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WEST WALLSEND COLLIERY CONTINUED OPERATIONS PROJECT

ENVIRONMENTAL ASSESSMENT

Umwelt
Environmental Consultants

JULY
2010

VOLUME 3
Appendices 9-12 (Part 1)

VOLUME 1 Main Text, Appendices 1-5A (Part 1)

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Air Quality Assessment

West Wallsend Colliery Continued Operations Project – Air Quality Assessment

Prepared for:
Umwelt (Australia) Pty Limited

On behalf of:
West Wallsend Colliery

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Executive Summary

ENVIRON Australia Pty Ltd (ENVIRON) has been commissioned by Umwelt (Australia) Pty Limited (Umwelt) to undertake an Air Quality Assessment for the proposed West Wallsend Continued Operations Project (hereafter, "the Project").

The Project includes the continuation of existing mining West Wallsend Colliery (WWC) in the Western and Southern domains using longwall methods and existing infrastructure which includes the West Wallsend Pit Top and No. 2 and No. 3 ventilation shafts, in addition to a proposed Mining Services Facility (MSF) comprising a 20 m by 30 m compound with a sealed access road to be constructed off-site, situated off Wakefield Road in the southern part of the Project Area.

The Project will extend the mine life to 2022, with production of up to 5.5 Mtpa of Run-of-Mine (ROM) coal to be extracted. This maximum production rate is a factor of 1.8 greater than recent production rates at the existing WWC (2.8 Mtpa in 2008). Coal will continue to be trucked to the Macquarie Coal Preparation Plant (MCPP) for further processing and distribution under a separate existing approval.

The scope of the Project was restricted to the assessment of changes at the West Wallsend Pit Top site, but includes ventilation shafts which are situated further afield. Off-site haul roads and activities at the MCPP were outside of the scope of the Project and are understood to be covered by separate application and evaluation processes.

Existing air quality was characterised for the purpose of assessing the potential for cumulative air pollution levels, given predicted Project-related incremental levels. Site-specific background air quality levels determined based on measurement data are as follows.

- Dust: Annual dust deposition rates were observed to vary spatially, with rates recorded within the nearest residential areas being in the range of 0.8 to 2.7 g/m^2/month, as recorded during the 2005 to 2008 period.
- TSP: Average concentrations of the order of 30-34 µg/m^3 where recorded within the nearby residential area of Killingworth based on quarterly monitoring.
- PM_{10}: Annual average concentrations were in the range of 14-18 µg/m^3, with highest 24-hour averages varying between 30 and 82 µg/m^3, as measured within the nearby residential area of Wakesfield during the 2001 to 2008 period. Up to three exceedances of the DECCW daily PM_{10} criterion per year were observed to occur.

An assessment of the local meteorological conditions was conducted referencing automatic weather station data from the Westside Mine station which is located immediately south of the West Wallsend Pit Top boundary.

Atmospheric emissions from existing WWC operations contribute to suspended particulate concentrations and dust deposition rates measured in the area. To assess likely increases in these levels due to the Project, and the significance of such increases, it was necessary to:

- Establish WWC's current contribution to suspended particulate concentrations and dust deposition rates;

- Quantify incremental concentrations and deposition rates due to the Project, taking into account the maximum production rate increase to 5.5 Mtpa; and
- Determine whether the increment in suspended particulate concentrations and dust deposition rates is likely to increase cumulative levels sufficiently to cause non-compliance with DECCW air quality criteria.

Atmospheric dispersion modelling predictions of fugitive emissions from existing WWC operations and the Project were undertaken using the AERMOD Gaussian Plume Dispersion Model software developed by the USEPA.

These predictions indicate that, provided the general design and operational safeguards documented within this report are implemented, particulate matter and dust deposition emissions attributable to the proposed Project are anticipated to be within the current NSW DECCW air quality goals at all surrounding non-Project related residences.

Dust control measures outlined are currently being implemented as part of the existing WWC operations and are therefore considered feasible.

1 Introduction

ENVIRON Australia Pty Ltd (hereafter, "ENVIRON") has been commissioned by Umwelt (Australia) Pty Limited (hereafter, "Umwelt") to undertake an Air Quality Assessment for the West Wallsend Colliery Continued Operations Project (hereafter, "the Project"). The Project comprises progression of West Wallsend Colliery's operations in the Western and Southern domains, all of which are situated within the Newcastle Coalfield of NSW (**Figure 1**).

West Wallsend Colliery (WWC) is an existing underground colliery managed by Oceanic Coal Australia Limited (OCAL) on behalf of Macquarie Coal Joint Venture. WWC mines the Borehole and West Borehole seams using longwall mining techniques. Mining within the project is comprised of two domains, namely the Western and Southern Domains. Mining is currently being undertaken in the Western Domain in LW38 and will continue during 2009.

Based on the removal of the existing saving provision for the current mining operations a new project approval is required for all mining within CCL 725 and ML 1451 after December 2010. The proposed West Wallsend Colliery Continue Operations Project comprises the progression of existing underground mining operations from the Western to the Southern domains using longwall methods and existing infrastructure. The Project will extend the mine life to 2022, with production of up to 5.5 Mtpa of Run-of-Mine (ROM) coal to be extracted.

The majority of the coal from WWC is washed and loaded onto trains at the Macquarie Coal Preparation Plant (MCPP) and transported to Newcastle Port for export. A small percentage of coal mined from WWC is transported from MCPP to Eraring Power Station via coal haul trucks on a private coal haul road.

An air quality assessment is required as part of the project approvals process to satisfy the requirements of the Director General of the NSW Department of Planning. The assessment for the WWC Continued Operations Project covers the following aspects:

- Characterisation of the existing environment, specifically the existing air quality, prevailing meteorology and regulatory context;
- Quantification and modelling of dust emissions for the proposed project based on clear assumptions and approved methodologies;
- Presentation and evaluation of predicted total suspended particulate (TSP) and fine particulate (PM_{10}, particulate matter with an aerodynamic diameter of less than 10 microns) concentrations and dust deposition against applicable air quality criteria;
- Recommendations of possible mitigative measures as necessary, with an assessment of control efficiencies achievable; and
- Accounting for cumulative impacts associated with nearby developments.

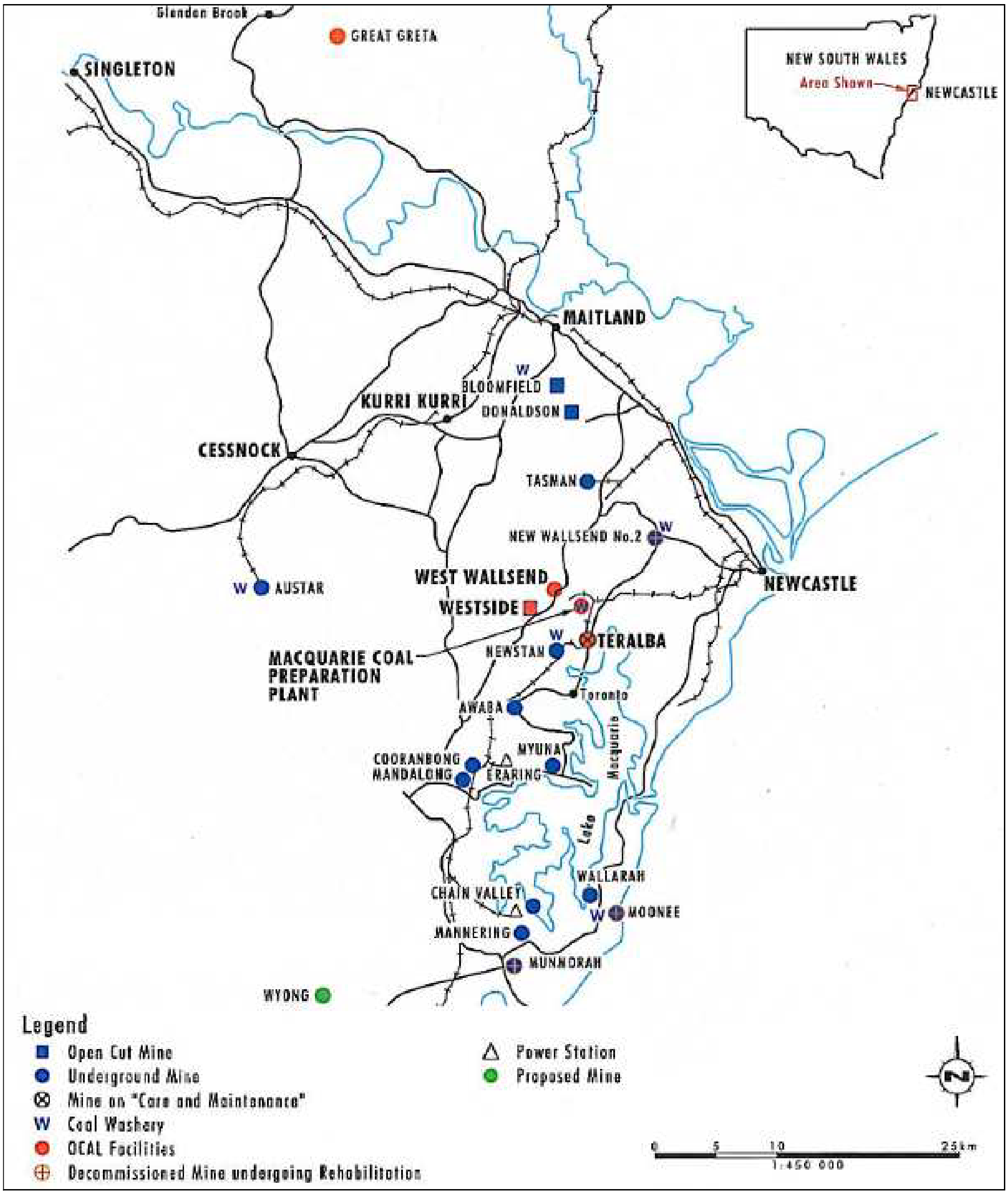

Figure 1: Location of West Wallsend Colliery within the Lower Hunter Coal Fields

Source: Umwelt (2009)

2 Project Overview

2.1 Existing Mining Operations

West Wallsend Colliery (WWC), an existing underground colliery, currently undertakes longwall mining within its Western Domain in LW38 with 2.5 Mtpa of ROM coal extracted in 2008.

Coal is currently conveyed from underground, fed to breakers for sizing and waste rock removal, and subsequently conveyed to a 200 kt silo. Trucks are bottom loaded from the silo with coal trucked off-site (i.e. outside of the West Wallsend Pit Top perimeter) to the Macquarie Coal Preparation Plant (MCPP) for transportation to Newcastle Port for export. A small percentage of coal is transported from MCPP to Eraring Power Station via coal haul trucks on a private coal haul road.

Other on-site activities include forklift and loader operations at the stores, deposition and recovery of waste rock from the waste rock bin located at the breakers, and stockpiling of coal fines recovered from under the breakers. Coal fines are slurried, vacuumed up at the breakers and stockpiled with periodic recovery by loaders and transport by trucks off-site.

2.2 Project Mining Operations

The WWC Continued Operations Project comprises the progression of existing underground mining operations from the Northern Domain to the Western and Southern domains using longwall methods and existing infrastructure in addition to a newly constructed Mining Services Facility (MSF). The Project area is depicted in **Figure 2**, with key features of the Project summarised in **Table 1**.

Table 1: Key Features of the West Wallsend Colliery Continued Operations Project

Major Project Components/Aspects	Proposed Operations
Limits on Extraction	Up to 5.5 Mtpa
Mine Life	2022
Operating Hours	24 hours per day; 7 days per week
Number of Employees	Approximately 350 Full Time Equivalents
Mining Methods	Underground Mining – longwall method
Mining Areas	Western and Southern Domains
Infrastructure	West Wallsend Pit Top Facilities No. 2 and No. 3 vent shafts Proposed Mining Services Facility (MSF)
Project Area	Approximately 1200 hectares

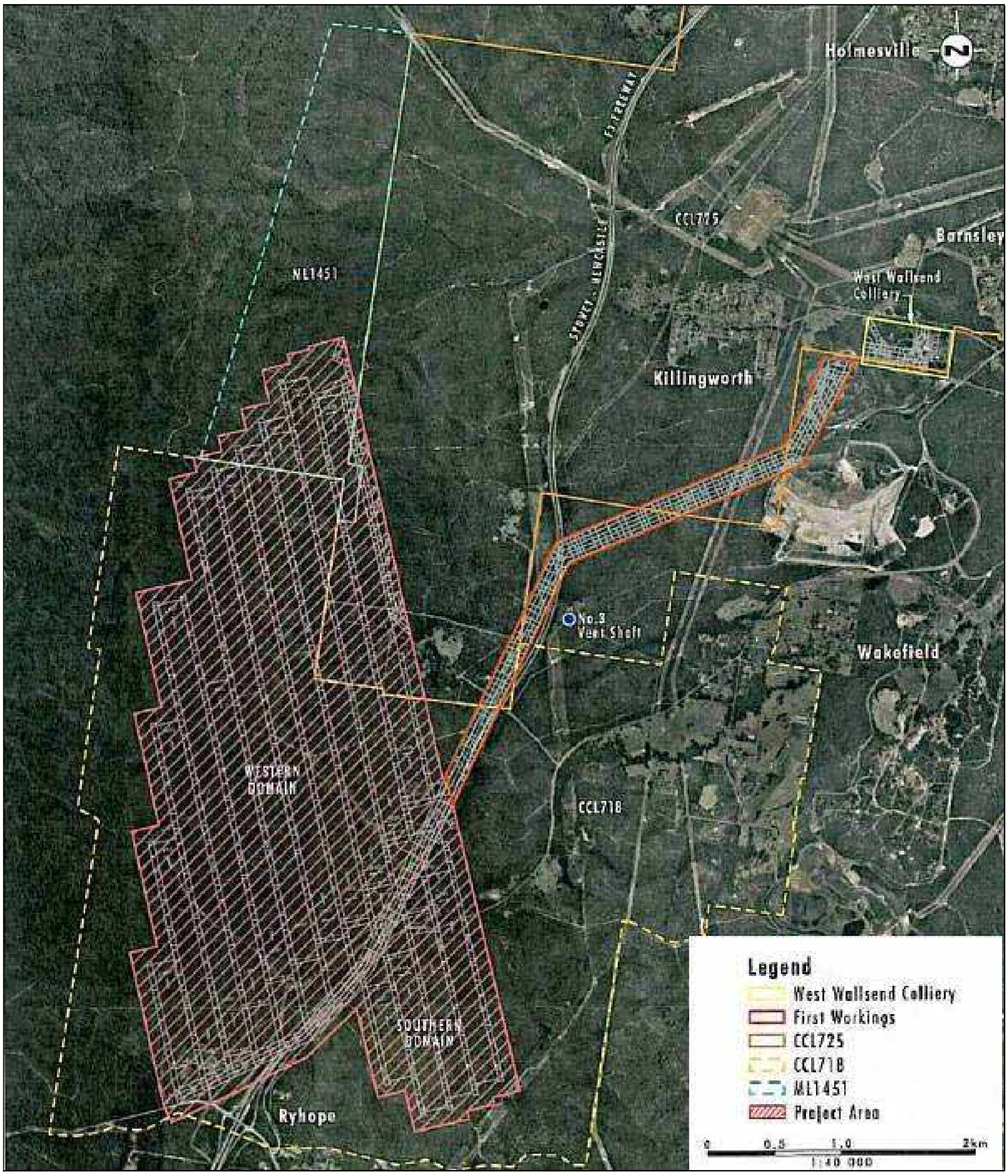

Figure 2: West Wallsend Colliery Continued Operations Project – Project Area
Source: Umwelt, 2008

The Project will extend the mine life to 2022, with production of up to 5.5 Mtpa of ROM coal to be extracted. Existing infrastructure to be used by the Project includes the West Wallsend Pit Top and the No. 2 and No. 3 ventilation shafts. The West Wallsend Pit Top area includes: conveyors, breakers, waste rock bin, coal fines stockpile area, a tripper pad for coal overflow stockpiling (when the silo is at capacity), the stores and workshops, mine and regional offices, and paved and unpaved roads. Paved roads include the main access road which is primarily used by light vehicles, and the ring road used by haul roads collecting coal from the silo. The unpaved road is used by trucks making deliveries and some light vehicles, which access the site at the western entrance.

The proposed Mining Services Facility (MSF) comprises a 20 m by 30 m compound with a sealed access road. This facility is proposed to be constructed off-site, off Wakefield Road in the southern part of the Project Area. The MSF will be used for the provision of essential mining services such as ballast and solcenic oil.

Proposed operations will progress as for current operations, despite provision being made for an expansion of production from 2.5 Mtpa to a maximum of 5.5 Mtpa ROM coal. Coal will be trucked to MCPP for further distribution as is currently conducted.

The scope of the current Project is restricted to the assessment of the existing West Wallsend Pit Top site, ventilation shafts which are situated further afield and the proposed Mining Services Facility (MSF). Off-site haul roads and activities at the MCPP are outside of the scope of the Project and are covered by separate application and evaluation processes.

2.3 Regional and Project Area Topography

The Project area is located at an altitude of approximately 30m AHD. A three-dimensional representation of the topography of the region surrounding the Project area is presented in **Figure 3**.

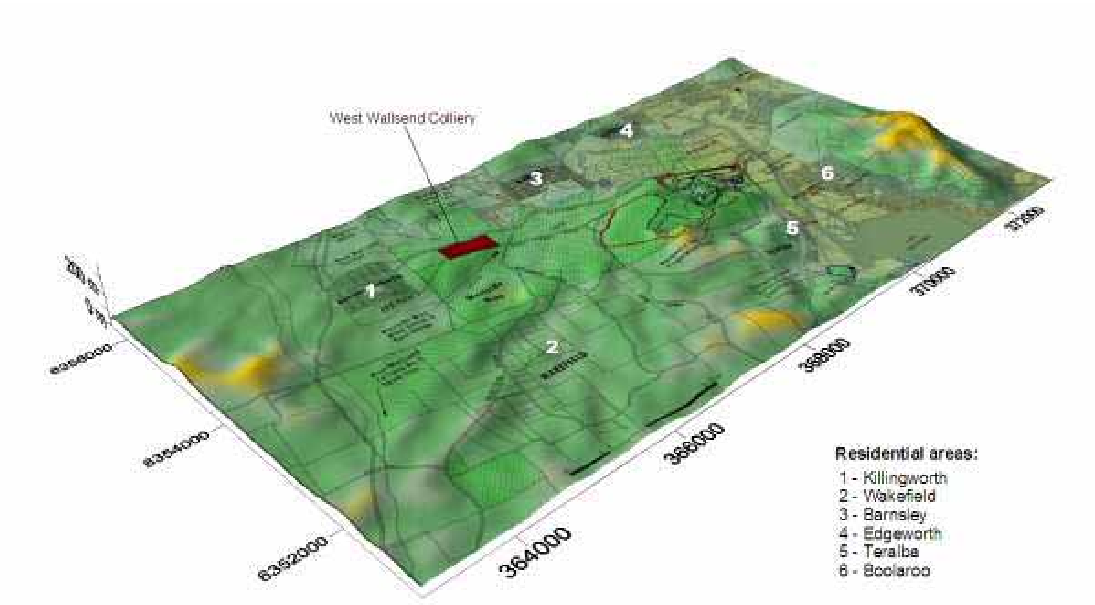

Figure 3: Regional Topography showing the West Wallsend Colliery and neighbouring Residential Areas

Although the region comprises relatively undulating terrain, due to the proximity of residential areas to the WWC, the topography between the Project and the nearest residences are classifiable as uncomplicated from an atmospheric dispersion perspective. However, to account for variability in the topography between the Project and the nearest non-project related residential receptors, topography has been incorporated within the atmospheric dispersion model (refer **Section 6**).

2.4 Nearest Residences

A representative sample of the nearest potentially affected dwellings that are non-project related are depicted in **Figure 4** and listed in **Table 2** including property identifier, dwelling locations and coordinates. Although the Westside Mine Offices have been included in the simulations as a discrete receptor due to their proximity to WWC, this site is noted to have a mining-related status.

Table 2: Nearest Potentially Affected Non-Project Related Residential Dwellings (and Nearby Westside Mine Offices)

Residence # Identifier	Distance/Direction from Project	MGA Dwelling Coordinates	
		East (m)	North (m)
Killingworth			
1	~750 m west of WWC, representing residences situated within the eastern-most extent of Killingworth	365733	6355199
2		365721	6355095
3		365699	6354984
4		365673	6354855
5		365652	6354743
6		365639	6354618
7		365622	6354523
Barnsley			
8	~500 m north-east of WWC	367322	6355187
9(a)	~550 m east-north-east of WWC	367507	6354878
Westside Mine Offices			
10	Immediately south-east of WWC	366924	6354559
Wakefield			
11	~2.53 km south-south-west of WWC	365379	6352369
12	~2.45 km south-south-west of WWC	365395	6352477
13	~2.38 km south-south-west of WWC	365409	6352544
14	~2.28 km south-south-west of WWC	365446	6352632
15	~2.15 km south-south-west of WWC	365505	6352740
16	~2.05 km south-south-west of WWC	365594	6352799
17	~1.95 km south-south-west of WWC	365866	6352821
18	~1.90 km south-south-west of WWC	365984	6352842
19	~2.05 km south-south-west of WWC	365952	6352700
20	~2.15 km south-south-west of WWC	365944	6352598
21	~2.15 km south-south-west of WWC	366132	6352579

(a) Owned by the mine and no longer occupied.

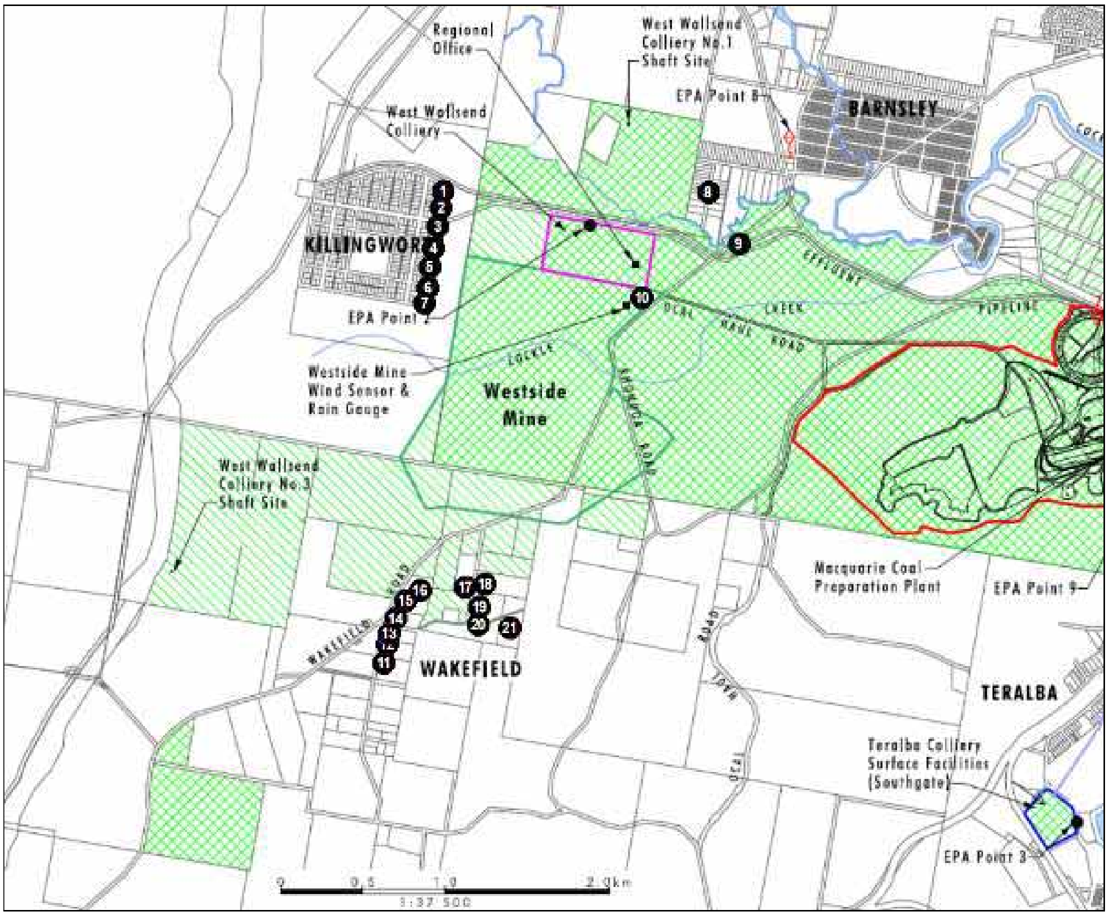

Figure 4: Location of Nearest Potentially Affected Non-Project Related Residential Dwellings and Westside Mine Offices (site 10)

3 Air Quality Goals

To be in compliance, proposed operations must demonstrate that cumulative air pollutant concentrations, taking into account incremental concentrations due to the operation's emissions and existing background concentrations, are within ambient air quality limits. Relevant ambient air quality criteria applicable to the proposed development are presented in this section.

3.1 Goals Applicable to Airborne Particulate Matter

Air quality limits for particulates are typically given for various particle size fractions, including total suspended particulates (TSP) and inhalable particulates or PM_{10} (i.e. particulates with an aerodynamic diameter of less than 10 µm). Although TSP is defined as all particulate with an aerodynamic diameter of less than 100 µm, an effective upper limit of 30 µm aerodynamic diameter is frequently assigned. PM_{10} is of concern due to its health impact potential. Such fine particles are able to be deposited in, and cause damage to, the lower airways and gas-exchanging portions of the lung. Potential adverse health impacts associated with exposure to PM_{10} include increased mortality from respiratory and cardiovascular diseases, chronic obstructive pulmonary disease, and heart disease and reduced lung capacity in asthmatic children (Pope and Dockery, 2006; WHO, 2007).

Despite the international medical community not having been able to establish a threshold value for particulate matter below which there are no adverse health impacts, air quality limits are routinely issued for this pollutant, including by federal and state governments in Australia. Air quality limits issued by federal and NSW government for particulates are given in **Table 3**.

Table 3: Impact assessment goals for airborne particulates

Pollutant	Averaging Period	Concentration (µg/m³)	Reference
TSP	annual	90	NSW DECCW(a)(b)
PM_{10}	24 hours	50	NSW DECCW(a)
	24 hours	50(d)	NEPM(c)
	annual	30	NSW DECCW(a)

(a) NSW DEC, 2005 *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*
(b) NSW DECCW impact assessment goal based on the subsequently rescinded National Health and Medical Research Council (NHMRC) recommended goal.
(c) NEPC, 2003, *National Environment Protection (Ambient Air Quality) Measure, as amended.*
(d) Provision made for up to five exceedances of the limit per year.

The NSW 24-hour PM_{10} assessment goal of 50 µg/m^3 is numerically identical to the equivalent National Environment Protection Measure (or NEPM) reporting standard except that the NEPM reporting standard allows for five exceedances per year. The NEPM goals were developed by the National Environmental Protection Council (NEPC) in 1998 to be achieved within 10 years of commencement.

Air quality goals for TSP were typically set prior to the development of an improved understanding of the relationship between health impacts and exposure to fine particulate concentrations, and have subsequently either been discarded or given reduced importance by countries internationally. The NSW DECCW TSP impact assessment goal is based on the goal recommended by the National Health and Medical Research Council (NHMRC) (DEC, 2005; NHMRC, 1996). (The NHMRC goals have subsequently been rescinded.)

In mining areas, the PM_{10} particle size fraction is typically of the order of 40% of the TSP mass (SPPC, 1986). In semi-urban and urban areas impacted by motor vehicles, such as the current Project site, this percentage may be expected to be even higher. Based on this PM_{10} to TSP ratio, the impact assessment goal for TSP would be equivalent to an annual PM_{10} goal of at least 36µg/m^3. Thus, the historical NHMRC goal may be regarded as less stringent than the DECCW PM_{10} goal of 30 µg/m^3 expressed as an annual average.

While it is anticipated therefore that the annual TSP goal will be seen to be achieved if the annual PM_{10} goal is satisfied, predictions of annual average TSP concentrations are provided within this report for completeness.

3.2 Dust Deposition Criteria

Nuisance dust deposition is regulated through the stipulation of maximum permissible dust deposition rates. The NSW DECCW impact assessment goals for dust deposition are given in **Table 4** illustrating the allowable increment in dust deposition rates above ambient (background) dust deposition rates which would be acceptable so that dust nuisance could be avoided.

Table 4: DECCW Goals for Allowable Dust Deposition

Averaging Period	Maximum Increase in Deposited Dust Level	Maximum Total Deposited Dust Level
Annual	2g/m^2/month	4g/m^2/month
Source: AMMAAP, 2005		

3.3 Project Air Quality Goals

The NSW DECCW air quality impact assessment goals applicable to the assessment of the current Project are as follows.

PM_{10}: A 24-hour maximum of 50 µg/m^3

An annual average of 30 µg/m^3

TSP: An annual average of 90 µg/m^3

Dust deposition: Nuisance expected to impact at surrounding residences when total annual average dust deposition levels exceed 4g/m^2/month.

4 Existing Air Quality Environment

The quantification of cumulative air pollution concentrations and the assessment of compliance with ambient air quality limits necessitate the characterisation of baseline air quality. Given that particulate matter represent the primary emissions from the Project, it is pertinent that existing sources and resultant ambient suspended particulate concentrations and dust deposition be considered.

4.1 Existing Local Sources of Atmospheric Emissions

Industrial and mining activities operating within 10 km of the WWC which are either National Pollutant Inventory (NPI) reporting activities or DECCW licence holders are listed in **Table 5**. Due to the proximity and nature of the Westside Mine operations, these operations hold the greatest potential for cumulative impacts on nearby receptors.

Table 5: Industrial Operations and Mines Situated in Proximity to the Project

Facility Name	Approximate Distance from Project Site	Description
West Wallsend Colliery	On-site	Black coal mining
Westside Mine	Immediately south of WWC	Open cut black coal mine
Macquarie Coal Preparation Plant	1.6 km SE (End Railway St, Teralba)	Black coal handling
Works Infrastructure Teralba	3 km SE (Rhondda Road, Teralba)	Asphalt operations
Newstan Colliery	4.5 km S of WWC	Underground coal mine and coal washery
Boral Resources	4.5 km SE of site (65 Seventh St, Boolaroo)	Concrete batching
Pasminco Cockle Creek Smelter – remediation operations	5 km east of WWC	Previous lead smelter; site currently being remediated
Incitec Pivot Cockle Creek	5.2 km ESE of WWC	Fertilizer manufacturer ceased operations Jan 2009; site remediation proposed
Inghams Cardiff Feedmill	6.8 km E (48 Nelson Road Cardiff)	Prepared animal feed manufacturing
New Wallsend No. 2 Colliery (decommissioned)	9 km NE of WWC	Decommissioned coal mine
Tasman Colliery	9 km NNE of WWC	Underground coal mine
Awaba Colliery	10 km SSW of WWC	Underground coal mine

Sources situated further afield include the Donaldson and Bloomfield open cast coal mines situated 15 km and 17 km north of the WWC respectively; the Eraring Power Station and several neighbouring underground mines located ~15 km south of WWC; and the industrial areas of Newcastle (15 km NE of WWC).

Other potential sources of atmospheric emissions in the vicinity of the Project Site include:

- Dust entrainment due to vehicle movements along unsealed roads and sealed roads with high silt loading levels;
- Vehicle exhaust and rail related emissions;
- Wind blown dust from open areas; and
- Episodic emissions from vegetation fires.

Long-range transport of fine particles and precursors are also expected to contribute to suspended particulate concentrations in the study area.

4.2 Monitoring Data Available for Baseline Air Quality Characterisation

Monitoring data sets which were made available and used in the characterisation of the existing air quality at the Project Site are given in **Table 6**. Permission was granted by the various data owners for the use of these data sets for the specific purpose of the assessment. The locations of the Westside Mine and MCPP sampling sites are illustrated in **Figure 5** and **Figure 6** respectively.

Table 6: Monitoring Data used in the Baseline Air Quality Characterisation

Data Owner / Data Set	Sampling Sites	Parameters Measured	Monitoring Duration
Westside Mine	8 Dust Deposition Monitoring sites (D5, D10, D11B, D13A, D18, D19, D20, D21)	Dust deposition (monthly)	July 2004 – Dec 2008
	High Volume Air Sampler (EPA 13), situated on eastern perimeter of Killingworth residential area	TSP (quarterly sampling)	Sept 2004 – Jun 2008
	High Volume Air Sampler No. 12, School Rd, Wakefield (EPA 18)	PM_{10} (six day schedule sampling; 24 hour averages reported)	1 July 2001 – 20 Jan 2009
MCPP	7 Dust Deposition Monitoring sites (D1, D2, D3, D4, D5, D6, D7)	Dust deposition (monthly)	Jan 2005 – Dec 2008

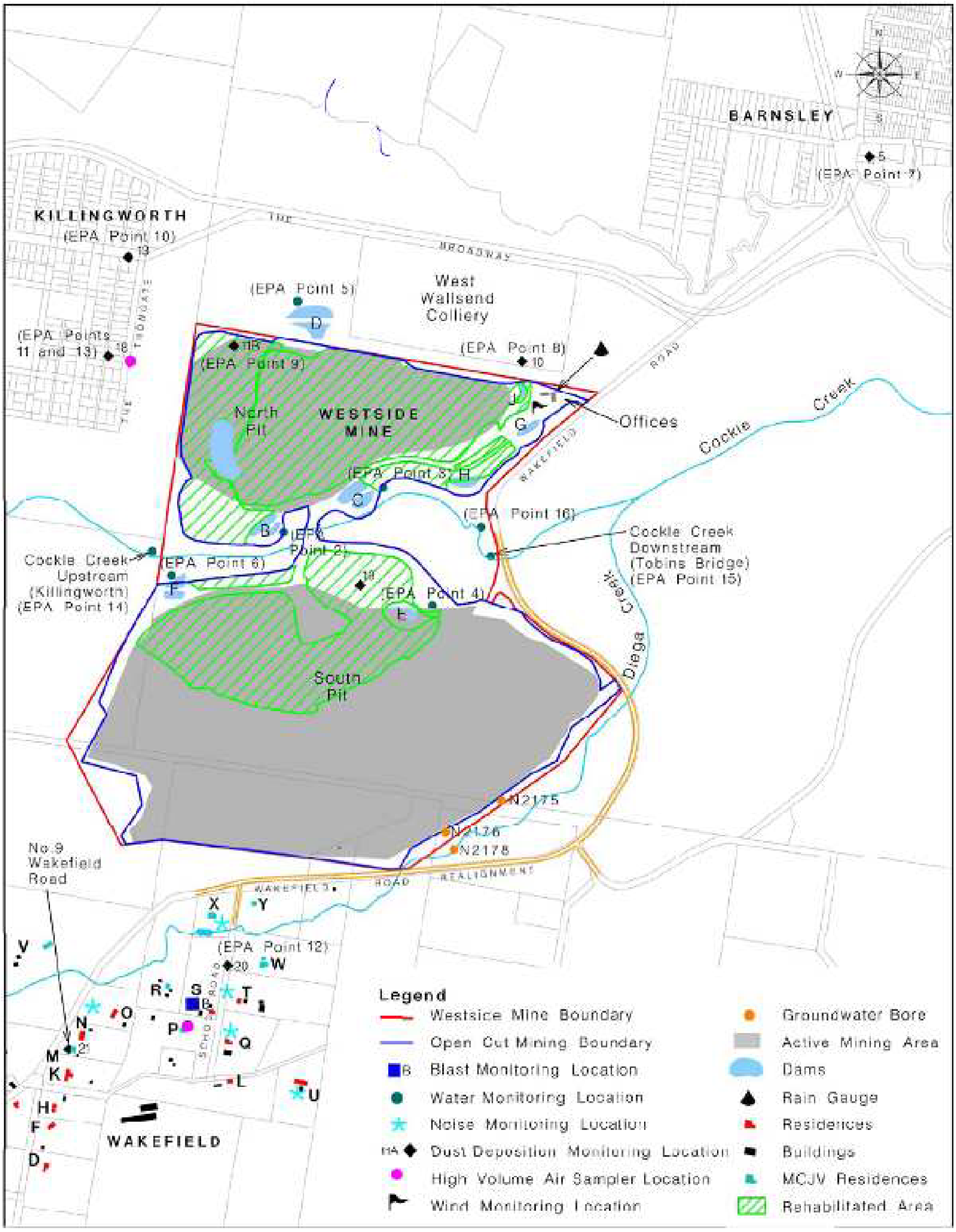

Figure 5: Locations of Westside Mine monitoring stations

Source: Umwelt (2009) (OCAL June 2007)

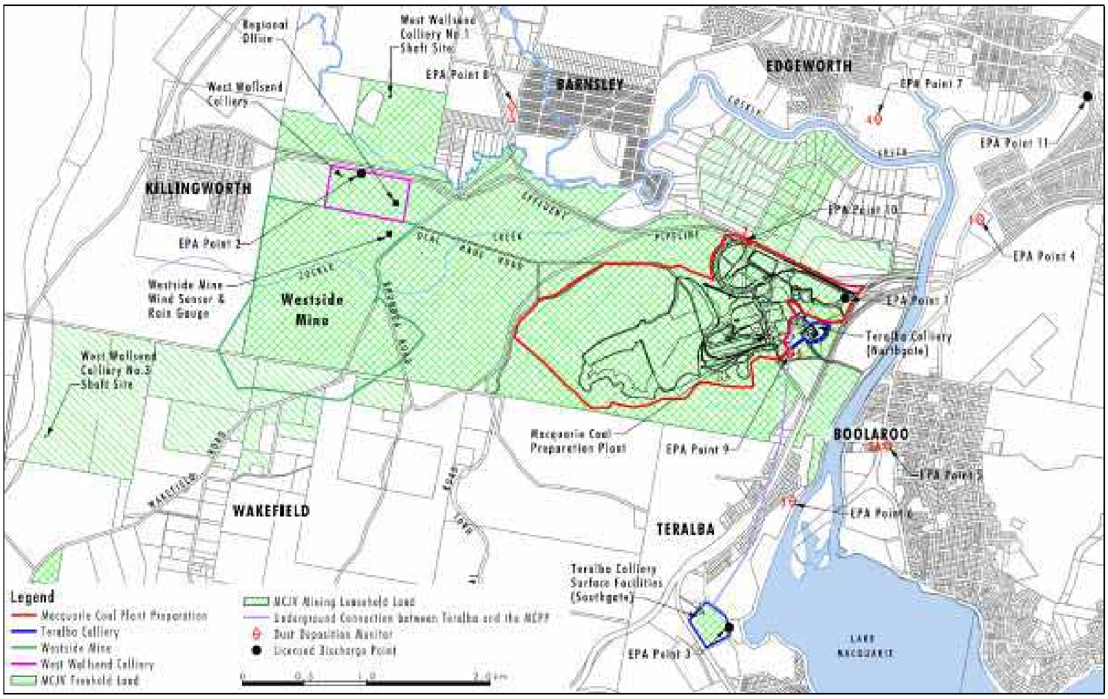

Figure 6: Locations of Macquarie Coal Preparation Plant monitoring stations

Source: Umwelt (2009)

4.3 Ambient TSP Concentrations

TSP concentrations recorded at the Westside Mine High Volume Air Sampling (HVAS) station are given **Table 7** and depicted in **Figure 7**.

TSP concentrations were measured to vary significantly with minimum and maximum concentrations of 3 µg/m³ and 87 µg/m³ recorded respectively across the 16 samples taken over the September 2004 to June 2008 period. The average concentration across samples was 31 µg/m³, representing 34% of the DECCW goal of 90 µg/m³.

Table 7: Ambient TSP concentrations measured at the Westside Mine TSP HVAS site

	2005	2006	2007	2004-2008
Number of samples	4	4	4	16
Average concentration (µg/m³)	31	30	34	31
Average as % of DECCW Goal of 90 µg/m³	35%	34%	38%	34%

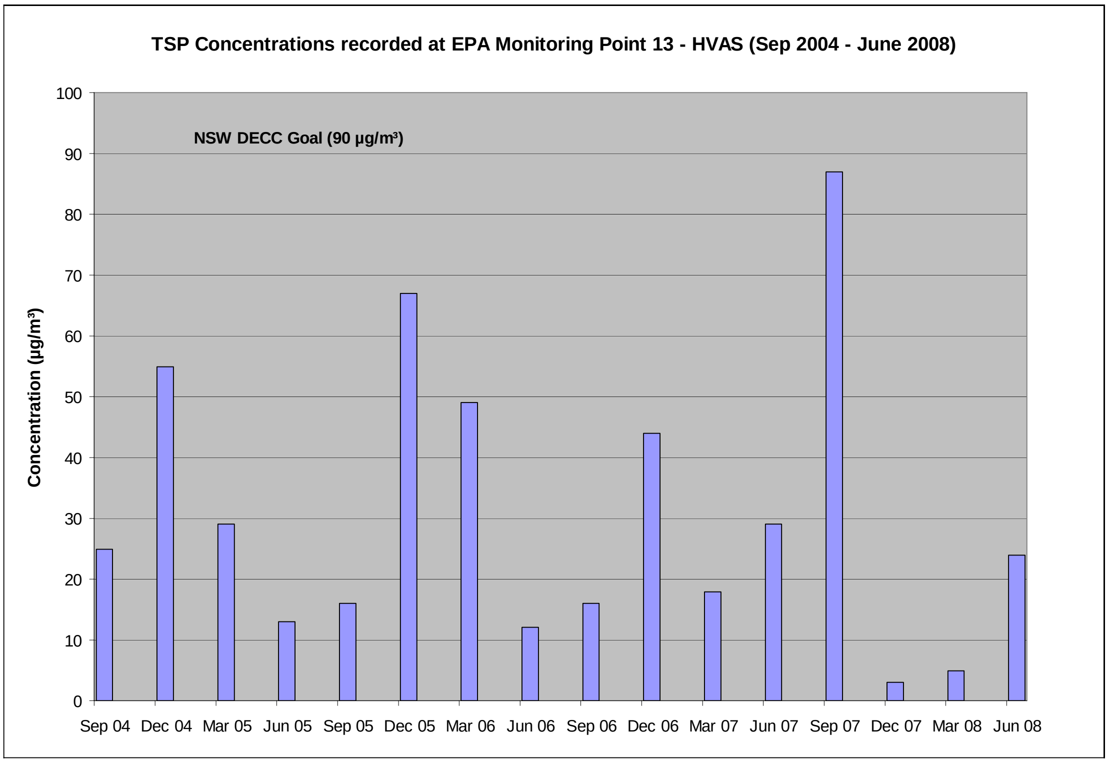

Figure 7: TSP concentrations recorded on a quarterly basis at the Westside Mine TSP HVAS site (EPA Monitoring Point 13) during the September 2004 to June 2008 period

4.4 Ambient PM_{10} Concentrations

The Westside Mine PM_{10} monitoring station is situated within the residential area of Wakefield, in close proximity (~550 m) to the southern boundary of the Westside South Pit (**Figure 5**). Mining at Westside has progressed from the northern side of the South Pit, with active mining recently underway within the southern portion of South Pit. The PM_{10} monitoring station is therefore expected to reflect the impacts of mine generated dust, with the potential for direct cumulative dust contributions to the sampling site during northerly winds when the Westside Mine and WWC is aligned upwind of the sampling station.

PM_{10} monitoring is conducted on a six day schedule. PM_{10} concentrations sampled during the 5 July 2001 to 30 January 2009 period are illustrated in **Figure 8**, with monitoring statistics given in **Figure 9** and **Table 8**.

Annual average PM_{10} concentrations were recorded to be in the range of 14 µg/m³ to 18 µg/m³, constituting 47% to 59% of the DECCW annual goal of 30 µg/m³. A long-term average PM_{10} concentration of 16 µg/m³ was recorded, comprising 53% of the DECCW goal.

Maximum 24-hour average PM_{10} concentrations in the range of 30-82 µg/m³ were recorded. Exceedances of the DECCW daily goal of 50 µg/m³ occurred during 2002 (3 days), 2007 (3 days; one of which was attributable to bushfires) and 2008 (1 day).

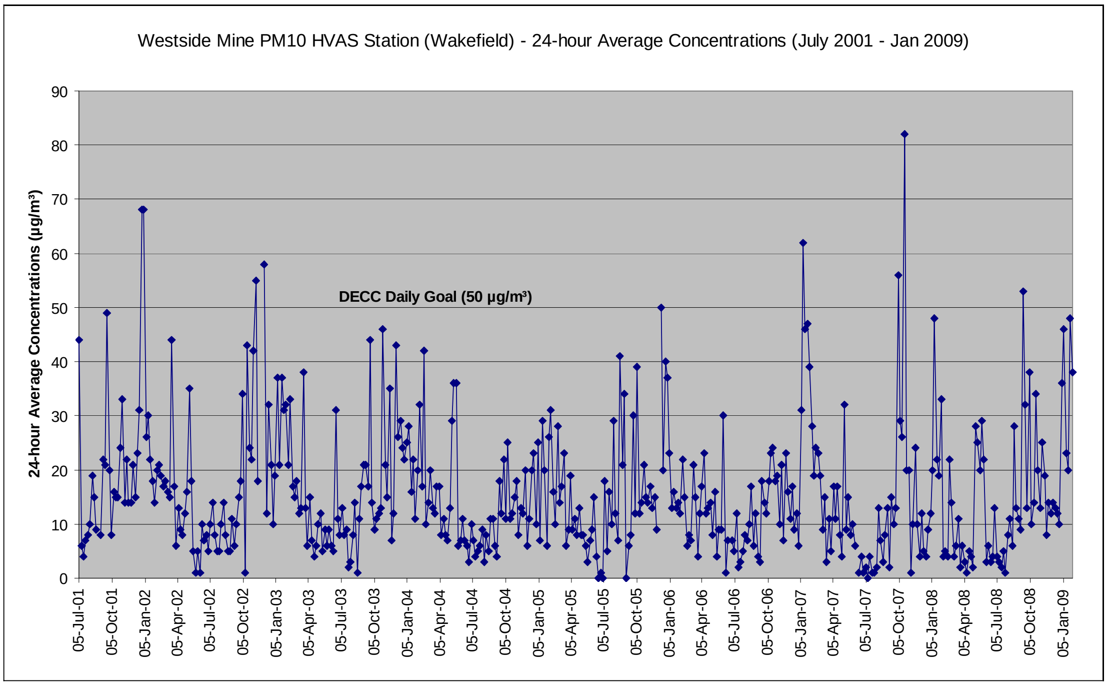

Figure 8: Daily average PM_{10} concentrations recorded at the Westside Mine HVAS Station (School Road, Wakefield) for the period 5 July 2001 to 30 Jan 2009

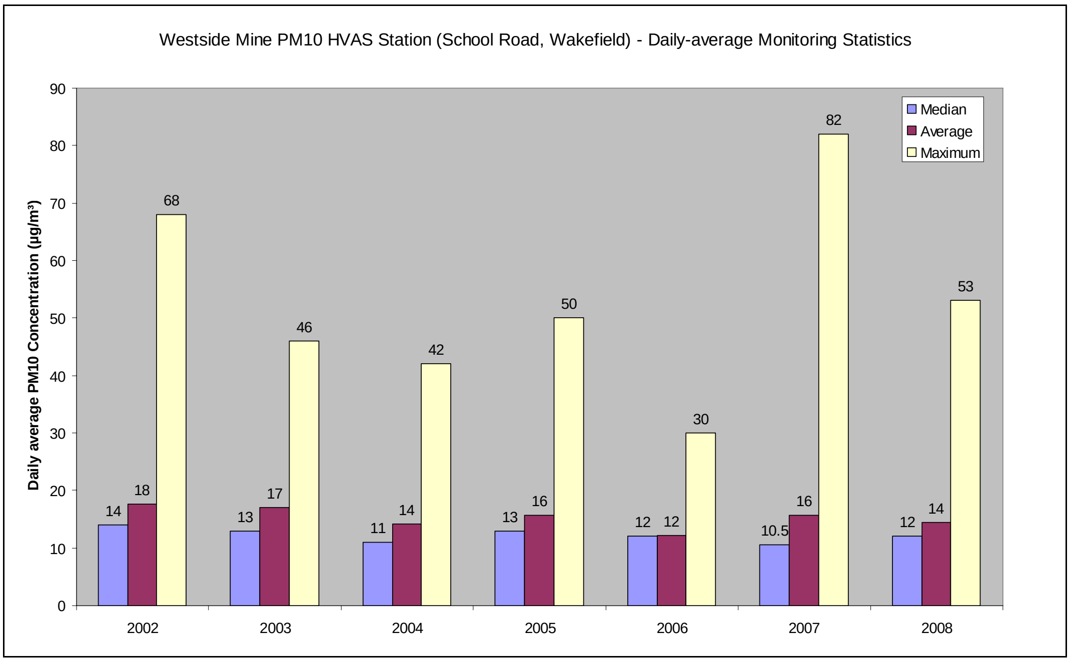

Figure 9: Ambient PM_{10} monitoring statistics for the Westside Mine HVAS Station (School Road, Wakefield) for the period 2002 to 2008

Table 8: Ambient PM_{10} concentrations measured at the Westside Mine PM_{10} HVAS site

Year	Number of Data Days	Maximum 24-hour Average (µg/m³)	No. of Record Days Exceeding DECCW Goal of 50 µg/m³	Annual Average (µg/m³)	Annual Average as Percentage of DECCW Goal of 30 µg/m³
2002	58	68	3	17.6	59%
2003	61	46	0	17.0	57%
2004	61	42	0	14.1	47%
2005	59	50	0	15.6	52%
2006	60	30	0	12.2	41%
2007	60	82	3(a)	15.7	52%
2008	62	53	1	14.4	48%
July 2001 – Jan 2009	455	82	8	15.8	53%

(a) One of these exceedances (62 µg/m³ recorded on 11 Jan 2007) was attributed to bushfires.

4.5 Dust Deposition

4.5.1 Dust Deposition recorded by Westside Mine

Dust deposition recorded at the Westside Mine Dust Deposition Monitoring stations during the 2005 to 2008 period are illustrated in **Figure 10** and **Figure 11** and documented in **Table 9**.

Annual average dust deposition rates were recorded to be in the range of 0.5 to 2.7 g/m²/month, with a spatially and temporally averaged mean dust deposition rate of 0.9 g/m²/month. Dust deposition rates are therefore noted to be well below the DECCW cumulative dust limit of 4 g/m²/month.

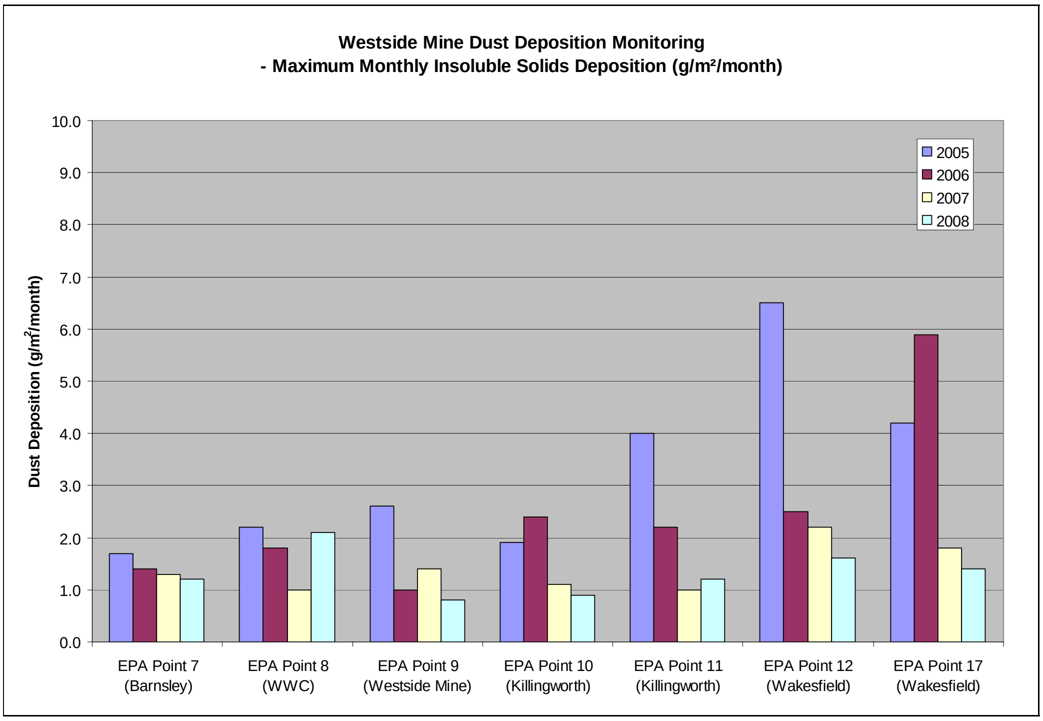

Figure 10: Maximum monthly dust deposition recorded at Westside Mine sampling sites during the 2005 to 2008 period (excludes contaminated samples)

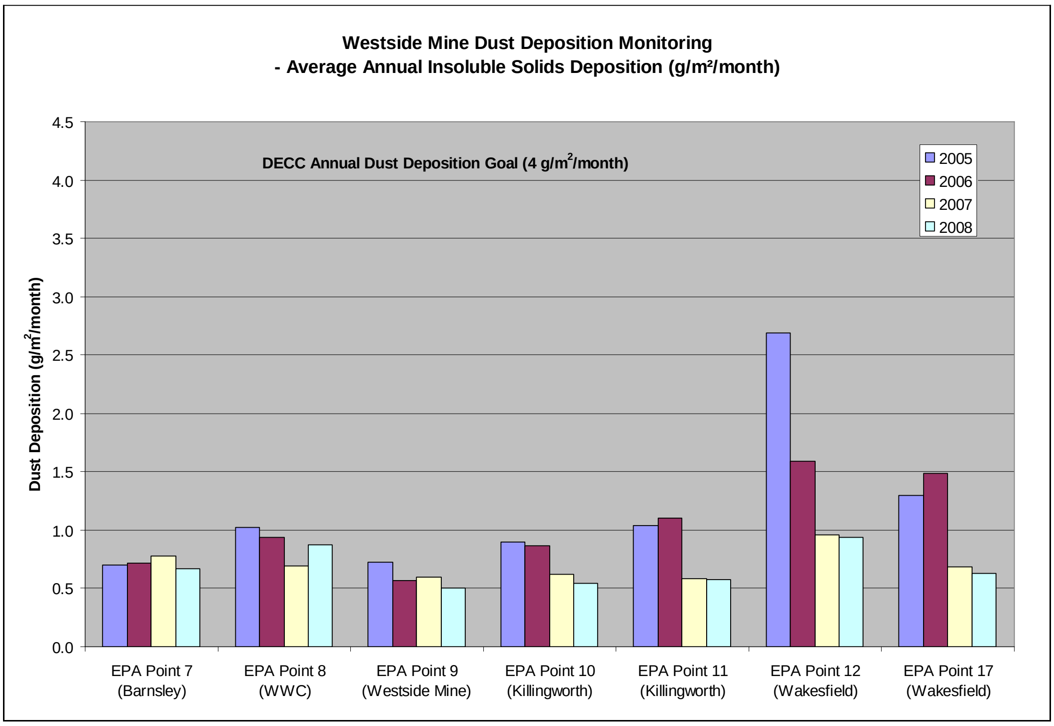

Figure 11: Annual average dust deposition recorded at Westside Mine sampling sites during the 2005 to 2008 period (excludes contaminated samples)

Table 9: Dust Deposition measured at Westside Mine Sampling Sites

	Westside No.	EPA Point	2005	2006	2007	2008	Maximum (2005-8)
Maximum Monthly Dust Deposition (g/m²/month)	D5	7	1.7	1.4	1.3	1.2	1.7
	D10	8	2.2(a)	1.8	1.0	2.1	2.2
	D11B	9	2.6	1.0	1.4	0.8	2.6
	D13A	10	1.9	2.4	1.1	0.9	2.4
	D18	11	4.0	2.2	1.0	1.2	4.0
	D20	12	6.5	2.5	2.2	1.6	6.5
	D21	17	4.2	5.9	1.8	1.4(b)	5.9
	Westside No.	**EPA Point**	**2005**	**2006**	**2007**	**2008**	**Maximum (2005-8)**
Average Annual Dust Deposition (g/m²/month)	D5	7	0.7	0.7	0.8	0.7	0.8
	D10	8	1.0(a)	0.9	0.7	0.9	1.0
	D11B	9	0.7	0.6	0.6	0.5	0.7
	D13A	10	0.9	0.9	0.6	0.5	0.9
	D18	11	1.0	1.1	0.6	0.6	1.1
	D20	12	2.7	1.6	1.0	0.9	2.7
	D21	17	1.3	1.5	0.7	0.6(b)	1.5
	Westside No.	**EPA Point**	**2005**	**2006**	**2007**	**2008**	**Total (2005-8)**
Number of Samples	D5	7	11(a)	12	11	12	46
	D10	8	12	12	12	12	48
	D11B	9	12	12	12	12	48
	D13A	10	11	12	12	12	47
	D18	11	11	12	12	12	47
	D20	12	12	11	12	12	47
	D21	17	12	10	12	11(b)	45

(a) Excludes sample (16.3 g/m²/month) noted to be contaminated with dirt and sand

(b) Excludes sample (6 g/m²/month) noted by laboratory to contain a high content of insect and plant material

The highest dust deposition rates were recorded to occur at the two Wakesfield sites (EPA Points 12 and 17), with peaks of up to 6.5 g/m²/month having been recorded and annual average dust deposition in the range of 0.6 to 2.7 g/m²/month.

Lower dust deposition was recorded to occur at the two Killingworth sites (EPA Points 10 and 11), with average dust deposition rates in the range of 0.5 to 1.1 g/m²/month and peaks of up to 4.0 g/m²/month having been recorded.

The site situated within the WWC (EPA Point 8) recorded average dust deposition rates of 0.7 to 1.0 g/m²/month and peaks of up to 2.2 g/m²/month.

The site at Barnsley (EPA Point 7) recorded the lowest dust deposition rates, with average dust deposition rates in the range 0.7 to 0.8 g/m²/month and peaks of up to 1.7 g/m²/month having been recorded.

It is notable that the highest dust deposition levels occurred during 2005 and 2006, with later years being characterised by lower dust deposition rates at most sites. This reduction in dust deposition over time is clearly evident at the Wakesfield sites, where dust deposition rates were reduced by half.

4.5.2 Dust Deposition recorded at MCPP Sampling Sites

Dust deposition recorded at the MCPP Dust Deposition Monitoring stations during the 2005 to 2008 period are illustrated in **Figure 12** and **Figure 13** and documented in **Table 10**.

In assessing measured dust deposition rates it is important to note that MCPP sites D6 and D7 (EPA Points 9 and 10) are situated at the MCPP boundary. The remaining sites D1-5 (EPA Points 4-8) are situated in proximity to residential areas.

Annual average dust deposition rates are recorded to be in the range of 0.6 and 1.3 g/m²/month at the residential dust deposition sites, and well below the DECCW cumulative dust limit of 4 g/m²/month. Peak dust deposition rates at these sites vary from 1.6 g/m²/month at D4 (EPA Point 7) situated near Edgeworth to 4.7 g/m²/month at D2A (EPA Point 5) located in Boolaroo.

Higher dust deposition rates recorded at sites D6 and D7 (EPA Points 9 and 10) are situated at the MCPP boundary, particularly at D6 which is situated immediately south of the coal preparation plant. Annual average dust deposition rates at this site range from 1.1 to 3.4 g/m²/month, with a peak monthly dust deposition rate of 18.4 g/m²/month having been recorded.

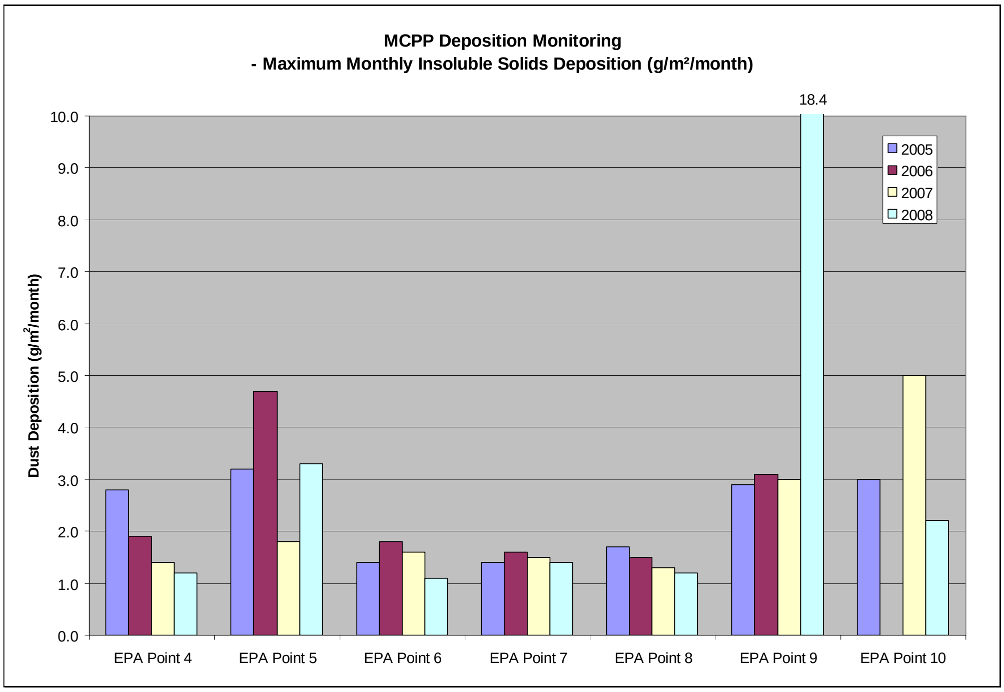

Figure 12: Maximum monthly dust deposition recorded at MCPP sampling sites during the Jan 2005 to Dec 2008 period

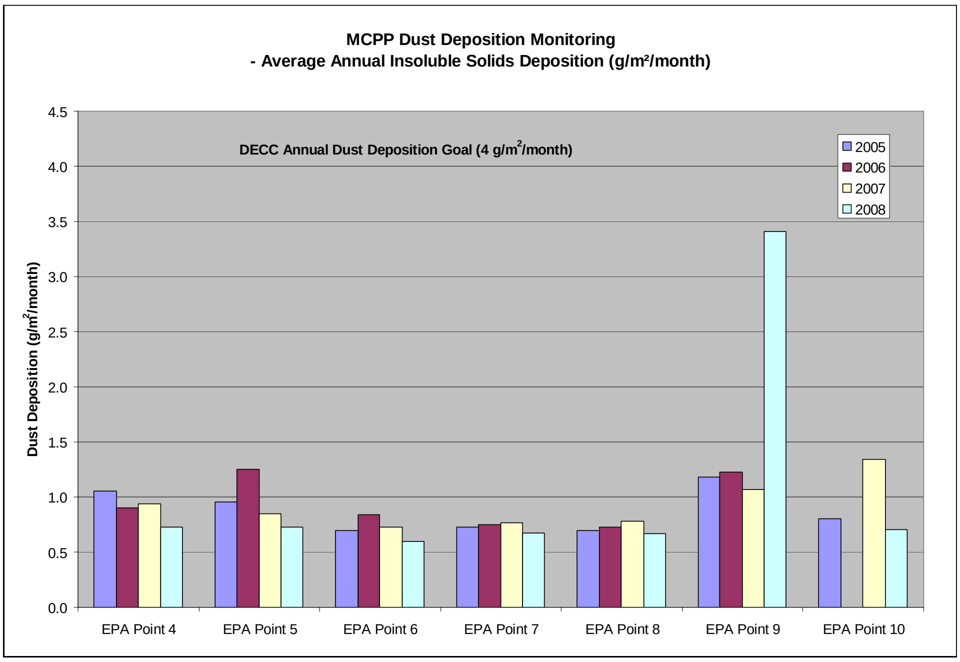

Figure 13: Annual average dust deposition recorded at MCPP sampling sites during the Jan 2005 to Dec 2008 period

Table 10: Dust Deposition measured at MCPP Sampling Sites

	MCCP No.	EPA Point	2005	2006	2007	2008	Maximum (2005-8)
Maximum Monthly Dust Deposition (g/m²/month)	D1	4	2.8	1.9	1.4	1.2	2.8
	D2	5	3.2	4.7	1.8	3.3	4.7
	D3	6	1.4	1.8	1.6	1.1	1.8
	D4	7	1.4	1.6	1.5	1.4	1.6
	D5	8	1.7	1.5	1.3	1.2	1.7
	D6	9	2.9	3.1	3.0	18.4	18.4
	D7	10	3.0		5.0(a)	2.2	5.0(a)
	MCCP No.	EPA Point	2005	2006	2007	2008	Maximum (2005-8)
Average Annual Dust Deposition (g/m²/month)	D1	4	1.1	0.9	0.9	0.7	1.1
	D2	5	1.0	1.3	0.8	0.7	1.3
	D3	6	0.7	0.8	0.7	0.6	0.8
	D4	7	0.7	0.8	0.8	0.7	0.8
	D5	8	0.7	0.7	0.8	0.7	0.8
	D6	9	1.2	1.2	1.1	3.4	3.4
	D7	10	0.8		1.3	0.7	1.3
	MCCP No.	EPA Point	2005	2006	2007	2008	Total (2005-8)
Number of Samples	D1	4	10	11	11	12	44
	D2	5	12	12	11	12	47
	D3	6	12	12	12	12	48
	D4	7	10	10	12	12	44
	D5	8	11	12	11	12	46
	D6	9	12	12	12	12	48
	D7	10	12	0	12	12	36

(a) These elevated readings are expected to be the result of a bushfire that occurred adjacent to Teralba Public school on 15 October 2007.

4.6 Background Air Quality Environment for Assessment Purposes

For the purposes of assessing the potential air quality impacts of the Project, an estimate of background air quality parameters is required. For each pollutant and averaging period, the TSP and PM_{10} concentration range expected to be characteristic of baseline conditions was determined based on the monitoring data analysed as discussed in previous sections. Background suspended particulate concentrations are given in **Table 11**.

Dust deposition varies spatially with data having been made available from a network of dust gauges to facilitate the characterisation of deposition rates. Maximum total annual dust deposition rates recorded within various residential areas and at certain mine sites during the 2005 to 2008 period are included in **Table 11** to provide a conservative estimate of existing dust deposition.

Table 11: Background dust levels for cumulative assessment purposes

Averaging Period	Ambient TSP Concentrations	Ambient PM_{10} Concentrations	Dust Deposition
Highest Daily Average	N/A	30 – 82 µg/m³	N/A
Exceedances of Daily Limit	N/A	0 – 3 days/year	N/A
Annual Average	30 – 34 µg/m³	14-18 µg/m³	Wakefield (2.7 g/m²/month) Killingworth (1.1 g/m²/month) Barnsley (0.8 g/m²/month) WWC vicinity (1.0 g/m²/month) Edgeworth (0.8 g/m²/month)
Exceedances of Annual Limit	None	None	None

Atmospheric emissions from existing WWC operations are expected to have contributed to the suspended particulate concentrations and dust deposition rates recorded. To assess likely increases in these levels due to the Project, and the significance of such increases, it is necessary to:

- establish WWC's current contribution to suspended particulate concentrations and dust deposition rates;
- quantify incremental concentrations and deposition rates due to the Project, taking into account the maximum production rate increase to 4.5 Mtpa; and
- determine whether the increment in suspended particulate concentrations and dust deposition rates increases cumulative levels sufficiently to cause non-compliance with DECCW air quality criteria.

In the case of PM_{10} concentrations, where exceedances of the DECCW daily goal has been observed to occur, it is necessary to determine whether incremental PM_{10} concentrations due to the Project results in additional exceedances. It was therefore decided to use 2007 data for cumulative assessment purposes given the number of exceedances occurring during this year and the availability of complete meteorological data for the period.

5 Climate and Dispersion Meteorology

Meteorological mechanisms govern the dispersion, transformation and eventual removal of pollutants from the atmosphere. The extent to which pollution will accumulate or disperse in the atmosphere is dependent on the degree of thermal and mechanical turbulence within the earth's boundary layer. Dispersion comprises vertical and horizontal components of motion. The stability of the atmosphere and the depth of the surface-mixing layer define the vertical component. The horizontal dispersion of pollution in the boundary layer is primarily a function of the wind field. The wind speed determines both the distance of downwind transport and the rate of dilution as a result of plume 'stretching'. The generation of mechanical turbulence is similarly a function of the wind speed, in combination with the surface roughness. The wind direction, and the variability in wind direction, determines the general path pollutants will follow, and the extent of crosswind spreading. Pollution concentration levels therefore fluctuate in response to changes in atmospheric stability, concurrent variations in the mixing depth, and shifts in the wind field (Oke, 2003; Sturman and Tapper, 2006).

Spatial variations and diurnal and seasonal changes in the wind field and stability regime are functions of atmospheric processes operating at various temporal and spatial scales. Atmospheric processes at macro- and meso-scales need therefore be taken into account to accurately parameterise the atmospheric dispersion potential of a particular area.

A qualitative description of the synoptic systems determining the macro-ventilation potential of the region is provided in **Section 5.1** based on a review of pertinent literature. An overview of the meso-scale meteorology of the study region is presented in **Section 5.2**. Climate statistics obtained from the Bureau of Meteorology's long-term weather station at Newcastle Nobbys Signal Station (Station number 061055), and hourly meteorological data obtained from the Westside Mine automatic weather station were used to characterise the climate and dispersion meteorology of the study area. The weather station, located in the vicinity of the Westside Mine offices just south of the WWC Pit Top, is indicated in **Figure 5**.

In the selection of data from the Westside Mine weather station for use in the study, reference was made to 2007 given that the highest PM_{10} concentrations were recorded in this year and that the meteorological data collected during 2007 was found to be most complete. Meteorological data availability for the 2007 period is as follows: wind speed and direction (92%), temperature (80%), sigma theta (92%) and solar radiation (85%). These data were further supplemented by meteorological modelling to provide a complete data set for dispersion modelling purposes.

5.1 Climate Statistics

Climate statistics from the Bureau of Meteorology's Newcastle Nobbys Signal Station (Station number 061055) for the period 1862 to 2008 are presented in **Appendix A**.

5.2 Ambient Temperature

Air temperature is important, both for determining the effect of plume buoyancy and determining the development of the mixing and inversion layers. The study area is characterised by a warm climate, with mean daily temperatures in the range of 14℃ to 22℃ based on the long-term record. Peaks occur during summer months with the highest temperatures typically being recorded in January to February. The lowest temperatures are usually experienced during July.

5.3 Rainfall and Evaporation

Precipitation is important to air pollution studies since it represents an effective removal mechanism of atmospheric pollutants. Annual rainfall ranges from approximately 600 mm to 1900 mm, and is on average about 1140 mm. Although significant inter-annual variations in rainfall occur, intra-annual variations are small with rainfall occurring during all months of the year. The highest rainfall typically occurs during the February to June period (>100 mm/month). On average 132 rain days occur per year, ranging from about 10 during September to 12 in March.

Evaporation is a function of ambient temperature, wind and the saturation deficit of the air. On average the region experiences a moderate water deficit with evaporation (1200 mm/year to 1400 mm/year) marginally exceeding rainfall. This moisture deficit may be more significant during drier, hotter years. This would need to be accounted for in the dust controls to be implemented for the proposed project which involve wet suppression of fugitive dust sources.

5.4 Prevailing Wind Regime

Due to significant spatial variations in wind field, emphasis is placed on site-specific meteorological data in terms of characterising the local wind regime. At least one year of wind data is required to adequately characterise seasonal fluctuations in the wind field for analysis and dispersion modelling purposes.

The annual average wind rose generated for 2007 based on data from the Westside Mine automatic weather station is depicted in **Figure 14**. Seasonal and diurnal wind roses generated based on the Westside Mine 2007 dataset are given in **Appendix 2**.

Airflow is dominated by southerly-component winds, with wind from the SSW to SE sector being most prevalent. Wind from the W to NW sector is also evident with the highest incidence of airflow being from the WNW. Wind from the W to NW sector is characterised by stronger winds compared to southerly airflows. Wind speeds are typically in the <0.5 m/s to 3 m/s range, with a mean annual wind speed of 1.4 m/s and calm conditions occurring 19.8% of the time.

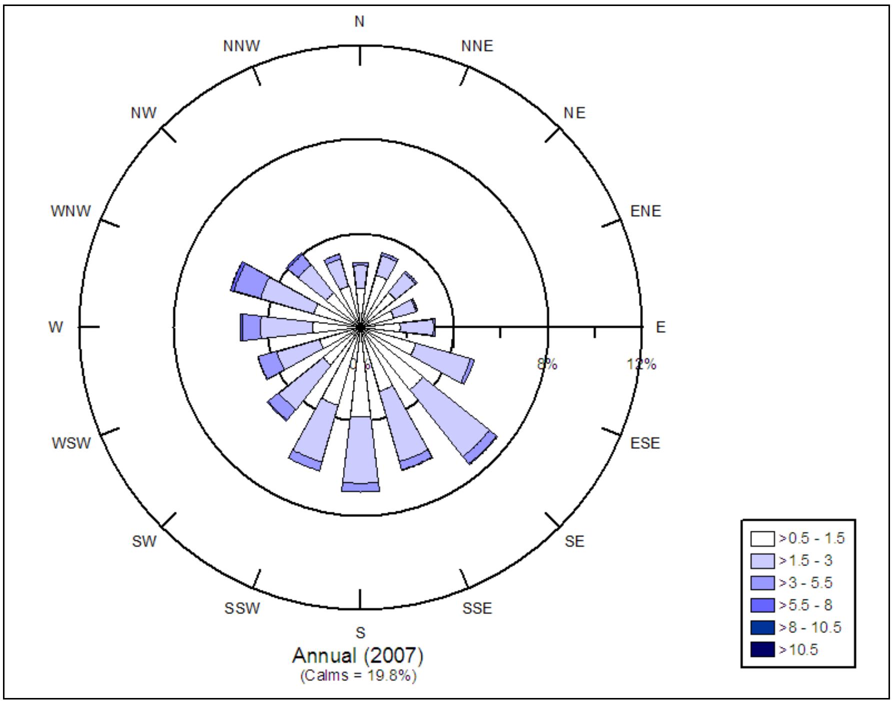

Figure 14: Annual wind rose for 2007 based on data from the Westside Mine Station

Distinct seasonal shifts in the wind field are evident. During Summer southerly-component airflow prevails, with a lower incidence of ENE and W winds. Wind from the SW quadrant and ENE winds are generally characterised by higher wind speeds compared to SE airflow. Calm wind conditions occur for 16% of the time.

During Autumn the incidence of calms increases significantly (28.9%) with SE wind being most prevalent. As during other times of the year, westerly-component airflow is associated with higher wind speeds compared to easterly-component winds.

In Winter there is a significant increase in WNW, W and NW winds, and a moderate increase in the incidence of airflow from the SW to S sector. Airflow from the NE quadrant is largely absent. Wind speeds are higher than for autumn, with calm conditions occur 16.5% of the time during Winter. Wind patterns occurring during Spring are very similar to those prevailing in winter, with WNW, W and NW wind and airflow from the SW to S sector persisting and calms occurring 17.1% of the time.

No significant diurnal shift in airflow was noted to occur, with daytime and night-time airflow patterns being similar and only a moderate increase in the incidence of SE wind was apparent during the daytime. This indicates that thermo-topographic flows are not prevalent at the site. Daytime wind speeds were on average higher (1.6 m/s) than nocturnal wind speeds (1.1%), with a lower incidence of calm periods (13.2%) compared to the night-time (26.3%).

5.5 Atmospheric Stability

The atmospheric boundary layer constitutes the first few hundred metres of the atmosphere. This layer is directly affected by the earth's surface, either through the retardation of flow due to the frictional drag of the earth's surface, or as result of the heat and moisture exchanges that take place at the surface (Stull, 1997; Oke, 2003). During the daytime, the atmospheric boundary layer is characterised by thermal turbulence due to the heating of the earth's surface and the extension of the mixing layer to the lowest elevated subsidence inversion. Elevated inversions may occur for a variety of reasons including anticyclonic subsidence, land-sea breeze interfaces and the passage of frontal systems.

Radiative flux divergence during the night usually results in the establishment of ground-based inversions and the erosion of the mixing layer. Nighttimes are characterised by weak vertical mixing and the predominance of a stable layer. These conditions are normally associated with low wind speeds, hence less dilution potential. The mixed layer thus ranges in depth from a few metres (i.e. stable or neutral layers) during nighttimes to the base of the lowest-level elevated subsidence inversion during unstable, daytime conditions.

Atmospheric stability refers to the tendency of the atmosphere to resist or enhance vertical motion. The Pasquill-Turner assignment scheme identifies six Stability Classes, "A" to "F", to categorise the degree of atmospheric stability (**Table 12**).

Table 12: Description of Atmospheric Stability Classes

Atmospheric Stability Class	Category	Description
A	Very unstable	Low wind, clear skies, hot daytime conditions
B	Unstable	Clear skies, daytime conditions
C	Moderately unstable	Moderate wind, slightly overcast daytime conditions
D	Neutral	High winds or cloudy days and nights
E	Stable	Moderate wind, slightly overcast night-time conditions
F	Very stable	Low winds, clear skies, cold night-time conditions

The frequency of occurrence of the various stability classes was modelled using the CSIRO TAPM model for the year 2007 to give an indication of the prevailing stability regime of the study area (**Figure 15**). The prevalent atmospheric stability regimes occurring for different wind directions are illustrated by wind quadrant in **Figure 16**.

Figure 15 - Frequency of Occurrence of Atmospheric Stability Classes

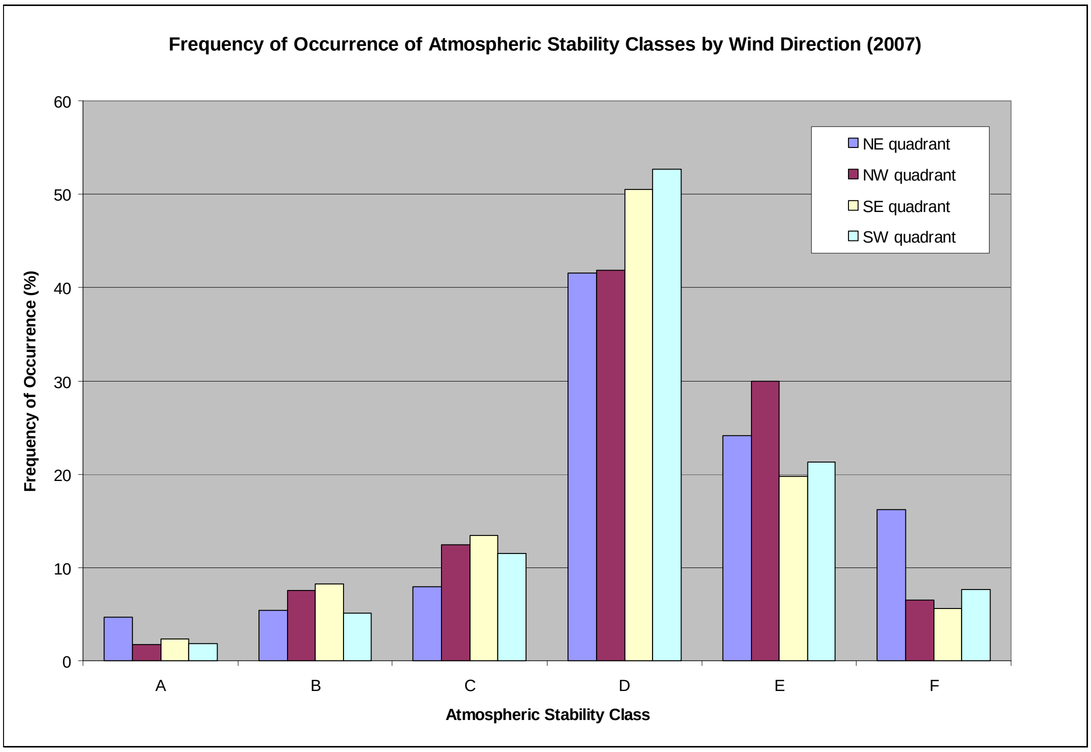

Figure 16 - Occurrence of Atmospheric Stability Classes by Wind Direction

Neutral conditions were predicted to prevail within the study area (46%), with stable and very stable conditions projected to occur 22% of the time and unstable conditions 32% of the time. Neutral conditions prevail coincident with airflows from all quadrants, with southerly-component airflow being associated with a higher incidence of neutral conditions (~50%) when compared to northerly-component airflows (~40%). A distinct increase in the frequency of stable conditions coincides with the NE quadrant airflow, and to a lesser extent NW airflow. .

5.5.1 Mixing Depth

Average annual diurnal variations in mixing depths for the study area during 2007 are illustrated in **Figure 17**. An increase in the mixing depth during the morning arising due to the onset of vertical mixing following sunrise is apparent with maximum mixing heights occurring in the mid to late afternoon due to the dissipation of ground-based temperature inversions and the growth of convective mixing layer.

Low mixing depths were projected to prevail at the Project area, with depths of <500m forecast to occur 79% of the time. Mixing depths of greater than 500 m were predicted to be primarily confined to afternoon hours.

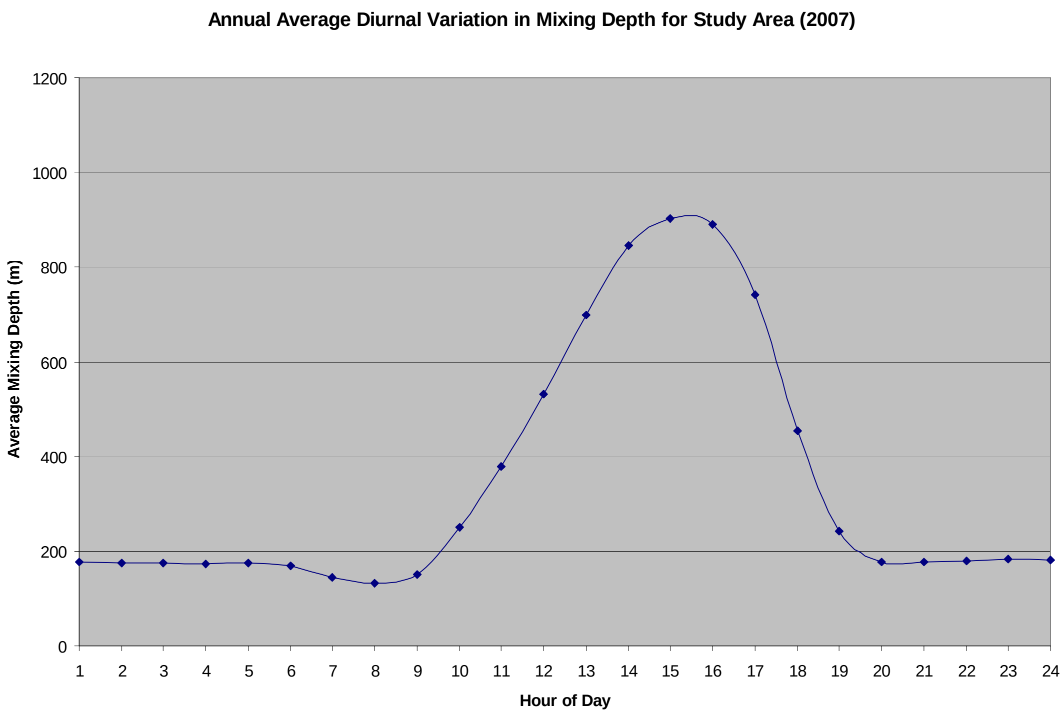

Figure 17: Average Annual Diurnal variation in TAPM-projected Mixing Depth (2007)

6 Emission Estimation

The estimation of incremental emissions and associated impacts due to the Project necessitates the quantification of emissions from both existing and proposed WWC operations.

The Project comprises the continuation of existing surface operations at the WWC in addition to the construction of a small (20 m by 30 m) Mining Services Facility (MSF), but makes provision for a maximum production rate of 5.5 Mtpa ROM coal. This maximum production rate is significantly higher than the 2.5 Mtpa reported to have been produced during 2008.

The approach adopted was to compile an emissions inventory for existing WWC operations which could be used to simulate the contribution of WWC to ambient suspended particulates and dust deposition rates. The emissions inventory compiled for existing WWC operations was then appropriately scaled to reflect the increased ROM coal throughput.

6.1 Quantification of Existing WWC Emissions

The WWC operates 24 hours per day over a 7 day week. Coal is conveyed from underground, fed to breakers for sizing and waste rock removal, and subsequently conveyed to a 200 kt silo. Trucks are bottom loaded from the silo with coal trucked off-site (i.e. outside of the West Wallsend Pit Top perimeter) to the Macquarie Coal Preparation Plant (MCPP) for further processing and distribution.

Other on-site activities include forklift and loader operations at the stores, deposition and recover of waste rock from the waste rock bin located at the breakers, and stockpiling of coal fines recovered from under the breakers. Coal fines are slurried, vacuumed up at the breakers and stockpiled with periodic recovery by loaders and transport by trucks off-site.

Potential sources of atmospheric emission associated with WWC's existing operations, identified based on information received from Umwelt and observations made during a site visit undertaken on 17 March 2009, were as follows:

- Coal handling operations - including coal transfer to and from the breakers; coal tipping and recovery from the tripper pad (overflow) stockpile; and coal loading from the silo to trucks;
- Coal crushing operations;
- Haul truck entrainment of road silt while in transit along the paved ring road;
- Entrainment of dust from the unpaved road sections by delivery trucks and light vehicles;
- Waste rock handling;
- Wind blown dust from the coal stockpile and coal fines stockpiles;
- Ventilation shaft emissions (vent shaft nos. 2 and 3);

- Intermittent loading of coal fines;
- Front end loader and forklift activity within the unpaved stores area; and
- Vehicle exhaust releases.

Vehicle exhaust emissions were considered a minor source due to the limited on-site traffic movements and were therefore not quantified. Instead the assessment focused on the quantification of fugitive dust emissions.

The access road to the MSF will be sealed and will typically operate with 2-3 light vehicle movements per day and 2-4 large vehicle movements each week. Due to the small footprint of the facility (20 m by 30 m), the access road being sealed and subject to limited vehicle activity, dust emissions due to the construction and operation of the facility are considered negligible.

Dust control measures currently being implemented at the site include:

- the use of manually-operated water sprays for unpaved areas and for the paved ring haul road;
- periodic (two weekly) sweeping of the haul road and other paved areas including the car park area to reduce road surface silt loadings; and
- use of ‘loading flaps’ during truck loading at the silo to restrict dust.

Haul truck drivers are tasked with the operation of the loading flaps and have the option of switching on the ring road sprayers as needed.

Fugitive dust sources were quantified through the application of Australian National Pollutant Inventory (NPI) emission estimation techniques and United States Environmental Protection Agency (US-EPA) AP-42 predictive emission factor equations. Particulate releases were quantified for various particle size fractions, with the Total Suspended Particulate (TSP) fraction being estimated and simulated to provide an indication of nuisance dust deposition rates. Fine particulates (PM_{10}) were estimated and resultant concentrations simulated for the purpose of assessing compliance with air quality criteria which are protective of human health.

Emissions estimates for current WWC operations, taking account of the above documented dust mitigation measures, are presented in **Table 13**. Information on the emission factors applied in the quantification of sources and the inputs used in predictive emission factor equations are also provided.

In estimating particulate emissions from the ventilation shafts reference was made to measured PM_{10} emissions undertaken previously by EML Air (2005) for the ventilation shaft of an operational underground coal mine with an annual production of 5.2 Mtpa. Given that the maximum proposed (5.5 Mtpa) production rates at WWC are a similar order of magnitude, it is expected that the use of the EML (2005) data will provide a reasonable estimate.

EML Air (2005) measured the PM_{10} concentrations within the vent to be 1.6 mg/m³. This vent concentration was multiplied by the volumetric flows for WWC's number 2 and 3 vent shafts to determine the PM_{10} emission rate, as given in **Table 13**. Vent parameters inventoried to permit the modelling of vent shafts as point sources are given in **Table 14**.

Table 13: Estimated emissions for existing WWC operations

Source	TSP tpa	PM_{10} tpa	Emission Factor Applied	Calculation Inputs
Paved roads	20.78	3.98	US-EPA AP-42 Paved Roads (Section 13.2.1) (November 2006)	Silt loading of 2.4 g/m² assumed based on site observations and generic loadings for similar operations with controls (sweeping) in place. Vehicle kilometres travelled (VKT) estimated to be approximately 39.5 per day, given the 2.5 Mtpa to be hauled, the 52 t payload and the on-site ring road length of 300 m. The mean vehicle weight was calculated to be 42.5 tonnes (accounting for full, 68.5 t, and empty, 16.5 t, vehicle weights).
Unpaved roads	6.36	1.61	US-EPA AP-42 Unpaved Roads (Section 13.2.2) (November 2006)	The silt content of the road surface material was assumed to be 8.5%, given by the US-EPA as being characteristic of haul roads within quarry operations. The mean vehicle weight was taken to be 20 tonnes (accounting for full and empty trips). Vehicle kilometres travelled (VKT) estimated to be approximately 15 per day, given 2-3 delivery trucks per hour (daytime) and assuming an unpaved road section of ~250 m. The dust control efficiency due to watering was assumed to be 60%.
Materials handling	3.90	1.71	NPI EETM for Mining Version 2.3, Dec 2001	Default emission factors for coal loading (trucks and transfer points) were used. Volumes handled were taken to be 2.5 Mtpa ROM coal, of which 62.15 ktpa were noted to be stockpiled with the remainder going to the silo. Approximately 2 ktpa of waste rock was estimated to be handled (weekly removal of ~40 t).
Coal Crushing	5.00	2.00	NPI EETM for Mining Version 2.3, Dec 2001	Emission factor corresponding to High Moisture Ores (>4%) selected for coal crushing, due to the coal moisture content (5.8%). An 80% control efficiency was assumed due to the use of water sprays and the enclosure of processes.
Front End Loader operations	0.12	0.05	NPI EETM for Mining Version 2.3, Dec 2001	Loaders at the tripper pad stockpile are recorded to have operated 337 hours during 2008. The loader operating in the stores area was conservatively assumed to operate 12 hours/day throughout the year.
Stockpile Wind Erosion	0.95	0.48	Wind dependant emission rates applied consistent with US-EPA AP-42 Industrial Wind Erosion (Section 13.2.5 (2006)	The area of the coal stockpile was estimated to be 700 m² based on its dimensions. The coal fines stockpile area was estimated to be 2,500 m² in extent. Emissions were estimated for every hour of the year using as input the 2007 wind data from the Westside Mine automatic weather station. The threshold wind velocity was conservatively taken to be 5.4 m/s.

Table 13: Estimated emissions for existing WWC operations				
Source	**TSP**	**PM_{10}**	**Emission Factor Applied**	**Calculation Inputs**
	tpa	**tpa**		
Vent Shaft Emissions	0.004	0.002	Ventilation shaft measurements for underground coal mine producing 5.2 Mtpa (EML Air, 2005)	EML (2005) measured the PM_{10} concentrations within the vent to be 1.6 mg/m³. This vent concentration was multiplied by the volumetric flows for WWC's number 2 and 3 vent shafts to determine the PM_{10} emission rate. Volumetric flows were given as 120-130 m³/hour for no. 3 shaft (services southern and western domains) and 30 m³/hour (services the northern domain).
TOTAL	**37.10**	**9.83**		

Table 14: Ventilation shaft parameters and estimated emission rates							
Vent Shaft	**Vent Opening Height**	**Vent Opening Width**	**Estimated Equivalent Stack Diameter**	**Gas Exit Velocity**	**Gas Exit Temperature**	**TSP Emission Rate**	**PM_{10} Emission Rate**
	m	**M**	**m**	**m/s**	**K**	**g/s**	**g/s**
Vent Shaft 3 a	4.01	3.93	4.5	4.1	293	5.8E-05	2.9E-05
Vent Shaft 3 b	4.01	3.93	4.5	4.1	293	5.8E-05	2.9E-05
Vent Shaft 2	3.77	3.8	4.3	2.1	293	2.7E-05	1.3E-05

Total emissions from existing WWC operations are estimated to be ~37 tpa for TSP and ~10 tpa for PM_{10}. Estimated source contributions to total emissions are illustrated in **Figure 18**. Despite the low surface silt loading assumed due to the periodic use of road sweeping and water sprays, vehicle entrainment from the paved haul ring road is estimated to be the largest fugitive dust source. This is due to the high volume of truck traffic on this road. Vehicle entrainment from unpaved roads, coal crushing and handling also contribute significantly to total emissions. The contribution of coal crushing and handling is greater for PM_{10}, compared to TSP, due to the projected particle size distribution of the releases.

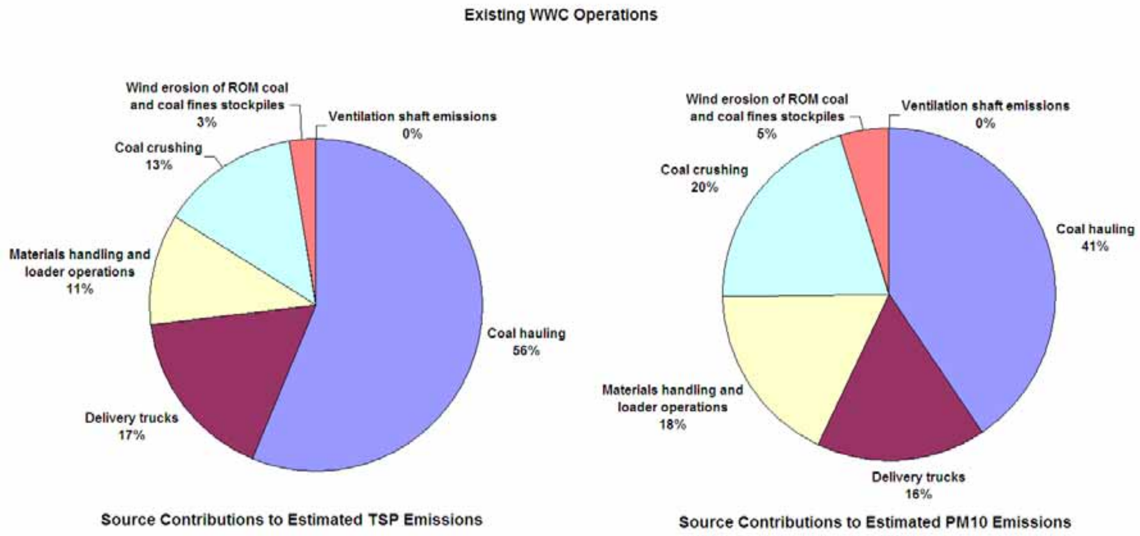

Figure 18: Source contributions to estimated emissions from existing WWC operations

6.2 Quantification of Project-related Emissions

Emission estimates for existing WWC operations were scaled to reflect the increased ROM coal throughput as documented in **Table 15**. The nature of site operations are assumed to remain largely unchanged from existing operations, with only the rates of activities estimated to increase in line with the increased production rate.

Total emissions from Project-related WWC operations are estimated to be 72.7 tpa for TSP and 19.1 tpa for PM_{10}. Whereas the increase in production from 2.5 Mtpa to 5.5 Mtpa represents a factor of 2.2 increase in production rates, site PM_{10} emissions are estimated to increase by a factor of 1.9.

Estimated source contributions to total emissions are illustrated in **Figure 19**. The contribution of vehicle entrainment from the paved haul road and fugitive emissions from coal handling and crushing operations to total site emissions are projected to increase for Project-related future WWC operations. This is to be expected given that other site operations, such as delivery truck activity along unpaved on-site roads, are assumed to remain unchanged.

Table 15: Estimated emissions for Project-related WWC operations

Source	TSP	PM_{10}	Emission Factor Applied	Calculation Inputs and Assumptions
	tpa	tpa		
Paved roads	45.7	8.8	US-EPA AP-42 Paved Roads (Section 13.2.1) (November 2006)	Vehicle kilometres travelled (VKT) scaled to account for additional 3 Mtpa ROM coal, with total VKT estimated to be approximately 86.9 km per day, given the 5.5 Mtpa to be hauled, the 52 t payload and the on-site ring road length of 300 m.
Unpaved roads	6.4	1.6	US-EPA AP-42 Unpaved Roads (Section 13.2.2) (November 2006)	Delivery truck activity assumed to be unchanged from existing WWC operations.
Materials handling	8.6	3.7	NPI EETM for Mining Version 2.3, Dec 2001	Coal and waste rock handling volumes scaled to 5.5 Mtpa and ~4,580 tpa waste rock.
Coal Crushing	11.0	4.4	NPI EETM for Mining Version 2.3, Dec 2001	Coal crushing volumes scaled from 2.5 Mtpa to 5.5 Mtpa.
Front End Loader operations	0.13	0.06	NPI EETM for Mining Version 2.3, Dec 2001	Hours of operation of loaders working on the tripper pad scale from 337 hrs/year to 741 hrs/year to account for the additional throughput. Front end loader operations within stores area assumed to remain unchanged.
Stockpile Wind Erosion	0.95	0.48	Wind dependant emission rates applied consistent with US-EPA AP-42 Industrial Wind Erosion (Section 13.2.5 (2006)	Dimensions of coal and coal fines stockpiles assumed to be unchanged from existing WWC operations.
Vent Shaft Emissions	0.004	0.002	Ventilation shaft measurements for underground coal mine producing 5.2 Mtpa (EML Air, 2005)	Volumetric flows given for ventilation shaft nos. 2 and 3 are given as being unchanged for Project-related operations.
TOTAL	**72.71**	**19.05**		

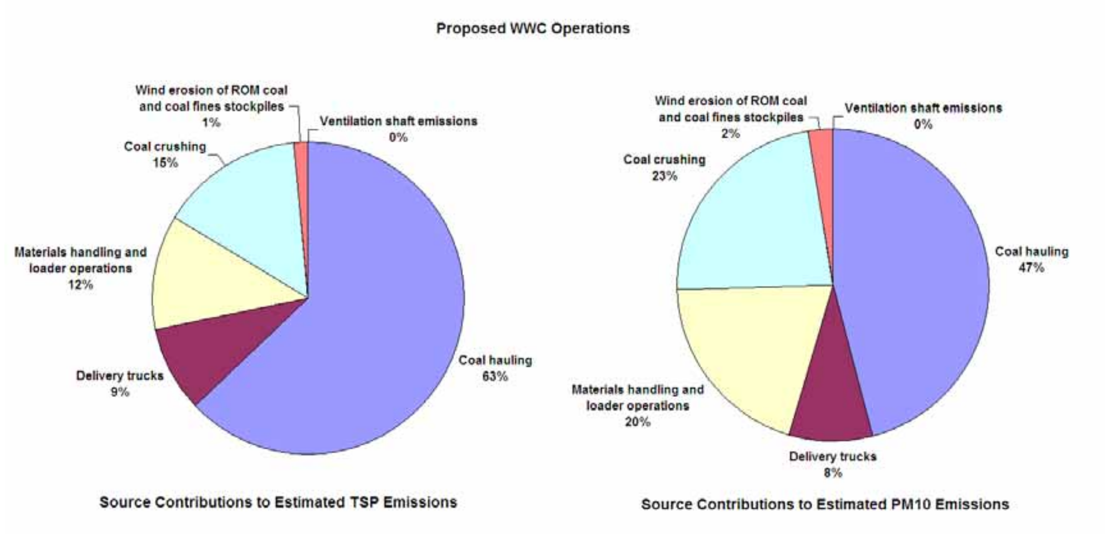

Figure 19: Source contributions to estimated Project-related emissions

7 Dispersion Modelling Method and Results

7.1 Dispersion Model Selection and Methodology

The atmospheric dispersion modelling carried out in the present assessment utilises the US-EPA regulatory AERMOD model. A detailed account of the model selection and modelling methodology is presented in **Appendix 3**. An overview of model inputs and results is given in this section.

7.2 AERMOD Dispersion Model Inputs

Input data types required for the AERMOD model include: topography, meteorological data (from AERMET/TAPM), source data (from the emissions inventory compiled), and information on the nature of the receptor grid.

7.2.1 *Project Topography*

As discussed in **Section 2.3**, the topography between the Project and the nearest receptors is relatively uncomplicated. However, topography within the modelling domain has been incorporated in the dispersion simulations using NASA's Shuttle Radar Topography Mission (SRTM) Data. This data set provides high-resolution topography at 3 arc-second (~90m) grid spacings.

7.2.2 *Meteorological Inputs*

AERMET generated meteorological files were used as input in the dispersion simulations. A detailed account of the AERMET modelling undertaken is given in **Appendix 3**.

7.2.3 *Source and Emissions*

Emissions estimated for existing WWC operations and for the Project, as documented in **Section 6**, were simulated. Hourly varying TSP and PM_{10} emission files generated during the emissions inventory were input in the dispersion modelling to facilitate the projection of dust deposition rates (in the case of TSP emissions) and suspended PM_{10} concentrations.

Atmospheric emissions from existing WWC operations were modelled to establish WWC's current contribution to suspected particulate concentrations and dust deposition rates.

Estimated emissions from the Project were simulated to determine incremental concentrations and deposition rates due to future WWC operations, taking into account the maximum production rate increase to 5.5 Mtpa, for use in the cumulative impact assessment.

Source locations are illustrated in **Figure 20** and documented in **Table 16**, with source configurations modelled indicated.

Figure 20: Source locations for proposed Project operations

Table 16: Locations and modelling configurations for Project-related sources

Source Coordinates		SourceID	Source Description	Source Configuration
East (m)	North (m)			
366,722	6,354,741	VOL1	coal handling at breakers	Volume
366,712	6,354,741	VOL2	waste rock handling	Volume
366,487	6,354,769	VOL3	coal stockpiling tripper pad	Volume
366,452	6,354,774	VOL4	coal loading from bin to trucks	Volume
366,478	6,354,785	VOL6	loading of coat from stockpile	Volume
366,722	6,354,741	VOL7	Crushing coal	Volume
366,525	6,354,698	VOL8	coal haul	Volume
366,508	6,354,710	VOL9	coal haul	Volume
366,486	6,354,720	VOL10	coal haul	Volume
366,465	6,354,728	VOL11	coal haul	Volume
366,453	6,354,740	VOL12	coal haul	Volume
366,448	6,354,759	VOL13	coal haul	Volume
366,457	6,354,796	VOL14	coal haul	Volume
366,466	6,354,807	VOL15	coal haul	Volume

Table 16: Locations and modelling configurations for Project-related sources

Source Coordinates		SourceID	Source Description	Source Configuration
East (m)	North (m)			
366,479	6,354,812	VOL16	coal haul	Volume
366,496	6,354,812	VOL17	coal haul	Volume
366,510	6,354,806	VOL18	coal haul	Volume
366,518	6,354,795	VOL19	coal haul	Volume
366,522	6,354,782	VOL20	coal haul	Volume
366,523	6,354,767	VOL21	coal haul	Volume
366,519	6,354,746	VOL22	coal haul	Volume
366,510	6,354,730	VOL23	coal haul	Volume
366,816	6,354,929	VOL24	loader operations	Volume
366,762	6,355,003	VOL25	deliveries	Volume
366,758	6,354,975	VOL26	deliveries	Volume
366,755	6,354,956	VOL27	deliveries	Volume
366,749	6,354,932	VOL28	deliveries	Volume
366,746	6,354,915	VOL29	deliveries	Volume
366,741	6,354,897	VOL30	deliveries	Volume
366,737	6,354,880	VOL31	deliveries	Volume
366,732	6,354,858	VOL32	deliveries	Volume
366,727	6,354,838	VOL33	deliveries	Volume
366,723	6,354,819	VOL34	deliveries	Volume
366,716	6,354,794	VOL35	deliveries	Volume
366,708	6,354,776	VOL36	deliveries	Volume
366,703	6,354,755	VOL37	deliveries	Volume
366,487	6,354,770	STOCK	coal stockpile	Circular Area Source
366,523	6,354,842	FINES	coal fines	Circular Area Source
366,642	6,356,902	VENT2(a)	Ventilation Shaft 2	Point
364,123	6,351,956	VENT3(a)	Ventilation Shaft 3	Point

(a) Not shown in Figure 20.

7.2.4 *Receptor Grid and Discrete Receptors*

The dispersion of pollutants was modelled for an area covering 10.2 km (east – west) and 5.9 km (north – south). Gridded receptor points were specified at intervals of 100m, with discrete receptor points also being specified for selected sensitive receptor points coinciding with nearby residences.

Monitoring sites, as described in **Section 4.2**, were also specified in the model as discrete receptors to permit the simulations at these sites for source contribution and cumulative assessment purposes.

Ground-level concentrations and deposition rates were simulated for the gridded receptors for use in the generation of isopleth plots to demonstrate spatial variations in pollutant concentrations/deposition rates. Model outputs for discrete receptor points were used in the compliance assessment of cumulative levels.

7.3 Model Results

Dispersion simulations were undertaken and results analysed for annual average dust deposition and highest 24-hour and annual average PM_{10} concentrations.

Results are presented as isopleth plots of PM_{10} concentrations and deposition rates due to existing WWC operations and Project-related emissions (**Appendix 4**). These isopleth plots illustrate spatial variations in particulate concentrations and dust deposition.

Isopleth plots of *incremental* (additional) PM_{10} concentrations and dust deposition due to Project-related emissions are presented in **Appendix 5**. These plots reflect Project-related increments in PM_{10} concentrations and dust deposition above the levels which are predicted to occur due to existing WWC operations.

Tabulated results for discrete receptor points are presented in **Section 8** for PM_{10}, TSP and dust deposition, for the purpose of existing mine impact contribution analysis and Project-related cumulative impact assessment.

8 Air Quality Assessment

8.1 Contribution of Existing WWC Operations to Ambient Levels

Atmospheric emissions from existing WWC operations are expected to have contributed to the suspended PM_{10} concentrations and dust deposition rates recorded in the Project area. To assess likely increases in these levels due to the Project, and the significance of such increases, it was therefore necessary to establish the contribution of existing WWC operations to ambient PM_{10} concentrations and dust deposition rates.

8.1.1 *Contribution to Dust Deposition*

The predicted contribution of existing WWC operations to measured dust deposition rates during 2007 is presented in **Table 17**. Emissions from existing WWC operations were predicted to be responsible for over 100% of the annual dust deposition recorded at the Westside D10 station which is situated in the south-eastern corner of the WWC Pit Top site. This indicates that the emission estimations and dispersion modelling undertaken over predicts dust deposition rates and therefore provides a conservative estimate of WWC's contribution to ambient deposition levels.

Table 17: Predicted Contribution of Existing WWC Operations to Measured Dust Deposition Rates during 2007

Monitoring Site(a)		Measured Annual Average Dust Deposition for 2007 (g/m²/month)	Predicted Dust Deposition due to Existing WWC Operations (g/m²/month)	Predicted Contribution of Existing WWC Operations to Measured Annual Dust Deposition Rates during 2007 (%)
Westside No.	**EPA Point**			
D5	7	0.78	0.018	2.3
D10	8	0.69	0.783	113.2
D11B	9	0.60	0.096	16.0
D13A	10	0.63	0.047	7.5
D18	11	0.58	0.034	5.9
D19	N/A	0.99	0.041	4.2
D20	12	0.96	0.007	0.8
D21	17	0.68	0.005	0.7
MCCP No.	**EPA Point**			
D1	4	0.94	0.002	0.2
D2	5	0.85	0.002	0.3
D3	6	0.73	0.003	0.4
D4	7	0.77	0.002	0.3
D5	8	0.78	0.016	2.1
D6	9	1.07	0.004	0.3
D7	10	1.34	0.005	0.3

(a) Refer to **Figure 5** and **Figure 6** for an illustration of site locations.

The contribution of estimated current WWC emissions to dust deposition rates recorded within the Westside Mine boundary was projected to be in the range of ~6% (Westside D19) to 16% (Westside D11B). D11B is situated within the north- corner of the Westside Mine, with D19 being located between Westside Mine's North and South Pits.

Existing WWC operations were predicted to contribute to <8% of the annual dust deposition rates recorded at the stations within Killingworth (Westside D13A and D18), approximately 2% of the rates recorded at the station within Barnsley (Westside/MCPP D5), and <1% of the dust deposition measured in Wakefield (Westside D20, D21).

The contribution of existing WWC operations to dust deposition recorded at sites situated in proximity to the MCPP and to the east of this plant (MCPP D1, D2, D3, D4, D6, D7) was estimated to be negligible (<0.5%).

8.1.2 *Contribution to PM_{10} Concentrations*

The contribution of existing WWC operations to PM_{10} concentrations recorded at the Westside Mine PM_{10} Station in Wakesfield was modelled for 2007.

Emissions due to existing WWC operations were predicted to result in 24-hour average PM_{10} concentrations in the range of 0.002 to 0.5 µg/m³, with an annual average concentration of 0.12 µg/m³.

On days during 2007 when daily-average PM_{10} concentrations were measured to be higher than 20 µg/m³, the contribution of WWC operations was predicted to be <0.8% as is illustrated in **Figure 21**.

On days during 2007 when exceedances of the DECCW daily PM_{10} goal of 50 µg/m³ were recorded at the Westside Mine PM_{10} monitoring station, the contribution of emissions from the existing WWC operation was predicted as follows (assuming routine emissions from WWC):

- 11 January 2007 – PM_{10} concentration of 62 µg/m³ recorded at station; WWC's contribution predicted to be 0.12%.
- 2 October 2007 – PM_{10} concentration of 56 µg/m³ recorded at station; WWC's contribution predicted to be 0.15%.
- 20 October 2007 – PM_{10} concentration of 82 µg/m³ recorded at station; WWC's contribution predicted to be 0.22%.

Existing WWC operations were simulated to account for <0.7% of the annual average PM_{10} concentrations recorded at the Westside Mine PM_{10} monitoring site.

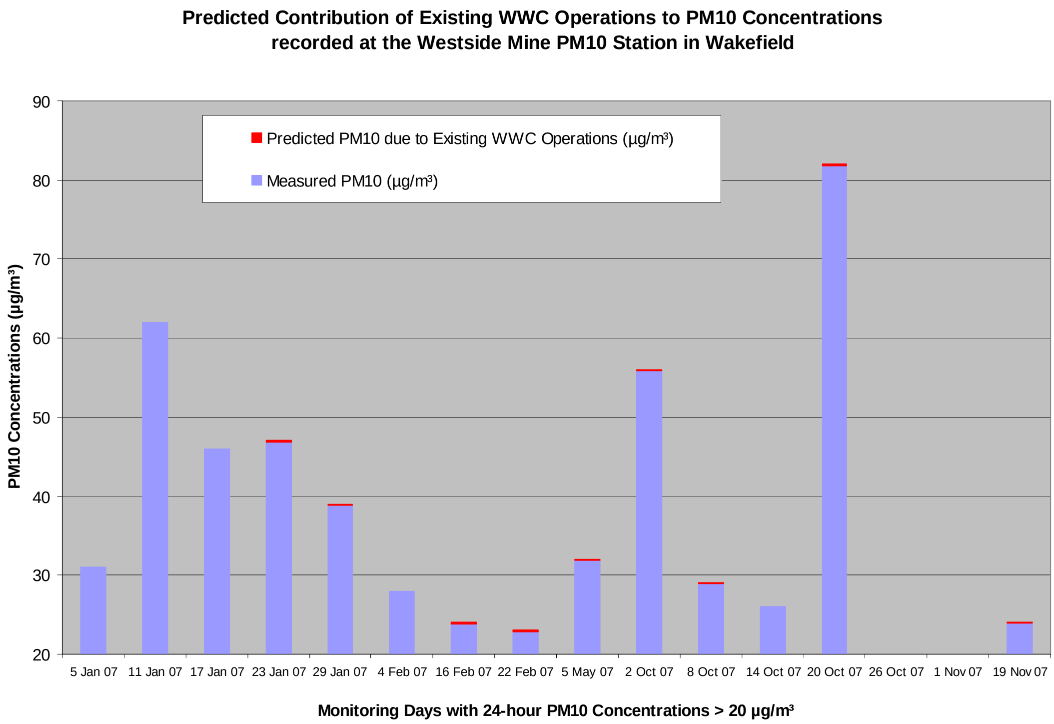

Figure 21: Predicted Contribution of Existing WWC Operations to PM_{10} Levels Measured at the Westside Mine PM_{10} Station in Wakesfield

8.2 Incremental Suspended Particulate Concentrations and Dust Deposition due to the Project

8.2.1 *Increment in Highest Daily PM_{10} Concentrations*

Highest daily PM_{10} concentrations predicted to occur as a result of existing WWC operations and Project-related emissions are given in **Table 18** for nearby residences and illustrated for the entire area in **Appendix 4**. Increments in highest daily PM_{10} concentrations due to the Project, calculated by subtracting concentrations due to existing operations from Project-related concentrations, are presented in the table and illustrated spatially in **Appendix 5**.

The maximum increment in highest daily average PM_{10} concentrations across nearby residences was predicted to be 3 µg/m³ (Residence No. 3 located in Killingworth). The greatest increments were projected to occur within Killingworth as may be expected given its proximity and the prevailing wind regime. Increments at Wakefield residences were predicted to be at or below 0.5 µg/m³.

The Project was predicted to result in a ~9 µg/m³ increment in WWC-related highest daily average PM_{10} concentrations at the Westside Mine Offices.

Table 18: Highest Daily PM_{10} Concentrations at Nearby Residences due to Existing Operations and Project-related Emissions, and Resultant Increment due to Project

Residential Area	Residence No.	Highest Daily Average PM_{10} Concentrations (µg/m³)		
		Predicted due to Existing WWC Operations	Predicted due to Project-related Emissions	Increment due to Project-related Emissions
Killingworth	1	2.1	4.5	2.3
	2	2.3	4.5	2.2
	3	2.7	5.7	3.0
	4	2.0	4.2	2.2
	5	1.8	3.6	1.7
	6	1.6	3.3	1.7
	7	1.6	3.3	1.6
Barnsley	8	2.3	4.3	2.0
	9(a)	2.2	4.3	2.1
Wakefield	11	0.4	0.7	0.3
	12	0.5	1.0	0.5
	13	0.6	1.1	0.5
	14	0.5	1.0	0.4
	15	0.4	0.8	0.4
	16	0.4	0.8	0.4
	17	0.4	0.8	0.4
	18	0.4	0.9	0.4
	19	0.5	0.9	0.4
	20	0.5	0.9	0.4
	21	0.4	0.8	0.4
Westside Mine Offices	10	9.1	17.9	8.8

(a) Owned by the mine and no longer occupied.

8.2.2 *Increment in Annual Average PM_{10} Concentrations*

Annual average PM_{10} concentrations predicted to occur as a result of existing WWC operations and Project-related emissions are given in **Table 19** for nearby residences and illustrated for the entire area in **Appendix 4**. Increments in annual average PM_{10} concentrations due to the Project, calculated by subtracting concentrations due to existing operations from Project-related concentrations, are presented in the table and illustrated spatially in **Appendix 5**.

The maximum increment in annual average PM_{10} concentrations across nearby residences was predicted to be 0.65 µg/m³ (occurring at Residence No. 3 located in Killingworth). The greatest increments were projected to occur within Killingworth and at nearby Barnsley residences as may be expected given their proximity to WWC. Increments at Wakefield residences were predicted to be below 0.15 µg/m³.

The Project was predicted to result in a ~3 µg/m³ increment in WWC-related annual average PM_{10} concentrations at the Westside Mine Offices.

Table 19: Annual Average PM_{10} Concentrations at Nearby Residences due to Existing Operations and Project-related Emissions, and Resultant Increment due to Project

Residential Area	Residence No.	Annual Average PM_{10} Concentrations (µg/m³)		
		Predicted due to Existing WWC Operations	Predicted due to Project-related Emissions	Increment due to Project-related Emissions
Killingworth	1	0.58	1.18	0.60
	2	0.60	1.23	0.63
	3	0.61	1.25	0.65
	4	0.57	1.18	0.61
	5	0.51	1.06	0.55
	6	0.47	0.99	0.52
	7	0.43	0.91	0.47
Barnsley	8	0.69	1.32	0.62
	9(a)	0.61	1.17	0.57
Wakefield	11	0.08	0.16	0.08
	12	0.09	0.18	0.09
	13	0.09	0.19	0.10
	14	0.10	0.19	0.10
	15	0.10	0.21	0.11
	16	0.11	0.23	0.12
	17	0.12	0.25	0.13
	18	0.13	0.26	0.13
	19	0.11	0.23	0.11
	20	0.10	0.21	0.10
	21	0.10	0.20	0.10
Westside Mine Offices	10	3.25	6.48	3.22

(a) Owned by the mine and no longer occupied.

8.2.3 *Increment in Annual Average TSP Concentrations*

Annual average TSP concentrations predicted to occur as a result of existing WWC operations and Project-related emissions are given in **Table 20** for nearby residences. The maximum increment in annual average TSP concentrations across nearby residences was predicted to be below 1 µg/m³.

The Project was predicted to result in a 4 µg/m³ increment in WWC-related annual average TSP concentrations at the Westside Mine Offices.

Table 20: Annual Average TSP Concentrations at Nearby Residences due to Existing Operations and Project-related Emissions, and Resultant Increment due to Project

Residential Area	Residence No.	Annual Average TSP Concentrations (µg/m³)		
		Predicted due to Existing WWC Operations	Predicted due to Project-related Emissions	Increment due to Project-related Emissions
Killingworth	1	0.74	1.52	0.77
	2	0.77	1.57	0.81
	3	0.78	1.60	0.83
	4	0.73	1.50	0.78
	5	0.65	1.34	0.69
	6	0.60	1.25	0.65
	7	0.55	1.14	0.59
Barnsley	8	0.87	1.65	0.78
	9(a)	0.75	1.45	0.70
Wakefield	11	0.10	0.19	0.10
	12	0.11	0.22	0.11
	13	0.11	0.23	0.12
	14	0.12	0.24	0.12
	15	0.13	0.26	0.13
	16	0.14	0.28	0.14
	17	0.15	0.31	0.16
	18	0.16	0.32	0.16
	19	0.14	0.28	0.14
	20	0.13	0.26	0.13
	21	0.13	0.25	0.13
Westside Mine Offices	10	4.05	8.01	3.96

(a) Owned by the mine and no longer occupied.

8.2.4 *Increment in Annual Average Dust Deposition*

Annual average dust deposition predicted to occur as a result of existing WWC operations and Project-related emissions are given in **Table 21** for nearby residences and illustrated for the entire area in **Appendix 4**. Increments in annual average dust deposition due to the Project, calculated by subtracting deposition due to existing operations from Project-related deposition, are presented in the table and illustrated spatially in **Appendix 5**.

Table 21: Annual Average Dust Deposition at Nearby Residences due to Existing Operations and Project-related Emissions, and Resultant Increment due to Project

Residential Area	Residence No.	Annual Average Dust Deposition (g/m²/month)		
		Predicted due to Existing WWC Operations	Predicted due to Project-related Emissions	Increment due to Project-related Emissions
Killingworth	1	0.052	0.105	0.052
	2	0.053	0.107	0.054
	3	0.051	0.102	0.052
	4	0.044	0.089	0.045
	5	0.037	0.076	0.039
	6	0.033	0.068	0.035
	7	0.029	0.060	0.031
Barnsley	8	0.052	0.099	0.047
	9(a)	0.046	0.086	0.040
Wakefield	11	0.004	0.008	0.004
	12	0.004	0.008	0.004
	13	0.004	0.009	0.004
	14	0.005	0.009	0.005
	15	0.005	0.010	0.005
	16	0.006	0.011	0.006
	17	0.006	0.013	0.007
	18	0.007	0.014	0.007
	19	0.006	0.012	0.006
	20	0.005	0.011	0.005
	21	0.005	0.011	0.005
Westside Mine Offices	10	0.269	0.523	0.253

(a) Owned by the mine and no longer occupied.

Incremental dust deposition rates due to Project-related emissions are predicted to be below the DECCW incremental dust deposition goal of 2 g/m²/month.

The maximum increment in annual average dust deposition rates across nearby residences was predicted to be 0.054 g/m²/month (occurring at Residence No. 2 located in Killingworth). The greatest increments were projected to occur within Killingworth and at nearby Barnsley residences as may be expected given their proximity to WWC. Increments in annual dust deposition at Wakefield residences were predicted to be at or below 0.007 g/m²/month.

The Project was predicted to result in a ~0.25 g/m²/month increment in WWC-related annual average dust deposition at the Westside Mine Offices.

8.3 Potential for Cumulative Impacts

To determine the potential for cumulative impacts, the predicted incremental annual average suspended particulate concentrations and deposition rates due to the Project were summed with measured background levels, with resultant cumulative levels compared to DECCW air quality criteria.

In the case of PM_{10} concentrations, where exceedances of the DECCW daily goal has been observed to occur, it was necessary to determine whether incremental PM_{10} concentrations due to the Project would result in additional exceedances of this goal.

8.3.1 *Dust Deposition*

Cumulative annual average dust deposition rates predicted to occur due to the Project, taking into account measured background rates and the increment in such rates due to Project-related emissions, are given in **Table 22**.

Table 22: Background Annual Average Dust Deposition, and Incremental and Cumulative Dust Deposition Predicted due to the Project

Residential Area	Residence No.	Annual Average Dust Deposition (g/m²/month)		
		Measured Background Levels(a)	Predicted Increment due to Project-related Emissions	Projected Cumulative Deposition due to Project-related Emissions
Killingworth	1	1.100	0.052	1.152
	2	1.100	0.054	1.154
	3	1.100	0.052	1.152
	4	1.100	0.045	1.145
	5	1.100	0.039	1.139
	6	1.100	0.035	1.135
	7	1.100	0.031	1.131
Barnsley	8	0.782	0.047	0.829
	9(b)	0.782	0.040	0.822
Wakefield	11	2.692	0.004	2.696
	12	2.692	0.004	2.696
	13	2.692	0.004	2.696
	14	2.692	0.005	2.697
	15	2.692	0.005	2.697
	16	2.692	0.006	2.698
	17	2.692	0.007	2.699
	18	2.692	0.007	2.699
	19	2.692	0.006	2.698
	20	2.692	0.005	2.697
	21	2.692	0.005	2.697

(a) Based on maximum annual dust deposition recorded during the 2005 – 2008 period (Ref. **Section 4.6**).
(b) Owned by the mine and no longer occupied.

Cumulative dust deposition rates, comprising the sum of background deposition and Project-related incremental deposition, are projected to be below the DECCW cumulative dust deposition goal of 4 g/m²/month (<70% of goal).

8.3.2 *Annual Average PM_{10} Concentrations*

Cumulative annual average PM_{10} concentrations predicted to occur due to the Project, taking into account measured background concentrations and increments due to Project-related emissions, are given in **Table 23**.

Table 23: Background Annual Average PM_{10} Concentrations, and Incremental and Cumulative Concentrations Predicted due to the Project

Residential Area	Residence No.	Annual Average PM_{10} Concentrations (µg/m³)		
		Measured Background Levels(a)	Predicted Increment due to Project-related Emissions	Projected Cumulative Concentration due to Project-related Emissions
Killingworth	1	17.63	0.60	18.23
	2	17.63	0.63	18.26
	3	17.63	0.65	18.28
	4	17.63	0.61	18.24
	5	17.63	0.55	18.18
	6	17.63	0.52	18.15
	7	17.63	0.47	18.10
Barnsley	8	17.63	0.62	18.25
	9(b)	17.63	0.57	18.20
Wakefield	11	17.63	0.08	17.71
	12	17.63	0.09	17.72
	13	17.63	0.10	17.73
	14	17.63	0.10	17.73
	15	17.63	0.11	17.74
	16	17.63	0.12	17.75
	17	17.63	0.13	17.76
	18	17.63	0.13	17.76
	19	17.63	0.11	17.74
	20	17.63	0.10	17.73
	21	17.63	0.10	17.73

(a) Based on maximum annual average PM10 concentrations recorded at the Westside Mine PM_{10} station at Wakesfield, over the 2002 to 2008 period (Ref. **Section 4.6**).

(b) Owned by the mine and no longer occupied.

Cumulative annual average PM_{10} concentrations, comprising the sum of background concentrations and Project-related incremental concentrations, are predicted to be below the DECCW annual PM_{10} goal of 30 µg/m³ (as a maximum ~60% of goal).

8.3.3 *Annual Average TSP Concentrations*

Cumulative annual average TSP concentrations predicted to occur due to the Project, taking into account measured background concentrations and increments due to Project-related emissions, are given in **Table 24**.

Table 24: Background Annual Average TSP Concentrations, and Incremental and Cumulative Concentrations Predicted due to the Project

Residential Area	Residence No.	Annual Average TSP Concentrations (µg/m³)		
		Measured Background Levels(a)	Predicted Increment due to Project-related Emissions	Projected Cumulative Concentration due to Project-related Emissions
Killingworth	1	34	0.77	34.77
	2	34	0.81	34.81
	3	34	0.83	34.83
	4	34	0.78	34.78
	5	34	0.69	34.69
	6	34	0.65	34.65
	7	34	0.59	34.59
Barnsley	8	34	0.78	34.78
	9(b)	34	0.70	34.70
Wakefield	11	34	0.10	34.10
	12	34	0.11	34.11
	13	34	0.12	34.12
	14	34	0.12	34.12
	15	34	0.13	34.13
	16	34	0.14	34.14
	17	34	0.16	34.16
	18	34	0.16	34.16
	19	34	0.14	34.14
	20	34	0.13	34.13
	21	34	0.13	34.13

(a) Based on TSP concentrations recorded at the Westside Mine TSP station in Killingworth (Ref. **Section 4.6**).
(b) Owned by the mine and no longer occupied.

Cumulative annual average TSP concentrations, comprising the sum of background concentrations and Project-related incremental concentrations, are predicted to be below the DECCW annual TSP goal of 90 µg/m³ (<40% of goal).

8.3.4 *24-Hour Average PM_{10} Concentrations*

Up to three exceedances of the DECCW daily PM_{10} goal per year have been recorded to occur at the Westside Mine PM_{10} Station at Wakesfield. This is generally consistent with the annual number of exceedances typical of the broader region.

In instances where the daily PM_{10} goal is already exceeded, DECCW (2005) stipulates that proposed developments may not result in any increase in the number of exceedances. It is therefore necessary to demonstrate that the daily varying incremental PM_{10} concentrations due to the Project will not result in additional exceedances at nearby residences.

To illustrate that the Project is expected to satisfy the DECCW requirement that no additional exceedances will occur as a result of the Project, predicted Project-related concentrations at Receptor 3 (Killingworth) and Receptor 8 (Barnsley) are plotted in combination with measured PM_{10} concentrations from the Westside Mine PM_{10} station at Wakesfield (**Figure 22**, **Figure 23**). Receptors 3 and 8 were selected for the cumulative assessment due to the highest Project-related PM_{10} concentrations having been predicted to occur at these locations.

Figure 22 and **Figure 23** illustrate that the highest predicted Project-related 24-hour PM_{10} concentrations are not expected to trigger any additional exceedance of the DECCW 24-hour PM_{10} criterion when combined with background concentrations, taking into account both the frequency and magnitude of the increment.

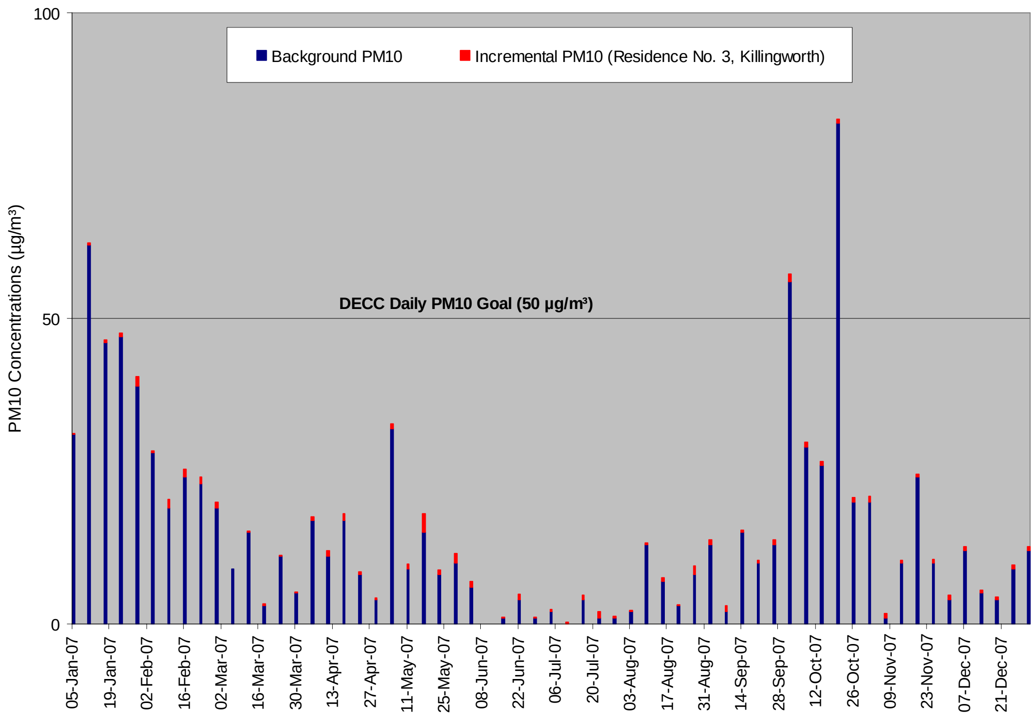

Figure 22: Predictions of 24-hour PM_{10} at Residence 3 (Killingworth), Combined with Concurrent Observations from the Westside Mine PM_{10} Station at Wakesfield

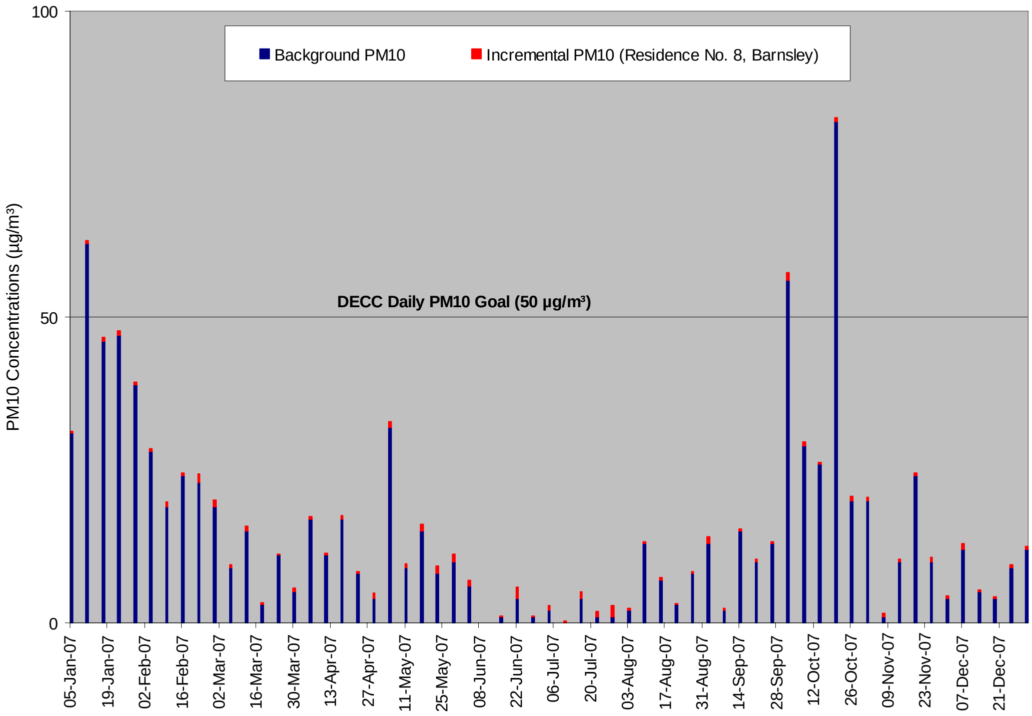

Figure 23: Predictions of 24-hour PM_{10} at Residence 8 (Barnsley), Combined with Concurrent Observations from the Westside Mine PM_{10} Station at Wakesfield

9 Dust Management and Monitoring Recommendations

9.1 Operational Dust Management

Predicted air quality impacts will comply with Project air quality goals, provided adequate operational dust management strategies are adhered to for the life of the Project, as documented in **Section 6**. Such dust control measures are currently being implemented as part of the existing WWC operations and are therefore considered feasible.

Potential additional dust control measures which could be implemented to further reduce dust impact potentials are more frequent sweeping of the paved haul road, minimisation of tripper pad coal stockpiling and associated loader operations.

9.2 Air Quality Monitoring Recommendations

Suspended particulate concentrations and dust deposition are currently being monitored as part of the Westside Mine and MCPP monitoring networks.

It is recommended that, as a minimum, dust deposition monitoring at the stations located at WWC (D10), and within Barnsley (D5) and Killingworth (D13, D18) be continued for the life of the Project to track changes in on-site and ambient dust deposition rates.

Furthermore, it is recommended that 24-hour average PM_{10} monitoring be undertaken within the WWC impact area for the life of the Project. Such monitoring could either comprise continued operations at the existing Westside Mine PM_{10} HVAS station at Wakesfield, and/or a new PM_{10} station situated along the eastern perimeter of Killingworth (potentially co-located with the Westside Mine TSP HVAS station).

All monitoring should be conducted in accordance with the following Australian Standards:

- Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales (DEC, 2007);
- AS 2922-1987 Ambient Air - Guide for the Siting of Sampling Units.

Monitoring for dust deposition should be conducted in accordance with the following Australian Standard.

- AS 3580.10.1-2003 Methods for Sampling and Analysis of Ambient Air - Determination of Particulates - Deposited Matter - Gravimetric Method (DECCW Method AM-19).

Monitoring for PM_{10} should be undertaken according to the following Australian Standard, or using another approved continuous method:

- AS 3580.9.6-2003 Particulate Matter - PM_{10} - high volume sampler with size-selective inlet (DECCW Method AM-18).

10 Conclusion

Modelling of fugitive dust and particulate matter emissions was undertaken to determine the resulting air quality impacts of the West Wallsend Continued Operations Project.

Atmospheric emissions from existing WWC operations contributed to suspended particulate concentrations and dust deposition rates measured in the area. To assess likely increases in these levels due to the Project, and the significance of such increases, it was necessary to:

- establish WWC's current contribution to suspended particulate concentrations and dust deposition rates;
- quantify incremental concentrations and deposition rates due to the Project, taking into account the maximum production rate increase to 5.5 Mtpa; and
- determine whether the increment in suspended particulate concentrations and dust deposition rates increases cumulative levels sufficiently to cause non-compliance with DECCW air quality criteria.

Atmospheric dispersion modelling predictions of fugitive emissions from existing WWC operations and the Project were undertaken using the AERMOD Gaussian Plume Dispersion Model software developed by the USEPA. Existing air quality was characterised for the purpose of assessing the potential for cumulative air pollution levels, given predicted Project-related incremental levels.

These predictions indicate that, provided the general design and operational safeguards documented within this report are implemented, particulate matter and dust deposition emissions attributable to the proposed Project are anticipated to be within the current NSW DECCW air quality goals at all surrounding non-Project related residences. Dust control measures outline are currently being implemented as part of the existing WWC operations and are therefore considered feasible.

11 References

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12 Glossary of Acronyms And Symbols

AHD	Australian Height Datum
AMMAAP	Approved Methods for the Modelling and Assessment of Air Pollutants in NSW,
AWS	Automatic Weather Station
bcm	Bench cubic metres - a measure of volumes mined, equal to the weight of material divided by its specific gravity.
BoM	Australian Bureau of Meteorology
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DECCW	NSW Department of the Environment, Climate Change and Water
EETMM	Emission Estimation Technique Manual for Mining, Version 2.3
ENVIRON	ENVIRON Australia Pty Ltd
ktpa	kilotonnes per annum
mg	Milligram (g x 10-3)
µg	Microgram (g x 10-6)
µm	Micrometre or micron (metre x 10-6)
m^3	Cubic metre
MCPP	Macquarie Coal Preparation Plant
Mtpa	Megatonnes per annum
ML	Mining Licence
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NHMRC	National Health and Medical Research Council
NPI	National Pollutant Inventory
PM_{10}	Particulate matter less than 10microns in aerodynamic diameter
ROM	Run of Mine
TAPM	“The Air Pollution Model”
TEOM	Tapered Element Oscillating Microbalance
The Project	Cumnock Wash Plant Pit
TSP	Total Suspended Particulate
USEPA	United States Environmental Protection Agency
WWC	West Wallsend Colliery

Appendices

Appendix 1	Climate Averages for Nobbys Signal Station (number 061055)
Appendix 2	Seasonal and Diurnal Wind Roses for Project for 2007
Appendix 3	Dispersion Modelling Methodology
Appendix 4	Isopleth Plots of PM_{10} Concentrations and Dust Deposition due to Existing WWC Operations and Project-related Operations
Appendix 5	Isopleth Plots of Incremental PM_{10} Concentrations and Dust Deposition due to Project-related Emissions

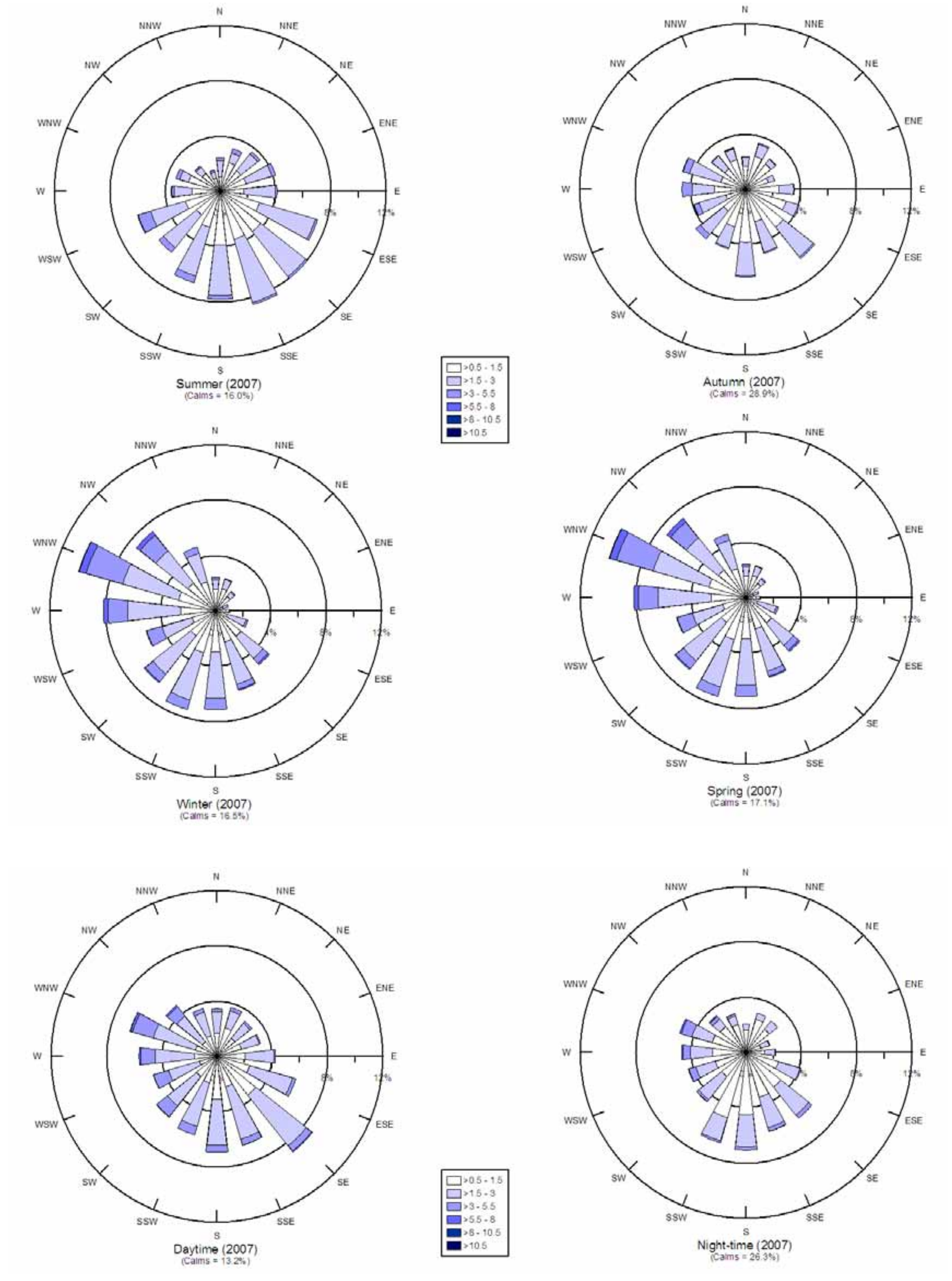
Appendix 1
Climate Statistics for Bureau of Meteorology – Nobbys Signal Station (number 061055)

Climate statistics for Newcastle Nobbys Signal Station, 32.92°S and 151.80°E, 33 m agl for the period 1862 to 2008

Statistic Element	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean maximum temperature (Degrees C)	25.5	25.4	24.7	22.8	20	17.5	16.7	18	20.2	22.1	23.5	24.9	21.8
Highest temperature (Degrees C)	41.4	40.9	39	36.8	28.5	26.1	26.3	29.9	34.4	36.7	41	42	42
Lowest maximum temperature (Degrees C)	18.4	18.1	17.8	15.6	12.8	10.6	8.9	11.2	11.7	14	15.6	17.2	8.9
Mean number of days >= 30 Degrees C	2.7	1.9	1.5	0.6	0	0	0	0	0.5	1.8	2.4	2.9	14.3
Mean number of days >= 35 Degrees C	0.9	0.5	0.2	0	0	0	0	0	0	0.1	0.5	1	3.2
Mean number of days >= 40 Degrees C	0	0	0	0	0	0	0	0	0	0	0.1	0.1	0.2
Mean minimum temperature (Degrees C)	19.2	19.3	18.2	15.3	12	9.6	8.4	9.2	11.4	14	16.1	18	14.2
Lowest temperature (Degrees C)	12	10.3	11.1	7.4	4.7	3	1.8	3.3	5	6.5	7.2	11	1.8
Highest minimum temperature (Degrees C)	25.5	24	23.9	21.9	19.5	17.6	15.7	17.2	19.8	21	22.4	24	25.5
Mean rainfall (mm)	89.5	108	120.8	116.6	117.4	117.5	95	75.1	73	73.2	70.5	81.8	1140.3
Highest rainfall (mm)	404	559.2	544.4	546.4	441.3	495.8	351.1	545.3	283.1	277.5	203.9	326.5	1919.4
Lowest rainfall (mm)	2	0.5	2.8	0	2.1	0.8	0	0	0.8	4.6	2.4	4.6	596.9
Highest daily rainfall (mm)	144.8	252.7	283.7	231.1	181.9	209.8	118.6	168.9	157.5	96.5	103.7	177.5	283.7
Mean number of days of rain	11	11.1	12.2	11.9	12	11.6	10.7	10.2	9.9	10.7	10.6	10.5	132.4
Mean daily wind run (km)	577	561	535	522	491	544	541	543	561	575	585	594	553
Maximum wind gust speed (km/h)	121	141	137	115	171	152	139	135	131	141	145	130	171
Mean daily solar exposure (MJ/(m*m))	24.2	21.9	19	14.8	10.6	9	10	13.8	17.5	20.7	23.1	24.7	17.4
Mean number of clear days	6.3	5.3	6.4	7.4	6.9	7.5	9.7	10.8	9.3	7.4	5.5	6.3	88.8
Mean number of cloudy days	12.4	11.9	11.7	10.7	11.9	11.7	9.5	8.3	9	12.1	12.2	11.7	133.1
Mean 9am temperature (Degrees C)	21.9	21.8	20.8	18	14.6	12	10.9	12.1	15	17.9	19.5	21.1	17.1
Mean 9am wet bulb temperature (Degrees C)	19.3	19.5	18.4	15.7	12.7	10.3	8.9	9.8	12.1	14.6	16.4	18.2	14.7
Mean 9am dew point temperature (Degrees C)	17.7	18.3	16.9	14.1	10.9	8.4	6.6	7.1	9.2	11.6	14	16.2	12.6
Mean 9am relative humidity (%)	77	80	79	78	79	79	77	73	70	68	72	75	75
Mean 9am cloud cover (okas)	4.6	4.6	4.4	4.1	4.2	4.2	3.5	3.3	3.6	4.1	4.5	4.5	4.1
Mean 9am wind speed (km/h)	21	20.9	20.9	21.5	23.7	26.7	26.6	25.9	25.2	23.8	23.3	21.7	23.4
Mean 3pm temperature (Degrees C)	23.3	23.5	22.9	21.3	18.8	16.5	15.9	16.9	18.5	19.8	20.9	22.4	20.1
Mean 3pm wet bulb temperature (Degrees C)	19.9	20.3	19.5	17.3	14.9	12.7	11.7	12.3	13.9	15.7	17.2	18.9	16.2
Mean 3pm dew point temperature (Degrees C)	17.9	18.5	17.2	14.3	11.6	9.3	7.3	7.6	9.4	12.2	14.4	16.4	13
Mean 3pm relative humidity (%)	72	74	72	66	64	63	59	56	59	64	68	71	66
Mean 3pm cloud cover (oktas)	4.1	4.2	4.3	4.3	4.5	4.5	4.1	3.7	3.8	4.2	4.4	4.3	4.2
Mean 3pm wind speed (km/h)	33.4	32.8	30.7	28.1	26.3	28.5	29.2	30.7	34.2	34.6	35.6	35.4	31.6

Source: Bureau of Meteorology (2009)

Appendix 2
Diurnal and Seasonal Wind Roses for the West Wallsend Continued Operations Project


Summer (2007)
(Calms = 16.0%)
Autumn (2007)
(Calms = 28.9%)
Winter (2007)
(Calms = 16.5%)
Spring (2007)
(Calms = 17.1%)
Daytime (2007)
(Calms = 13.2%)
Night-time (2007)
(Calms = 26.3%)
>0.5 - 1.5
>1.5 - 3
>3 - 5.5
>5.5 - 8
>8 - 10.5
>10.5

Appendix 3
Dispersion Modelling Methodology

Dispersion Model Selection and Application

Dispersion models compute ambient concentrations and deposition rates as a function of source configurations, emission strengths and meteorological characteristics, thus providing a useful tool to ascertain the spatial and temporal patterns in the ground level concentrations. Knowledge of spatial and temporal variations in pollutant concentrations is essential for the assessment of the potential which exists for non-compliance with ambient air quality limits and for impact on human health and the biophysical environment.

Given the nature of the source and the local environment, AERMOD was selected for application in the prediction of ambient particulate concentrations and dust deposition rates occurring due to WWC operations. AERMOD is the US-EPA's recommended steady-state plume dispersion model for US regulatory purposes. AERMOD is designed to handle a variety of pollutant source types, including surface and buoyant elevated sources, in a wide variety of settings such as rural and urban as well as flat and complex terrain[(1)]. Source types for which AERMOD is able to predict pollutant concentrations include point, area and volume sources in addition to 'open pit' sources.

AERMOD replaced the Industrial Source Complex (ISC) model for regulatory purposes in the US in December 2006 as it provides more realistic results with concentrations that are generally lower and more representatives of actual concentrations compared to the conservative ISC model. Ausplume, a steady state Gaussian plume dispersion model developed by the Victorian EPA and frequently used in Australia for simple near-field applications, is largely based on the ISC model.

Compared to ISC and Ausplume, AERMOD represents an advanced new-generation model which requires additional meteorological and land use inputs in order to provide more refined predictions. The most important feature of AERMOD, compared to ISC and Ausplume, is its modification of the basic dispersion model to account more effectively for a variety of meteorological factors. In particular it uses the Monin-Obukhov length scale rather than Pasquill-Gifford stability categories to account for the effects of atmospheric stratification. Whereas Ausplume and ISC parameterise dispersion based on semi-empirical fits to field observations and meteorological extrapolations, AERMOD uses surface-layer and boundary-layer theory for improved characterisation of the planetary boundary layer turbulence structure.

Verification studies have been undertaken for AERMOD both locally and abroad (Hanna *et al.,* 2001*;* Perry *et al*., 2005; Hurley 2006). Hanna *et al.* (2001) concluded that AERMOD performed better than ISC with predictions generally within a factor of two of actual values. It was noted that AERMOD did tend to under-predict actual concentrations by 20% to 40%, with predictions more accurate for short-term averaging periods. Perry *et al.* (2005) summarises the performance of AERMOD across 17 field study databases placing emphasis on statistics that demonstrate the model's abilities to reproduce the upper end of the concentration distribution which are of importance in terms of regulatory modelling. The field studies include flat and complex terrain cases, urban and rural conditions and elevated

1 Under complex wind conditions and for regional applications, CALPUFF is the US-EPA's recommended model for regulatory purposes.

and surface releases with and without building wake effects. Perry et al. (2005) concludes that, with few exceptions AERMOD's performance was superior to that of the other applied models tested.

Hurley (2006) compared the performance of Ausplume, AERMOD and TAPM across several case studies including flat terrain, flat terrain with building downwash, in complex terrain and coastal terrain. AERMOD was determined to perform acceptably for all of the datasets but was found unable to simulate shoreline fumigation in the case of the Kwinana case study. This potential limitation of AERMOD is not expected to significantly influence dispersion within the modelling domain for this Project due to the nature of the project area.

AERMET Meteorological Modelling

The AERMOD system is composed of two pre-processors on top of the dispersion model: AERMET (for the preparation of meteorological data) and AERMAP (for the preparation of terrain data. Terrain data for the modeling domain was sourced from NASA's Shuttle Radar Topography Mission (SRTM) Data, as purchased from MapMart, an approved vendor for such data. This data set provides high-resolution topography at 3 arc-second (~90m) grid spacings, with MapMart having undertaken quality assurance on the data set and having filled in any potential voids in the raw shuttle data.

AERMET provides information to AERMOD for the characterisation of the planet boundary layer (PBL) such as friction velocity, mixing height. Inputs in the AERMET modeling are described below.

Surface Characteristics

In applying the AERMET meteorological processor to prepare the meteorological data for the AERMOD model appropriate values for three surface characteristics needed to be determined, viz.: surface roughness length, albedo, and Bowen ratio. The surface roughness length is related to the height of obstacles to the wind flow and is, in principle, the height at which the mean horizontal wind speed is zero based on a logarithmic profile. The surface roughness length influences the surface shear stress and is an important factor in determining the magnitude of mechanical turbulence and the stability of the boundary layer. The albedo is the fraction of total incident solar radiation reflected by the surface back to space without absorption. The daytime Bowen ratio, an indicator of surface moisture, is the ratio of sensible heat flux to latent heat flux and is used for determining planetary boundary layer parameters for convective conditions driven by the surface sensible heat flux.

Aerial photographs and site observations were used to inform the designation of land use and associated effective surface roughness on a sector-by-sector basis within a 1 kilometer radius around the Westside Mine meteorological station. Values of Bowen ratio and albedo were determined over a greater domain (10 km by 10 km) centered on Westside Mine meteorological station as recommended.

The Westside Mine meteorological station is located in a clearing surrounded by treed areas. Land use within 10 km from the station comprises: treed areas (70%), urban/suburban areas (20%), grassland (4%), cultivated land (3%) and water (3%). Reference was made to the AERMET user's guide (EPA, 2004) and to Sturman and Tapper

(2006) in assigning surface roughness, Bowen ratio and albedo values to designated land cover categories.

The land use values of surface roughness, Albedo and Bowen rations are tabulated below. The surface roughness was allocated consistent with a coniferous forested area. The Bowen ratio and Albedo were allocated on a monthly varying basis to account for seasonal effects, as indicated by the ranges given in the table.

Surface Roughness	Albedo	Bowen
1.3	0.13 – 0.36	0.7 – 1.5

Meteorological Inputs

AERMET typically requires surface and upper air meteorological data as input. The Breeze version of AERMET facilitates the input of UK-ADMS meteorological data without the need for upper air data due to this package incorporating the PBLAER module. PBLAER computes mixing heights in the absence of upper air sounding data, using a semi-empirical method to estimate the surface similarity parameters of friction velocity, sensible heat flux, temperature scale and Monin-Obukhov length using the routinely collected meteorological variables of cloud cover, ceiling height, wind speed, temperature and estimates of surface roughness (Trinity Consultants, 2007). Surface meteorological data for the modeling period (January 1 2007 to December 31 2007) from the Westside Mine meteorological station were formatted in ADMS format for input to AERMET.

AERMET Outputs

AERMET calculates planetary boundary layer parameters, including: friction velocity, Monin-Obukhov length, convective velocity scale, temperature scale, mixing height and surface heat flux. These parameters are used, in conjunction with measurements, to calculate vertical profiles of wind speed, lateral and vertical turbulent fluctuations, potential temperature gradient and potential temperature.

AERMET outputs two files: a surface data file and a profile data file for input to AERMOD (US-EPA, 2004).

TAPM Meteorological Modelling

Due to cloud cover not being available for input in AERMET, and the importance of the AERMET meteorological outputs for AERMOD accuracy, the decision was taken to generate cloud cover data using TAPM.

The CSIRO's The Air Pollution Model (TAPM) is a prognostic model which may be used to predict three-dimensional meteorological data, with no local data inputs required. The model predicts wind speed and direction, temperature, pressure, water vapour, cloud, rain water and turbulence. The program allows the user to generate synthetic observations by referencing databases, including terrain, vegetation and soil type, temperature and synoptic scale meteorological analysis, which are subsequently used in the model input to generate site-specific hourly meteorological observations. TAPM is routinely used in Australia to provide meteorological input data for dispersion modeling.

TAPM was run for the period January 1 2007 to December 31 2007 with surface data and profile data files being generated. The cloud cover calculated by TAPM was used in the surface meteorological file for input into the AERMOD dispersion modelling.

AERMOD Dispersion Modelling

Model Inputs

Input data types required for the AERMOD model include: topography, meteorological data (from AERMET/TAPM), source data (from the emissions inventory compiled), and information on the nature of the receptor grid.

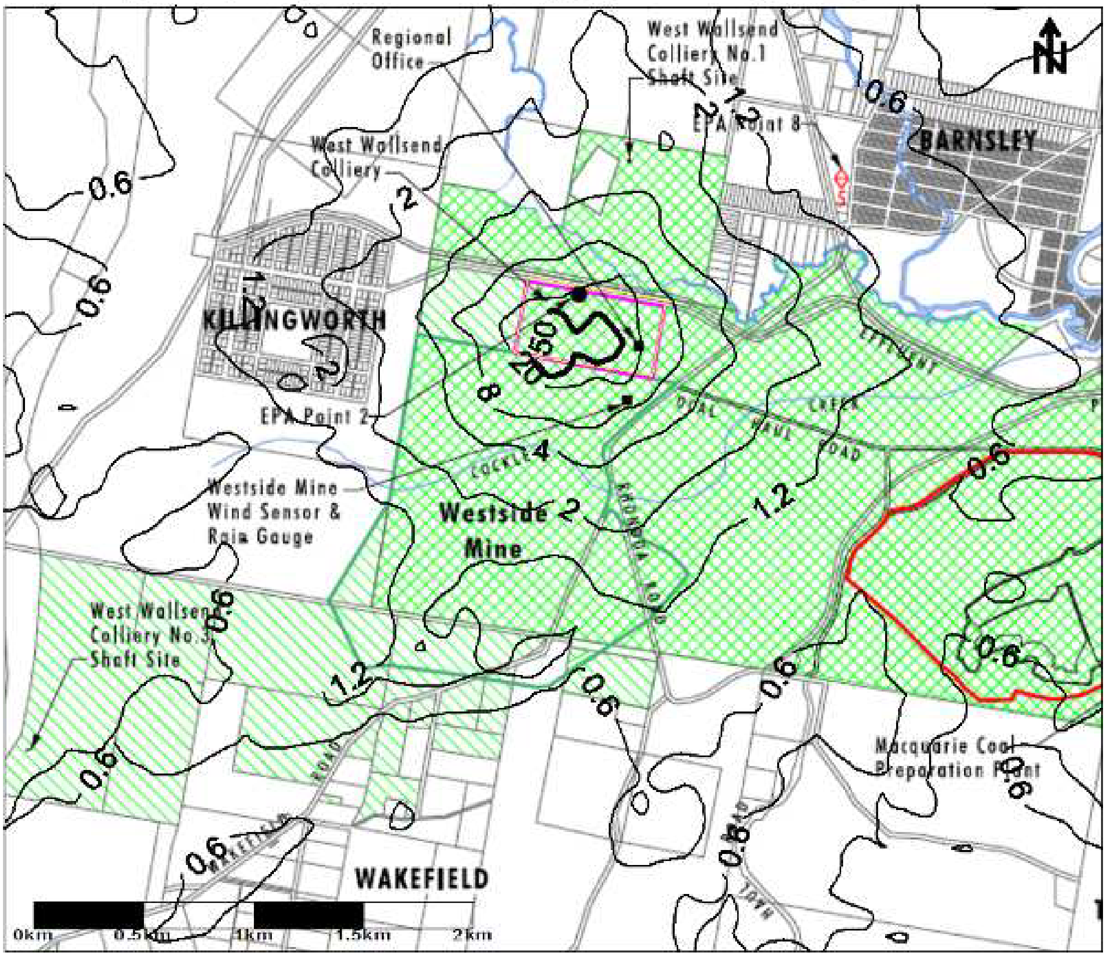
Model Accuracy

Base on the findings of the verification studies it is expected that AERMOD will perform well in the current case, particularly given the near-field and flat terrain nature of the application. AERMOD predictions are likely to be within 20% of actual peak concentrations and within 40% of longer-term averages.

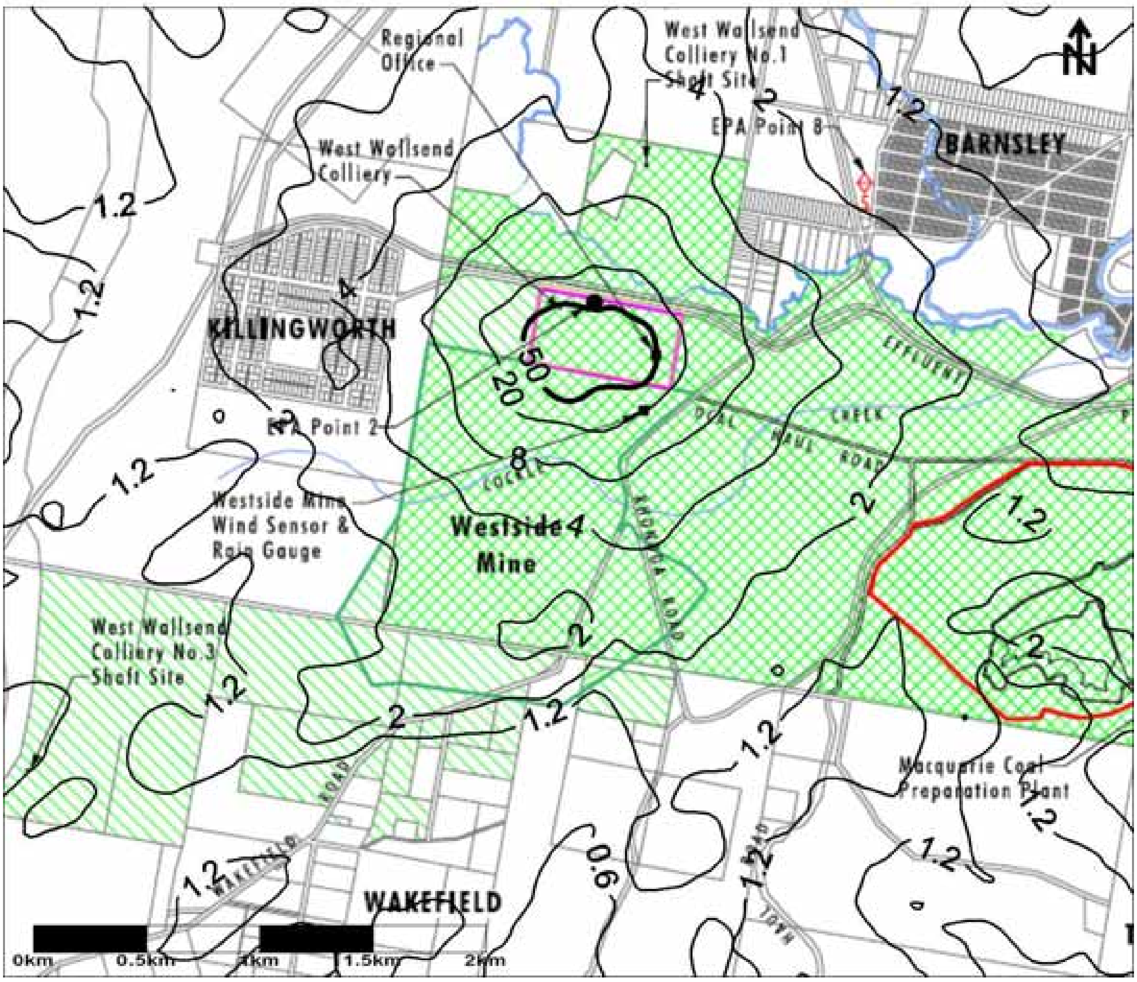
The accuracy of model predictions is dependent on model suitability, the accuracy of the emissions and meteorological data use and the complexity of the terrain and is typically in the range of -50% to 200%. Considering the ratings of the emission factors applied, the high level of meteorological data availability, the uncomplicated nature of the local terrain and the capabilities of the dispersion model selected, the level of uncertainty in the model predictions is estimated to be well in the typical range. Model performance and accuracy was taken into account in the air quality assessment.

Appendix 4
Isopleth Plots of PM_{10} and TSP Concentrations and Dust Deposition due to Existing WWC Operations and Project-related Operations

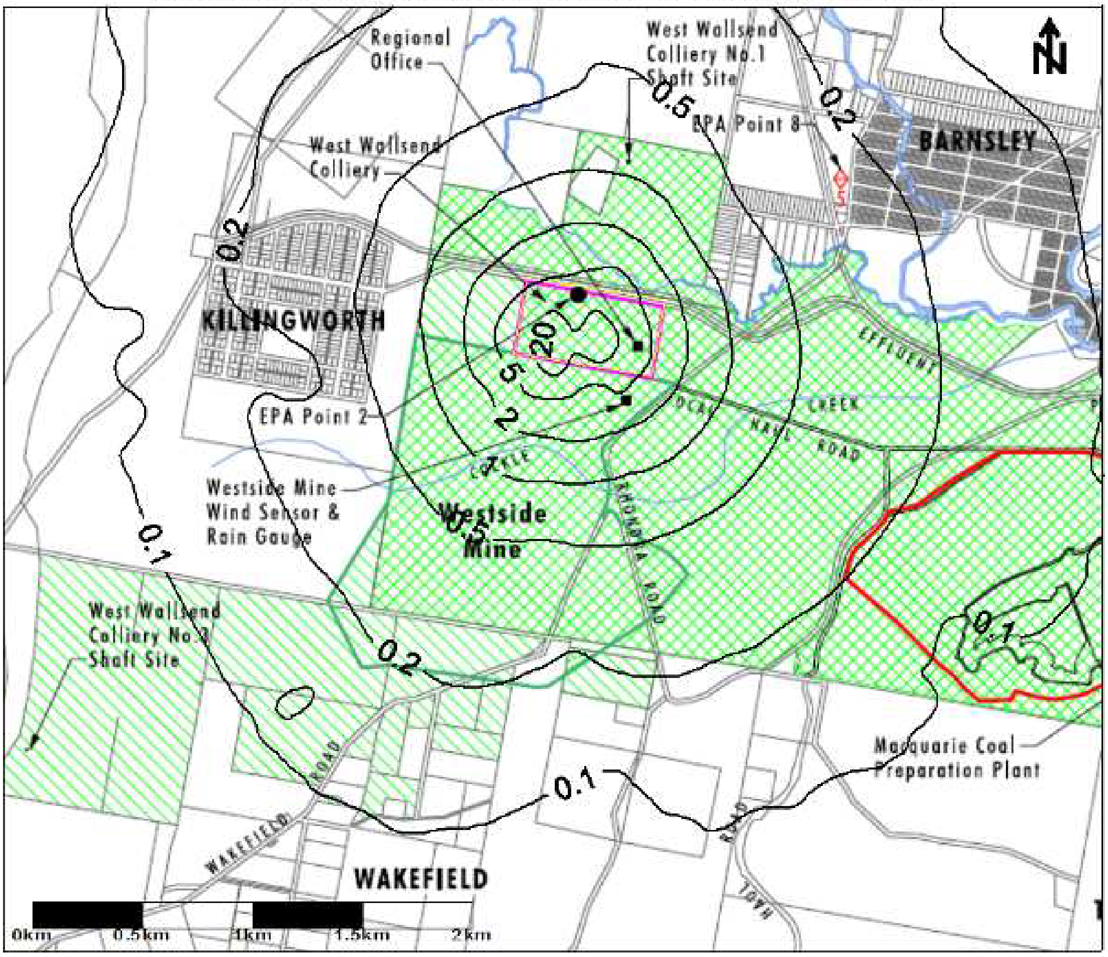
Highest Daily Average PM10 Concentrations (µg/m³) due to Existing WWC Operations



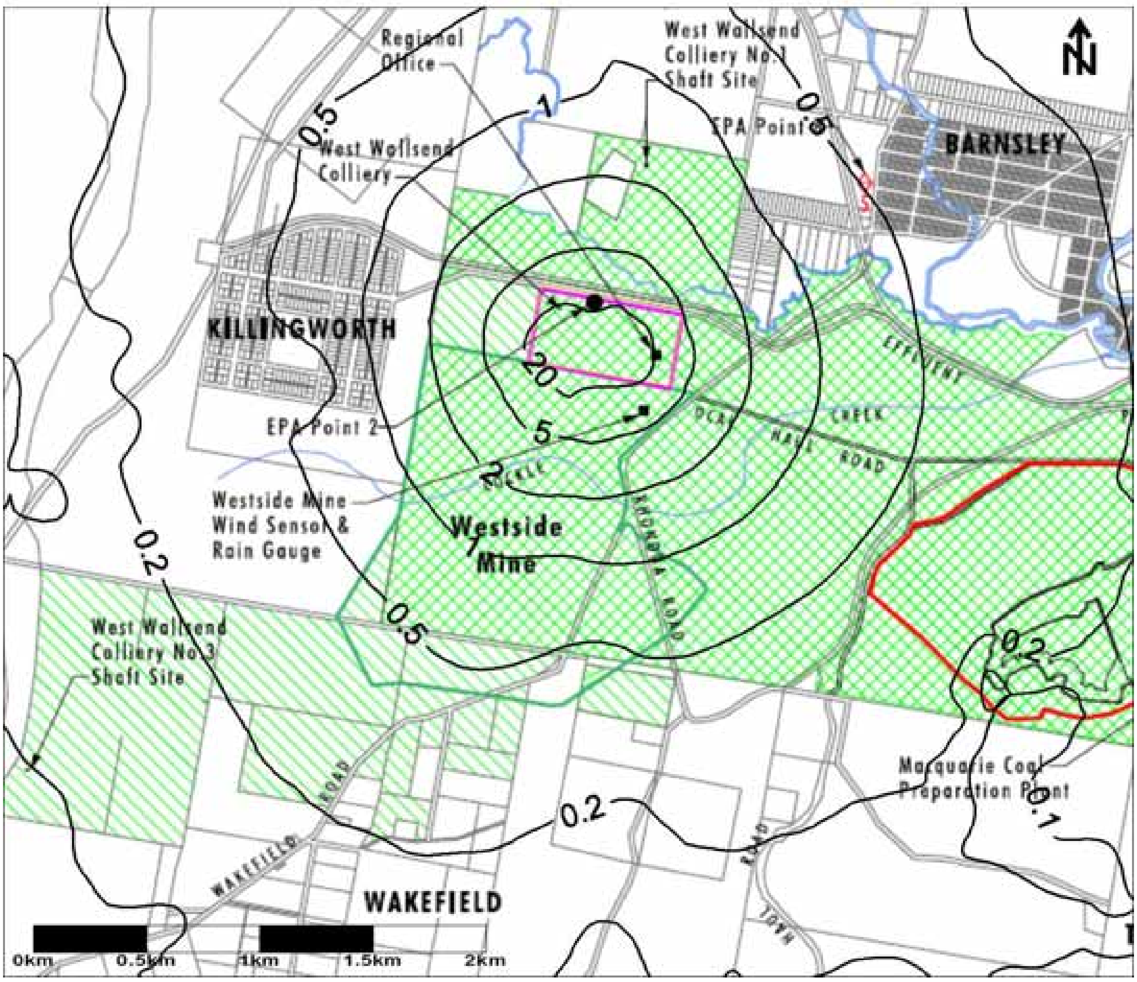
Highest Daily Average PM10 Concentrations (µg/m³) due to Proposed Future WWC Operations



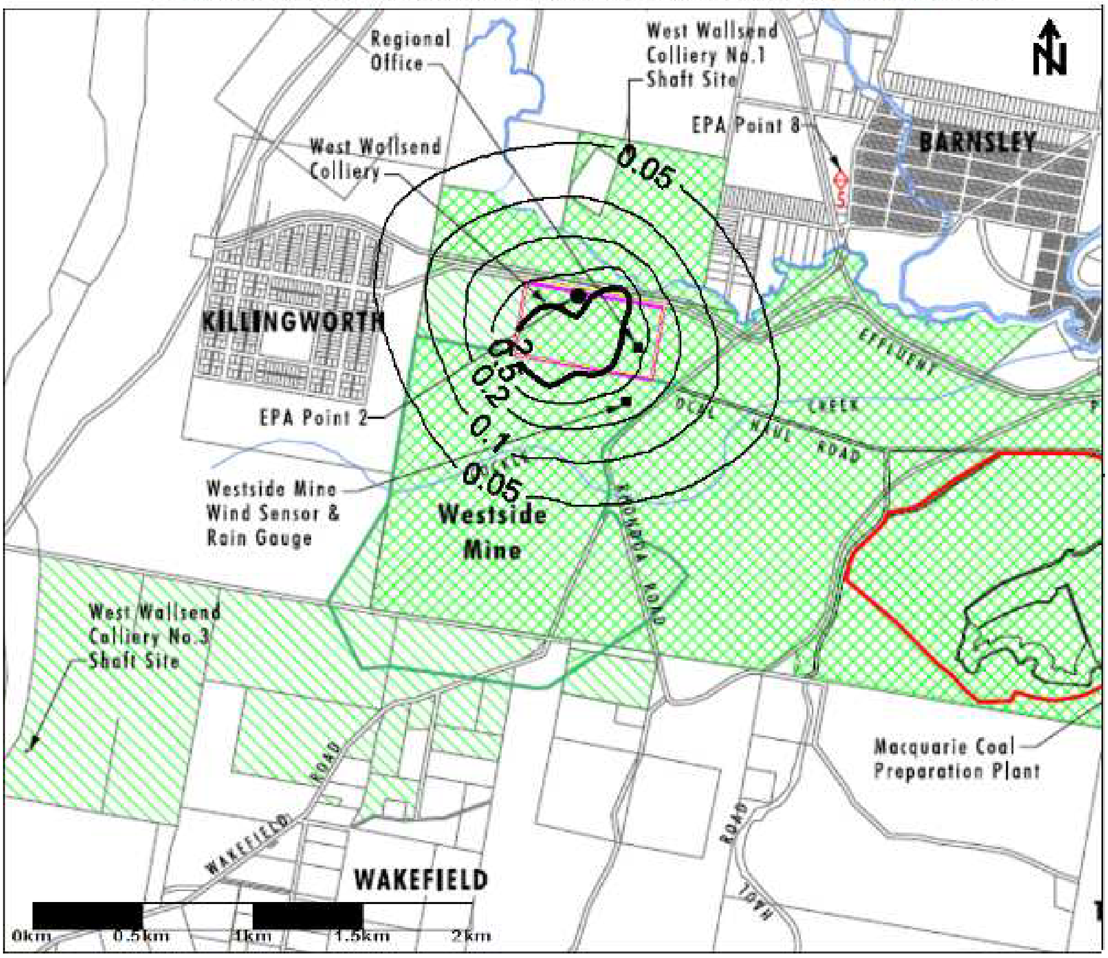
Annual Average PM10 Concentrations (µg/m³) due to Existing WWC Operations



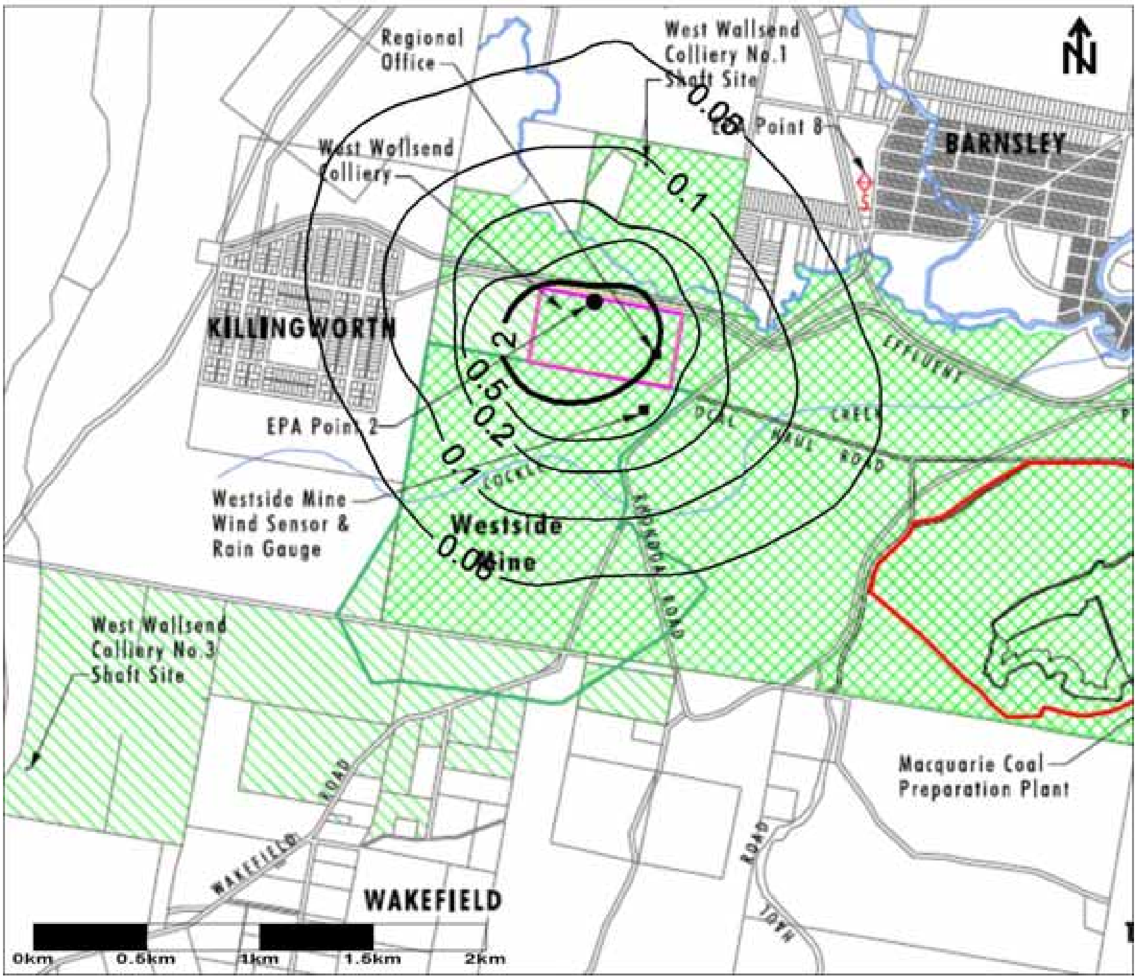
Annual Average PM10 Concentrations (µg/m³) due to Proposed Future WWC Operations



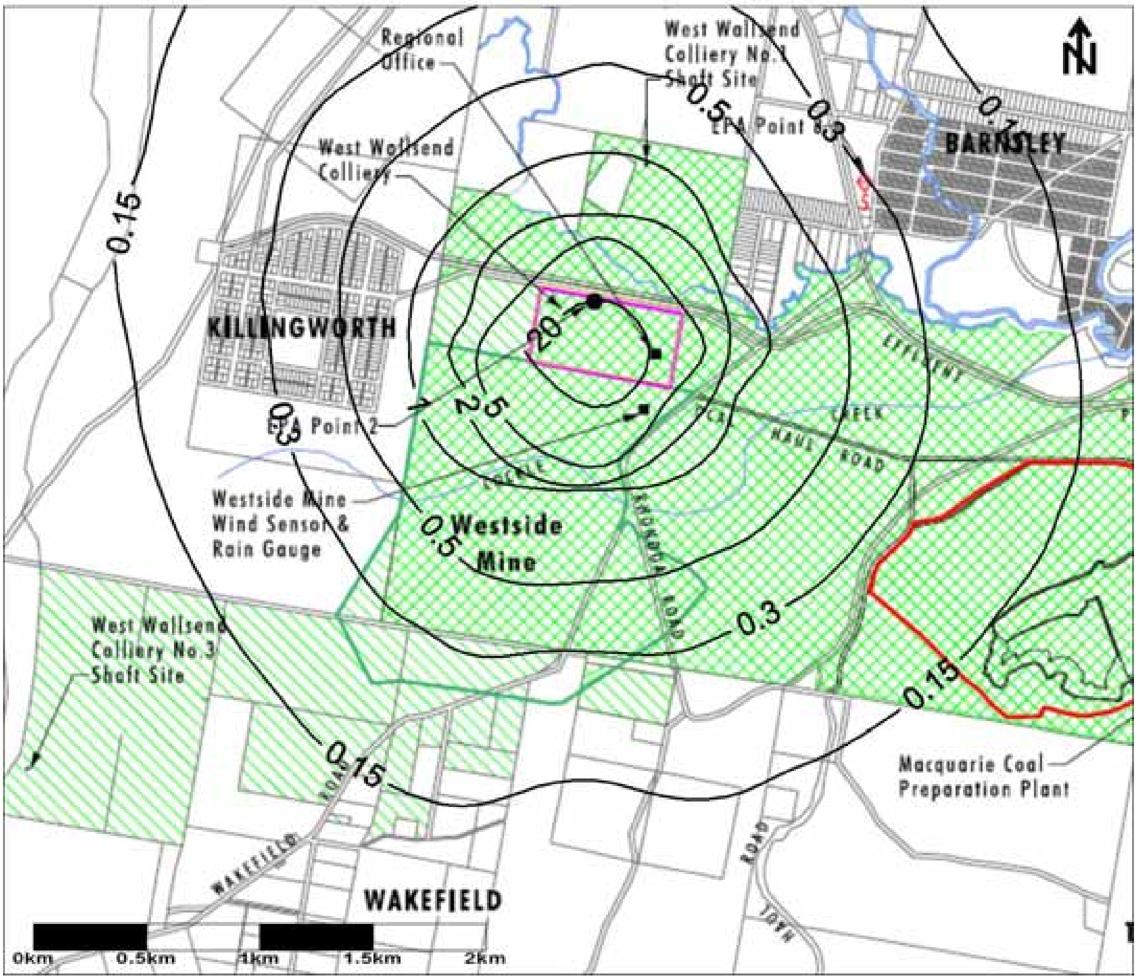
Annual Average Dust Deposition Rates (g/m²/month) due to Existing WWC Operations



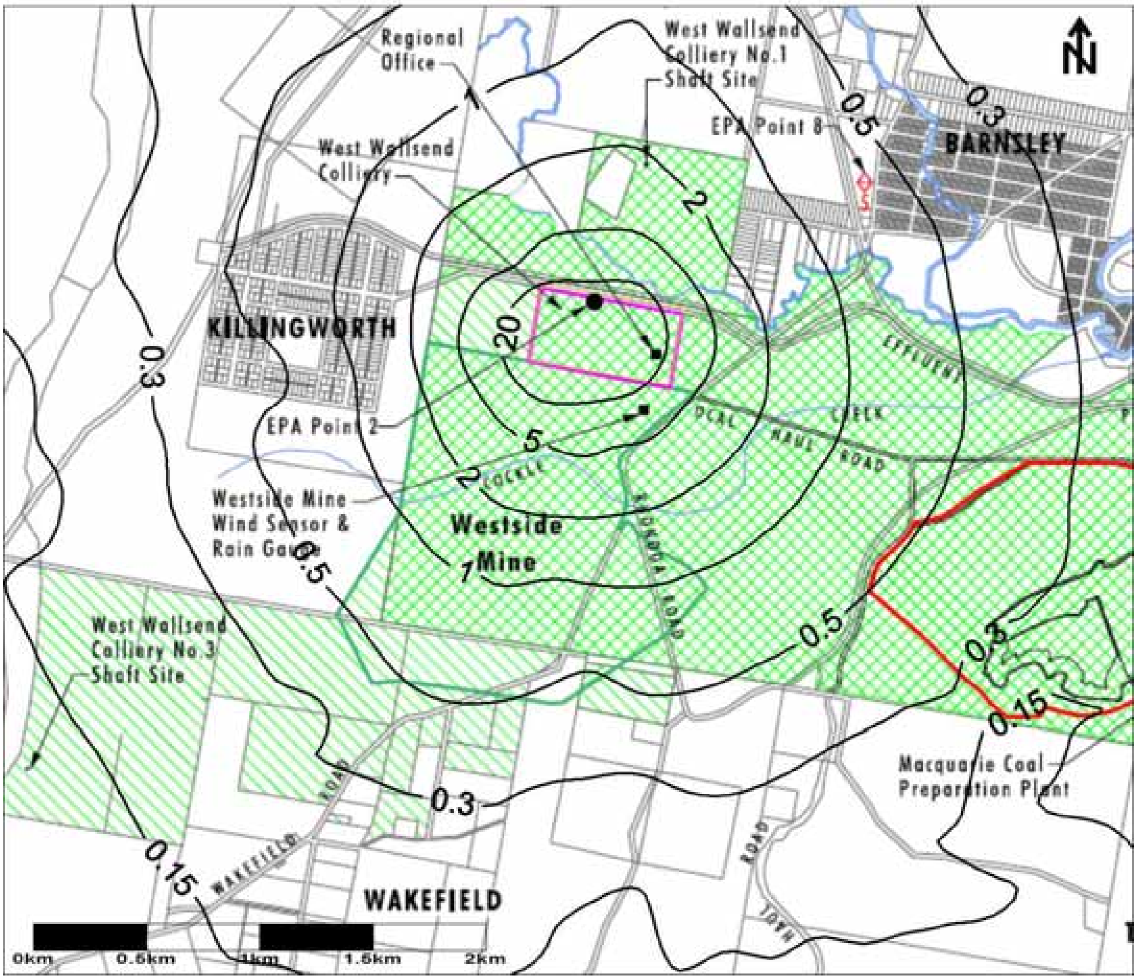
Average Annual Dust Deposition (g/m²/month) due to Proposed Future WWC Operations



Annual Average TSP Concentrations (µg/m³) due to Existing WWC Operations



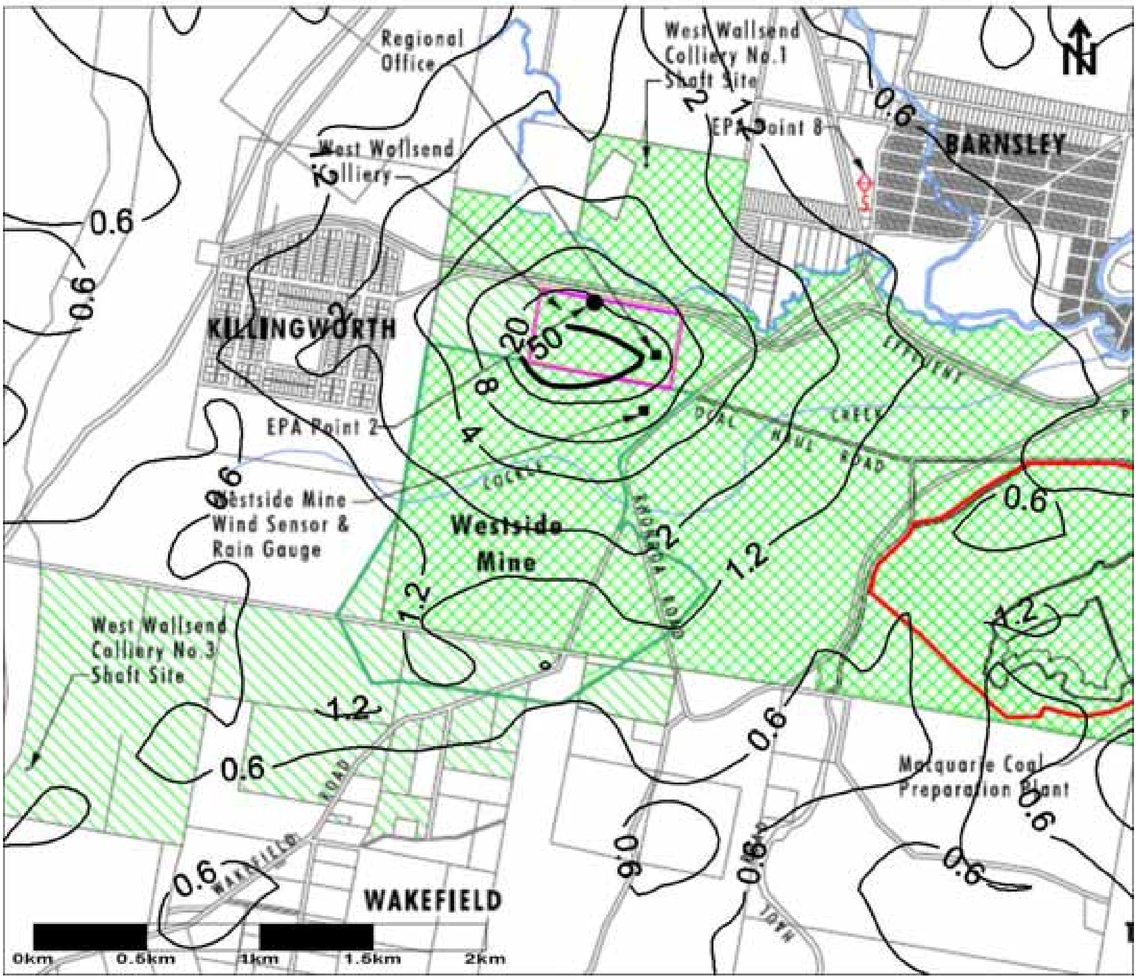
Average Annual TSP Concentrations (µg/m³) due to Proposed Future WWC Operations



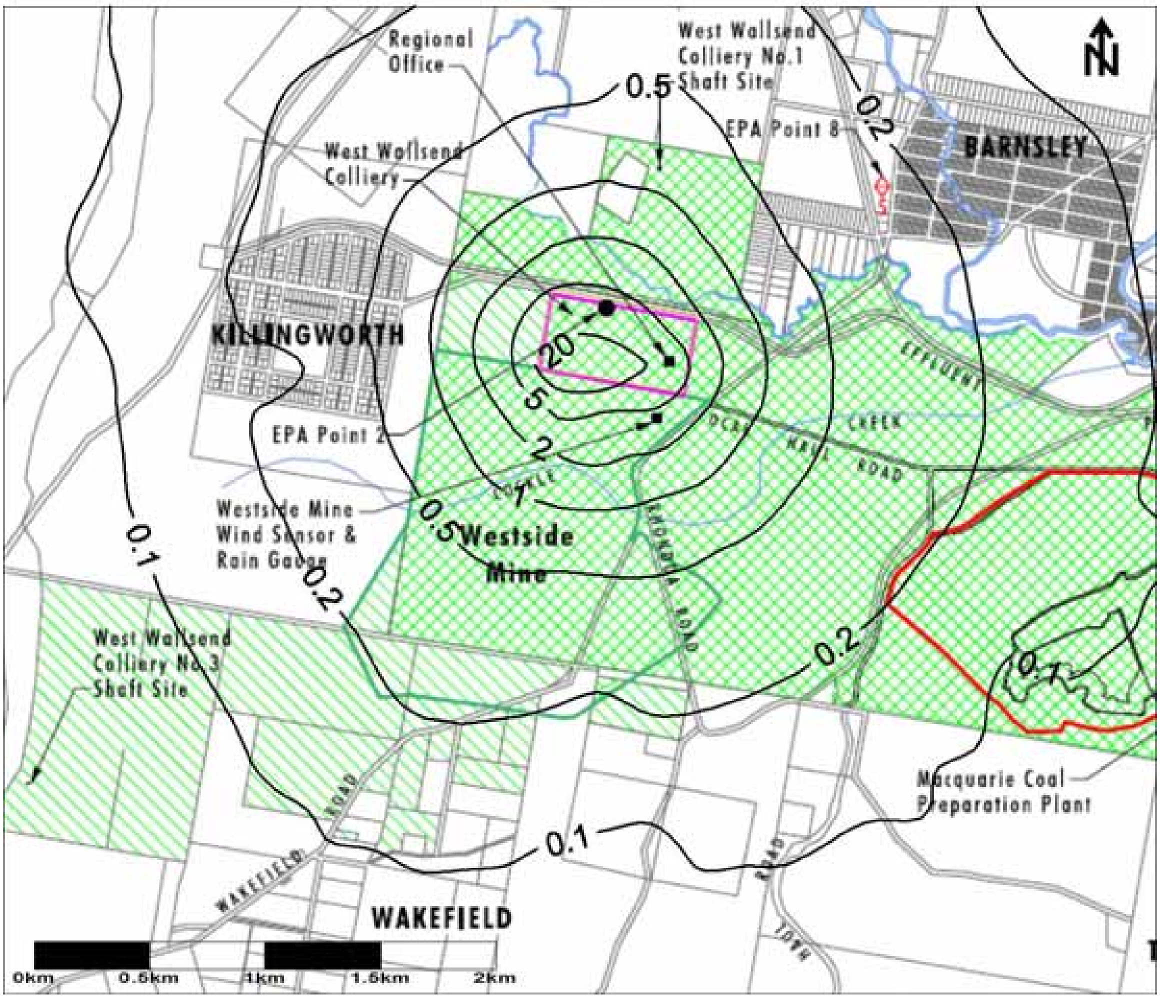
Appendix 5
Isopleth Plots of Incremental[2] PM_{10} Concentrations and Dust Deposition due to Project-related Emissions

2 Represents Project-related increments in PM_{10} concentrations and dust deposition above that which is currently predicted to occur due to existing WWC operations

Increment in Highest Daily Average PM10 Concentrations (µg/m³) due to Project-related Emissions



Increment in Annual Average PM10 Concentrations (µg/m³) due to Project-related Emissions



Increment in Annual Average Dust Deposition Rates (g/m²/month) due to Project-related Emissions