11. Air Quality Assessment

11.1 Introduction

The aim of this chapter is to assess the potential air quality impacts associated with the Emu Swamp Dam.

The Project has the potential to generate air quality impacts at sensitive receivers as a result of construction works. Construction is expected to commence in mid 2008. .There will be no significant air emission contributions from the operation of the project.

The potential air quality impacts associated with the Project have been assessed by:

- reviewing legislative requirements and ambient air quality goals, and describing the air quality environmental values to be protected or enhanced;
- describing existing air quality and dispersion meteorology within the Project area;
- identifying the nearest sensitive sites including residential, industrial and agricultural sites;
- estimating air emissions associated with construction of the Project and predicting particulate matter concentrations and dust deposition rates at nearest sensitive receivers using dispersion modelling;
- determining the likelihood for potential air quality impacts through comparison with air quality goals; and
- identifying impact mitigation measures to assist with the management of the air quality impacts from the project.

11.2 Air Quality Guidelines

Air quality in Queensland is administered under the *Environmental Protection (Air) Policy 1997* (EPP Air) The intention of EPP Air is to support the *Environmental Protection Act 1994* by:

- identifying environmental values to be enhanced or protected;
- specifying air quality indicators and goals to protect the environmental values;
- providing a framework for making consistent and fair decisions about management of the air environment; and
- involving the community in achieving air quality goals that best protect Queensland's air environment.

The current goals for criteria pollutants considered relevant to the assessment of air quality impacts during construction of the Project, as shown in Schedule 1 of the EPP (Air), are as follows:

- PM_{10} maximum 24-hourly average, 150 µg/m^3;
- PM_{10} annual average, 50 µg/m^3;
- TSP annual average, 90 µg/m^3.

The National Environment Protection Measure (NEPM) for Air Quality was released by the National Environment Protection Council (NEPC, 2003). The relevant standard in the NEPM for PM_{10} is a maximum 24-hourly average of 50 µg/m^3 (with 5 allowable exceedances per year).

The application of the NEPM is intended to provide a representative measure of regional air quality, rather than a project specific target. Although the NEPM is not considered strictly applicable to construction projects it is recognised that projects should work towards achieving the NEPM goals.

The policy is designed for consideration when siting industrial developments and is not necessarily relevant to the assessment of construction impacts associated with the Project. However, given the expected duration of the construction works and the location of residences near the construction site, it would be prudent to adopt these goals as part of the environmental performance criteria for the Project.

Deposited dust, if present at sufficiently high levels, can reduce the amenity of an area. No formal criteria for dust deposition exist within Queensland however an informal draft guideline of 120 mg/m^2/day was introduced some years ago by the then Department of Environment and Heritage (now the EPA) applicable at nearby sensitive residential places. Dust deposition monitoring has historically been undertaken as part of mining and large scale construction projects to assist with the monitoring of satisfactory performance related to nuisance dust. The EPA (2003) recommends this guideline for preparing environmental management plans for non-standard mining projects.

A dust deposition guideline of 120 mg/m^2/day is therefore considered appropriate for the construction of the Project.

The air quality goals for the assessment of construction impacts are presented in **Table 11-1**.

Table 11-1 Construction Air Quality Goals for the Project

	Construction Air Quality Goals	
Pollutant	Aim to achieve	Not to be exceeded
Particles as PM10	50 µg/m3 (24 hr average)	150 µg/m^3 (24 hr average) 50 µg/m^3 (annual average)
Total Solid Particulates	-	90 µg/m^3 (annual average)
Dust deposition	-	120 mg/m^2/day

11.3 Existing environment

This section identifies nearest sensitive receivers, and describes the local environment, including meteorology and ambient air quality in the vicinity of the proposed Emu Swamp Dam.

11.3.1 Local setting and sensitive receivers

The proposed location for Emu Swamp Dam is on the Severn River approximately 15 km southwest of Stanthorpe. The predominant land use in the Project area is a mix of agricultural and rural and remnant vegetation communities. The topography near the dam wall is hilly, ranging from 700 m AHD to the north of the dam wall up to heights of more than 950 m AHD. The Severn River flows in a south westerly direction from the proposed dam location.

The nearest sensitive receivers to the Project were identified from aerial photography and site visits to the Project area and are presented in **Section 11.4.4** (refer to **Table 11-6**). Sensitive receivers within this environment include residential, agricultural and industrial sites with the nearest site being a residence located approximately 50 m from stockpiles and 400 m from dam wall construction.

11.3.2 Climate and dispersion meteorology

Meteorological data recorded by the Bureau of Meteorology (BoM) at Stanthorpe have been reviewed to describe the existing meteorological and climatological influences in the Project area. **Table 11-2** provides a summary of the temperature, humidity and rainfall data for the Stanthorpe meteorological station. Graphical presentations of the temperature, relative humidity, rainfall totals and days are provided in **Appendix F**.

Stanthorpe typically has warm days during summer with average maximum daytime temperatures around 27 °C falling to 15°C during the winter months. Overnight temperatures are generally cool all year round and cold during the winter months with average minimum daily temperatures of 1 °C in July, rising to greater than 14°C between December and March. Relative humidity is a measure of the moisture carrying capacity of the atmosphere. Mean 9 am relative humidity is generally greatest during the months from February to July and least during September to December. Mean 3 pm relative humidity is generally lower than 9am through the year, ranging from 42% in September up to 56% in February. August to September generally experiences the lowest 3pm relative humidity

Highest rainfall is generally recorded during summer months with monthly rain averages above around 85 mm/month from December to February. Mean monthly rainfall generally drops off in late autumn and winter with average monthly rainfalls less than 50 mm from April till August. However, it is not uncommon for no significant rainfalls to occur during the winter period in some years.

- **Table 11-2 Climatic Summary for Stanthorpe (BoM 041095)**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean daily maximum temperature (°C)	27	26	25	22	18	15	15	16	19	23	25	27	22
Mean daily minimum temperature (°C)	16	16	14	10	6	3	1	2	5	9	12	14	9
Mean 9am air temp (°C)	22	21	19	16	12	8	7	10	14	17	20	21	16
Mean 9am relative humidity (%)	66	71	71	71	77	79	75	69	62	60	59	61	68
Mean 3pm air temp (°C)	26	25	24	21	17	14	14	15	18	21	24	26	20
Mean 3pm relative humidity (%)	51	56	54	51	55	55	51	45	42	45	45	46	50
Mean monthly rainfall (mm)	97	87	67	43	47	47	50	43	52	69	74	94	770
Mean no. of rain days	10	9	9	6	7	8	8	7	7	8	8	10	96
Mean no. of clear days	6	5	7	10	10	11	14	14	13	10	8	8	116
Mean no. of cloudy days	12	11	10	8	10	9	9	8	6	9	10	10	112

Dispersion modelling requires hourly breakdown of wind speed and direction, and other meteorological parameters such as mixing height and Pasquill-Gifford stability class. TAPM version 3 was used to generate a meteorological file for the Project area for 2004 to input to the Ausplume air dispersion model. TAPM is a three-dimensional prognostic meteorological and air pollution model which produces detailed fields of hourly estimated temperature, winds, pressure, turbulence, cloud cover and humidity at various levels in the atmosphere as well as surface solar radiation and rainfall.

Windroses of the TAPM generated Emu Swamp Dam meteorological file for 2004 are presented in **Figure 11-1**, **Figure 11-2** and **Figure 11-3**.

The windroses in **Figure 11-1**, **Figure 11-2** and **Figure 11-3** indicate that:

- wind directions are predominantly from the northeast;
- wind speeds are fairly light, generally less than 5 m/s;
- during summer and autumn, winds are predominantly from the northeast;
- during winter and spring winds are variable but mainly from the northeast or the west;
- winter winds are generally lighter (and less dispersive) than summer winds;
- morning winds are light and variable in direction, tending to become west-southwesterly in the afternoon; and
- overnight winds are light from the northeast.

Figure 11-1 All hours windrose for TAPM generated meteorological data

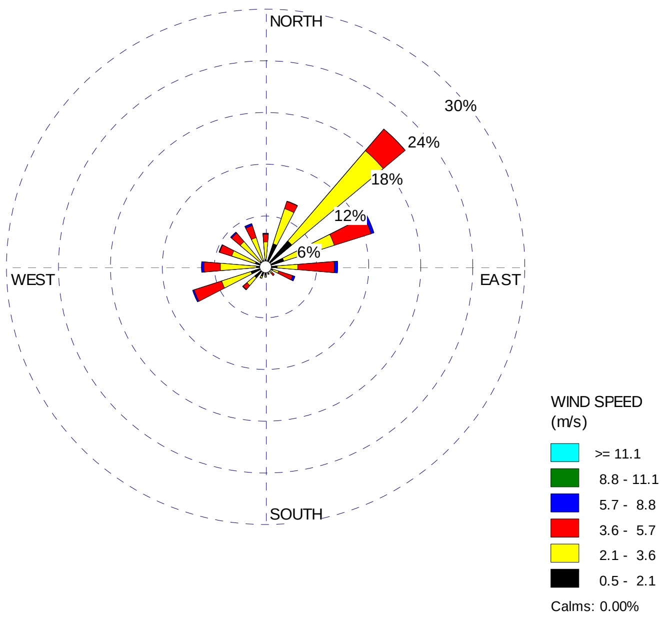


Figure 11-2 Windroses by season for TAPM generated meteorological data

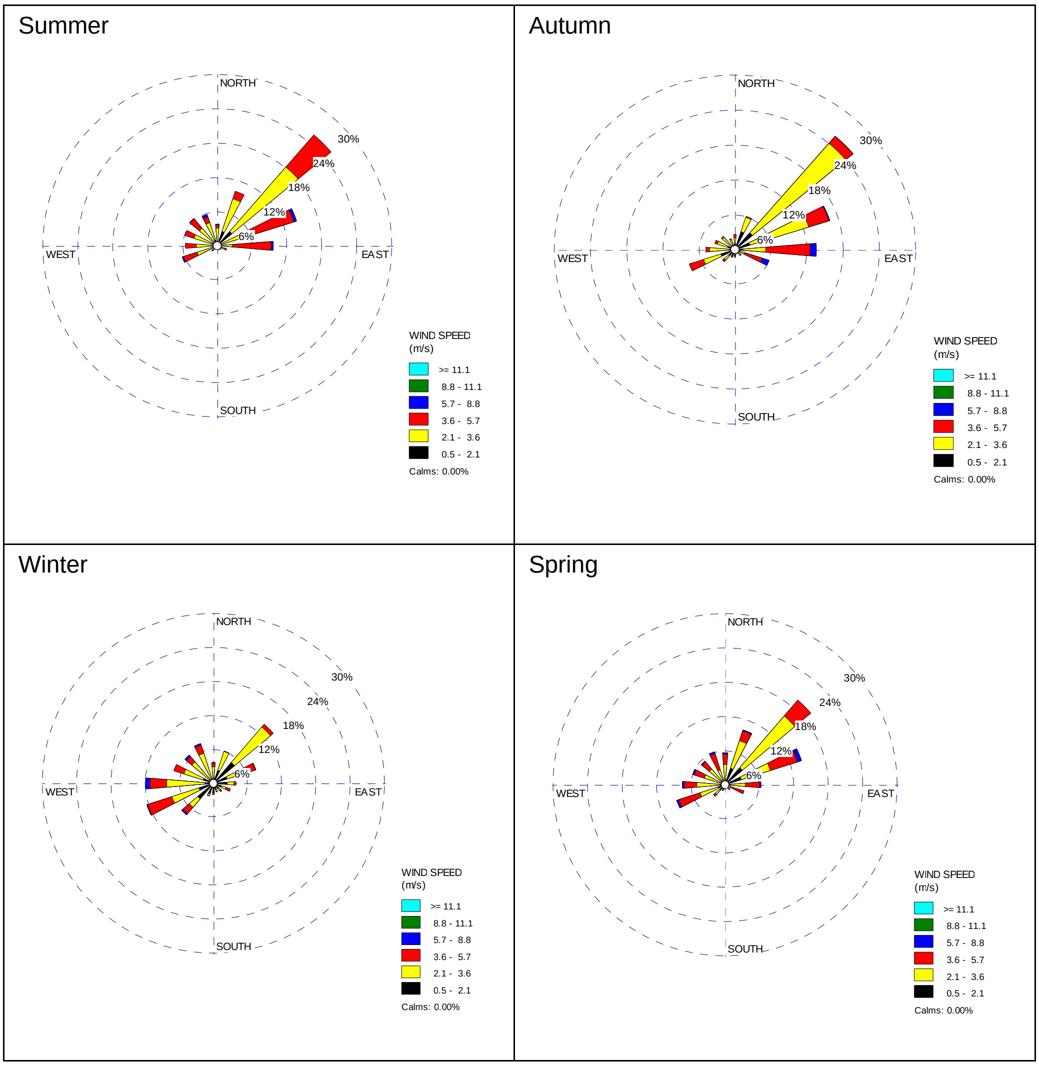
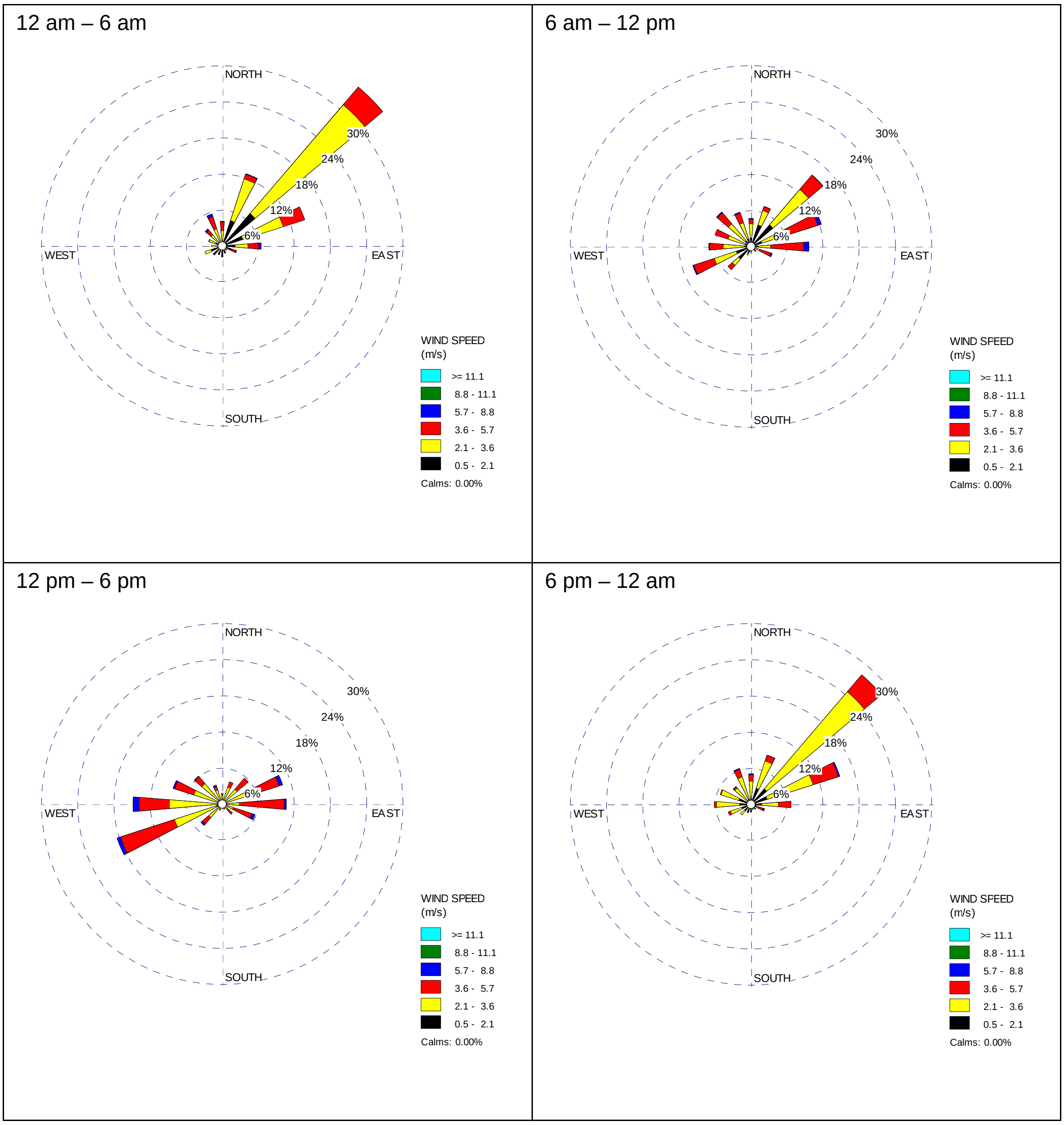


Figure 11-3 Windroses by time of day for TAPM generated meteorological data



The patterns of prevailing winds will influence the dispersion of dust from construction activities associated with the project. During times of light winds, such as during the morning hours or during the daytime hours of the cooler months, dust dispersion will be poor, and will not tend to influence areas far from the construction site. During periods of strong wind dust generation is more likely to impact off site receivers (if adequate management controls are not implemented).

Table 11-2 indicates that the highest rainfall and the greatest number of rain days generally occur during the warmer months from December through to March. Driest times of the year are typically June through to September and it is during this period that dust emissions from excavation, haulage along unsealed roads and wind erosion from exposed areas would be greatest.

11.3.3 Ambient air quality

Emissions sources

Existing air quality in the study area is influenced by local sources including:

- motor vehicle emissions from major roads (New England Highway, 4 km east of the proposed dam wall);
- agricultural activity or dust from cultivation and harvesting (tractors, pesticide spraying etc);
- smoke from domestic woodheaters;
- occasional bushfires and control burns; and
- regional (or widespread) wind blown dust from dry inland areas.

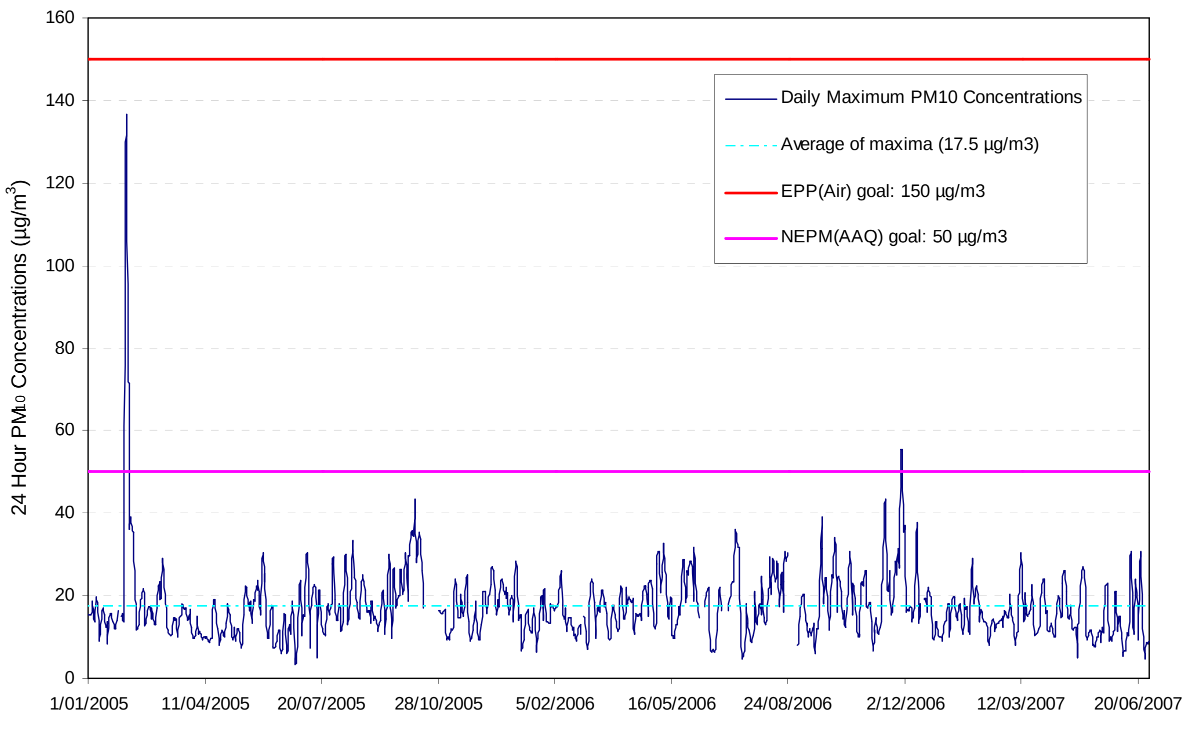
Ambient air quality monitoring

The main air emission of potential concern for the project is particulate matter during construction. The closest EPA air quality monitoring site is located at Toowoomba, approximately 120 km north of Stanthorpe. PM_{10} concentrations from January 2005 through to June 2007 at Toowoomba are presented in **Figure 11-4**. The average of these 24-hour maxima is 17.5 µg/m^3 and the 95th percentile is 30.5 µg/m^3. Most concentrations are less than the air quality goal in the EPP(Air). A dust storm caused the high concentrations recorded in February 2005.

The annual average background PM_{10} for the Toowoomba site is 16 µg/m^3, significantly less than the air quality goal of 50 µg/m^3 in the EPP(Air). The annual average background TSP concentration has been assumed to be double the average annual PM_{10} concentration at 32 µg/m^3. This is also significantly less than the air quality goal of 90 µg/m^3 in the EPP(Air).

Given the differences in population between Toowoomba and the Project area, the influence of vehicle emissions and combustion sources for domestic heating would be considered more significant at Toowoomba. Therefore, the expected PM_{10} concentrations would be lower at the Project area. However in the absence of site monitoring at Stanthorpe, Toowoomba data has been adopted as conservative estimates of background concentrations at the Project area to determine cumulative impacts of the Project.

- **Figure 11-4 Maximum 24-Hour Average PM_{10} Concentrations (Toowoomba)**



11.4 Impact Assessment – Construction Dust

11.4.1 Sources of Air Emissions and Assessment of Likely Impact

Construction of the Project is expected to occur for 18 months. As outlined in **Table 11-3**, construction activities will involve excavation, blasting, stockpiling, transport of spoil, earthworks and concreting. The majority of construction works are expected to occur 6 days per week from Monday to Saturday. Concrete batching operations will occur for 7 days per week. Construction hours for most operations will be 10 hours per day, apart from crushing operations (20 hours per day) and concrete batching (24 hours per day). The different types of construction activities typically associated with projects of this kind and potential sources of air emissions have been presented in **Table 11-3**.

The main potential for impacts to air quality is likely to arise from the generation of particulate matter resulting from excavation activities, blasting and wheel-generated dust from haul roads during construction of the project.

The impacts and activities associated with pipeline construction will be similar to those of the dam wall construction, and the operational hours will be the same.

There will be no significant air emission contributions from the operation of the Project, apart from occasional vehicle emissions associated with the fish transfer, if fitted. The quantities of emissions are expected to be low and have not been assessed as part of the EIS.

This air quality assessment will therefore focus on the impact of TSP, PM_{10} and dust deposition generated during construction of the Project on nearby sensitive sites.

There will also be small emissions of carbon monoxide (CO), oxides of nitrogen (NO_X), sulphur dioxide (SO_2), and PM_{10} from exhaust emissions from construction equipment and haul trucks on-site. These emissions are not expected to be significant for this study due to their low levels of emissions. A summary of expected operational activity and haul distances is presented in **Table 11-4**.

Table 11-3 Construction Activities and Air Emissions Sources

Construction Activity	Air Emissions sources
Excavation	Fugitive dust from: ▪ Excavation of rock and overburden; ▪ Drilling and blasting operations; ▪ Clearing trees and topsoil with dozer; and ▪ Wind blown dust from exposed areas. Diesel emissions from construction equipment.
Sand Screening	Fugitive dust from: ▪ Extraction of sand material from inundation zone; ▪ Screening of sand ▪ Stockpiling and loading to haul trucks
Crusher	Fugitive dust from crushing of rock
Stockpiles	Fugitive dust from: ▪ Wind blown dust from exposed areas
Concrete Batch Plant	Fugitive dust from: ▪ Mixing materials for concrete manufacture ▪ Wind blown dust from stockpiles of sand and aggregate
Haul Roads	Fugitive dust from ▪ wheel-generated dust by vehicles travelling on unsealed roads; and ▪ graders maintaining haul roads on-site. Diesel emissions from haul trucks and water trucks transporting sand from the extraction sites and materials within the Project area
Dam Construction	Fugitive dust from drilling as part of dam footings Diesel emissions from construction equipment.
Inundation clearing	Fugitive dust from clearing trees from inundation zone Combustion products from burning of cleared timber
Pipeline Construction	Fugitive dust from: ▪ Clearing ▪ Trench excavation including drilling and blasting in rock (where required) for buried pipes ▪ Concrete pedestal construction for above ground pipes ▪ Directional drilling for road, rail and creek crossings

Some vegetation from the inundation zone around the dam will need to be burned on-site as a result of access and to avoid water quality issues associated with vegetation left to decay underwater. Burning of cleared vegetation will generate CO, NO_X, PM_{10} and odour. These events will be undertaken in consultation with the Queensland Rural Fire Service, and Queensland Parks and Wildlife Service to avoid burning during times when unfavourable dispersion conditions prevail.

The construction of the Stalling Lane Access will generate fugitive dust. However, these works are not expected to be significant in comparison with major excavation and haulage activities and have not been considered in the detailed air quality assessment. Management measures outlined in **Section 11.4.5** would be incorporated into site EMPs as part of approvals for these works.

Construction of the pipeline would involve a lower level of dust generating activities, however given that the pipeline would be constructed within road reserve boundaries which could be much closer to residences; the potential for dust impacts could be higher. Air quality management plans for these works will be required and will be prepared by the construction contractor.

11.4.2 Emissions Estimation

A snapshot of construction activities likely to result in the greatest potential for air quality impacts were identified (refer to **Table 11-3**). Dust emissions from the main sources were estimated using emission factors in the *Emission Estimation Technique Manual for Mining version 2.3* (NPI, 2001) and *AP-42 Compilation of Air Pollutant Emission Factors* (US EPA, 1998). The construction information which has been used as the basis for calculations is presented in **Table 11-4**. The emission factors used to estimate dust emissions from site are presented in **Table 11-5**.

Table 11-4 Construction Information used for emissions estimates

Parameter	Parameter	Value
Material quantities	Rock for dam wall	54,000 m^3
	Coarse sand for dam wall	38,000 m^3
	Fine sand for dam wall	1,500 m^3
	Cement for dam wall	10,300 t
	Fly ash for dam wall	7,800 t
	Concrete in total for dam wall	162,300 t
Haul distances (return)	Quarry to crusher	1.3 km
	Crusher to stockpiles	1 km
	Sand screener to stockpiles	1 km
	RCC concrete: Batch plant to dam	0.6 km
	Conventional concrete: Batch plant to dam	0.6 km
Blasting	Area	30 m^2
	Depth	5 m
	Frequency	3 blast/week
	Average holes drilled per blast	8
Other	Grading speed	20 km/day
	Exposed Area	72.5 ha
	Concrete batching plant	445 t/day
	Crusher	621 t/day

Table 11-5 Summary of Dust Emission Factors

Construction Activity	TSP Emission Factors	PM_{10} Emission Factors	Dust Control
Excavation of rock	0.00170 kg/t	0.00080 kg/t	-
Excavation of overburden	0.01181 kg/t	0.00559 kg/t	-
Scraper	1.644 kg/VKT	0.529 kg/VKT	-
Grader	0.19 kg/VKT	0.085 kg/VKT	-
Dozer	4.533 kg/hr	0.947 kg/hr	-
Wind erosion	2.2 x 10-6 g/m^2/sec	1.1 x 10-6 g/m^2/sec	-
Blasting	77.3 kg/blast	40.2 kg/blast	-
Drilling	0.59 kg/hole	0.31 kg/t	70% control with water sprays
Crushing	0.2 kg/t	0.02 kg/t	-
Concrete Batching	0.0087 kg/t	0.0024 kg/t	
Wheel Generated Dust			50% control with watering
▪ CAT770 loaded	1.57 kg/VKT	0.374 kg/VKT	
▪ CAT770 unloaded	1.098 kg/VKT	0.28 kg/VKT	

11.4.3 Modelling Methodology

The Ausplume version 6.0 dispersion model has been used to predict ground level concentrations of PM_{10} and TSP, and dust deposition amounts, within a 3 km x 2 km receptor grid surrounding the site. The grid receptor spacing is 100 m. Particle concentrations and dust deposition amounts have also been predicted for eight discrete receptors to predict air quality impacts at sensitive receivers close to the construction site. The TAPM generated meteorological data file described previously was used (refer **Section 11.3.2**). Impacts at sensitive receivers (including residences) are compared to the goals for ambient air quality shown in **Table 11-1**.

The Ausplume dispersion modelling options assumed as part of this air quality assessment include:

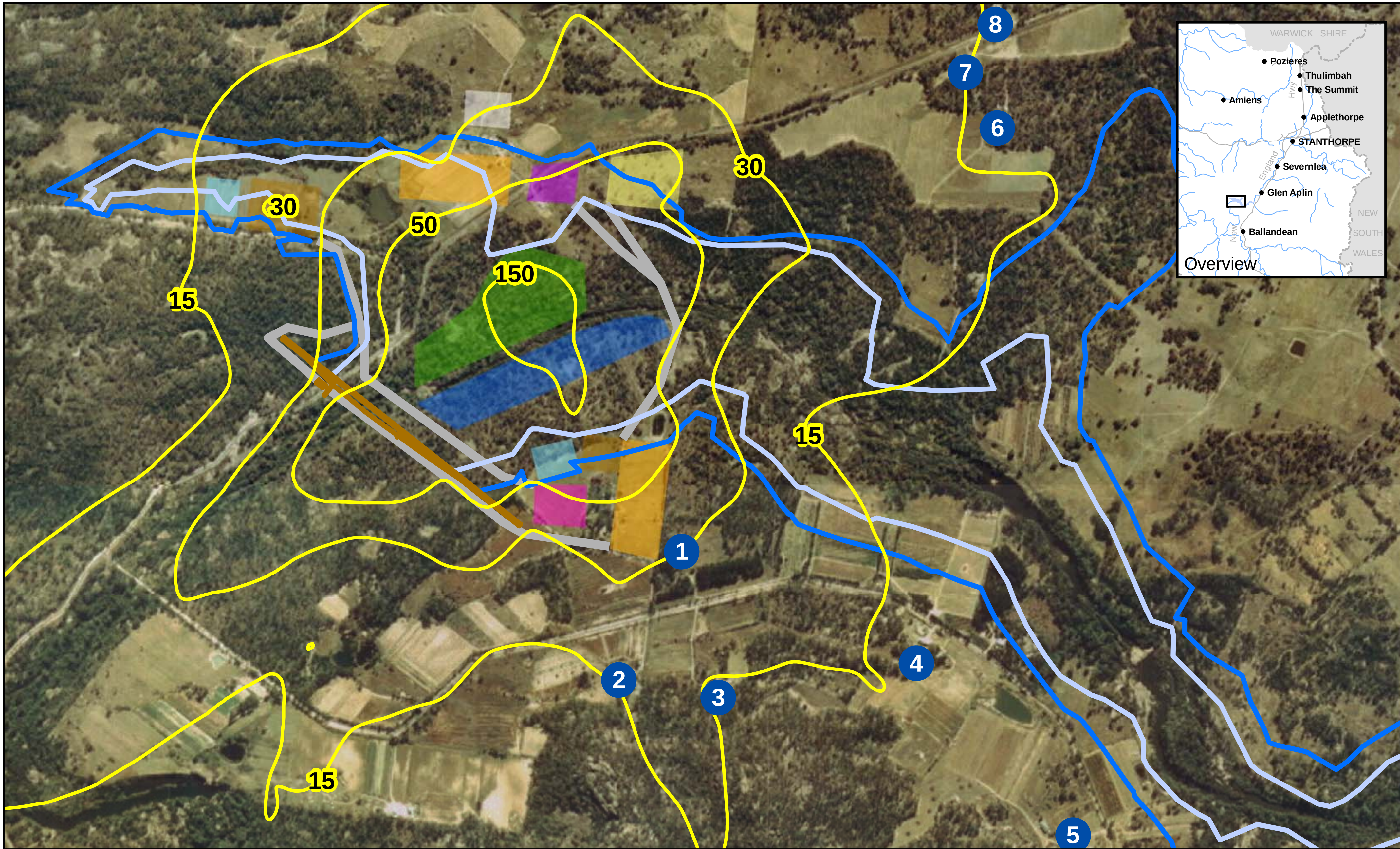
- regulatory default model options for dispersion;
- Irwin rural wind profile exponents;
- average roughness length of 0.6 m;
- terrain file for the receptor grid was generated from the contour data;
- emissions were grouped to represent areas of activity and modelled as 6 volume sources across the project construction site;
- emissions were assumed to be emitted for 10 hours per day between 7am and 5pm, apart from concrete batching (24 hours per day), crushing (20 hours per day) and blasting which occurred for one hour each day;
- annual average dust deposition rates were divided by number of 365 to determine average daily dust deposition rates;
- dry depletion options in Ausplume with particle size distribution information based on estimated TSP and PM_{10} emissions; and
- particle size for TSP and PM_{10} is 20 µm and 10 µm respectively.

11.4.4 Modelling Results

This section outlines the predicted concentrations of particulate matter and dust deposition rates from the construction of the Project for the indicative scenario outlined in **Table 11-4** and **Table 11-5**. The predicted increase in concentrations as a result of Project construction and the cumulative impact (including estimated background concentrations) is presented in the tables below. Contour plots presented below indicate the increase in particulate matter concentrations and dust deposition rates from construction.

11.4.4.1 PM_{10} Concentrations (24 hour average)

The maximum predicted 24 hour PM_{10} concentrations at nearest sensitive receivers during construction of the Project are presented in **Table 11-6**. The cumulative concentrations (including an assumed background of 30.5 µg/m^3) are also presented in **Table 11-6**. All concentrations at sensitive receivers are below the ambient air quality goal of 150 µg/m^3 in the EPP(Air). Contour plots of maximum PM_{10} concentrations (24 hour average) during construction are presented in **Figure 11-5**.



SHIRE OF STANTHORPE

Legend

- Full Supply Level 734.5m AHD
- Full Supply Level 738m AHD
- Dam Wall
- Haul Road

Construction Site Facilities

- Batch Plant
- Crusher
- Filter/Sand
- Laydown Area
- Quarry
- Sand Screen
- Site Office
- Stockpile
- Workshop

Air Quality

- 1 Residence
- Concentration Contours

N W E S

0 50 100 200 300 400 500
Metres

Scale - 1:11,330 (at A4)
Projection: Map Grid of Australia Zone 56

EMU SWAMP DAM EIS

Emu Swamp Dam Site

Figure 11-5 Contour Plot of Maximum PM_{10} Concentrations (bg/m^3) (24 Hour Average)

I:\QENV2\Projects\QE06454\Spatial\Arc_MXD\Figures\AirQuality\071218_AirQuality_Max24hr_av.mxd Produced: 18/12/2007

Table 11-6 Predicted PM_{10} concentrations (24 hour average) at nearest residences

Location	Description	PM_{10} Concentration (µg/m^3) Predicted increase	Including background
1	Residence #1	31	62
2	Residence #2	16	47
3	Residence #3	14	45
4	Residence #4	13	44
5	Residence #5	10	41
6	Residence #6	14	45
7	Residence #7	15	46
8	Residence #8	15	46

11.4.4.2 PM_{10} Concentrations (annual average)

The annual average PM_{10} concentrations at nearest sensitive receivers during construction are presented in **Table 11-7**. The cumulative concentrations (including a background of 15.8 µg/m^3) are also presented in **Table 11-7**. All concentrations at sensitive receivers are well below the ambient air quality goal of 50 µg/m^3 in the EPP(Air). Contour plots of PM_{10} concentrations (annual average) during construction are presented in **Figure 11-6**.

Table 11-7 Predicted PM_{10} concentrations (annual average) at nearest residences

Location	Description	PM_{10} Concentration (µg/m^3) Predicted increase	Including background
1	Residence #1	1.5	18
2	Residence #2	0.9	17
3	Residence #3	0.7	17
4	Residence #4	0.5	17
5	Residence #5	0.3	16
6	Residence #6	0.8	17
7	Residence #7	0.8	17
8	Residence #8	0.6	17

11.4.4.3 TSP Concentrations (annual average)

The average annual TSP concentrations at nearest sensitive receivers during construction are presented in **Table 11-8**. The cumulative concentrations (including a background of 32 µg/m^3) are also presented in **Table 11-8**. All concentrations at sensitive receivers are below the ambient air quality goal of 90 µg/m^3 in the EPP(Air). Contour plots of TSP concentrations (annual average) during construction are presented in **Figure 11-7**.

Table 11-8 Predicted TSP concentrations (annual average) at nearest residences

Location	Description	TSP Concentration (µg/m3)	
		Predicted increase	Including background
1	Residence #1	3	35
2	Residence #2	2	34
3	Residence #3	2	34
4	Residence #4	1	33
5	Residence #5	1	33
6	Residence #6	2	34
7	Residence #7	1	33
8	Residence #8	1	33

11.4.4.4 Dust Deposition

The average dust deposition rates nearest sensitive receivers during construction are presented in **Table 11-9**. Dust deposition rates at nearest sensitive receivers are predicted to be less than the guideline of 120 mg/m^2/day. Contour plots of average dust deposition rates during construction are presented in **Figure 11-8**.

Table 11-9 Predicted average dust deposition rates (mg/m^2/day) at nearest residences

Location	Description	Dust Deposition Rate (mg/m^2/day)
1	Residence #1	19
2	Residence #2	10
3	Residence #3	8
4	Residence #4	6
5	Residence #5	3
6	Residence #6	9
7	Residence #7	8
8	Residence #8	6

11.4.4.5 Discussion

The dispersion modelling results presented above show possible ground level concentration or deposition rates which may occur adjacent to the dam construction area.

The modelling predictions incorporate a range of meteorological conditions. The highest dust concentrations are recorded under calm conditions close to the dam construction area.

All mathematical models of airborne pollutant dispersion are simplifications of reality. Ausplume is a Gaussian plume model that is accepted by the EPA for the majority of regulatory applications.

The following factors should be considered when interpreting dust emission assessment:

- the construction scenario assessed is a snapshot of typical activities that could be expected to occur at the site during a high level of activity;
- actual emission rates may differ from the estimates in **Table 11-5**;
- emission factors are generally long-term averages, whereas actual emissions will vary on a short-term time scale;
- estimated dust emission rates are based on an assumption that dust emission controls have been utilised on many of the dust emitting processes as outlined in **Table 11-5**; and
- dispersion models are based on a number of assumptions about regional homogeneity of winds and surface conditions.

11.4.5 Mitigation Measures

Although the dispersion modelling results presented above indicate compliance with goals, dust management and minimisation measures are an important component of the Project.

The construction mitigation measures may be implemented to minimise the potential for nuisance dust impacts during the Project. The dust control strategies provided in the points below have also been provided in the framework for the Environmental Management Plan (EMP) and would be considered further as part of the detailed design for construction works:

- haul roads would be watered regularly using truck water carts as required to reduce emissions of wheel generated dust. Recycled water would be used preferentially for dust suppression purposes;
- the size of cleared areas would be minimised to limit exposed areas available for dust emissions by wind erosion;
- surface excavation works and blasting activities would incorporate consideration of prevailing meteorological conditions wind speed and direction, with works potentially ceasing if high winds are blowing in the direction towards sensitive receivers. This is particularly important when dust emissions are close to sensitive receivers;
- limit speeds of haul trucks to 40 km/hr on-site to reduce wheel-generated dust from haul roads located near sensitive receivers;
- regular monitoring of dust deposition levels at the nearest sensitive sites would provide a basis for compliance with appropriate criteria;
- retention of existing vegetation, where practical, between construction activities and sensitive receivers would reduce particulate concentrations and dust deposition rates at receivers;
- construction of an enclosure around the crushing area should be considered if dust impacts from crushing operations become problematic;
- the prevailing meteorological conditions should be considered before undertaking any burn event to minimise potential air quality impacts from this activity. These events would be undertaken in consultation with the Queensland Rural Fire Service and the Queensland Parks and Wildlife Service;

- sealed access roads to the worksite sheds would be kept relatively dust free by regular sweeping and washing if needed. At certain times of the year, natural rainfall should keep this surface washed; and
- concrete batching will require separate approvals and a detailed air quality management plan recommending mitigation measures such as enclosures around cement unloading areas and stockpiles and regular watering of stockpiles.

In order to ensure that impacts to sensitive receivers are maintained at a minimum, an iterative monitoring and adaptive management approach using visual inspection and community complaints as key triggers for initiating environmental management response investigations. Through this approach, and by notifying the community of proposed activity prior to the works, potential air quality impacts can be effectively managed.

11.5 Greenhouse Assessment

11.5.1 Introduction

Increasing concentrations of greenhouse gases in the atmosphere have the potential to cause climate change. The *Queensland Greenhouse Strategy* (EPA 2004) was developed in response to the potential social, economic and environmental implications of climate change. The key objectives of the *Queensland Greenhouse Strategy* are to:

- foster increased knowledge and understanding of greenhouse issues and climate change impacts;
- reduce greenhouse gas emissions; and
- lay the foundation for adaptation to climate change.

The Australian Greenhouse Office (AGO 2007) estimated that in 2005 Queensland emitted 157.0 Mt CO_2-e (approximately 28% of Australia's total greenhouse gas emissions). The breakdown of Queensland's greenhouse gas emissions by sector is: 91.1 Mt CO_2-e from energy sector, 5.6 Mt CO_2-e from industrial processes, 25.8 Mt CO_2-e from agriculture and 30.2 Mt CO_2-e from land use, land use change and forestry.

11.5.2 Methodology

A preliminary greenhouse gas inventory has been prepared for the construction and operation of the project, to provide an indication of the relative benefits and impacts of the Emu Swamp Dam. The *AGO Factors and Methods Workbook* (AGO 2006) was used in the preparation of the greenhouse gas inventory. The relevant emission factors are summarised in **Table 11-10**.

- **Table 11-10 Greenhouse Gas Emission Factors**

Source	Emission Factor	Units
Electricity end use (QLD)	1.046	t CO_2-e/MWh
Automotive diesel	2.7	t CO_2-e /kL
Explosives (Heavy ANFO)	0.178	t CO_2-e /t explosive

Source: AGO, 2006

Note: t CO_2-e = tonnes of CO_2 equivalents

The greenhouse gas emissions from land clearing have not been estimated as part of the EIS. These emissions are not expected to be significant as the Project revegetation of the buffer area and any vegetation offsets will offset most of these emissions. Therefore the net change in greenhouse emissions is not expected to be significant.

11.5.3 Construction

Estimates of construction greenhouse gas emissions for the Urban Water Supply Project and Combined Urban and Irrigation Project are presented in **Table 11-11**. These estimates include the construction of Emu Swamp Dam, the Urban Pipeline and the Irrigation Pipeline (for the Combined Urban and Irrigation Dam). The estimates relate to typical diesel consumption rates in the construction vehicle fleet, electricity consumption from site services, and explosives used in quarry operations over the construction period. Construction of the Urban Water Supply Project is estimated to result in approximately 3,666 t CO_2-e of greenhouse gases, and the Combined Urban and Irrigation Project in 4,231 t CO_2-e of greenhouse gases. These emissions represent a small fraction of Queensland's annual greenhouse gas emissions.

- **Table 11-11 Diesel, Electricity and Explosives Use and Greenhouse Gas Emissions during construction for dam and pipelines**

Source	Urban Water Supply Project		Combined Urban and Irrigation Project	
	Usage (units)	GHGs (t CO_2-e)	Usage (units)	GHGs (t CO_2-e)
Diesel [1]	1,325 kL	3,578	1,525 kL	4,118
Electricity [2]	73 MWh	76	95 MWh	99
Explosives [1]	68 t	12	80 t	14
TOTAL		**3,666**		**4,231**

[1] Direct site emissions

[2] Indirect site emissions

11.5.3.1 Construction Greenhouse Management Measures

The mitigation measures to minimise greenhouse gas emissions as part of the construction works include:

- designing a construction works program to source most construction materials from within or close to the Project area to reduce fuel use from transporting materials;
- maintaining construction equipment and haul trucks in good working order so fuel efficiency of equipment is maximised;
- using appropriately sized equipment for construction activities;
- minimising waste from construction; and
- investing in accredited renewable energy providers or using biodiesel in construction equipment on-site, where feasible.

11.5.4 Operation

Greenhouse gas emissions will be generated as a result of energy consumption to pump water for both the Urban Water Supply Project and the Combined Urban and Irrigation Project. There will be minor quantities of greenhouse gases will be generated intermittent vehicle activity associated with fish transfer operations, if fitted.

For the Urban Water Supply Project the annual energy requirements have been estimated as 594 MWh. For energy consumption in Queensland, this corresponds with annual greenhouse gas emissions of 621 t CO_2-e. The operation of the Urban Water Supply Dam represents approximately 0.0004% of Queensland's annual greenhouse gas emissions.

For the Combined Urban and Irrigation Project the annual energy requirements have been estimated as 3,012 MWh due to the additional pipeline and pumping demand. For energy consumption in Queensland, this corresponds with annual greenhouse gas emissions of 3,150 t CO_2-e. The operation of the Combined Urban and Irrigation Dam represents approximately 0.002% of Queensland's annual greenhouse gas emissions.

Energy efficiency will be a key feature in the design of the dam wall and will be managed through further efficiency measures incorporated into the Project as outlined in **Section 11.5.4.1**.

11.5.4.1 Operation Greenhouse Management Measures

The following management measures are proposed for the operation of the Project to minimise greenhouse gas emissions:

- review annual energy use to assist with ongoing management of energy efficiency programs; and
- purchase of green energy to reduce the indirect greenhouse emissions from dam operation.

11.6 Implications of Climate Change

Changes in local weather patterns resulting from climate change have the potential to affect the project in the future. A climate change risk assessment has been undertaken for the Emu Swamp Dam Project and is summarised below.

CSIRO (2006) report that South East Queensland is likely to become warmer; have more hot days and fewer cold nights in the future. A decline in annual rainfall with higher evaporative losses would lead to a tendency for less runoff into rivers. Droughts are likely to become more frequent and severe, with greater fire risk. Increases in extreme weather events are likely to lead to increased flash flooding, strains on drainage systems, greater insurance losses, possible black-outs, and challenges for emergency services.

The climate change risk assessment for this project is based on high and low global warming scenarios from:

- predicted rainfall-runoff modelling for the Border Rivers region in 2030 (CSIRO 2007); and
- climate change scenarios South East Queensland in 2030 (CSIRO 2006).

The percentage change for a number of key climate parameters are presented for these two climate change scenarios (see **Table 11-12**).

- **Table 11-12 Change in Climate by 2030, relative to 1990**

Climate Parameter	Source	Low Global Warming Scenario	High Global Warming Scenario
Annual average temperature	CSIRO 2006	+0.6 ±0.2˚C	+1.3 ±0.6˚C
Annual average rainfall	CSIRO 2006	-1.50 ±6.5%	-3.50 ±15%
Mean annual runoff	CSIRO 2007	-9% to +5%	-28% to +20%
Annual average potential evaporation	CSIRO 2006	+2.40%	+5.60%
Annual average number of hot days (>35 °C)	CSIRO 2006	0	+5 days
Annual average number of cold nights (<0 °C)	CSIRO 2006	0	-5 days
Extreme daily rainfall intensity (1 in 20 year event)	CSIRO 2006	0% [1]	+30% [1]
CO_2 concentration	CSIRO 2006	+73 ppm	+102 ppm

1 – These results are for 2040 as changes for 2030 were not available

The potential risk to the project posed by each climate change parameter has been assessed and mitigation measures have been proposed, where appropriate, in **Table 11-13**. The greatest potential impacts are:

- a potential increase in water demand as a result of higher temperatures;
- a potential reduction in yield as a result of decreased annual rainfall and increased evaporation;
- a potential increase in flood peaks due to an increase in rainfall intensity.

The Project generally has a limited vulnerability to the impact of climate change.

The potential risks of increased water demand and reduced yield from the dam can be mitigated through water demand management. These risks increase the need for the Emu Swamp Dam to supplement water supplies from the existing Storm King Dam.

Predicted increases in tropical cyclone intensity in Queensland have the potential to increase extreme daily rainfall and increase flood peaks. However, the dam will be designed for over-topping in extreme events and will be able to withstand the associated loads.

Table 11-13 Potential Impacts of Climate Change and Proposed Mitigation Measures

Climate Change Parameter	Potential Impact	Mitigation Measures
Increase in annual average temperature	Potential increase in water demand.	Water demand management
	Potential for temperature increase to affect reliability of infrastructure or equipment (e.g. pumps)	Infrastructure and equipment design will allow for extreme operating temperatures and conditions
Decrease in annual average rainfall	Potential to reduce the yield from the dam due to predicted decrease in annual average rainfall. It should be noted the predicted uncertainty is greater than the predicted decrease.	Water demand management. The larger storage capacity than the existing situation provides mitigation against impacts.
Decrease in mean annual runoff	Potential to reduce the yield from the dam due to predicted decrease in mean annual runoff.	Water demand management. The larger storage capacity than the existing situation provides mitigation against impacts.
Change in seasonal average rainfall	Potential to reduce yield from the dam due to predicted decrease in rains during autumn, winter and spring.	As for decrease in annual rainfall.
Increase in annual average potential evaporation	Potential to reduce the yield from the dam due to increase in average potential evaporation. Potential to reduce runoff to the dam due to increased catchment losses leading to reduced yield from the dam.	Water demand management. The larger storage capacity than the existing situation provides mitigation against impacts.
Increase in annual number of hot days	Potential temperature increase to affect reliability of infrastructure or equipment (e.g. pumps).	Infrastructure and equipment design will allow for extreme operating temperatures and conditions.
Annual average number of cold nights (<0 °C)	No Impact	N/A
Increase in extreme daily rainfall intensity	Potential to increase flood peaks.	Dam is designed for over-topping and will withstand larger floods.
Increase in CO_2 concentration	Potential for increase in water acidity due to greater diffusion of CO_2.	The expected increase in water acidity is not expected to affect water quality significantly. Water quality sampling at the water treatment plant will be able to determine any long term changes in water quality in the dam.

11.7 Summary and Conclusions

This chapter has assessed the air quality impacts of the Emu Swamp Dam. The Ausplume air dispersion model was used to predict PM_{10} and TSP concentrations and dust deposition rates at sensitive receivers near the construction area. The predicted PM_{10} and TSP concentrations were well below ambient air quality goals in EPP(Air).

However, it is considered highly unlikely that this Project will result in exceedances of the guidelines if appropriate mitigation measures are employed throughout the construction period.

Greenhouse gas emissions from construction and operation of the Project represent a small fraction of Queensland's greenhouse gas emissions. The construction program has been designed to maximise energy efficiency and minimise greenhouse gas emissions from the works. This has been done primarily by sourcing almost all materials from the Project area.

Climate change risk assessment has determined that the Project has limited vulnerability to climate change. Climate change has the potential to reduce the potential yield from the Project but the larger storage capacity of the dam will provide mitigation against potential impacts.