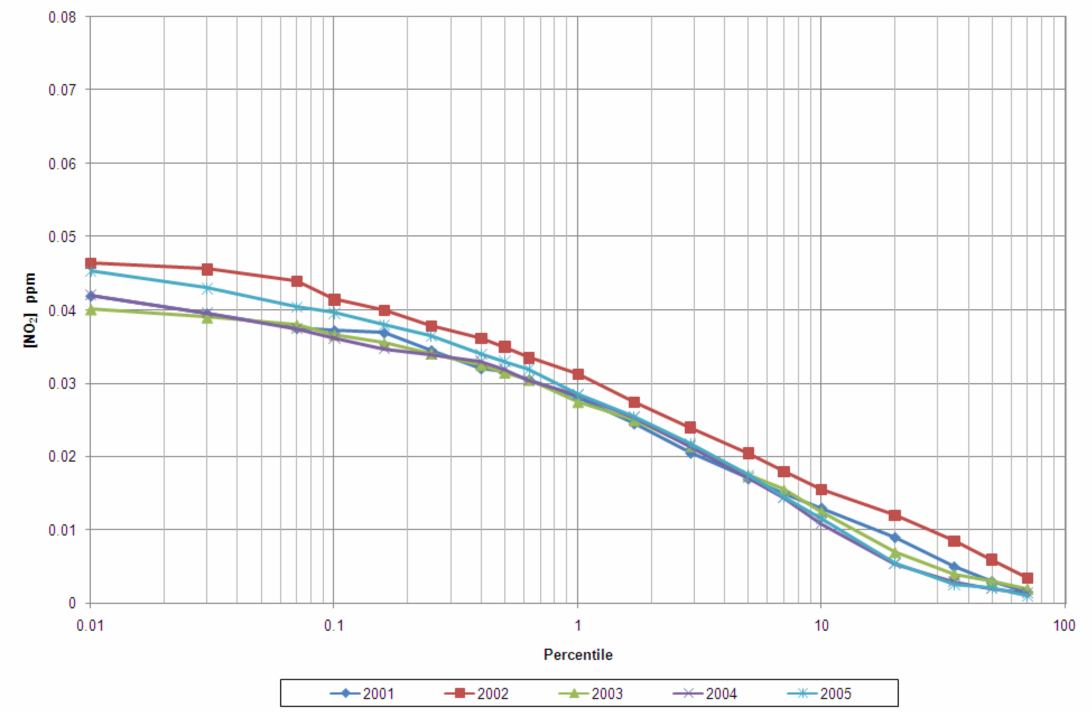

Figure 10.18 Cumulative frequency distribution of 1-hour average concentrations of nitrogen dioxide (NO_2) (ppm) at Targinie (Stupkin Lane), 2001-2005

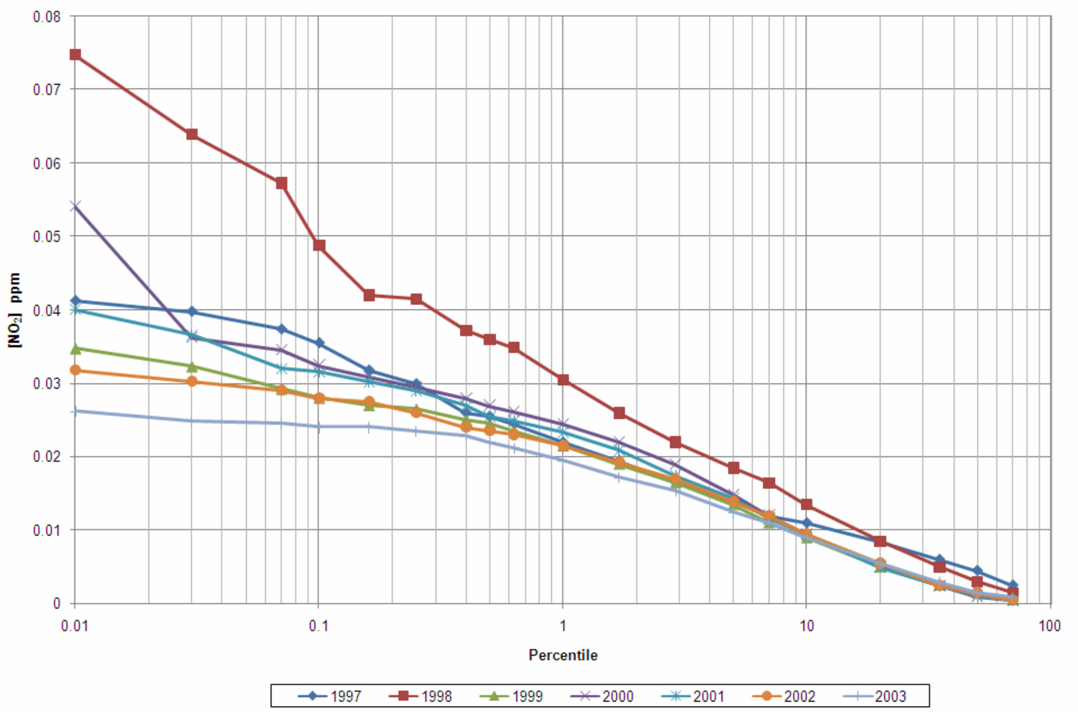

Figure 10.19 Cumulative frequency distribution of 1-hour average concentrations of nitrogen dioxide (NO_2) (ppm) at Barney Point, 1997-2003

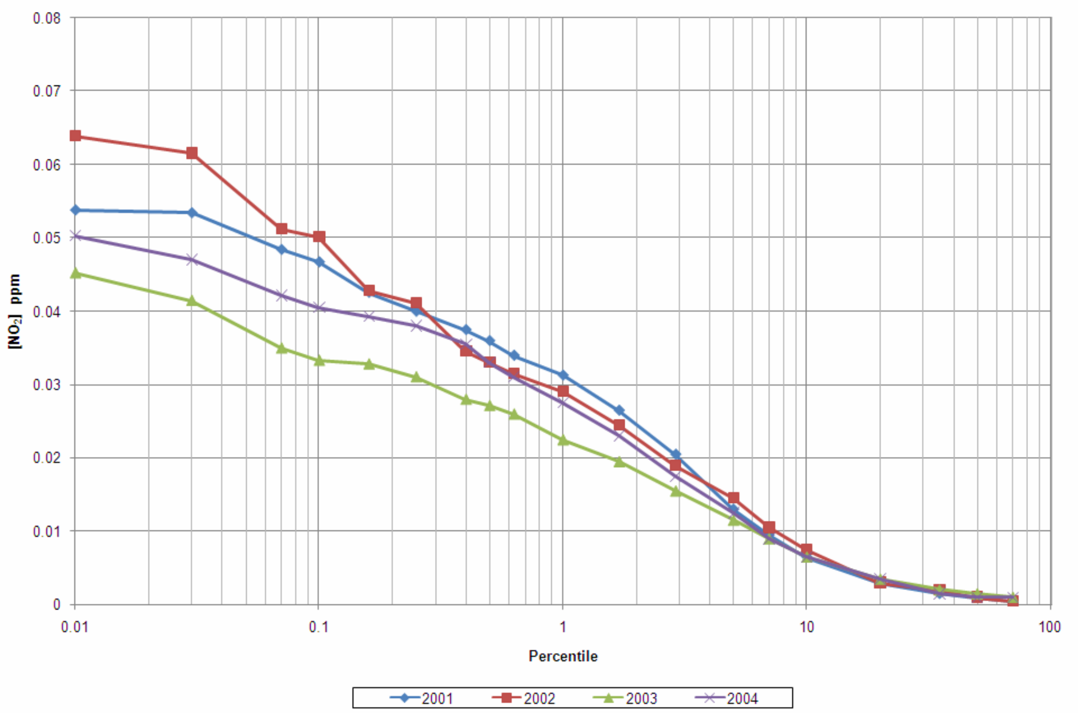

Figure 10.20 Cumulative frequency distribution of 1-hour average concentrations of nitrogen dioxide (NO_2) (ppm) at Mount Miller, 2001-2004

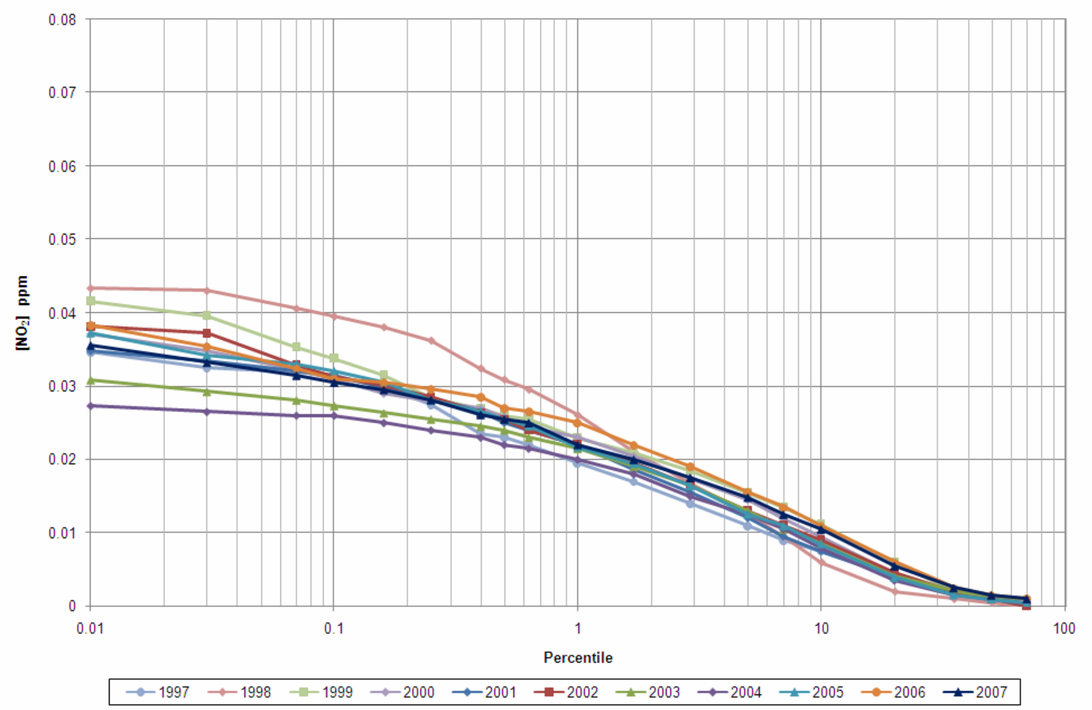

Figure 10.21 Cumulative frequency distribution of 1-hour average concentrations of nitrogen dioxide (NO_2) (ppm) at Targinie (Swans Road), 1997-2007

Annual average of nitrogen dioxide

Table 10.13 summarises the annual average concentrations of NO_2 from data obtained from each site for each year. There were no exceedances of the EPP(Air) goal of 0.01 ppm for annual average concentrations of NO_2.

Table 10.13 Annual average concentration of nitrogen dioxide (ppm)

Year	Clinton	South Gladstone	Targinie (Stupkin Lane)	Barney Point	Mt Miller	Targinie (Swans Road)
1997	-	0.003	-	0.005	-	0.002
1998	-	0.002	-	0.005	-	0.003
1999	-	0.003	-	0.003	-	0.004
2000	-	0.003	-	0.003	-	0.003
2001	0.003	0.004	0.005	0.003	0.003	0.003
2002	0.003	0.004	0.008	0.003	0.003	0.003
2003	0.004	0.004	0.004	0.004	0.003	0.003
2004	0.004	0.004	0.004	-	0.003	0.003
2005	0.004	0.004	0.004	-	-	0.003
2006	0.004	0.004	-	-	-	0.004
2007	0.005	0.005	-	-	-	0.003

The Targinie (Stupkin Lane) monitoring site is considered the most representative of the existing air quality at the site of the Project. Based on this a concentration of 0.008 ppm has been used to represent the annual average background concentration of NO_2.

Background levels of nitrogen dioxide

The EPA recommends using the 95th percentile of the 1-hour average concentration of NO_2 to represent the background level for air quality assessments and these are presented in Table 10.14 for each site for each year for which NO_2 data is available. The Targinie (Stupkin Lane) monitoring site is considered to be most representative of the existing air quality at the site of the Project as it is remote from diffuse sources such as motor vehicles.

Table 10.14 95th percentile of 1-hour average nitrogen dioxide (ppm) concentrations for each site for each year

Year	Clinton	South Gladstone	Targinie (Stupkin Lane)	Barney Point	Mt Miller	Targinie (Swans Road)
1997	-	0.009	-	0.014	-	0.011
1998	-	0.007	-	0.018	-	0.012
1999	-	0.011	-	0.013	-	0.015
2000	-	0.011	-	0.015	-	0.014
2001	0.013	0.012	0.017	0.014	0.013	0.012
2002	0.012	0.012	0.020	0.014	0.014	0.013
2003	0.011	0.013	0.018	0.012	0.011	0.013
2004	0.012	0.014	0.017	-	0.012	0.012
2005	0.011	0.013	0.017	-	-	0.012
2006	0.012	0.013	-	-	-	0.015
2007	0.014	0.014	-	-	-	0.015

The Targinie (Stupkin Lane) monitoring site is considered the most representative of the existing air quality at the site of the Project. Based on this a concentration of 0.02 ppm has been used to represent the 1-hour average background concentration of NO_2. The annual

Dust deposition

There are no known measurements of dust deposition rate at the Project site. There are dust deposition rate measurements within Gladstone that should represent an upper bound of what may occur at Aldoga.

As noted in the WICT EIS (Connell Hatch 2007), the Gladstone Ports Corporation has operated a network of dust deposition gauges in Gladstone for several years (refer Figure 10.22). Most of these monitoring stations are located close to the RG Tanna and Barney Point Coal Terminals and, therefore, experience higher dust levels than would be experienced within Gladstone. The monitoring stations that are located away from the coal terminals in residential areas – sites 6, 8, 12 and 67 in Figure 10.22 – are likely to be the most representative sites for background dust levels at Aldoga.

The dust deposition rate recorded at these sites is well below the EPA recommended guideline of 120 mg/m²/day. The dust deposition rate recorded at these sites between 2003 and 2007 ranged from 29.6 mg/m²/day to 91 mg/m²/day (Connell Hatch 2008b).

For the purpose of this assessment, a background level of 40 mg/m²/day has been used.

The estimated annual average coal dust deposition values are taken from the dust characterisation analyses conducted on the dust samples at each of these sites on a twice-per year basis. The coal dust deposition rate is very low at these residential sites (Connell Hatch 2008b).

10.2 Potential impacts

10.2.1 Construction

The construction phase of the Project has the potential to generate dust. However, air quality management strategies will be established in order to mitigate and manage the potential impacts of construction activities on the degradation of local air quality.

Activities which may lead to elevated levels of dust as a result of the construction may include, but are not limited to:

- Clearing of vegetation and topsoil
- The demolition of dwellings and/or buildings and the removal of construction material
- Excavation and transport of materials
- Loading and unloading of trucks
- Movement or queuing of construction vehicles
- Re-entrainment of deposited dust by vehicle movements
- Wind erosion of stockpiles and unsealed roads

Strong winds 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.

Dust generated by erosion from stockpiles requires sufficient wind speed over the stockpile surface to raise dust from the surface. Parrett (1992) notes that threshold friction velocities (at the material surface) of 0.15 m/s to 0.3 m/s are typically found for bulk materials, equating to a wind speed of 1.5 m/s to 3 m/s as measured at the standard of 10 m height.

A summary of wind speeds greater than 1.5 m/s and greater than 3 m/s representative of the study area is presented in Table 10.15. Winds passing over a stockpile would direct emissions towards a given receptor location up to 16.7% of the time for 1.5 m/s winds, and up to 7.8% of the time for winds over 3 m/s.

In general, larger particles will deposit within a short distance of a stockpile, and will tend to not be emitted offsite, assuming that the boundaries of the site are located a sufficient distance from the stockpile.

Table 10.15 Percentage of 10 m level winds over 1.5 m/s and 3 m/s for each direction range for the Project

Wind Speed (m/s)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
>1.5	1.0%	1.4%	2.9%	10.9%	16.7%	9.2%	4.4%	1.3%	0.6%	0.6%	1.1%	0.8%	0.2%	0.3%	0.8%	1.2%	53.3%
>3.0	0.1%	0.2%	0.8%	5.8%	7.8%	2.6%	1.1%	0.2%	0.0%	0.0%	0.3%	0.0%	0.0%	0.0%	0.0%	0.1%	19.0%

10.2.2 Operation

Overview of air quality issues

The main sources of potential emissions associated with the operation of the Project include:

- Coal dust emissions from coal wagons
- Emissions associated with the combustion of diesel fuel by NCL locomotives hauling coal

QR Environmental Evaluation of coal dust emissions

Background

In 2007, the EPA requested QR to conduct an environmental evaluation of fugitive emissions of coal dust from trains travelling from mines to ports (or coal consumers) on the Moura, Blackwater and Goonyella coal transport systems. QR appointed Katestone Environmental, Connell Hatch and Introspec Consulting to undertake the Coal Loss Management Project.

The Coal Loss Management Project required QR to:

- Identify all potential sources of coal dust emissions from QR trains
- Quantify the potential risk of environmental harm posed by each dust source
- Identify the factors and circumstances that contribute to dust emissions and/or impacts from each source
- Identify locations where proximity of railway lines to communities may give rise to higher risk of environmental harm due to fugitive coal dust
- Identify ways to reduce the risk being caused by coal dust emissions and assess each for practicability, effectiveness and cost, in relation to the mitigation of environmental impacts of fugitive coal dust emissions

The extensive study programme was approved by the EPA and included:

- Literature review and inspections of representative infrastructure
- Consideration of dust complaints
- Monitoring of ambient dust levels in close proximity to the tracks at two locations on each of the Moura, Blackwater and Goonyella systems and correlation with meteorological conditions and train movements
- Monitoring ambient dust levels at residential locations along the tracks
- Collation and analysis of ambient monitoring data that has been previously collected by QR and others
- Collation and analysis of available data relating to coal dustiness and wind tunnel testing
- Dispersion modelling of dust emissions to estimate dust levels away from the tracks due to coal trains
- Identification of locations that are at risk of impact due to dust from coal trains
- Assessment of potential dust control measures and cost/benefit analysis

A full copy of the Coal Loss Management Project is available for download from the QR website (http://www.networkaccess.qr.com.au/customer/Coal_Loss_Management_Project/).

Monitoring of coal dust adjacent to the rail corridor

Various studies have been undertaken to quantify ambient concentrations of coal dust and deposition rates of coal dust adjacent to QR rail corridors. The following studies were reported in the Coal Loss Management Project and are of particular relevance to the Project due to their being conducted within the Moura and Blackwater systems and in relatively close proximity to the study area:

- Simtars study at Callemondah, 2007
- Monitoring at the townships of Mount Larcom, Beecher and Raglan, 2007-2008

The remainder of this section summarises short-term (1-hour average) and medium-term (24-hour and month average) data collected in these studies.

A summary of the concentrations of TSP measured by the TEOM[1] at Callemondah is shown in Table 10.16. The highest average and maximum concentrations of TSP were measured during April and September 2007 at 25 µg/m³ and 800 µg/m³, respectively. Compositional analysis of TEOM filters indicates that the 24-hour average concentrations of TSP are between 5% and 30% coal dust.

Table 10.16 TSP concentration (µg/m³) collected by TEOM at 10 m downwind of the coal freight line at Callemondah, 5-minute averages

Month	Mean	Maximum
April 2007	25	800
May 2007	19	246
June 2007	12	485
July 2007	20	570
August 2007	19	332
September 2007	22	345

Source: Simtars (2008)

A statistical comparison of the concentrations of TSP measured by TEOM with train and coal movements was undertaken. The statistical analysis concluded that dust from loaded trains coming from Oaky Creek, Kestrel, Rolleston, Kinrola, Curragh, Minerva and Ensham was similar to dust from empty trains. Loaded trains from Ensham, Laleham, Gregory, Boonal, Boorgoon, Blackwater and Yongala produced more dust than empty trains. Results from Koorilgah were inconclusive. Notwithstanding this, the increases in dust associated with coal trains were relatively small in most circumstances.

A plot of the cumulative frequency distribution of concentrations of TSP measured at Callemondah, Beecher and Raglan (1-hour averages) is shown in Figure 10.23. This plot shows the maximum 1-hour average concentration of TSP to be about 170 µg/m³ at Callemondah and 330 µg/m³ at Raglan. For about 1% of the time (or 88 hours per year), the concentrations of TSP that were measured at Callemondah, Raglan and Beecher were found to be more than 70 µg/m³. For about 0.2% of the time (or 19 hours per year), the concentration of TSP was found to be more than 100 µg/m³.

This data indicates that it is unlikely that during the monitoring period the concentrations of TSP associated with coal trains would have caused nuisance at locations outside of the rail corridor.

It is likely, however, that coal dust may have been visible in the vicinity of the coal trains at Callemondah, Beecher and Raglan on a very infrequent basis.

[1] TEOM – Tapered Element Oscillating Microbalance, EPA approved dust monitoring equipment

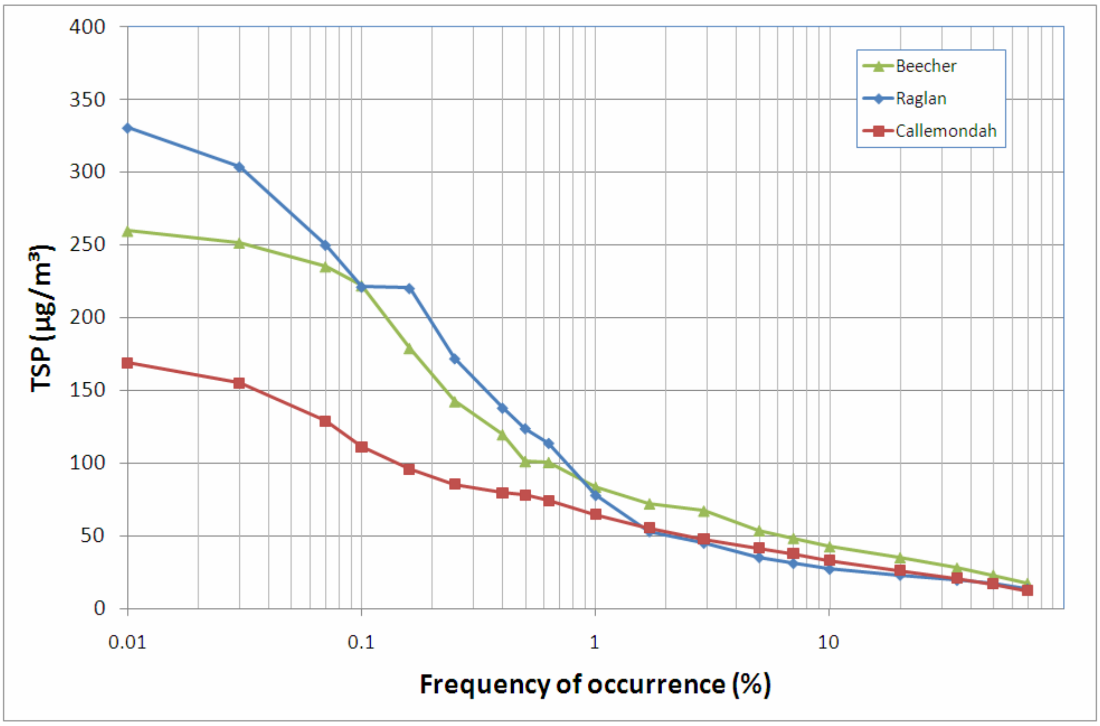

Figure 10.23 Cumulative frequency distributions of 1-hour average concentrations of TSP (µg/m³) measured at about 10 m from the edge of tracks at Callemondah, Raglan and Beecher, 2007 and 2008

Data on movements of coal trains in the vicinity of the monitoring stations at Beecher and Raglan has been collected concurrently with monitoring data. This data has been compared with peak 5-minute average concentrations of TSP to quantify the frequency that peak concentrations coincide with train movements. Given that the monitoring stations have not been able to be collocated with rail signals, the exact time that the trains pass the monitoring station cannot be identified. However, corrections have been made based on the distance that the rail signal is from the monitoring station and the local speed of trains.

Table 10.17 summarises the number of trains passing the monitoring stations in the period from 22 October 2007 to 29 February 2008, coinciding with a 1-hour average concentration of TSP that is greater than 10 µg/m³. A peak is deemed to occur when the 5-minute average concentration is more than twice the corresponding 1-hour average. The number of occasions that passing trains has coincided with peak concentrations of TSP is also shown in Table 10.17. Between 1.1% and 2.1% of loaded trains coincide with a peak concentration of TSP.

Table 10.17 Number of times that loaded trains coincide with peak concentrations of TSP. A peak concentration is defined as the 1-hour average concentration of TSP being greater than 10 µg/m³ and the ratio of 5-minute average and 1-hour average concentrations of TSP is greater than 2

Location	Number of passing loaded trains	Peak TSP occurs as train passes		Peak TSP occurs within ± 5 mins of train passing	
		Count	%	Count	%
Beecher	280	6	2.1%	32	11.4%
Raglan	355	4	1.1%	16	4.5%

If a broader window is defined to account for the uncertainty in the time that the train passes, where a peak is considered to coincide with a train passing if it occurs within 5 minutes of the train passing, then between 4.5% and 11.4% of trains coincide with peak concentrations of TSP (refer Table 10.17).

Table 10.18 summarises the concentrations of TSP that coincide with passing trains. The peak 5-minute average concentration of TSP that corresponds with a significant change in concentration of TSP as a loaded train passes is 209 μg/m³ at Beecher and 658 μg/m³ at Raglan. On average at each of the monitoring sites, the concentration of TSP when passing trains coincide with a peak is between 105 μg/m³ and 133 μg/m³.

Table 10.18 Maximum and average concentrations of TSP (μg/m³) and 5-minute to 1-hour ratios that coincide with a loaded train passing, TSP 1-hour average concentration greater than 10 μg/m³ and 5-minute to 1-hour ratio of greater than 2

Location	Maximum 5-minute TSP when train passes and TSP ratio ≥ 2 (μg/m³)	Average TSP where TSP ratio ≥ 2 (μg/m³)	TSP 5-minute to 1-hour average ratio maximum	TSP 5-minute to 1-hour average ratio average
Beecher	209	105	2.8	2.4
Raglan	658	133	6.2	3.1

Table 10.19 examines the differences in the peak and average concentrations of TSP for coal trains and non-coal trains as they pass the monitoring station at Raglan. This table shows that peak concentrations of dust that are associated with coal trains are two times higher than those associated with trains not carrying coal when considering concentrations of TSP within 5-minutes of the train pass time. This is illustrated in Figure 10.24, indicating that concentrations of TSP associated with coal carrying trains are consistently higher than associated with trains carrying other types of freight.

Table 10.19 Maximum 5-minute and average concentrations of TSP (μg/m³) and 5-minute to 1-hour ratios that coincide with a loaded train passing, TSP 1-hour average concentration greater than 10 μg/m³ and 5-minute to 1-hour ratio of greater than 2

Location	Load	TSP as train passes (μg/m³)			TSP within ± 5 mins of train passing (μg/m³)		
		Count	Maximum 5-minute average	Average	Count	Maximum 5-minute average	Average
Raglan	Non-coal	23	178	52	55	320	57
Raglan	Loaded trains	31	658	104	104	658	91

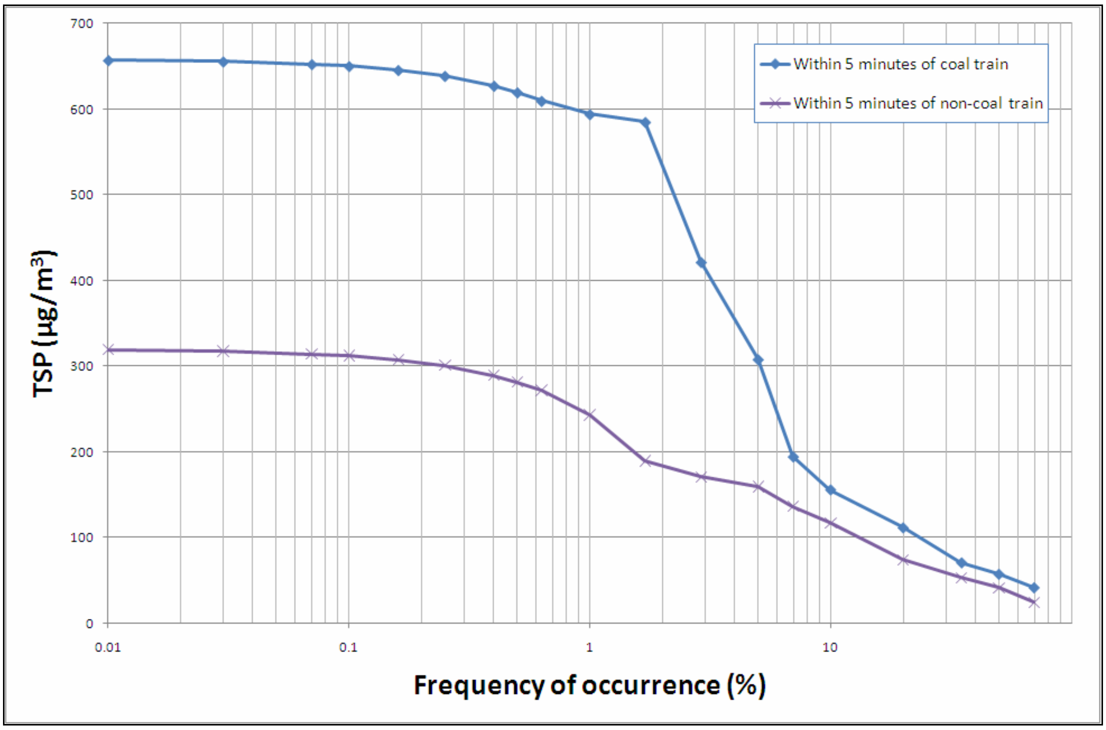

Figure 10.24 Cumulative frequency distributions of 5-minute average concentrations of TSP (µg/m³) measured at about 10 m from the edge of tracks at Raglan and filtered for type of train passing during studies in 2007 and 2008

A summary of the 24-hour average concentrations of PM_{10} that were collected by the Partisol upwind (south) and downwind (north) of the coal freight line at Callemondah is shown in Table 10.20. This table shows the maximum, minimum and average concentrations measured at the upwind and downwind locations and the maximum, minimum and difference between the paired measurements that were collected at the same time. Whilst the NEPM(Air) standard and the EPP(Air) goal do not apply within the rail corridor, the monitoring results have been compared to these health-related standards and goals to assess the likelihood that they would have been exceeded outside of the corridor due to trains carrying coal.

The 24-hour average concentration of PM_{10} exceeded the EPP(Air) goal of 150 µg/m³ on two occasions during the monitoring period. These occurred on 31 May and 6 June with concentrations of PM_{10} of 156 µg/m³ and 168 µg/m³, respectively. Neither event was found to be caused by dust from coal trains. Compositional analysis indicates that salt contributed most significantly to the measurement on 31 May and coal dust contributed little. On 6 June the upwind measurement was 137 µg/m³, suggesting that the coal freight line was a minor contributor and other unidentified dust emission sources are likely to have been the main contributor.

On one occasion the 24-hour average concentration of PM_{10} exceeded the NEPM(Air) standard of 50 µg/m³ at the downwind location. This occurred on 25 April when a concentration of PM_{10} of 82 µg/m³ was measured. At the same time, a concentration of 52 µg/m³ was measured at the upwind site.

Table 10.20 Concentration of PM_{10} (µg/m³) collected by Partisol at 10 m downwind (north) and upwind (south) of the coal freight line at Callemondah, 24-hour averages

Month	North			South			Difference		
	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave
April 2007	26	24	25.3	24	18	21.3	8	0	4
May 2007	156	20	54.3	83	12	34.8	73	-2	19.5
June 2007	168	5	48.5	137	3	39.5	31	-1	9
July 2007	19	12	15.3	14	12	13	6	0	2.25
August 2007	26	3	17.3	22	2	15.8	6	-4	1.5
September 2007	30	2	18.3	29	3	17.4	8	-3	1.3
October 2007	15	14	14.5	18	17	17.5	-2	-4	-3.0

Source: Simtars (2008)

Figure 10.25 provides a plot of 24-hour average concentrations of TSP that were measured at Callemondah from April to October 2007. Throughout the monitoring period, the concentration of TSP is below the EPP(Air) goal of 150 µg/m³ and the NEPM(Air) standard of 50 µg/m³ for PM_{10}. The peak 24-hour average concentration of TSP of 48 µg/m³ was measured on 13 October 2007. A compositional analysis of the filter that was collected on this day indicates that 10% of the sample was coal dust.

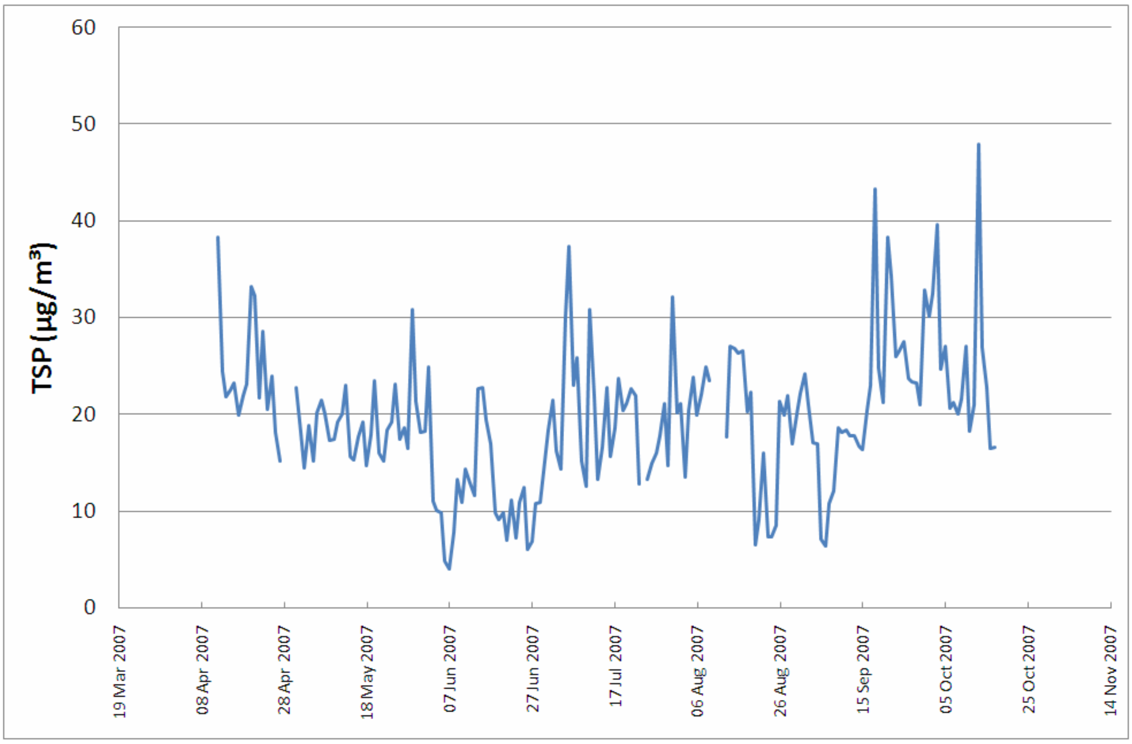

Figure 10.25 24-hour average concentration of TSP (µg/m³) measured at Callemondah from October to December 2007

Table 10.21 provides a summary of 24-hour average concentrations of TSP that were measured at Beecher and Raglan. From October to December 2007, the concentration of TSP measured at Beecher and Raglan was below the EPP(Air) goal of 150 µg/m³ and the NEPM(Air) standard of 50 µg/m³ for PM_{10}, as can be seen in Figure 10.26.

Table 10.21 24-hour average TSP concentration statistics (µg/m³) for Beecher and Raglan

Monitoring site	24-hour Average TSP Concentration Statistics		
	Maximum	Minimum	Average
Beecher	43.6	7.8	26.6
Raglan	46.0	7.3	19.1

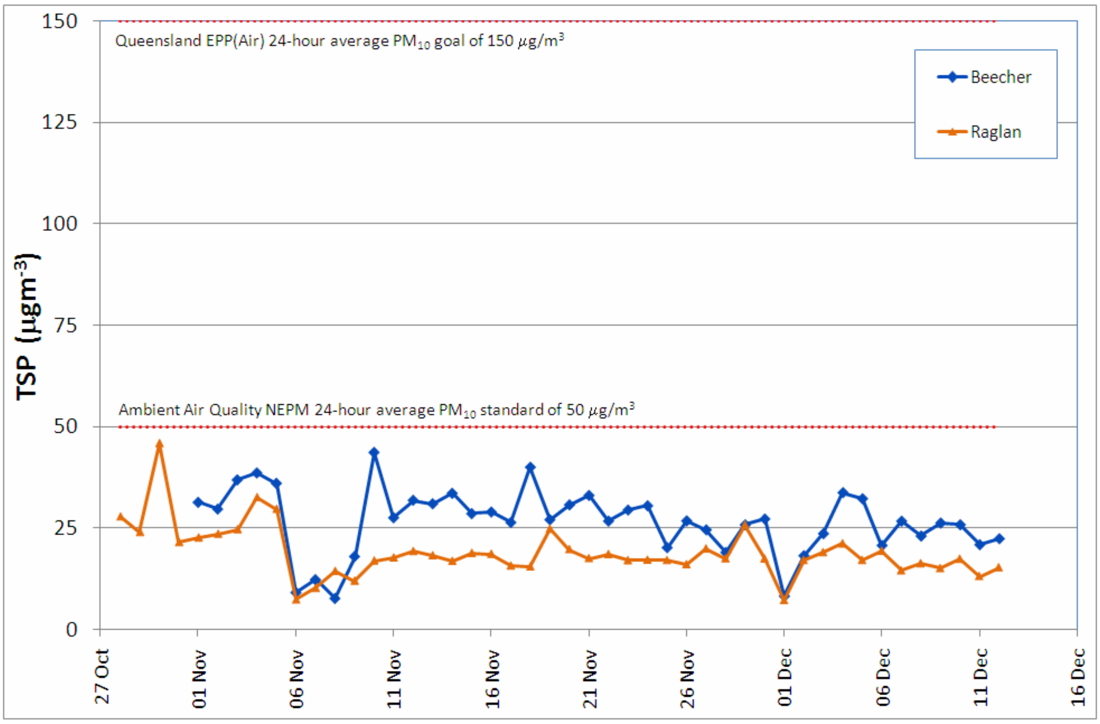

Figure 10.26 24-hour average concentration of TSP (µg/m³) measured at about 10 m from the tracks at Beecher and Raglan, October to December 2007

Dust deposition rates were measured every month for a six-month period from April to October 2007. The dust deposition rate samples were submitted for compositional analysis. The results of dust deposition monitoring at 3 m and 10 m from the edge of tracks on the downwind side are included in Table 10.22.

Table 10.22 Dust deposition and coal deposition rates (mg/m²/day) measured at 3 m and 10 m from the tracks at Callemondah

Sample dates	Location	Insoluble solids	Coal
15 April – 10 May 2007	North 10 m	58	26
10 May – 12 June 2007*	North 10 m	21	15
14 June – 17 July 2007*	North 10 m	23	17
17 July – 16 August 2007	North 10 m	46	30
16 August – 16 September 2007*	North 10 m	35	23
17 September – 15 October 2007	North 10 m	43	15
15 April – 10 May 2007	North 3 m	263	79
10 May – 12 June 2007*	North 3 m	166	75
14 June – 17 July 2007*	North 3 m	177	89

Sample dates	Location	Insoluble solids	Coal
17 July – 16 August 2007	North 3 m	137	55
16 August – 16 September 2007*	North 3 m	142	57
17 September – 15 October 2007	North 3 m	209	73

Table note:
*Dust gauge covered for one day during rail grinding

The generally accepted threshold dust nuisance is 120 mg/m^2/day as the average of twelve consecutive monthly samples of insoluble solids. Whilst twelve samples were not collected at Callemondah, Table 10.22 indicates that the nuisance threshold is likely to be exceeded at 3 m from the edge of the tracks. At 10 m from the edge of tracks, the dust deposition rate is, at most, 58 mg/m^2/day. The dust deposition rate is unlikely to exceed the nuisance threshold at 10 m from the tracks. At 10 m from the edge of the tracks, the coal deposition rate ranged between 35% and 75% of insoluble solids.

Outcomes of the Environmental Evaluation

The Coal Loss Management Project recommended that QR develop a coal dust management plan as a framework for the ongoing management of the coal dust issue. The coal dust management plan should detail short-, medium- and long-term strategies for minimising coal dust emissions from the key dust sources. The coal dust management plan should incorporate the principle of continual environmental improvement.

A range of measures were identified that show potential to reduce the risk being caused by coal dust emissions. The following techniques could be implemented within the Goonyella, Blackwater and Moura rail systems:

- Coal surface veneering using chemical dust suppressants at the mine
- Improved coal loading techniques at the mine to reduce parasitic load on horizontal wagon surfaces and reduce over-filling and hence spillage during transport
- Load profiling to create a consistent surface of coal in each wagon, to be implemented at the mine
- Improved unloading techniques to minimise coal ploughing and parasitic load on wagons

Dispersion modelling

The dispersion modelling of the impacts of the Project on local air quality was conducted using the Cal3QHCR dispersion model and based on the Stage 4 throughput.

Cal3QHCR has been used extensively in Queensland and New South Wales and is currently recommended by AusRoads and Australian regulatory agencies as being an appropriate dispersion model for estimating near-field impacts in the proximity of major roads. It has been used in the current Project to model dust emissions from the loaded coal wagons and emissions of oxides of nitrogen and particulate matter from non electric locomotives. The meteorological file used by Cal3QHCR was generated based on the data described in the existing environment section and using the techniques detailed in Appendix H1.

The modelling was conducted to illustrate the impact of the Project, in isolation to current operations along the NCL and MSL, on the existing air shed.

Sensitive receptor locations

Figure 10.27 shows the locations of nearest residences to the Project. Appendix H2 shows the nearest residences and summarises the distance from each residence to the rail line.

Nitrogen dioxide from diesel locomotives

Results of the dispersion modelling using Cal3QHCR are summarised in Tables 10.23 to 10.24 for the maximum 1-hour average and annual average ground-level concentration of NO_2, at the location of the most affected receptors. A summary of the predicted concentrations from the dispersion modelling at all the sensitive receptor locations is provided in Appendix H3.

Results suggest that the maximum 1-hour average ground-level concentration of NO_2 will remain below the NEPM(Air) standard of 0.12 ppm and EPP(Air) goal of 0.16 ppm at all sensitive receptor locations. The combustion of diesel fuel by locomotives is predicted to add between 0.003 ppm and 0.05 ppm to background levels of 0.02 ppm.

The annual average concentration of NO_2 is predicted to remain well below the NEPM(Air) standard of 0.03 ppm at all sensitive receptor locations. Locomotive emissions are predicted to add between 0.00003 ppm and 0.0009 ppm to background levels of 0.008 ppm.

Table 10.23 Predicted maximum 1-hour average and annual average ground-level concentration of nitrogen dioxide (ppm) for the Moura Link Eastern Option configuration

Residential dwelling	Averaging period	Goal	Background	Locomotives	Locomotives + background	Percent of standard
22	1-hour	0.16 and 0.12	0.02	0.050	0.070	58%
	Annual	0.03	0.008	0.000	0.008	28%
23	1-hour	0.16 and 0.12	0.02	0.039	0.059	49%
	Annual	0.03	0.008	0.000	0.008	28%
24	1-hour	0.16 and 0.12	0.02	0.030	0.050	41%
	Annual	0.03	0.008	0.001	0.009	29%
42	1-hour	0.16 and 0.12	0.02	0.013	0.033	28%
	Annual	0.03	0.008	0.001	0.009	29%
20	1-hour	0.16 and 0.12	0.02	0.012	0.032	27%
	Annual	0.03	0.008	0.000	0.008	27%

Table 10.24 Predicted maximum 1-hour average and annual average ground-level concentration of nitrogen dioxide (ppm) for the Moura Link Western Option configuration

Residential dwelling	Averaging period	Goal	Background	Locomotives	Locomotives + background	Percent of standard
16	1-hour	0.16 and 0.12	0.02	0.015	0.035	30%
	Annual	0.03	0.008	0.000	0.008	27%
17	1-hour	0.16 and 0.12	0.02	0.015	0.035	29%
	Annual	0.03	0.008	0.001	0.009	28%
18	1-hour	0.16 and 0.12	0.02	0.013	0.033	28%
	Annual	0.03	0.008	0.000	0.008	27%
19	1-hour	0.16 and 0.12	0.02	0.012	0.032	26%
	Annual	0.03	0.008	0.000	0.008	27%

Residential dwelling	Averaging period	Goal	Background	Locomotives	Locomotives + background	Percent of standard
27	1-hour	0.16 and 0.12	0.02	0.011	0.031	26%
	Annual	0.03	0.008	0.000	0.008	27%

Particulate matter as PM_{10} and TSP from coal wagons and diesel locomotives

In general, results from the dispersion modelling using Cal3QHCR suggest that the ground-level concentrations of particulate matter (TSP and PM_{10}) will remain below the relevant standard or goal (refer Tables 10.25 to 10.26). A summary of the predicted concentrations from the dispersion modelling at all the sensitive receptor locations is provided in Appendix H3.

The proximity of a residence to the rail lines will determine the relative contribution of emissions of particulate matter from either the coal wagons or diesel locomotives, to predicted ground-level concentrations of TSP and/or PM_{10}. In general, emissions of particulate matter associated with the coal wagons is the dominant source at the majority of the residential locations.

The 24-hour average ground-level concentration of PM_{10} is predicted to remain below the NEPM(Air) standard of 50 $\mu g/m^3$. Of the maximum 24-hour average concentration of PM_{10} predicted at residential dwellings 15, 17, 22 to 24, 30, 42 and 44, a range of only 2.31 to 6.44 $\mu g/m^3$ (or 5% to 13% of the NEPM(Air) standard) is attributed to the proposed Moura Link or the Aldoga Rail Yard and 38.5 $\mu g/m^3$ attributed to background levels.

The annual average ground-level concentration of PM_{10} is predicted to be up to 47% of the EPP(Air) goal of 50 $\mu g/m^3$ (or 23.3 $\mu g/m^3$) at the location of residential dwelling 30. The background concentration is estimated to be 22 $\mu g/m^3$. Of the 1.30 $\mu g/m^3$ attributed to rail yard activities at this location, 1.05 $\mu g/m^3$ is predicted to be associated with dust from the coal wagons.

The contribution of the Project to the annual average ground-level concentration of TSP is predicted to be up to 3.25 $\mu g/m^3$ at the location of residential dwelling 30. When combined with an estimated background concentration of 44 $\mu g/m^3$, air quality is predicted to remain well below the EPP(Air) goal of 90 $\mu g/m^3$.

Table 10.25 Predicted maximum ground-level concentrations of TSP and PM_{10} ($\mu g/m^3$) for the Moura Link Eastern Option configuration

Residential dwelling	Pollutant $\mu g/m^3$	Averaging period	Goal	Background	Coal wagons	Diesel locomotives	Project + background	Percent of standard
22	TSP	annual	90	44	0.84	0.08	44.9	50%
	PM_{10}	24-hour	50 or 150	38.5	6.44	1.85	46.8	94%
		annual	50	22	0.29	0.08	22.4	45%
23	TSP	annual	90	44	0.79	0.08	44.9	50%
	PM_{10}	24-hour	50 or 150	38.5	5.32	1.53	45.3	91%
		annual	50	22	0.28	0.08	22.4	45%
24	TSP	annual	90	44	1.49	0.15	45.6	51%
	PM_{10}	24-hour	50 or 150	38.5	5.57	1.52	45.6	91%
		annual	50	22	0.52	0.15	22.7	45%
30	TSP	annual	90	44	3.00	0.25	47.2	52%
	PM_{10}	24-hour	50 or 150	38.5	3.99	0.88	43.4	87%
		annual	50	22	1.05	0.25	23.3	47%

42	TSP	annual	90	44	1.01	0.09	45.1	50%
	PM_{10}	24-hour	50 or 150	38.5	3.50	0.99	43.0	86%
		annual	50	22	0.35	0.09	22.4	45%

Table 10.26 Predicted maximum ground-level concentrations of TSP and PM_{10} ($\mu g/m^3$) for the Moura Link Western Option configuration

Residential dwelling	Pollutant $\mu g/m^3$	Averaging period	Goal	Background	Coal wagons	Diesel locomotives	Project + background	Percent of standard
15	TSP	annual	90	44	2.28	0.19	46.5	52%
	PM_{10}	24-hour	50 or 150	38.5	3.35	0.74	42.6	85%
		annual	50	22	0.80	0.19	23.0	46%
17	TSP	annual	90	44	1.69	0.14	45.8	51%
	PM_{10}	24-hour	50 or 150	38.5	5.58	1.23	45.3	91%
		annual	50	22	0.59	0.14	22.7	45%
30	TSP	annual	90	44	2.93	0.24	47.2	52%
	PM_{10}	24-hour	50 or 150	38.5	3.71	0.82	43.0	86%
		annual	50	22	1.03	0.24	23.3	47%
42	TSP	annual	90	44	0.88	0.08	45.0	50%
	PM_{10}	24-hour	50 or 150	38.5	2.57	0.85	41.9	84%
		annual	50	22	0.31	0.08	22.4	45%
44	TSP	annual	90	44	0.83	0.07	44.9	50%
	PM_{10}	24-hour	50 or 150	38.5	2.31	0.79	41.6	83%
		annual	50	22	0.29	0.07	22.4	45%

Dust deposition

Dust deposition is predicted to remain well below the EPP(Air) recommended rate of 120 $mg/m^2/day$ at all locations (refer Tables 10.27 to 10.28). A summary of the predicted concentrations from the dispersion modelling at all the sensitive receptor locations is provided in Appendix H3. A maximum dust deposition rate of 72.5 $mg/m^2/day$ is predicted at the location of residential dwelling 30 with coal wagons the primary source of particulate matter.

Table 10.27 Predicted maximum dust deposition rate ($mg/m^2/day$) for the Moura Link Eastern Option configuration

Residential dwelling	Background	Coal Wagons	Project + background	Percent of goal
30	40	32.5	72.5	60%
24	40	16.1	56.1	47%
28	40	11.5	51.5	43%
29	40	11.7	51.7	43%
42	40	11.0	51.0	42%

Table 10.28 Predicted maximum dust deposition rate (mg/m²/day) for the Moura Link Western Option configuration

Residential dwelling	Background	Coal Wagons	Project + background	Percent of goal
30	40	31.7	71.7	60%
15	40	24.7	64.7	54%
17	40	18.3	58.3	49%
47	40	12.2	52.2	43%
28	40	10.0	50.0	42%
29	40	10.4	50.4	42%

10.3 Greenhouse gas assessment

The major activities of the Project that are associated with the release of greenhouse gases are the result of direct and indirect sources such as the burning of fossil fuels and electricity usage.

10.3.1 Background to greenhouse gases

Greenhouse gases such as carbon dioxide (CO_2) have been implicated in gradual global climatic changes as they affect the balance between incoming solar energy and losses due to radiation from the earth and atmosphere. Under the Kyoto Protocol, Australia is committed to monitor and report greenhouse gas emissions and has set a target level for emissions in 2010 to be no more than 8% higher than the emissions for 1990.

Pollutants of importance to global warming are water vapour (H_2O), nitrous oxide (N_2O), CO_2 and methane (CH_4). Indirect greenhouse gases such as carbon monoxide (CO), nitrogen oxides other than N_2O and non-methane volatile organic compounds (NMVOCs) do not have a strong radiative forcing effect in themselves, but influence atmospheric concentrations of the direct greenhouse gases.

Water vapour is the major contributor to the greenhouse effect but is not normally considered because fluxes are dominated by the day-to-day precipitation cycle. Carbon dioxide is the next most significant greenhouse gas and the major anthropogenic contributor.

The relative importance of a greenhouse gas is measured in terms of its global warming potential (GWP), usually related to a GWP of 1 for carbon dioxide. Nitrous oxide and carbon dioxide are greenhouse gases that are associated with combustion activities, such as those that occur in diesel fuelled vehicles and the combustion of fossil fuels to generate electricity. Carbon dioxide tends to remain active for a lifetime of around 150 years and has a GWP of 1 on a 100 year timeframe. Nitrous oxide has a lifetime of 120 years and a GWP of 310 on a 100 year timeframe. Methane has a lifetime of 14.5 years and a GWP of 21 on a 100 year timeframe. Whilst nitrous oxide and methane have a greater potential to cause global warming, carbon dioxide is produced in far greater quantities by anthropogenic activities than nitrous oxide and methane and consequently, carbon dioxide is the most important greenhouse gas.

Greenhouse gas emissions are reported in terms of tonnes of carbon dioxide equivalent ($tCO_{2\text{-}e}$). Carbon dioxide equivalents are calculated as the sum of the emission rate of each greenhouse gas multiplied by the GWP.

As follows: $tCO_{2\text{-}e}$ = tonnes CO_2 x 1.0 + tonnes CH_4 x 21 + tonnes N_2O x 310.

10.3.2 Greenhouse Challenge Plus and emissions estimation

The Greenhouse Challenge Plus programme is part of the Federal Government's climate change strategy and is managed by the Australian Greenhouse Office (AGO). The Greenhouse Challenge Plus programme is designed to:

- Reduce greenhouse gas emissions
- Accelerate the uptake of energy efficiency
- Integrate greenhouse gas issues into business decision making, and
- Provide more consistent reporting of greenhouse gas emission levels.

AGO part of the DEWHA monitors and compiles databases on anthropogenic activities that produce greenhouse gases in Australia. The AGO has published greenhouse gas emission factors for a range of anthropogenic activities. The AGO methodology for calculating greenhouse gas emissions is published in the AGO Factors and Methods Workbook (AGO 2008) and is based on Australian data. This workbook is updated regularly to reflect current compositions in fuel mixes and evolving information on emission sources.

The AGO Workbook defines three scopes of emission categories for calculating greenhouse gas emissions. These are as follows:

- Scope 1: This covers the direct emission sources within the boundary of an organisation such as the emissions from fuel combustion of vehicles and ships
- Scope 2: This covers indirect emissions from consuming purchased electricity, steam or heat that is produced by another organisation
- Scope 3: This covers all other indirect emissions from sources that are not owned or controlled by an organisation but occur as a consequence of the organisations activities

Scope 1, Scope 2 and some Scope 3 emissions are commonly reported. Scope 3 emissions that are usually reported include emissions from offsite waste disposal, emissions associated with production of fuels and emissions from transmission, distribution and generation of electricity.

10.3.3 Greenhouse gas producing activities and emission factors

The major activities that produce greenhouse gas emissions are:

- Scope 1: Diesel consumption of locomotives
- Scope 2: Electricity consumption of shunt locomotives
- Scope 3: Production, transport and distribution of fuel and electricity

Table 10.29 summarises the greenhouse gas emission factors used to quantify greenhouse gas emissions from fuel and electricity consumption associated with the Moura Link and Aldoga Rail Yard activities.

Table 10.29 Greenhouse gas emission factors

Activity/ source	Units	Scope 1	Scope 2	Scope 3	Total
Diesel combustion	t CO_{2-e}/kL	2.7	-	0.3	3.0
Electricity consumption	t CO_{2-e}/KWh	-	0.000903	0.000143	0.001046

Source: AGO (2005)

10.3.4 Greenhouse gas emissions

At the ultimate capacity of 90 Mtpa, the Project is expected to consume 170 million Litres of diesel per year and 2.5 GWhr of electricity per year. A summary of the greenhouse gas emissions calculated for the Project is shown in Table 10.30.

Table 10.30 Greenhouse gas emissions ($MtCO_2$-e per annum) associated with the direct operation of the Project

Source	Change
Diesel consumption	0.53
Direct energy consumption (electricity)	0.003
Total	**0.533**

Australia's assigned amount of emissions under the Kyoto Protocol is 108% of Australia's estimated emissions for 1990 or 598,075.71 Gg (598 MtCO2-e). Total emissions from the Project are predicted to equate to 0.09% of Australia's assigned amount under the Kyoto Protocol.

10.4 Mitigation measures

The measures proposed to mitigate potential air environment impacts for the Project are discussed in Section 20.

10.5 Conclusions

The air quality assessment for the Project has shown the following:

- The Targinie (Stupkin Lane) monitoring site is considered the most representative of the existing air quality at the site of the Project.
- Using 95th percentile data from the Targinie (Stupkin Lane) site has led to an estimate for the 24-hour background level at Aldoga of PM_{10} of 38.5 μg/m^3.
- The annual average background level of PM_{10} at Aldoga is estimated to be 22 μg/m^3 based on the Targinie (Stupkin Lane) monitoring data.
- Using 95th percentile data from the Targinie (Stupkin Lane) site has led to an estimate for the 1-hour average background level at Aldoga of NO_2 of 0.02 ppm.
- The annual average background level of NO_2 at Aldoga is estimated to be 0.008 ppm based on the Targinie (Stupkin Lane) monitoring data.
- The NEPM standard for the 24-hour average concentration of PM_{10} of 50 μg/m^3 has been exceeded at the EPA's South Gladstone monitoring station during 2001, 2002, 2005 and 2006. However, during each of those years the number of exceedances is less than the NEPM(Air) goal of less than 5 exceedances per year. The exceedances have been consistently attributed to bushfires and dust storms.
- The EPP(Air) goal for the 24-hour average concentration of PM_{10} of 150 μg/m^3 has been exceeded at all stations on only two days during the period 2001-2007. These occurred on 26 October 2002 and 3 February 2005. Both of these exceedances are attributable to dust storms and/or bushfires that affected the region.
- Using the 95th percentile data from the Targinie (Stupkin Lane) site has led to an estimate for the background level at Aldoga of NO_2 of 0.018 ppm.
- No exceedances of the EPP(Air) or NEPM(Air) standard for the 1-hour or for the annual average of NO_2 were recorded at the monitoring stations.

The dispersion modelling findings for the Project include:

- The combustion of diesel fuel by locomotives is predicted to add a maximum of 0.05 ppm of NO_2 for the 1-hour average ground-level concentration and a maximum of 0.0009 ppm for the annual average ground-level concentration. These increases are well below the NEPM(Air) standards and EPP(Air) goals.

- The 24-hour average ground-level concentration of PM_{10} is not predicted to exceed the NEPM(Air) standard. The maximum ground-level concentrations of PM_{10} due to background levels in conjunction with the Project is predicted to be 46.8 $\mu g/m^3$, of which 14% is due to coal wagons in transit and 4% due to the combustion of diesel fuel by locomotives.
- The annual average ground-level concentrations of PM_{10}, TSP and dust deposition are predicted to remain below the relevant EPP(Air) goals.
- Dust emissions from construction and operation of the Project can be managed to ensure that potential impacts are minimised at sensitive locations.

10.6 Commitments

The relevant air quality commitments for the Project include:

- Prepare and implement a Dust Management Sub Plan during construction as part of the CEMP.
- QR to implement the relevant findings of the Coal Loss Management Project during operation.