Section 7

AIR QUALITY

SECTION 7

7. Air Quality

An air quality impact assessment study has been conducted to quantify the potential of the Project to adversely affect air quality. This Section presents the outcomes of the air quality impact assessment.

7.1 Methodology

The following methodology was used to characterise the existing environmental conditions and the potential impacts that the construction and operation of the Project may have on air quality and includes:

- Description of the legislative framework for air quality;
- Characterisation of meteorology and existing air quality in the study region through review of Gladstone, Toowoomba and Wandoan monitoring stations;
- Quantification of the potential emissions and impacts from construction and operation of the Project, in particular
  - Coal dust emissions from coal trains in transit on the Surat Basin Rail; and
  - Particulate matter and emissions of nitrogen oxides from diesel fuel combusion by locomotives;
- Estimation of greenhouse gas (GHG) emissions and comparison of emissions for diesel versus electric trains; and
- Advice on mitigation measures.

7.2 Legislative Framework

7.2.1 Environment Protection Act and Environment Protection (Air) Policy

The framework for managing air quality in Queensland is detailed in the *Environment Protection Act 1994* (EP Act). The 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 on an application for a development permit, amendment of a licence or approval of a draft EMP. Schedule 1 of the EPP(Air) specifies air quality indicators and goals for Queensland. Indicators and goals that are relevant to this Project are reproduced in Table 7-1.

The dust deposition guideline is not defined in the EPP(Air) and is therefore not enforceable by legislation, but has been recommended by the EPA as a design goal (pers. comm. Dr David Wainwright, Qld EPA Air Services Manager). Table 7-1 shows the dust deposition guideline commonly used in Queensland as a benchmark for avoiding amenity impacts due to dust. Whilst this guideline was originally defined as an annual average (NERDDC, 1998), the EPA has recently advised that this is to be interpreted as a monthly average.

7.2.2 *National Environmental Protection (Ambient Air Quality) Measures*

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). The goal of the NEPM(Air) is for the ambient air quality standards to be achieved at these monitoring stations by 2008, ten years after commencement of the NEPM (Air).

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. A further 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 not suitable for application to this Project.

The NEPM (Air) 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 rail transport activities is likely to overestimate the potential for adverse impact.

7.2.3 *Relevant Air Quality Guidelines and Standards*

The EPP(Air) goals are used to assess impacts at sensitive locations, such as residential areas and isolated dwellings that are located in close proximity to industrial sites and major traffic routes. The NEPM(Air) standards were developed to protect against health impacts in populated areas and 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. Relevant EPP(Air) goals, and recommendations, and the NEPM(Air) standards are listed in Table 7-1.

Table 7-1: Air Quality Goals and Standards Relevant to the Surat Basin Rail Project

Pollutant	Goal or Standard	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)
Total suspended particulates	90	$\mu g/m^3$	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)

7.3 Description of Environmental Values

7.3.1 Sources of Dust and Air Pollutants

As the Project is located in a rural area, the main sources of pollutants are likely to be particulate matter from agriculture and natural sources such as grass seeds and wind-blown dust from exposed areas. The EPA monitors ambient air quality in Queensland to assess compliance against the NEPM(Air) and EPP(Air). There is no EPA monitoring station at the Project site, the most comprehensive air quality monitoring data available in the vicinity of this site are the air quality monitoring stations located in Gladstone and Toowoomba that have both conducted long-term monitoring of air pollutants. It should be noted that background air quality levels estimated from monitoring in the Toowoomba and Gladstone airsheds will be of a higher concentration than those expected at the Project site as a result of more intensive urban and industrial activities and therefore will represent conservative estimates.

The Wandoan Joint Venture commenced monitoring of PM_{10} in March 2008 to measure the existing levels of PM_{10} at the Township of Wandoan and on the mine site. Dust deposition rates were also measured at both of these locations.

7.3.2 Air Quality Monitoring

Details of Gladstone regional EPA air quality monitoring stations are summarised in Table 7-2 and their locations are described below:

- The South Gladstone monitoring station is located near a major alumina refinery, within the South Gladstone State Primary School grounds. The EPA recommends using this station as an upper-end indicator for the NEPM(Air);
- The Clinton monitoring station is located at the Gladstone airport and is in the vicinity of a power station;
- There are two monitoring stations located at Targinie; namely, Targinie (Swans Road) and Targinie (Stupkin Lane). They are located north of the Gladstone industrial area. Targinie (Swans Road) does not monitor PM_{10} concentrations. Monitoring of nitrogen dioxide at Targinie (Stupkin Lane) was discontinued in 2006; and
- The Toowoomba monitoring station is located at Willowburn Oval and is surrounded by light industry and residential areas. The monitoring station is located in a valley. Consequently, pollutant levels at this site are expected to be indicative of maximum levels experienced across Toowoomba.

Table 7-2: EPA Air Quality Monitoring Sites

EPA Monitoring Site	Easting AMG	Northing AMG	Record Period	Parameters
Clinton	318914	7359008	02/01–02/08	PM_{10}, Nitrogen Dioxide
South Gladstone	323742	7359988	01/01–02/08	PM_{10}, Nitrogen Dioxide
Targinie (Stupkin Lane)	307169	7367541	01/01–02/08	PM_{10}, Nitrogen Dioxide
Targinie (Swans Road)	306949	7369454	01/97–02/08	Nitrogen Dioxide
Toowoomba	396637	6952153	09/03–07/07	PM_{10}, Nitrogen Dioxide
Note: PM_{10} measurements are undertaken at Clinton, South Gladstone, Targinie (Stupkin Lane) and Toowoomba by TEOM. Nitrogen dioxide measurements are undertaken at all of the above monitoring sites by chemiluminescence techniques				

Background Levels of Particulate Matter as PM_{10}

It is common practice in Queensland to use the 95th percentile (the concentration below which 95 percent of the collected data lie) to characterise the background level of air pollutants. The EPA uses the 95th percentile as an indicator of the underlying trend in air quality (EPA, 2005).

Presented in Table 7-3 is the 95th percentile of 24-hour average PM_{10} concentrations recorded at Gladstone and Toowoomba stations from 2001 to 2007.

Table 7-3: 24 hour Average Concentration of PM_{10} recorded by QLD EPA Air Quality Monitoring Stations at Gladstone and Toowoomba for 2001 to 2007

Year	95th percentile 24-hour average PM_{10} concentration ($\mu g/m^3$)			
	Clinton	South Gladstone	Targinie (Stupkin Lane)	Toowoomba
2001	31.4	29.8	31.0	-[1]
2002	31.8	33.5	38.5	-[1]
2003	25.2	26.1	31.5	33.2[2]
2004	23.6	25.2	29.7	32.9
2005	24.4	26.2	25.3	27.6
2006	25.0	27.7	24.3	30.0
2007	22.2	25.3	21.6	27.2
Note	[1]No data available [2]Data for part of the year available			

The years 2002 and 2005 show relatively high peak concentrations of PM_{10} recorded at all Gladstone sites. These high events were attributed to bushfires that occurred in 2002 and dust storms that occurred for two to three days over a significant portion of Queensland in 2005.

The range of the 95th percentile of 24-hour average PM_{10} concentrations is 22.2 $\mu g/m^3$ to 31.8 $\mu g/m^3$ for Clinton, 25.2 $\mu g/m^3$ to 33.5 $\mu g/m^3$ for South Gladstone, 21.6 $\mu g/m^3$ to 38.5 $\mu g/m^3$ for Targinie (Stupkin Lane) and 27.2 $\mu g/m^3$ to 33.2 $\mu g/m^3$ at Toowoomba.

Presented in Table 7-4 are the results of four months of monitoring of PM_{10} at the township of Wandoan and at the site of the proposed Wandoan coal mine. The monitoring results indicate levels that are relatively consistent with the monitoring data from Gladstone and Toowoomba.

Table 7-4: Measured PM_{10} ($\mu g/m^3$) for Wandoan Township and mine site

Monitoring Site	Mean	StDev	Max	Min	95th
Wandoan Township	15	11	100	5	25
Wandoan mine site	12	12	108	5	28

Whilst none of the monitoring sites match the topography of the Project, the Targinie (Stupkin Lane) monitoring site is sufficiently removed from major industrial sources of PM_{10} and is therefore considered to be most representative of the existing air quality within the study area. Therefore, based on the Targinie (Stupkin Lane) data, a value of 38.5 $\mu g/m^3$ has been used as representative of likely background 24-hour average PM_{10} concentration.

Table 7-5 summarises the annual average concentrations of PM_{10} from data obtained from each site for 2001 to 2007. Based on the data from Targinie (Stupkin Lane), a value of 23.0 $\mu g/m^3$ has been used to represent the annual average background concentration of PM_{10}.

Table 7-5: Annual Average Concentrations of PM_{10} recorded by Qld EPA Air Quality Monitoring Stations at Gladstoneand Toowoomba for 2001 to 2007

Year	Annual Average Concentration of PM_{10} ($\mu g/m^3$)			
	Clinton	South Gladstone	Targinie (Stupkin Lane)	Toowoomba
2001	17.8	16.8	18.9	-[1]
2002	17.6	17.9	23.0	-[1]
2003	14.7	15.0	16.4	-[2]
2004	17.1	17.5	19.4	16.9
2005	14.9	15.7	15.3	15.2
2006	15.6	16.8	15.0	15.7
2007	13.7	15.5	13.2	12.6
Note	[1]No data available [2]Data for part of the year available – insufficient to calculate annual average			

Total suspended particulates (TSP) are not monitored at these sites. As a general rule, PM_{10} constitutes approximately 50% of the TSP in a rural area. From the annual average background concentration of PM_{10}, an annual average background concentration of TSP of 46.0 $\mu g/m^3$ has been inferred.

Background Levels of Nitrogen Dioxide

Presented in Table 7-6 is the 95th percentile of 1-hour average of nitrogen dioxide concentrations recorded at each of the monitoring stations for each year that data is available.

Table 7-6: 1-hour Average Concentration of Nitrogen Dioxide Recorded by Qld EPA Air Quality Monitoring Stations at Gladstone and Toowoomba for 2001 to 2007

Year	95th percentile 1-hour average nitrogen dioxide concentration (ppm)				
	Clinton	South Gladstone	Targinie (Stupkin Lane)	Targinie (Swans Road)	Toowoomba
1997	-[1]	0.009	-[1]	0.011	-[1]
1998	-[1]	0.007	-[1]	0.012	-[1]
1999	-[1]	0.011	-[1]	0.015	-[1]
2000	-[1]	0.011	-[1]	0.014	-[1]
2001	0.013	0.012	0.017	0.012	-[1]
2002	0.012	0.012	0.020	0.013	-[1]
2003	0.011	0.013	0.018	0.013	0.022[2]
2004	0.012	0.014	0.017	0.012	0.022
2005	0.011	0.013	0.017	0.012	0.020
2006	0.012	0.013	-[1]	0.015	0.031
2007	0.014	0.014	-[1]	0.015	0.034
Note	[1]No data available [2]Data for part of the year available – insufficient to calculate annual average				

The Targinie (Stupkin Lane) monitoring site has been used to predict nitrogen dioxide concentrations for the Project as it is remote from diffuse nitrogen dioxide emission sources such as major roadways. As such, a value of 0.020 ppm has been used to represent the 1-hour average background concentration of nitrogen dioxide.

Table 7-7 summarises the annual average concentrations of nitrogen dioxide from measurements made at each of the monitoring stations for each year that data is available. From the data obtained from Targinie (Stupkin Lane), a value of 0.008 ppm has been used to represent the annual average background concentration of nitrogen dioxide.

Table 7-7: Annual Average Concentrations of Nitrogen Dioxide recorded by Qld EPA Air Monitoring Stations at Gladstone and Toowoomba for 2001 to 2007

Year	Annual Average Nitrogen Dioxide Concentration (ppm)				
	Clinton	South Gladstone	Targinie (Stupkin Lane)	Targinie (Swans Road)	Toowoomba
1997	-[1]	0.003	-[1]	0.002	-[1]
1998	-[1]	0.002	-[1]	0.003	-[1]
1999	-[1]	0.003	-[1]	0.004	-[1]
2000	-[1]	0.003	-[1]	0.003	-[1]
2001	0.003	0.004	0.005	0.003	-[1]
2002	0.003	0.004	0.008	0.003	-[1]
2003	0.004	0.004	0.004	0.003	-[2]

Year	Annual Average Nitrogen Dioxide Concentration (ppm)				
	Clinton	South Gladstone	Targinie (Stupkin Lane)	Targinie (Swans Road)	Toowoomba
2004	0.004	0.004	0.004	0.003	0.007
2005	0.004	0.004	0.004	0.003	0.006
2006	0.004	0.004	-[1]	0.004	0.005
2007	0.005	0.005	-[1]	0.003	0.010

Background Dust Deposition Levels

Dust deposition measurements undertaken at monitoring stations within the Gladstone region should represent an upper bound of levels that may occur within the study area. The four months of dust deposition monitoring conducted at Wandoan for the proposed Wandoan Coal Mine supports this conclusion.

As noted in the Wiggins Island Coal Terminal EIS (Connell Hatch, 2007), the Gladstone Ports Corporation has operated a network of dust deposition gauges in Gladstone for several years. Most of these monitoring stations are located close to the RG Tanna and Barney Point Coal Terminals and will therefore experience higher dust levels than would be experienced within the study area. However, there are monitoring stations located within residential areas away from the coal terminals (sites 6, 8, 12 and 67) that are likely to be the representative of background dust levels in the study area.

The dust deposition rate recorded near the residential areas is below EPA's 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). Four months of data from Wandoan township and the proposed mine site indicate levels of between 5 mg/m²/day to 45 mg/m²/day. For the purpose of this assessment, a background level of 40 mg/m²/day has been used.

7.3.3 Meteorology

Meteorological data has been measured at Wandoan and has been used to characterise meteorological conditions for dispersion of air pollutants in the region. Data from the BOM monitoring site located at Taroom has been used to supplement this, as rainfall data is not measured at Wandoan. The location of the meteorological monitoring stations aer outlined in Table 7-8.

Table 7-8: Location of Meteorological Monitoring Stations

Site	Easting MGA zone 56	Northing MGA zone 56	Record Period	Parameters
Taroom BOM	178675.3	7160288	1870-04/08	Monthly averaged rainfall measurements
Wandoan	193931.9	7107002	04/07-03/08	Hourly measurements of temperature, relative humidity, wind speed, wind direction, pressure and solar radiation

Wind

Wind speed and direction play an important role in the transport and dispersion of air pollutants. Figure 1 in Appendix E illustrates the wind rose for all 1-hour average measurements of wind speed and direction from the Wandoan monitoring site for the period 3 April 2007 to 31 March 2008. The frequency distribution of wind speed and wind direction is also shown in Table 7-9.

Table 7-9: Frequency Distribution (%) of the Wind Speed as a function of Wind Direction using 1-hour average data from Wandoan

Wind Speed (m/s)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
0-1	0.30	0.25	0.38	0.66	0.50	0.49	0.63	0.79	0.53	0.38	0.36	0.31	0.22	0.25	0.22	0.24	6.5
1-2	0.69	1.28	1.70	1.86	1.31	1.67	2.30	2.98	2.45	1.26	0.91	0.64	0.64	0.49	0.38	0.44	21.0
2-3	1.19	1.57	1.99	1.79	1.46	2.01	2.03	2.77	3.17	2.38	1.24	0.61	0.69	0.44	0.58	0.83	24.7
3-4	0.99	1.15	1.55	2.17	1.94	2.04	1.50	1.47	1.58	1.90	1.27	0.71	0.31	0.14	0.28	0.40	19.4
4-5	1.57	1.16	1.21	1.75	1.94	1.36	1.01	0.78	0.93	1.17	0.61	0.31	0.13	0.08	0.11	0.39	14.5
5-6	1.08	0.54	0.48	0.95	1.15	0.70	0.62	0.47	0.38	0.56	0.33	0.25	0.06	0.06	0.03	0.24	7.9
6-7	0.34	0.33	0.17	0.49	0.52	0.58	0.48	0.31	0.09	0.48	0.22	0.16	0.01	0.01	0.00	0.11	4.3
7-8	0.10	0.05	0.05	0.07	0.13	0.14	0.39	0.09	0.06	0.15	0.05	0.00	0.01	0.01	0.00	0.00	1.3
8-9	0.00	0.00	0.00	0.11	0.01	0.01	0.13	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.3
9-10	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Above 10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Total	**6.3**	**6.3**	**7.5**	**9.9**	**8.9**	**9.0**	**9.1**	**9.7**	**9.2**	**8.3**	**5.0**	**3.0**	**2.1**	**1.5**	**1.6**	**2.6**	**100.0**

Wind speeds greater than 10 m/s were not recorded during the monitoring period. The majority of the wind speeds greater than 5 m/s were recorded with winds from the east or north-east to the south-east.

The variation of wind speed during the day is illustrated in Figure 2 of Appendix E. The 1-hour average wind speed is relatively light in the early morning, steadily increasing through the morning hours until 3:00 pm in the afternoon, then decreasing till 9:00 pm, with lighter wind conditions observed during the night.

It can be seen in Figure 3 of Appendix E that there is a dominance of winds from an easterly direction in the summer, shifting to a southerly direction in winter. Winds are generally lighter in autumn and spring, with winds predominantly from the north in spring.

Rainfall

As rainfall data is not measured at the Wandoan site, the average monthly rainfall data has been taken from the Taroom BOM site and is shown in Table 3-1. The annual average rainfall is 673 mm/year.

As described in Section 3.2.1, and 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 around 40% of the average annual rainfall, while the months of June through September total only 20%.

Temperature

Figure 4 of Appendix E presents the monthly mean for the daily maximum, daily mean and daily minimum temperature, using 1-hour average data from the Wandoan monitoring site. The maximum mean temperature during summer is 34°C and minimum mean temperature is 21°C. During the summer months, the monthly averaged daily temperatures range by approximately 10°C. During the winter months, the average maximum temperature is 20°C and minimum temperature 5°C. The winter monthly averaged daily temperatures have a greater diurnal variation of approximately 13°C.

Relative Humidity

The monthly averaged relative humidity at Wandoan is presented in Figure 5 of Appendix E. There is only small variation throughout the year broadly ranging between 50 and 70%, with highest relative humidity experienced during mid summer and mid winter.

7.4 Dispersion Modelling

Dispersion modelling was undertaken to predict potential impacts on local air quality during operation of the Project using the Cal3QHCR dispersion model. 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. This model was recently used in the Environmental Evaluation of Coal Dust Emissions (Connell Hatch, 2008a) and this study has been accepted by the EPA. The CAL3QHCR model has been used here to model dust emissions from loaded coal wagons and emissions of oxides of nitrogen and particulate matter from fuel combustion by diesel locomotives.

The meteorological file used by CAL3QHCR was generated by CALMET v6 based on the data described in Section 3.2.1. CALMET is an advanced non-steady-state diagnostic 3-dimensional meteorological model with micro-meteorological modules for overwater and overland boundary layers. The meteorological file used is for the same location as the Wandoan monitoring station, the wind roses from the generated file showing good correlation with the Wandoan monitoring data Figures 7 to 9 in Appendix E.

7.4.1 Emissions Rates

Coal Dust

The primary mechanism for coal dust lift-off from coal trains is the erosion of the transported coal by the movement of air. Train operators in conjuction with the port and mine facilities run the majority of coal trains with open wagons, to facilitate quick and efficient loading from the top. This provides a substantial surface area of coal that may be subject to erosion. The airflow induced by the movement of the train travelling at a speed of 60 km/hr to 80 km/hr is the dominant factor with the effect of the ambient wind adding up to 7 km/hr on average and peaking at about 30 km/hr. The effect of the ambient wind will be greatest when the train is travelling directly into the wind. The influence of the ambient wind on dust emissions will be relatively minor when the wind is perpendicular or behind the train.

The airflow across the wagon can move particles by three transport modes: suspension, saltation and surface creep. Saltation occurs when particles (from 75 to 500 µm in size) move and bounce in the layer close to the interface between the coal surface and the flow of air. Particles that are less than 75 µm in size are small enough to become suspended in the airflow and readily follow the air currents. Larger particles (from 500 to 1,000 µm) move by surface creep propelled by wind and the impact of particles moving by saltation.

The surface wind speed (or friction velocity) at which dust begins to be raised from the surface is called the threshold friction velocity. Dust emissions will be negligible below the threshold friction velocity. The threshold friction velocity is intrinsic to the material. Wind tunnel testing of coals from the Callide and Bowen Basins has shown a wide variability in wind tunnel speeds that result in saltation and lift-off of coal dust.

Based on the work undertaken in the Environmental Evaluation of Coal Dust Emissions study (Connell Hatch, 2008), an air speed based emission factor equation has been derived as follows:

$$m = k1.v^2 + k2.v + k3$$

Where:

- m = the mass emission rate of coal dust (as TSP) from the wagon + 2.54 face in g/km/tonne of coal transported
- k1 = a constant with a value of 0.0000378
- k2 = a constant with a value of -0.000126
- k3 = a constant with a value of 0.000063, and
- v = the air velocity travelling over the surface of the train in km/hr

This equation has been used, in conjunction with wind speed and train speed data to estimate total dust emissions from the coal wagons.

Table 7-10: Summary of Emission Rates of Particulate Matter from Coal Wagons in Transit for a Train Speed of 60 km/hr

Pollutant	Units	Emission rate
Total suspended particulates	g/km/tonne	0.171
Particulate matter as PM_{10}	g/km/tonne	0.060

Oxides of Nitrogen and Particulate Matter from Diesel Locomotives

Emission rates of oxides of nitrogen and particulate matter as TSP and PM_{10} emitted from diesel locomotives in transit that were used in the dispersion modelling are summarised in Table 7-11. It is assumed here that all TSP emitted from diesel locomotives is in the form of PM_{10}, this is a conservative assumption. An in-service fuel consumption of 0.0026 L per hauled kilometre per tonne for diesel locomotives with a payload of 11,424 tonnes per train has been assumed.

Table 7-11: Emission Rates of Particulate Matter and Oxides of Nitrogen used in the Modelling of the Impacts of Diesel Locomotives Activities on Air Quality

TSP	Units	Line-haul cycle
Total suspended particulates	g/L	1.8
Particulate matter as PM_{10}	g/L	1.8
Oxides of nitrogen	g/L	47

7.4.2 Model Links

Two sections of the train track were modelled for the air quality assessment to quantify regional air quality conditions as shown in Figure 1 of Appendix I. These were located in the vicinity of Wandoan and in the vicinity of Theodore. For the purpose of air dispersion modelling, preliminary train numbers and configurations were used, as described in Section 2.5.1. It was assumed an annual coal haulage of 42 Mtpa, consisting of eleven loaded and eleven empty coal trains per day. It was also assumed that diesel freight trains would travel south past the Wandoan mine rail spur at a frequency of two trains per day.

7.4.3 Receptor Locations

A total of 55 sensitive receptor locations, typically residences, have been identified within 2.6 km of the centreline, as shown in Figure 2 in Appendix I, with the average distance being 1 km. These receptors were incorporated explicitly in the dispersion model. It is noted that the receiver identification numbers used in the air and noise models do not correlate and cannot be compared. To determine potential impacts on regional air quality, a grid of receptors following the train line was modelled in the two sections described above. A total of 26,323 receptors were modelled for the Wandoan region and 19,126 receptors for the Theodore region.

In order to indicate the overall impact of the Project on air quality within the region, contour plots of nitrogen dioxide, particulate matter as PM_{10}, TSP and dust deposition rate based on the results of the dispersion modelling are discussed below. A summary of indicative values calculated at a number of sensitive receivers are also presented.

It is important to note that the dispersion modelling results presented are based on the maximum concentration of each air pollutant as predicted at the receivers over the 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 receivers at different locations, these figures do not represent a single snapshot of conditions at any given time.

7.5 Potential Impacts on Regional Air Quality

In order to indicate the overall impact of the Project on air quality within the region, contour plots of nitrogen dioxide, particulate matter as PM_{10}, TSP and dust deposition rate based on the results of the dispersion modelling are discussed below. A summary of indicative values calculated at a number of sensitive receivers are also presented.

It is important to note that the dispersion modelling results presented are based on the maximum concentration of each air pollutant as predicted at the receivers over the 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 receivers at different locations, these figures do not represent a single snapshot of conditions at any given time.

7.5.1 Nitrogen Dioxide from Diesel Locomotives

Results suggest that there will be no exceedances of the NEPM(Air) or EPP(Air) standards for nitrogen dioxide outside of the multi-user corridor. This refers specifically to the maximum 1-hour average ground-level concentration of nitrogen dioxide for human health of 0.12 ppm (NEPM(Air)) or EPP(Air) goal of 0.16 ppm. It has been assumed that 30% of all oxides of nitrogen have been converted to nitrogen dioxide in the atmosphere and a background concentration of 0.020 ppm has been included.

As can be seen in Figure 3 in Appendix I the predicted 1-hour average ground-level concentration of nitrogen dioxide due to rail activities falls rapidly with increasing distance from the train line. Ground-level concentrations of nitrogen dioxide from rail activities for the two sections modelled decrease by 50% within 15 m of the track centreline and by 70% within 70 m.

No regions within the study area are predicted to exceed the annual average ground-level concentration of nitrogen dioxide NEPM(Air) standard of 0.03 ppm and predicted ground-level concentrations due to rail activities decreasing by 50% within 22 m of the track centreline and by 70% within 60 m, as can be seen in Figure 4 of Appendix I. It has been assumed that 30% of all nitrogen oxides have been converted to nitrogen dioxide and a background concentration of 0.008 ppm has been included.

7.5.2 Particulate Matter as PM_{10} and TSP from Coal Wagons and Diesel Locomotives

Results for the 24-hour maximum ground-level concentration of PM_{10} suggest that no areas outside the multi-user corridor are likely to exceed the NEPM(Air) standard of 50 $\mu g/m^3$. A background concentration of 38.5 $\mu g/m^3$ has been included.

Similarly to nitrogen dioxide, the predicted 24-hour average ground-level concentration of PM_{10} due to rail activities falls rapidly with increasing distance from the train line, as can be seen in Figure 5 of Appendix I. Ground-level concentrations of PM_{10} from rail activities for the two sections modelled decrease by 50% within 17 m of the track centreline and by 70% within 60 m.

Predictions for the annual average ground-level concentration of PM_{10} show no areas are predicted to exceed the EPP(Air) goal of 50 $\mu g/m^3$. Ground-level concentrations due to rail activities are predicted to decrease by 70% within 60 m of the track centreline, as shown in Figure 6 of Appendix I for the Wandoan section. A background concentration of 23 $\mu g/m^3$ has been included.

There will also be no exceedances of the EPP(Air) goal of 90 $\mu g/m^3$ for the annual average ground-level concentration of TSP. As indicated in Figure 7 of Appendix I, ground-level concentrations due to rail activities are predicted to decrease by 50% within 23 m of the track centreline, and by 70% within 60 m.

7.5.3 *Dust Deposition Rate*

Dust deposition is not predicted to exceed the EPA recommended rate of 120 mg/m^2/day outside the multi-user corridor. Areas at which this recommended guideline may be exceeded occur within 33 m from the track centreline, as can be seen in Figure 8 of Appendix I for the Wandoan section. Predicted dust deposition from rail activities decreases by 50% within 21 m of the track centreline and by 70% within 60 m. The results indicate that adverse impacts on residential amenity are unlikely to occur as a result of the Project. The Project is also unlikely to adversely impact agricultural activities in the vicinity of the train line due to coal dust deposition.

Other Impacts

The recent Environmental Evaluation (Connell Hatch, 2008) conducted on behalf of QR Ltd found that coal dust emissions from trains may be visible to the general public from time to time. Coal dust emissions could give rise to a negative perception of rail transport of coal. The controls discussed in Section 7.9.2 should minimise the potential for coal dust emissions to cause nuisance.

7.6 Potential Impacts on Sensitive Receivers

The model has shown that exceedances of relevant air quality guidelines are not expected outside the multi-user corridor. The following Section shows the percentage increase over background levels for the parameters modelled. Of the 55 sensitive receiver locations modelled, results are presented for locations where the highest impacts are predicted in order to demonstrate worst-case scenarios for the entire study area. These results are discussed in detail below. One identified receiver occurs within the proposed construction footprint and has therefore been excluded from further assessment.

7.6.1 *Nitrogen Dioxide from Diesel Locomotives*

Results of the dispersion modelling using Cal3QHCR are summarised in Table 7-12 for the maximum 1-hour average and annual average ground-level concentration of nitrogen dioxide. It has been assumed that 30% of all oxides of nitrogen have been converted to nitrogen dioxide in the atmosphere.

Results suggest that the maximum 1-hour average ground-level concentration of nitrogen dioxide will remain below the NEPM(Air) standard of 0.12 ppm and EPP(Air) goal of 0.16 ppm for all of the sensitive receiver locations. For the sensitive receiver locations, the combustion of diesel fuel by locomotives is predicted to add less than 0.001 ppm and up to 0.066 ppm of nitrogen dioxide to background levels of 0.020 ppm.

The annual average ground-level concentration of nitrogen dioxide is predicted to remain well below the NEPM(Air) standard of 0.03 ppm for all sensitive receiver locations.

Table 7-12: Predicted Contribution from Operation of the Project on Nitrogen Dioxide Levels at Sensitive Receiver Locations

Sensitive Receiver	Averaging Period	Background (ppm)	Locomotives (ppm)	Locomotives + Background (ppm)	Percent Project Contribution	Percent of Standard
33	1-hour	0.020	0.015	0.035	43%	29%
	Annual	0.008	< 0.001	0.008	3%	28%

Sensitive Receiver	Averaging Period	Background (ppm)	Locomotives (ppm)	Locomotives + Background (ppm)	Percent Project Contribution	Percent of Standard
34	1-hour	0.020	0.018	0.038	48%	32%
	Annual	0.008	0.001	0.009	11%	30%
35	1-hour	0.020	0.066	0.086	77%	72%
	Annual	0.008	0.005	0.013	39%	43%
36	1-hour	0.020	0.014	0.034	42%	29%
	Annual	0.008	0.001	0.009	11%	30%
55	1-hour	0.020	0.012	0.032	37%	26%
	Annual	0.008	< 0.001	0.008	5%	28%
8	1-hour	0.020	0.008	0.028	28%	23%
	Annual	0.008	< 0.001	0.008	5%	28%
9	1-hour	0.020	0.007	0.027	27%	23%
	Annual	0.008	< 0.001	0.008	4%	28%
10	1-hour	0.020	0.008	0.028	30%	24%
	Annual	0.008	< 0.001	0.008	4%	28%
13	1-hour	0.020	0.005	0.025	20%	21%
	Annual	0.008	< 0.001	0.008	3%	28%
14	1-hour	0.020	0.005	0.025	21%	21%
	Annual	0.008	< 0.001	0.008	3%	27%

Note:

NEPM(Air) standard for 1-hour average nitrogen dioxide is 0.12 ppm.

EPP(Air) goal for 1-hour average nitrogen dioxide is 0.16 ppm.

NEPM(Air) standard for annual average nitrogen dioxide is 0.03 ppm.

7.6.2 Particulate Matter as PM_{10} and TSP from Coal Wagons and Diesel Locomotives

Results from the dispersion modelling suggest that the ground level concentrations of particulate matter (TSP and PM_{10}) will remain below the relevant standard or goal, with results for the most affected receivers presented in Table 7-13.

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

The 24-hour average ground-level concentration of PM_{10} is predicted to remain below the NEPM(Air) standard of 50 $\mu g/m^3$. The maximum 24-hour average concentration of PM_{10} predicted at the most affected sensitive receiver locations range from 1.0 to 3.9 $\mu g/m^3$ (or 2% to 9% of the NEPM(Air) standard) due to the proposed train line and 38.5 $\mu g/m^3$ is attributed to background levels.

The annual average ground-level concentration of PM_{10} is predicted to be up to a maximum of 48% of the EPP(Air) goal of 50 $\mu g/m^3$. The background concentration is estimated to be 23 $\mu g/m^3$. The highest contribution attributed to rail activities is 0.5 $\mu g/m^3$ at the location of sensitive receiver 39, with 0.38 $\mu g/m^3$ predicted to be associated with dust from the coal wagons.

The contribution of rail activities to the annual average ground-level concentration of TSP is predicted to be up to a maximum of 1.2 µg/m^3. When combined with an estimated background concentration of 46 µg/m^3, air quality is predicted to remain well below the EPP(Air) goal of 90 µg/m^3.

Table 7-13: Predicted Contribution from the Operation of the Project on PM_{10} and TSP at Sensitive Receiver Locations

Sensitive Receiver	Pollutant	Averaging Period	Background (µg/m^3)	Coal Wagons (µg/m^3)	Diesel Locomotives (µg/m^3)	Project + Background (µg/m^3)	Percent Project Contribution	Percent of Standard
29	TSP	Annual	46	0.6	0.06	46.7	1.4%	52%
	PM_{10}	24-hour	38.5	1.44	0.4	40.3	4.6%	81%
		Annual	23	0.21	0.06	23.3	1.2%	47%
33	TSP	Annual	46	0.5	0.06	46.6	1.2%	52%
	PM_{10}	24-hour	38.5	1.68	0.53	40.7	5.4%	81%
		Annual	23	0.18	0.06	23.2	1.0%	46%
39	TSP	Annual	46	1.10	0.13	47.2	2.6%	52%
	PM_{10}	24-hour	38.5	1.13	0.39	40.0	3.8%	80%
		Annual	23	0.38	0.13	23.5	2.2%	47%
50	TSP	Annual	46	1.02	0.12	47.1	2.4%	52%
	PM_{10}	24-hour	38.5	1.4	0.38	40.3	4.4%	81%
		Annual	23	0.36	0.12	23.5	2%	47%
8	TSP	Annual	46	0.80	0.09	46.9	2%	52%
	PM_{10}	24-hour	38.5	1.11	0.39	40	4%	80%
		Annual	23	0.28	0.09	23.4	2%	47%
9	TSP	Annual	46	0.74	0.08	46.8	2%	52%
	PM_{10}	24-hour	38.5	1.04	0.32	39.9	3%	80%
		Annual	23	0.26	0.08	23.3	1%	47%
10	TSP	Annual	46	0.62	0.07	46.7	1%	52%
	PM_{10}	24-hour	38.5	0.98	0.29	39.8	3%	80%
		Annual	23	0.22	0.07	23.3	1%	47%
12	TSP	Annual	46	0.49	0.05	46.5	1%	52%
	PM_{10}	24-hour	38.5	0.78	0.21	39.5	2%	79%
		Annual	23	0.17	0.05	23.2	1%	46%
13	TSP	Annual	46	0.53	0.06	46.6	1%	52%
	PM_{10}	24-hour	38.5	0.80	0.23	39.5	3%	79%
		Annual	23	0.18	0.06	23.2	1%	46%

Note:

EPP(Air) goal for annual average TSP is 90 µg/m^3.

NEPM(Air) standard for 24-hour average PM_{10} is 50 µg/m^3.

EPP(Air) goal for 24-hour average PM_{10} is 150 µg/m^3.

EPP(Air) goal for annual average PM_{10} is 50 µg/m^3.

7.6.3 *Dust Deposition Rate*

Dust deposition is predicted to remain well below the EPA's recommended guideline of 120 mg/m^2/day at all locations, with the most affected receivers summarised in Table 7-14. The maximum dust deposition rate predicted is 59.3 mg/m^2/day at the location of sensitive receiver 8.

Table 7-14: Predicted Contribution of the Operation of the Project on Dust Deposition at Sensitive Receiver Locations

Sensitive Receiver	Background (mg/m^2/day)	Coal Wagons (mg/m^2/day)	Project + Background (mg/m^2/day)	Percent Project Contribution (mg/m^2/day)	Percent of Goal (mg/m^2/day)
33	40	14.2	54.2	26%	45%
39	40	15.5	55.5	28%	46%
44	40	13.1	53.1	25%	44%
50	40	15.7	55.7	28%	46%
55	40	13.4	53.4	25%	44%
8	40	19.3	59.3	33%	49%
9	40	19.1	59.1	32%	49%
10	40	15.7	55.7	28%	46%
12	40	13.8	53.8	26%	45%
13	40	14.3	54.3	26%	45%

Note:
EPA recommended guideline for monthly average dust deposition is 120 mg/m^2/day.

Whilst overall, amenity impacts due to deposition of coal dust has been predicted to be minimal as a result of the project, coal dust impacts have been associated with coal trains travelling through Gladstone and other urban areas. A recent study conducted for QR Ltd has shown that coal dust emissions can be minimised in the most cost effective way by the application of surface veneer treatments at the coal mine loading facility. The implementation of this technique at mines that transport coal on the Surat Basin Rail System would ensure that the potential for nuisance dust is minimised.

7.7 Greenhouse Gas Inventory of Projected Future Emissions

7.7.1 *Introduction*

A greenhouse gas (GHG) inventory details an organisation's GHG emissions to the atmosphere (sources) and GHG removals from the atmosphere (sinks). Here the organisation was defined as the construction, operation and maintenance phases of the Project. GHG emissions in the inventory are projected future emissions, and all assumptions made in estimating future emissions have been noted.

The National Greenhouse and Energy Reporting Act 2007 (the NGER Act) was passed in September 2007 and establishes a mandatory corporate reporting system for greenhouse gas emissions, energy consumption and production.

The following subordinate legislation has been made (or is proposed to be made) under the NGER Act:

- The National Greenhouse and Energy Reporting Regulations 2008;
- The National Greenhouse and Energy Reporting (Measurement) Determination 2008;
- The External Audit Legislative Instrument (under development – consultation scheduled for second half of 2008).

The NGER Act and associated subordinate legislation aims to:

- Provide robust data to underpin the environmental and financial integrity of Australia's national emissions trading scheme;
- Reduce the number of greenhouse and energy reports required across State, Territory and Australian Government programs;
- Provide corporate level information to the public on greenhouse and energy performance of Australian corporations.

Corporations will be required to register and report if they exceed various thresholds. By 2010/11 reporting year those thresholds are proposed to be:

- Emits 50 kilotonnes or more of greenhouse gases (CO2-e);
- Consumes 200 terajoules or more of energy; or
- Produces 200 terajoules or more of energy.

The relevant standards for GHG inventories are the AS ISO 14064 series. This inventory of projected future emissions has been guided by AS ISO 14064.1 Greenhouse gases – Part 1 (AS ISO 14064.1 – 2006). This standard details principles and requirements for designing, developing, managing and reporting organisational level GHG inventories.

There are a range of GHG's, and each has a different global warming potential (GWP). In order to facilitate GHG accounting, a coefficient is applied to quantities of the various gasses to calculate emissions in terms of equivalent carbon dioxide (eCO_2). This value is expressed in weight measurements. For the Project, the GHG inventory has been expressed in tonnes of eCO_2 per annum.

The National Greenhouse Accounts (NGA) Factors (Department of Climate Change, 2008) has been prepared by the Department of Climate Change and replaces the AGO Factors & Methods Workbook. This publication (NGAF) defines three scopes of emission categories for calculating greenhouse gas emissions. These are as follows:

Scope 1 (direct emissions) are produced from sources within the boundary of a project, and directly result from a project's activities. Scope 1 examples include:

- On-site generation of electricity from fuels;
- Removal of carbon sequestered in vegetation;
- Manufacturing processes such as cement, aluminium or ammonia production (there will be no emissions from manufacturing in the Project); and
- Use of fuels for the transportation of materials, products, waste and people on-site.

Scope 2 (energy indirect emissions) are physically produced by another organisation but arise because of a project's activities. Typically, this is:

- Emissions from the generation of electricity or the production of heat and steam that is produced outside the boundary of the project but consumed on-site.

Scope 3 (other indirect emissions) are all other indirect emissions not included in Scope 2. Examples include:

- Extraction and production of fossil fuels;
- Emissions due to disposal of waste; and
- Transportation of products, materials and waste to and from the organisation.

A GHG inventory should include all Scope 1 and 2 emissions. However, not all Scope 3 emissions may be relevant to an organisation's inventory.

The inventory should also include any GHG removals from the atmosphere through carbon sequestration in vegetation sinks. The basic criteria for recognising vegetation sinks under Article 3.3 of the Kyoto Protocol are forestry activities that establish a forest of trees on land that was clear of forest on 31 December 1989, is more than 0.2 ha in size and 10 m in width, with at least 20% canopy cover, and has the potential to reach 2 m in height (as seen in National Greenhouse Accounts Factors, DCC, 2008a p32).

7.7.2 Boundary of the Project and Sources of Greenhouse Gas Emissions

The first step in developing a GHG inventory is to establish the operational boundary that will apply to the organisation. A defined boundary allows for the identification of emissions under each Scope and provides clarification on whether emissions are direct or indirect.

The relevant organisation for the GHG inventory is the construction, operation and maintenance phases of the Project. The boundary therefore should cover the temporary construction camps and site offices, and construction and use of the railway infrastructure itself. The specific operational boundary and basic sources of GHG emissions expected for this project are set out below:

Construction Phase

- Installation and removal of construction camps and site offices (fuel use);
- Use of construction camps (fuel use);
- Travel between the camps and construction site (fuel use);
- Construction of the railway infrastructure (fuel use); and
- Construction impacts on vegetation (vegetation removal).

Note that the transportation of construction materials to the site has not been included in the boundary for the inventory.

Given this boundary, the relevant Scope 3 (other indirect) emissions that should be accounted for are:

- Emissions from the extraction, production and transport of any fuel used; and
- Emissions associated with the extraction, production, and transport of fuels used in the production of any electricity purchased from the grid, plus any emissions associated with the electricity lost in transmission and distribution to the customer.

No GHG sinks (such as tree planting that meets the requirements of Article 3.3 of the Kyoto Protocol) were identified.

Some minor additional sources of GHG emissions were not included, such as the disposal of any waste material from the removal of the construction camps and site offices. These sources were considered immaterial to the overall inventory.

Operational Phase

- Operation of trains, northbound and southbound and both coal and freight (fuel use). It is noted that train operation emissions only include travel on the preferred alignment and not to final destinations; and
- Use of signalling and communication equipment associated with the operation of the trains on the Project (fuel use).

Maintenance Phase

- Maintenance, monitoring, repair and replacement of track infrastructure (project alignment only), for the projected operating scenario (fuel use).

7.7.3 Quantification of Emissions

Quantification methods for inventories should be selected to minimise uncertainty and provide results that are as accurate, consistent and reproducible as possible (AS ISO 14064.1, 2006). Typical methods include:

- Mass balance;
- Using facility specific factors;
- GHG models; and
- Deriving emissions by applying relevant GHG emissions and removal factors to activity data from the project (such as fuel or electricity used in project activities).

For the Project, the only available method was to project future emissions using estimates of project activity data. The possible categories of activity data identified were:

- Petrol used in passenger vehicles;
- Diesel used in vehicles, trains, engines, and on-site electricity generation;
- Electricity taken from the network (grid electricity); and
- Vegetation removed from the site.

All relevant GHG emissions and removal factors for petrol, diesel and grid electricity activity data have been determined for Australia by the Commonwealth Government and published as the National Greenhouse Accounts Factors (DCC, 2008a).

There are very minor differences in emissions factors between diesel and petrol used for electricity generation and the same fuels used for transport. The emissions factors for transport were used for all uses of diesel or petrol. All diesel use was also assumed to be automotive diesel and not fuel oil.

Consumption of grid electricity results in Scope 2 (energy indirect) and Scope 3 emissions. The emissions factors for the Queensland grid were used.

Determining emissions resulting from vegetation clearance (a Scope 1 emission) is an uncertain science, and estimates depend on site specific variables like vegetation type, tree density and soil type. However, at a broad level, clearing of remnant vegetation is generally assumed to produce once-off emissions of 250 tonnes of eCO_2 per hectare (DCC, 2008b). This factor has been used in this inventory.

Petrol Factor

Scope 1 emissions	= 2.3 tonnes eCO_2/1,000 L
Scope 3 emissions	= 0.2 tonnes eCO_2/1,000 L
Petrol Factor	= 2.5 tonnes eCO_2/1,000 L

Automotive Diesel Factor

Scope 1 emissions	= 2.7 tonnes eCO_2/1,000 L
Scope 3 emissions	= 0.2 tonnes eCO_2/1,000 L
Diesel Factor	= 2.9 tonnes eCO_2/1,000 L

Grid Electricity Factor

Scope 2 emissions	= 0.91 tonnes eCO_2/Megawatt hour
Scope 3 emissions	= 0.13 tonnes eCO_2/Megawatt hour
Electricity Factor	= 1.04 tonnes eCO_2/Megawatt hour (MWh)

Vegetation Removal Factor

Vegetation Factor	= 250 tonnes eCO_2/hectare cleared

7.7.4 Estimation of Activity Data

Where the activity data method is used, the quality of the calculation of projected emissions is largely dependent on the quality of the estimates of activity data. For the Project, the basic emissions sources and sinks were listed in Section 7.7.2 above. Good quality estimates of activity and fuel use data were not available for all emission sources.

In particular, assumptions were made for some of the construction activity and fuel use. These assumptions included the amount of travel required during construction and the average amounts of fuel expected to be used in building and operating the construction camps. The average amount of fuel used during rail construction activity was also based on a rail project but in another part of the State. Information was also limited on the amount of fuel and electricity required for signalling and communication equipment during the operations phase, and for the maintenance phase in general. In each case, assumptions were made using best available data.

By far the largest contribution to projected annual emissions from the project was from actual train operation. In this case, good quality estimates of activity data were available from modelling of the operating scenarios. Estimates were available on size, speed, tonnage and number of trips for both north and south bound trains. This data was combined with the efficiency of the train engines expected to be used to estimate average fuel use per tonne and therefore total daily and annual fuel use.

Construction Phase Assumptions, Data Estimates and Emissions

Activity: Installation and removal of construction camps and associated site offices (fuel use):

- Three construction camps will an average occupancy of 300 staff with facilities such as accommodation, showers and toilets, kitchen and dining room, recreation centre, medical room, stores and a communications room (Connell Hatch, 2008c);

- Assume 2,000 km of heavy vehicle travel for each camp for site preparation works, minor earth and road works and installation of temporary services (and an equivalent amount of travel for removal works);
- Assume 40 heavy vehicle trips per camp for installation and the same for removal;
- Assume each trip from point of supply (and to point of disposal during removal) was 1,000 km total;
- Total km for installation of each camp and associated site office was therefore 42,000 km with another 42,000 km for removal;
- Average rate of fuel consumption used for heavy machinery and large trucks was 0.55 L per km travelled (Apelbaum, 2006);
- Total fuel use assumed for installation and removal was therefore 46,000 L; and
- Site office fuel use was included in the section on construction of the railway.

Activity: Use of construction camps (fuel use):

- All energy used in the construction camps was assumed to come from on-site diesel generators;
- Based on the expected average monthly work force requirement, the total monthly occupation of the construction camps was assumed to be 100 people for 360 days (12 months), 250 people for 180 days (6 months) and 500 people for 600 days (20 months);
- Total person days in the camps was therefore 381,000;
- Average daily electricity use at the construction camps was assumed to be 10 kilowatt hours(KWh)/day per person (the average daily household electricity use in South East Queensland is 25 KWh/day);
- Total electricity use in the construction camps was therefore estimated at 3,810,000 KWh;
- A 1,000 kW diesel generator set operating at average load of between 25 and 50% will run at around 0.3 L per kWh; and
- Fuel use for 3,810,000 kWh was therefore assumed to be 1,143,000 L.

Activity: Travel between the camps and construction sites (fuel use):

- Total person days in the camps was assumed to be 381,000;
- A 50 km per day travel distance was assumed;
- Travel was 90% by bus, carrying 342,900 people in total;
- Each bus would carry 40 people per day, for an approximate total of 8,600 trips;
- Travel was 10% by light commercial, carrying 38,100 people in total;
- Each light commercial vehicle would carry 4 people per day, for an approximate total of 9,500 trips;
- Total distance by bus was 430,000 km (50 km x 8,572 trips);
- Total distance by light commercial was 475,000 km (50 km x 9,500 trips);

- At an average fuel consumption of 0.27 L per km (ABS 2007), total fuel use by bus was 116,000 L; and
- At an average fuel consumption of 0.13 L per km for light commercial vehicles, total fuel use was 62,000 L.

Activity: Construction of the railway infrastructure (fuel use);

- Based on fuel consumption data from another railway construction project in Queensland (confidential source), and adjusted for different project size and duration, average fuel consumption per km of track was estimated to be 190,000 L;
- No adjustment was made for different project requirements such as number of bridge crossings;
- The estimate does include adjustments for different construction phases and full construction is assumed to occur for 18 months;
- The breakdown of fuel consumption was 80% heavy machinery, 15% light commercial, 4% on-site generators (including for use in site offices), and 1% for small passenger vehicles; and
- For 213 km of track, total fuel use was therefore estimated at 40,546,000 L.

Activity: Construction impacts on vegetation (fuel use);

- An estimated 140 ha of remnant vegetation would be impacted by the Project (refer to Section 5.3.2);
- The remaining areas of ground disturbance within the construction footprint have previously been cleared.

Emissions from fuel used in the transportation of construction materials to the site have not been included. These emissions could be estimated by quantifying the amount of construction material to be delivered, the number of vehicle kilometre travelled, and the type of vehicle.

Operational Phase Assumptions, Data Estimates and Emissions

Activity: operation of trains, northbound and southbound and both coal and freight, for the projected operating scenario (fuel use). The assumptions and data below were taken from the train performance calculations for the project, and are based on the ultimate 42 Mtpa configuration without consideration for a ramp up of rail traffic:

- Total one-way track distance was 213 km (Project only); and
- Each train is assumed to travel along the whole project alignment.

Coal Trains:

- Coal trains were the 1.5 Blackwater configuration;
- Each loaded coal train was assumed to haul approximately 14,144 gross tonnes and unloaded coal trains 2,666 gross tonnes;
- Maximum coal tonnes hauled per trip was 11,478 tonnes (14,144 – 2,666);
- Average tonnage efficiency was assumed to be 96% per coal train trip (11,019 tonnes);
- Fuel efficiency was 0.0026 L per hauled tonne km for loaded coal trains travelling northbound and 0.0077 L per hauled tonne km for unloaded coal trains travelling southbound;

- Total litres per loaded coal train trip was approximately 7,850 (0.0026 x 213.4 x 14,144);
- Total litres per unloaded coal train trip was approximately 4,380 (0.0077 x 213.4 x 2,666);
- Total litres per full round trip cycle was therefore 12,230,000 L;
- A total of 3,812 round trips was required for the 42 Mtpa scenario (42,000,000/11,019);
- Annual fuel consumption for the 42 Mtpa scenario was 46.62 ML (12.23 x 3,812).

Intermodal Freight Trains:

- Two freight trains per day were assumed to travel in each direction (two full round trip cycles per day);
- Each freight train consisted of 3 NR class head-end locomotives with 23 double stack, fully loaded 5-spine wagons;
- Each freight train was 1,830 m total length and 6,480 gross tonnes fully loaded;
- The loading percentage for each freight train was assumed to be 75%, irrespective of the direction of travel (4,860 gross tonnes);
- Fuel efficiency was 0.0046 L per hauled tonne km for freight trains travelling northbound and 0.0052 L per hauled tonne km for freight trains travelling southbound;
- Total litres per freight train trip northwards was approximately 4,770 (0.0046 x 213.4 x 4,860);
- Total litres per freight train trip southwards was approximately 5,390 (0.0052 x 213.4 x 4,860);
- For each full round trip cycle, total fuel use was therefore to 160 L; and
- Annual fuel consumption for 2 round trip cycles per day for 320 days was therefore 6,500,000 L (2 x 320 x 10.16).

Activity: use of signalling and communication equipment associated with the operation of the trains (electricity and fuel use):

- Power supply for signalling and communication equipment was from diesel operated generators;
- Each generator set was assumed to need 120,000 L per annum (two months for a 20,000 L tank);
- A total of 5 generator sets was assumed; and
- Annual fuel use for signalling, etc., was therefore approximately 600,000 L.

Maintenance Phase Assumptions, Data Estimates and Emissions

Activity: maintenance, monitoring, repair and replacement of track infrastructure, for the projected operating scenario (fuel use).

Light Commercial Vehicle:

- A full time track maintenance gang, with a light commercial vehicle (diesel);
- Light commercial vehicle travels 150 km per day for 320 days per year (48,000 km per year); and
- Average fuel consumption for light commercial vehicles is approximately 0.13 L per km (Apelbaum, 2006 for Queensland and ABS 2007 for Australia), resulting in total fuel use of 6,240 L per annum.

Rail Vehicles:

- Daily track inspection using a rail vehicle (diesel), travelling 50 km per day for 320 days (16,000 km per annum);
- Rail grinding and tamping, 50 km per day, 10 days per year (500 km per annum);
- Intermittent replacement of track infrastructure at an average fuel use of 1,000 km per annum; and
- Assume rail vehicles use an average of 0.5 L of diesel per km (ATOC, 2007) for the range of activities, over a total of 17,500 km, resulting in 8,750 L per annum.

7.7.5 Inventory of Projected Future Emissions

Future emissions were estimated by combining project activity data with the relevant emissions factors. The emissions inventory covered the Project only and did not include emissions from travel between the Project and the coal terminal.

Construction Phase

Emissions from the construction phase are once-off emissions and would not reoccur during the operational life of the railway. The emissions from vegetation clearing are likely an over-estimate because a 15 m buffer has been applied to the footprint of the rail formation to account for ancillary infrastructure. In areas of Endangered and Of Concern vegetation communities, the amount of clearing will be controlled through the *Vegetation Management Act 1999* to the minimum area required for the safe construction and operation of the Project. Clearing is likely to be limited to the area required for rail formation and maintenance track only in these sensitive environments.

Table 7-15: Construction Phase

Construction Activity	Total Activity	Average Fuel Consumption for Activity	Total Fuel (1,000 L)	GHG Factor (tonnes eCO2 /1,000 L)	Once-Off tonnes eCO2
Installation and removal of construction camps and offices	84,000 km	0.55 L per km	46	2.9	133
Use of camps and offices	3,810,000 KWh	0.3 L per KWh	1,143	2.9	3,315
Travel to and from construction site (bus)	430,000 km	0.27 L per km	116	2.9	336
Travel to and from construction site (light commercial)	475,000 km	0.13 L per km	62	2.9	180
Construction of the railway	213.4 km	190,000 L per km	40,546	2.9	117,583
Construction impacts on vegetation	140 ha cleared			250 tonnes eCO_2/ ha cleared	35,000
				TOTAL	**156,547 once-off tonnes**

Table 7-16: Operations Phase

Activity	Per trip fuel (1,000 L)	# trips per annum	Annual fuel (1,000 L)	GHG Factor (tonnes eCO_2 /1,000 L	Total tonnes eCO_2 per annum
Freight Trains	10.16	640	6,500	2.9	18,850
Coal trains (42 Mtpa)	12.23	3,812	46,620	2.9	135,200
Signalling, etc.			600	2.9	1,740
				TOTAL	**155,790**

As a reference, Queensland's total emissions in 2006 were estimated to be 170,900,000 tonnes (DCC 2008c). The operations phase of the Project would contribute an additional 0.09% per annum to the 2006 State-wide emissions.

Table 7-17: Maintenance Phase

Maintenance Activity	Total km travelled per annum	Average Fuel Consumption litres per km	Annual fuel (1,000 L)	GHG Factor (tonnes eCO_2 /1,000 L)	Total tonnes eCO_2 per annum
Light Commercial Vehicle Use	48,000	0.13	6.24	2.9	18
Rail Vehicle Use	17,500	0.5	8.75	2.9	25
				TOTAL	**43**

7.7.6 Limitations of the Inventory

The inventory was of projected future emissions, and used a number of assumptions. It should be used as an indication of the order of magnitude of project emissions. The basic limitation was the accuracy of the project activity data. In terms of average fuel use per activity unit, there were limited sources of reference material for the amount of fuel used on average during the construction of major transport projects. Given the early stage of engineering design, there was also uncertainty over some of the elements of the Project, leading to uncertainty about the expected amount of project activity.

7.8 Comparison of Emissions for Electricity versus Diesel Hauled Trains

As outlined in Section 1.3, future rail traffic demand could lead to the consideration of electrification of the preferred alignment. The following Section provides a simple comparison of the total GHG emissions associated with operation of the railway at 42 Mtpa capacity using diesel hauled trains compared with electric hauled trains.

Train performance calculations were modelled using diesel train configurations as outlined in Section 2.5.1 and included fuel burn calculations for both loaded and unloaded trains. Calculations of electrical consumption were taken from this model using a fixed ratio (i.e. different electric train configurations were not modelled independently). Electric trains were assumed to have the same basic performance characteristics as diesel trains in terms of speed and braking distances.

Electricity consumption was estimated to be 32,000 kWh to move a fully loaded coal train northward, and 18,000 kWh to move an empty coal train southward (50,000 kWh per round trip cycle, or 50 MWh).

As explained in Section 7.7.3, the estimate of grid electricity emissions factor for Queensland was 1.04 tonnes eCO_2/MWh. This includes both Scope 2 emissions arising from fuel used in the generation of electricity, and Scope 3 emissions from the extraction, production and transport of the fuel, and the transmission and distribution of the electricity.

The estimate for the emissions from the diesel powered coal trains was 2.9 tonnes eCO_2/ML. This includes Scope 1 emissions from the combustion of the diesel, and Scope 3 emissions from the extraction, production and transportation of the fuel.

It was assumed that all trains travel the entire length of the preferred alignment.

Table 7-18: Comparison of Emissions for Electricity versus Diesel

Operating Scenario	Per trip fuel	# trips per annum	Annual fuel	GHG Factor tonnes eCO_2	Total tonnes eCO_2 per annum
Diesel powered coal trains (42 Mtpa)	12.23 (1,000 L of diesel)	3,812	46,620 (1,000 L of diesel)	2.9 tonnes /1,000 L of diesel	135,200
Electrified coal trains (42 Mtpa)	50 MWh	3,812	190,600 MWh	1.04 tonnes/MWh	198,224

The emissions intensity of grid electricity would be expected to decrease over time as the overall proportion of gas-fired and renewable electricity generation increases. For example, the emissions intensity of gas-fired electricity generation is less than 0.5 tonnes eCO2/MWh. The energy content of diesel fuel will remain fixed. Assuming that the relative efficiencies of diesel and electrically powered engines remain constant, then the annual emissions from electrified coal trains will decrease at a faster rate than annual emissions from diesel powered trains. However, all else being equal and assuming a total of 190,600 MWh are required, the emissions factor for grid electricity would have to fall to 0.71 tonnes eCO_2/MWh to equal the emissions from the diesel powered engines.

7.9 Potential Impacts and Mitigation Measures

The potential impacts of these effects on the air environment and recommended mitigation measures are summarised in Table 7-19 and discussed in the subsequent sections.

Table 7-19: Potential Impact and Mitigation Measures for Air Quality during Construction

Potential Impact	Mitigation Measure
Dust emissions from the construction of the Project	• Development of a Dust Management Sub Plan to be incorporated into the EMP(C) prior to construction commencing; • Minimise significant dust generating activities during high wind speeds where practicable and unwatered; • Restrict vehicle speeds on unsealed haul roads to reduce dust generation; • Avoid spillages and prompt cleanup of any that occur;

Potential Impact	Mitigation Measure
	• Cover haul vehicles moving outside the construction site; • Stockpile material should be treated appropriately to prevent wind erosion from the prevailing wind; • Regularly clean machinery and vehicle tyres to prevent track-out of dust to public roads; • Minimise onsite burning or incineration; • Ensure that roads are appropriately surfaced as soon as possible after the commencement of site activities; • Route roads away from sensitive receivers wherever possible; • Revegetate disturbed areas as soon as possible; • Vehicles and equipment are to be appropriately maintained to minimise air emissions; • Visually monitor dust on a daily basis; and • Locate dust deposition gauges and real time air quality monitoring at nearby residential dwellings, if required.
Diesel fuel combustion emissions generated by locomotives hauling coal and freight on the rail tracks	• Air quality should be compliant with the requirements of the *EPP (Air) 1997*; • Ensure all operational personnel are aware of the sensitivities with regard to elevated dust levels within and adjacent to the Project; • Notify residents, commercial operators and the community if dust generating maintenance activities will be undertaken. A minimum of 48 hours notice should be given to residents; • Regular maintenance of all equipment; • Maintain a complaints register relating to air quality, including remedial actions; and • Implement corrective actions if dust levels exceed the nominated non-compliance level, including identification of the source.

7.9.1 Construction Dust and Emissions

The construction phase of the Project has the potential to generate dust. However, there are air quality management strategies that can mitigate and manage the potential impacts of construction activities on local air quality, particularly with respect to decreasing the number of potential sources of dust.

Activities that 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;
- Demolition of 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; and
- 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, attention should be paid to dust suppression particularly when working in close proximity of residences.

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 height of 10 m.

Based on the wind speed frequency data in Table 7-9, winds passing over a stockpile would direct emissions towards a given receiver location up to 9.2% of the time for 1.5 m/s winds, and up to 5.7% 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.

In relation to the operation of a concrete batching plant, it is expected that a detailed study will be conducted when full details of this aspect of the project are available. The key issues associated with a concrete batching plant are the emissions of particulate matter (TSP and PM_{10}). Provision will be made to ensure that any concrete batching plants that are associated with the construction of the project are well separated from sensitive land-uses and designed to minimise emissions of air pollutants. State government guidelines on buffer distances recommend between 100 metres and 500 metres to avoid adverse impacts from concrete batching plants (WA EPA (2005), SA EPA (2000) and VIC EPA (1990).

7.9.2 Coal Dust

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).

In 2007, the EPA requested QR Ltd 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. Results from this evaluation suggest that the main source of coal dust emissions is due to the surface of the coal wagons, namely:

- Lift-off from the surface of loaded wagons;
- Lift-off from spilled coal in the corridor;
- Door leakage;
- Parasitic load; and
- Residual coal in unloaded wagons.

The key factor that contributes to the emission rate of coal dust from wagons is the speed of the air passing over the coal surface. This is influenced by the train speed and the ambient wind speed and direction. Other factors that are also found to contribute include:

- Coal properties such as: dustiness, moisture content and particle size;
- Frequency of train movements;
- Vibration of the wagons;
- Profile of the coal load;
- Transport distance;
- Exposure to wind; and
- Precipitation.

The Environmental Evaluation recommended that QR Ltd develop a coal dust management plan as a framework for the ongoing management of the coal dust issue. The coal dust management plan for these coal transport systems should detail short, medium and long-term strategies for minimising coal dust emissions from the key dust sources, and incorporate the principle of continual environmental improvement.

The control of coal dust emissions for this Project will require consultation with the mines that use the line. Mining projects that are currently in development will be expected to implement the recommendations of the Environmental Evaluation to minimise coal dust emissions from wagons. A number of existing mines that operate trains on the Goonyella, Moura and Blackwater Systems have already partially or fully implemented the recommendations of the Environmental Evaluation and QR Ltd is continuing negotiations with mines to extend this program to a larger number of existing mines.

7.9.3 Intended Measures to Avoid or Minimise Greenhouse Gas Emissions

In relation to greenhouse gas emissions, the Project has been designed as far as is practicable to minimise operational costs and fuel usage, whilst also minimising capital costs. This fuel efficiency consideration couples as an intended measure to ensure that greenhouse gas emissions are minimised.