APPENDIX 9

Air Quality Impact Assessment

Mackas Sand

Air Quality Impact Assessment of Sand Extraction Operations from Lot 218 DP 1044608 and Lot 220 DP 1049608, Salt Ash

April 2009

Umwelt
Environmental Consultants

Air Quality Impact Assessment of Sand Extraction Operations from Lot 218 DP 1044608 and Lot 220 DP 1049608, Salt Ash

Prepared by

Umwelt (Australia) Pty Limited

on behalf of

Mackas Sand

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Report No.	1646/R11/FINAL	Date:	April 2009

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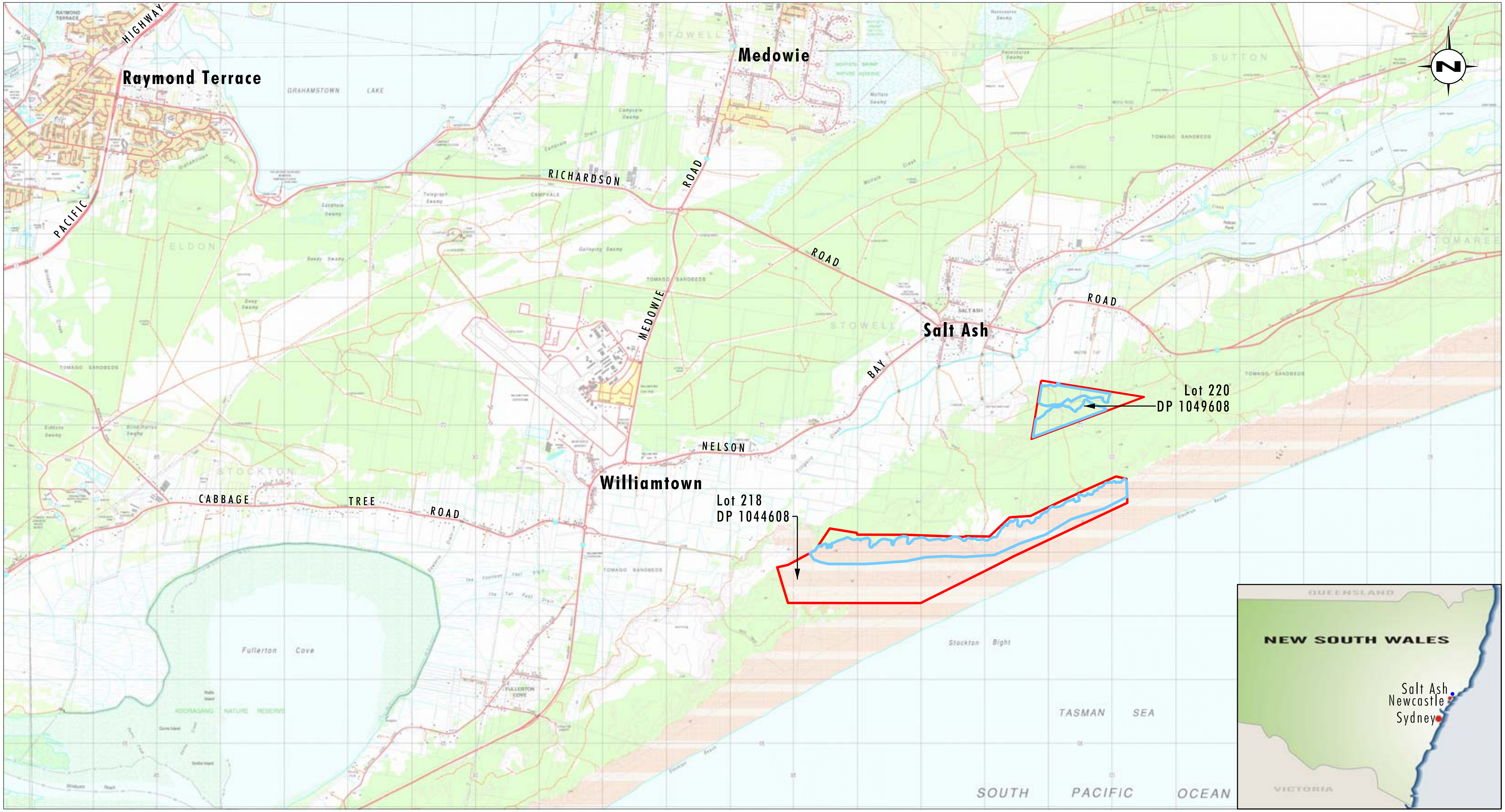
1.0 Introduction

Mackas Sand has operated a sand extraction and soil supply business based in Salt Ash since 1992. Mackas Sand currently operates a sand quarry at Salt Ash, NSW that will cease operating in early 2009 due to exhaustion of sand resources.

Mackas Sand proposes to extract industrial grade and construction sand resources from two sites at Salt Ash along the edge of at Stockton Bight (refer to **Figure 1.1**) on behalf of the Worimi Local Aboriginal Land Council (Worimi LALC). The extraction will be undertaken at the locations shown on **Figure 1.1** which are known as Lot 218 in DP 1044608 and Lot 220 in DP 1049608. The sites form part of the Stockton Bight dune system and are located approximately 20 to 25 kilometres to the north-east of Newcastle (refer to **Figure 1.1**).

This Air Quality Impact Assessment has been prepared by Umwelt (Australia) Pty Limited (Umwelt) on behalf of Mackas Sand to identify key issues relating to air quality to be addressed in the Environmental Assessment (EA) as required by the Director-General. This Air Quality Impact Assessment has been undertaken in accordance with requirements of the Department of Environment and Climate Change (DECC) and relevant industry standards.



Source: Department of Lands, 2006

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Legend

- Lot Boundaries (218 & 220)
- Proposed Operational Areas

FIGURE 1.1

Locality Plan

2.0 Project Description and Potential Dust Sources

2.1 Study Area

The study area for this assessment consists of the proposed Lot 218 operational area, Lot 220, two proposed access roads and the existing access roads shown on **Figure 2.1**. Lot 218 primarily consists of unvegetated outer mobile dunes and is surrounded by vegetated dunes to the north, mobile dunes to the south. A sand quarry adjoins the northernmost part of the site (refer to **Figure 2.1**). Lot 220 adjoins an existing sand extraction operation immediately to the west and is located approximately 750 metres east of an existing Mackas Sand operation. Rural land holdings and a small sand quarry operated by Hunter Quarries adjoin the site to the north, while sand dunes adjoin the eastern and southern property boundaries (refer to **Figure 1.1**).

2.2 Project Description - Operational Phase

2.2.1 Operations

The proposed sand extraction operations will involve the preparation of the site, extraction of sand with front-end loaders, transport operations and site rehabilitation as required. Some extracted sand will be processed through either vibrating screens or a sand processing plant located at Lot 220 prior to being transported off site.

Development of Lot 218 will involve the establishment of an extraction area up to 150 metres wide along the landward margin of the transgressive dune. Up to four front-end loaders will be used to work the area.

Development of Lot 220 will be undertaken in stages and will involve the staged removal of vegetation and topsoil by bulldozer, followed by sand extraction and loading with up to four front-end loaders working the area.

It is anticipated that up to 2 million tonnes of sand would be extracted from the combined operations each year, with a maximum of 1 million tonnes coming from either site.

2.2.2 Access

Transport operations from both extraction areas will utilise Nelson Bay Road (MR108) to access regional and state-wide transport routes. Access routes to both sites are shown on **Figure 2.1**. Access from Lot 218 to Nelson Bay Road is provided via Lavis Lane and an existing private access road (refer to **Figure 2.1**). A new access road approximately 50 metres in length will be created on Lot 227 in DP 1097995 to access Lot 218. Access from Lot 220 to Nelson Bay Road will occur through Oakvale Road and an existing unsealed road. A new unsealed access road with a length of approximately 550 metres will be constructed between Oakvale Road and Lot 220 (refer to **Figure 2.1**).

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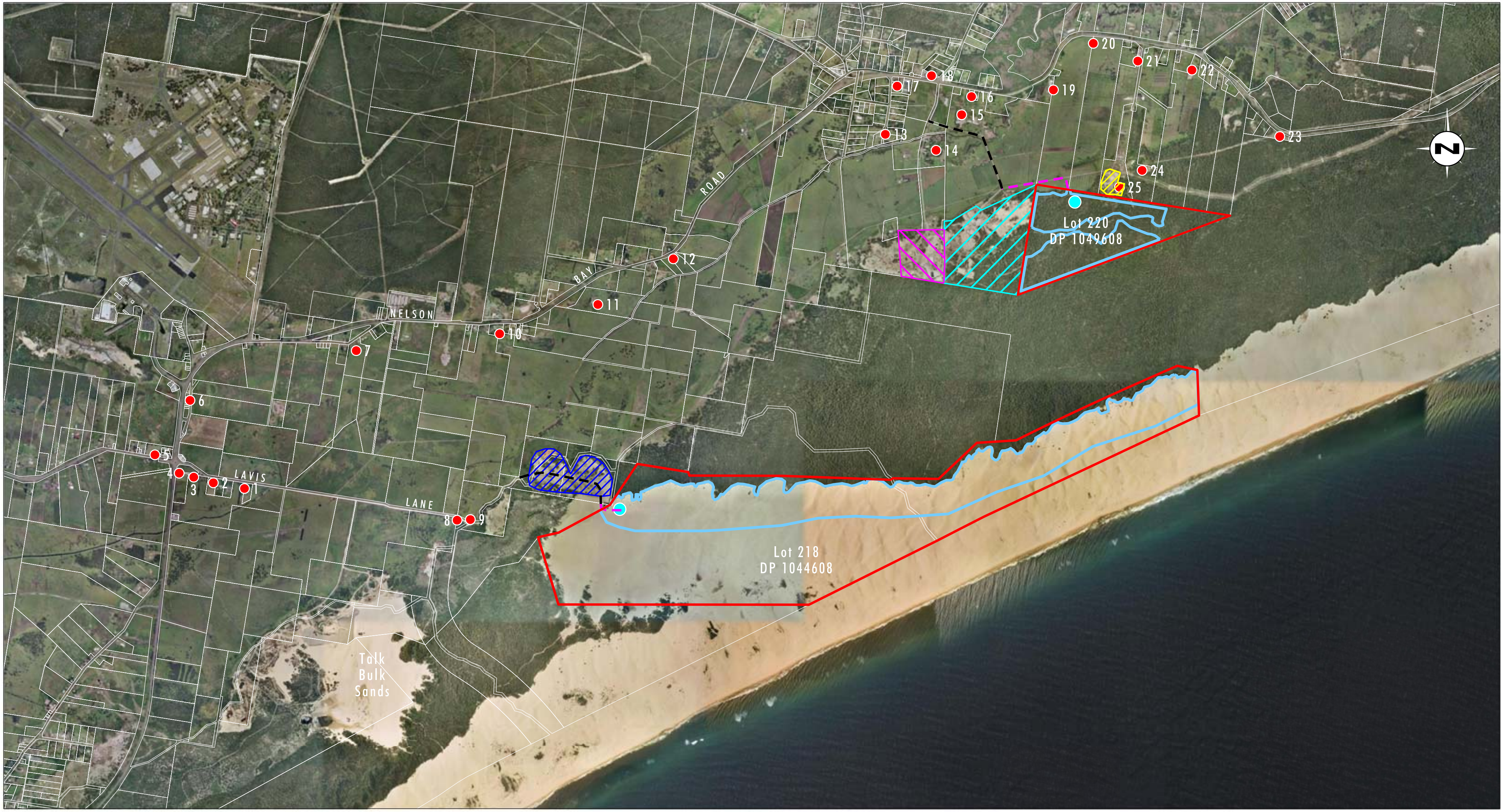

Source: Department of Lands (2003)

0 0.5 1 2km
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Legend

- Lot Boundaries (218 & 220)
- Mackas Sand (existing operations)
- Unimin
- Hunter Quarries
- Quality Sands and Ceramics
- Proposed Operational Area
- Proposed Weighbridge
- Site Access
- Proposed Site Access
- Air Receiver

FIGURE 2.1

Conceptual Layout of Proposed Operations

File Name (A4): R11_V1/1646_123.dgn

2.3 Dust Emission Sources

The activities associated with the proposed operations with the potential to generate dust include:

- operation of front-end loaders within the extraction areas;
- loading by front-end loaders to the sand processing plant, trucks or stockpiles;
- sand processing using vibrating screens;
- dust generated by haul truck movements; and
- wind blown dust from raw and product stockpiles.

2.4 Nearest Sensitive Residential Receivers

The nearest potentially affected residences to the site are shown on **Figure 2.1**. The residences are located in Salt Ash and Williamtown, along Nelson Bay Road and smaller rural streets. The surrounding area can be characterised as typical of a rural landscape. Residential dwellings located within approximately two kilometres of the site have been assessed as being potentially affected by air quality impacts. The locations of the nearest dwellings to the proposed development are given in **Table 2.1**.

Table 2.1 – Summary of Nearby Residential Receivers

Residence ID	Easting (MGA)	Northing (MGA)	Elevation (mAHD)
1	392296	6368160	2
2	392037	6368207	2
3	391874	6368254	2
4	391753	6368287	2
5	391551	6368440	2
6	391843	6368893	2
7	393226	6369307	2
8	394065	6367896	2
9*	394175	6367901	2
10	394419	6369447	2
11	395236	6369691	2
12	395864	6370071	2
13	397628	6371107	2
14	398050	6370974	2
15	398263	6371270	2

* this residence is part of the proposed development

Table 2.1 – Summary of Nearby Residential Receivers (cont)

Residence ID	Easting (MGA)	Northing (MGA)	Elevation (mAHD)
16	398345	6371421	2
17	397726	6371508	2
18	398012	6371595	2
19	399026	6371477	2
20	399358	6371864	2
21	399728	6371717	9
22	400179	6371642	2
23	400909	6371089	2
24	399764	6370807	2
25	399576	6370667	20

3.0 Air Quality Criteria

Sources of particulate matter may be naturally occurring or anthropogenic (that is, those produced by human activities). Naturally occurring particulates may be derived from dust storms, bush or grassland fires and living vegetation. Human activities, such as the burning of fossil fuel in vehicles, power plants and many industrial processes, also generate significant amounts of fine particles. Anthropogenic dust currently accounts for approximately 10 per cent of the total amount of dust concentrations in the global atmosphere. Increased levels of fine particles in the air are linked to health hazards such as heart disease and altered lung function.

3.1 Total Suspended Particulate and PM_{10} Particulate Matter

Particulate matter (PM) refers to tiny particles of solid or liquid suspended in air. Typical particle sizes range from less than 50 micrometres (µm) to 0.1 µm. Particulate matter less than 50 µm in size is referred to as total suspended particulates or TSP. Particles less than 10 µm in diameter are referred to as PM_{10} particles.

The NSW Department of Environment and Climate Change (DECC) defines air quality assessment criteria applicable to PM_{10} in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (DECC, 2006). These criteria are equivalent to the reporting standard for PM_{10} defined by the National Environmental Protection Council (NEPC) in the National Environment Protection Measure (or NEPM) for Ambient Air Quality (NEPC, 1998).

The National Health and Medical Research Council (NHMRC) defines an annual goal of 90 µg/m^3 for TSP as part of their 92^{nd} session in 1981.

The criteria for PM_{10} and TSP are outlined in **Table 3.1**.

Table 3.1 – Goals for Particulate Matter Concentrations

Pollutant	Goal (µg/m^3)	Averaging Period	Reference
Particulate matter < 10µm (PM_{10})	50	24-hour maximum	DECC (2006)
	30	Annual mean	DECC (2006)
	50	24-hour average, 5 exceedances allowed per year	NEPC (1998)
Total suspended particulate matter (TSP)	90	Annual mean	NHMRC (1981)

3.2 Dust Deposition

Dust is a general name for solid particles (insoluble solids) with diameters less than 500 µm. Dust is present in the atmosphere as a result of various events such as soil dust being lifted by wind, emissions from fires or dust generated by a volcanic eruption. Airborne dust is considered an aerosol and impacts on the atmosphere and the local climate. Under certain circumstances, large amounts of dust (such coal dust or flour) dispersed within the air in an enclosed space can present an explosion hazard. Airborne dusts can also contribute to occupational lung diseases such as pneumoconiosis.

Dust deposition is the process by which solid particles collect or deposit themselves on solid surfaces. The DECC defines dust deposition goals in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (DECC, 2006). These goals are presented in **Table 3.2**.

Table 3.2 – Goals for Dust Deposition

Pollutant	Goal ($g/m^2/month$)	Averaging Period	Reference
Maximum Increase in Deposited Dust Level	2	Annual	DECC (2006)
Maximum Total Deposited Dust Level	4		

3.3 Project Specific Air Quality Criteria

A summary of the applicable air quality criteria for the proposed operations are outlined in **Table 3.3**.

Table 3.3 – Project Specific Air Quality Criteria

Pollutant	Maximum Allowable Concentration	Averaging Period
PM_{10}	50 $\mu g/m^3$ (5 exceedances allowed per year)	24 hours
PM_{10}	30 $\mu g/m^3$	Annual
TSP	90 $\mu g/m^3$	Annual
Dust Deposition	2 $g/m^2/month$ (maximum increase in deposited dust level)	Annual

4.0 Existing Environment

4.1 Local Climatic Conditions

Local climatic information has been obtained from Bureau of Meteorology (BoM) Station 'Williamtown RAAF' over the period 1942 to 2000. Williamtown is located approximately four kilometres north-east of Lot 218. A summary of average climatic conditions at Williamtown is summarised in **Table 4.1**.

Table 4.1 – Climate Averages at BOM Station 'Williamtown RAAF' for Period 1942 to 2008

Parameter (Average)	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Maximum Temperature (°C)	27.9	27.5	26.2	23.6	20.2	17.6	17.0	18.6	21.2	23.6	25.4	27.2	23.0
Minimum Temperature (°C)	18.0	18.1	16.3	13.2	10.1	7.8	6.4	6.9	9.0	12.0	14.2	16.5	12.4
Daily Evaporation (mm)	6.9	6.2	4.9	3.8	2.7	2.5	2.6	3.5	4.6	5.6	6.3	7.2	4.7
Rainfall (mm)	99.9	121.4	121.7	104.3	113.7	121.0	71.6	78.1	59.4	74.5	80.9	80.0	1124.8
Temp. at 9am (°C)	23.0	22.5	21.2	18.2	14.3	11.5	10.4	12.2	15.6	18.8	20.4	22.2	17.5
Cloud Cover at 9am (oktas)	26.4	26.0	24.9	22.5	19.3	16.8	16.2	17.6	20.0	21.9	23.8	25.6	21.8
Temp. at 3pm (°C)	4.4	4.6	4.4	4.3	4.4	4.4	4.0	3.8	3.9	4.4	4.4	4.3	4.3
Cloud Cover at 3pm (oktas)	4.9	5.1	4.7	4.1	4.2	4.2	3.5	3.3	3.5	4.4	4.6	4.8	4.3

Source: DECC 2008

As indicated in **Table 4.1,** January is the warmest month with a mean daily maximum temperature of 27.9°C. July is the coldest month with mean daily minimum temperature of 6.4°C. March is the wettest month with average monthly rainfall of 121.7 mm. September is the driest month with average monthly rainfall of 59.4 mm. The evaporation rates are highest in December with 7.2 mm per day and lowest in June with 2.5 mm per day.

4.2 Local Wind Conditions

An analysis of wind conditions in the area surrounding the proposed operations was undertaken by pDs Consultancy. The results of this analysis is presented in *Input Meteorological data file for Ausplume Williamtown – 2006* (pDs Consultancy 2008), attached as **Attachment A**. pDs Consultancy analysed the 2006 wind records collected at the BOM's 'Williamtown RAAF' Station. Annual and seasonal wind roses for Williamtown are presented in **Attachment A**. The annual wind rose indicates that light to moderate westerly winds dominate at Williamtown. Calm winds occur for 10 per cent of the time and winds exceeding 10 km/hr which tend to be associated with dust generation from erodible surfaces only occur one per cent of the time.

The seasonal wind roses for summer, which include periods when hot dry conditions increase the potential for dust emissions, indicate that moderate north-easterly winds dominate. These winds would act to direct emissions away from the nearest residential receivers.

The wind roses for autumn and winter indicate that light to moderate west to north-westerly winds dominate, and light to moderate north-easterly winds dominate in spring.

4.3 Atmospheric Stability

Atmospheric stability indicates the capacity of a body of air to resist or enhance vertical movement, thus impacting on the tendency of gas plumes to dissipate or settle. Atmospheric stability is assessed using the Pasquill-Gifford method based on six stability classes. These classes range from highly unstable Stability Class A, typified by strong winds and convective winds, generally present in summer, to Stability Class F which is highly stable and is associated with temperature inversions which generally occur in winter.

The BoM meteorological data from the 'Williamtown RAAF' Station was assessed by pDs Consultancy (2008) to determine the atmospheric stability of the region. The annual distribution of stability classes are presented in **Table 4.2**.

Table 4.2 – Annual Stability Distribution at Williamtown

Pasquill-Gifford Stability Class	Frequency of Stability Class [1]
A	1.0%
B	6.0%
C	15.0%
D	43.0%
E	17.0%
F	17.0%

Note 1: Total is less than 100% due to the amount of data used in analysis.
Source: Input meteorological data file for Ausplume Williamtown – 2006 (pDs Consultancy 2008).

4.4 Existing Air Quality Environment

Information regarding the existing air quality environment in the vicinity of the study area was available from the DECC monitoring sites at Beresfield and Newcastle, located 21 kilometres and 17 kilometres from the study area respectively. Background information for PM_{10} was available for 2006; however dust deposition monitoring has not been undertaken at these locations. As a result the dispersion modelling has been compared to DECC criteria for maximum increase in dust deposition and does not consider the maximum total deposited dust level (refer to **Table 3.3**).

Statistical analysis of the results obtained from Newcastle and Beresfield indicated the PM_{10} levels at both sites would suitably represent background PM_{10} conditions at the study area. Therefore both sets of monitoring data have been analysed as part of this assessment.

The background daily average PM_{10} levels recorded at Beresfield monitoring location are presented graphically in **Figure 4.1**. The background daily average PM_{10} levels recorded at Newcastle monitoring location are presented in **Figure 4.2**.

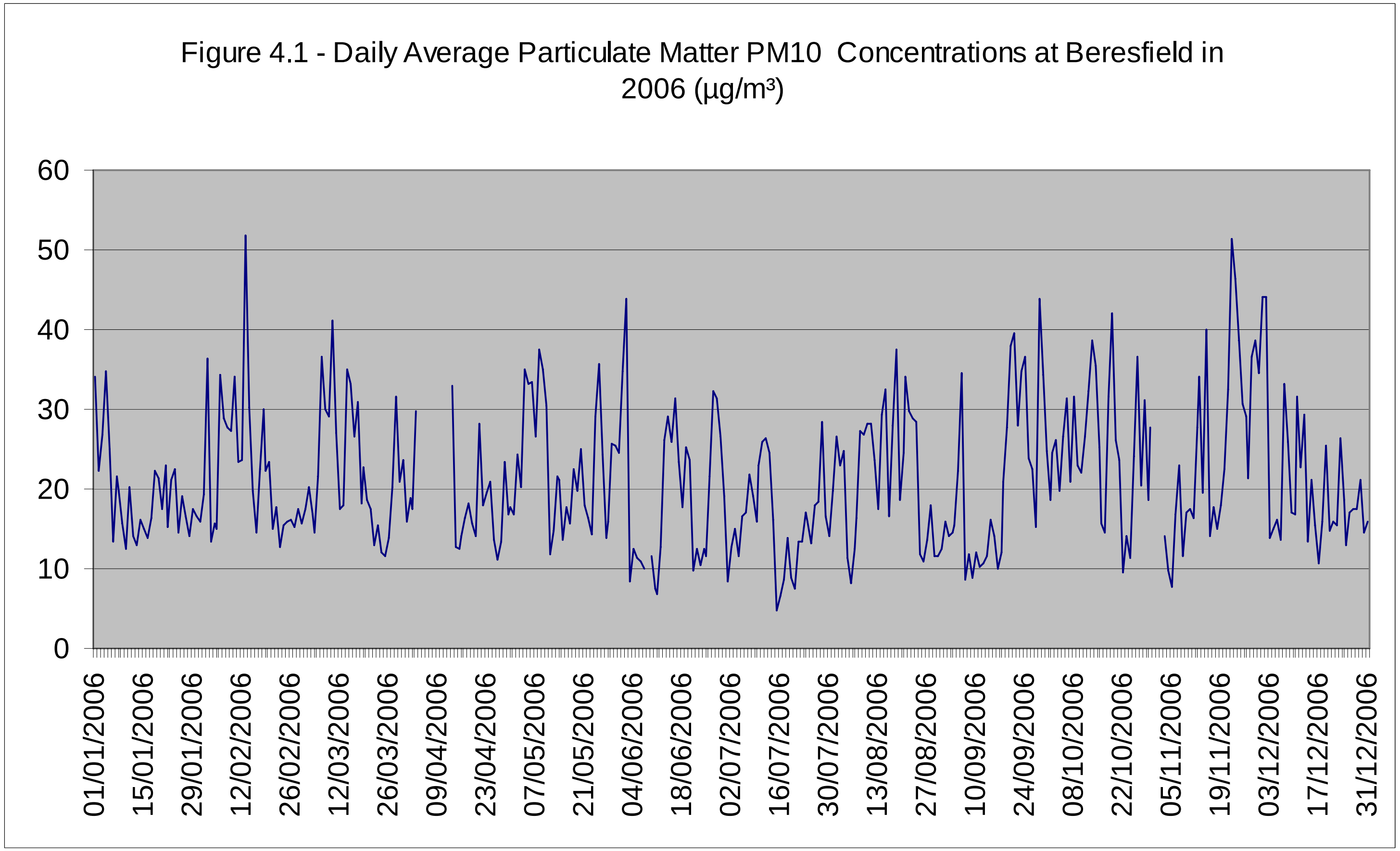

FIGURE 4.1

Daily Average Particulate Matter PM10 Concentrations at Beresfield in 2006 (µg/m³)

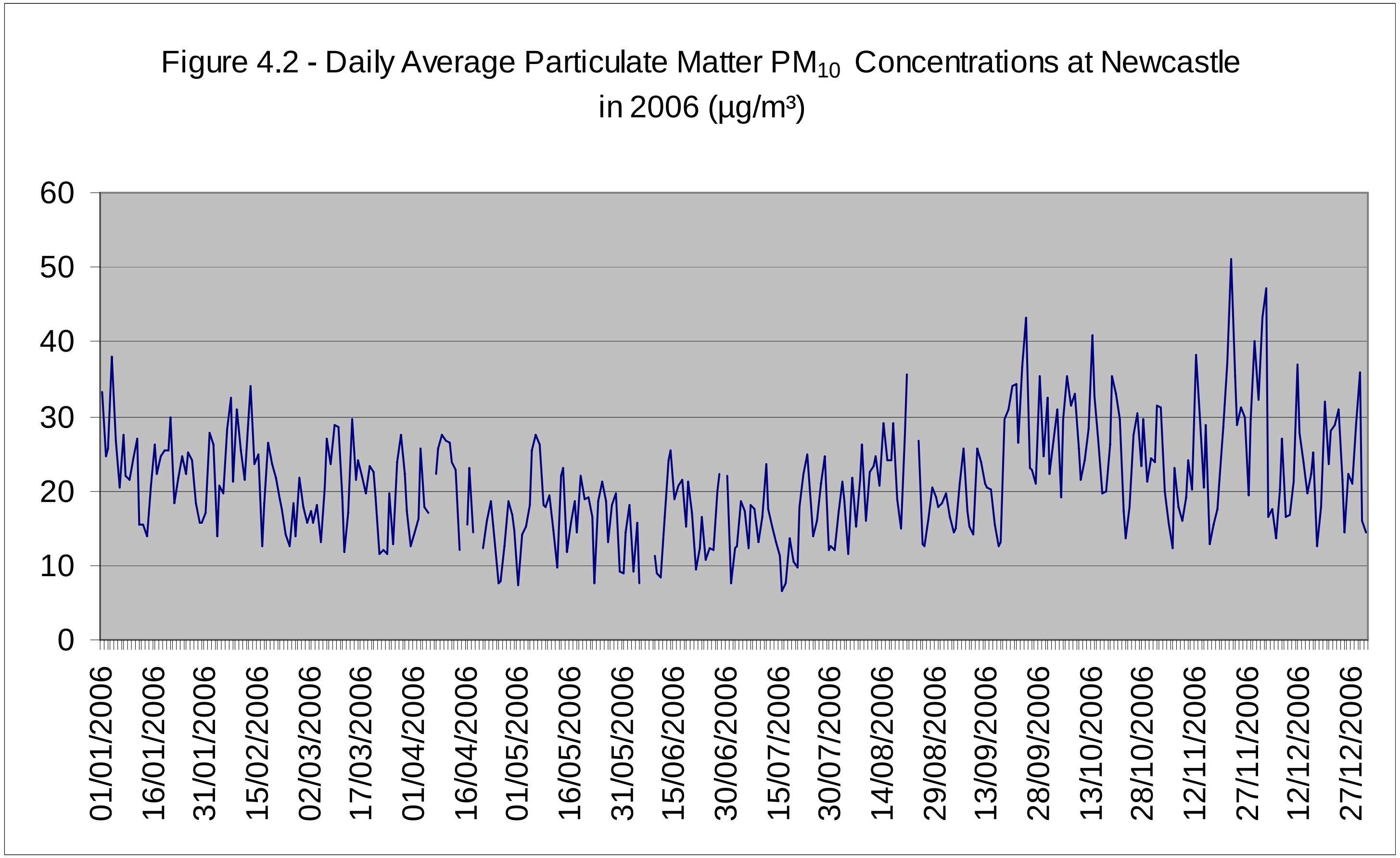

FIGURE 4.2

Daily Average Particulate Matter PM10
Concentrations at Newcastle in 2006 (μg/m³)

5.0 Atmospheric Dispersion Modelling

5.1 Assessment Methodology

Dispersion modelling involves the use of a computer model to simulate atmospheric conditions and the behaviour of pollutants. Dispersion models are used to determine the impact of a proposed development on the surrounding environment and determine concentration or deposition estimates for comparison against impact assessment criteria.

The DECC outlines two impact assessment levels for undertaking air impact assessment using dispersion models in *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (DECC 2006). These are:

- Level 1 impact assessments: screening-level assessments using worst-case input data (i.e. maximum pollutant loadings) overlaid onto the maximum background pollutant concentrations. The results represent a worst-case impact as they simulate maximum exposure levels at off-site receivers.

- Level 2 impact assessments: refined dispersion modelling assessments using site-specific background concentration and meteorological data to provide discrete dispersion model predictions that correlate to existing background concentrations.

A Level 1 assessment has been undertaken for the proposed operations due to the lack of site-specific background data for dust deposition, particulate matter and TSP.

5.2 Modelling Approach

The dispersion modelling was undertaken using AUSPLUME Gaussian plume dispersion model software (Version 6.0) developed by the former NSW Environment Protection Authority (EPA) (now DECC). AUSPLUME is a steady-state model, which assumes the atmosphere is a state of uniform flow, and that wind velocity is a function of height alone and does not vary with direction. AUSPLUME is the dispersion model used for the majority of assessments in New South Wales.

The dispersion modelling was conducted according to the methodology published in the AUSLPUME Gaussian Plume Dispersion Model: Technical User Manual (EPA, 2004) and the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (DECC 2006).

The dispersion model requires atmospheric dispersion data including wind speeds, wind directions, atmospheric stability classes and mixing heights relevant to the proposed development site. Meteorological data for dispersion modelling has been sourced from *Input Meteorological data file for Ausplume Williamtown – 2006* (pDs Consultancy 2008) and is attached as **Attachment A**.

5.3 Particulate Emission Factors Estimation

Emissions of atmospheric pollutants associated with the proposed operations were calculated using the emission estimation technique outlined by the National Pollutant Inventory (NPI) handbooks for mining and industry. These emission factors are used to estimate the potential average emissions associated with existing and proposed developments.

5.3.1 Emission Factor Estimation Methodology

Emission factors were determined for TSP and PM_{10} for the following activities:

- operation of front-end loaders within the extraction areas;
- loading by front-end loaders to the sand processing plant, trucks or stockpiles;
- sand processing using vibrating screens;
- wheel generated dust as a result of haul truck movements; and
- wind entrainment from raw and product stockpiles.

The emission factors relating to front-end loader operations and movements and wind entrainment were estimated using the equations presented in Table 1 of the *Emissions Estimation Technique Manual for Mining*, Version 2.3 (EETMM) (NPI, 2001). The emission factor for dry sand screening was estimated using Table 19 of *Emission Estimation Technique Manual for Mining and Processing of Non-Metallic Minerals*, Version 2.0 (NPI 2000).

The emission factor for the front-end loader sand extraction, loading and unloading was estimated using emission factor equation for Excavators/Shovels/Front-end Loaders on overburden (NPI, 2001). The equation is dependent on mean wind speed and material moisture content as follows:

$$E = k \times 0.0016 \times (U/2.2)^{1.3} / (M/2)^{1.4}$$

Where: E = emission factor
k = 0.74 for TSP, 0.35 for PM_{10}
U = Mean wind speed (m/a)
M = Moisture content (%)

The emission factor for wheel generated dust was estimated using emission factor equation for Wheel Generated Dust from Unpaved Roads (NPI, 2001) as follows:

$$E = K \times (s/12)^{A} \times (W/3)^{B} / (M/0.2)^{C}$$

Where: K = 2.82 for TSP and 0.733 for PM_{10}
s = Silt Content (%)
W = vehicle gross mass (tonnes)
A = 0.8 for PM_{10} and 0.8 for TSP
B = 0.4 for PM_{10} and 0.5 for TSP
C = 0.3 for PM_{10} and 0.4 for TSP
M = Moisture content (%)

Emission factors for the loading product stockpile and the wind entrainment from stockpiles were estimated using the default PM_{10} and TSP factors for Loading Stockpiles and Wind Erosion, respectively (NPI, 2001).

The emission factor for dry sand screening was estimated using the default PM_{10} factor for sand and gravel processing defined in the *Emission Estimation Technique Manual for Mining and Processing of Non-Metallic Minerals*, Version 2.0 (NPI 2000).

5.3.2 Emission Factors for Mackas Sand

Table 5.1 presents the emissions factors for atmospheric pollutants for the activities associated with the proposed development and used in the dispersion model. The emission inventory is presented in **Attachment B**.

Table 5.1 – Particulate Emission Factors for Air Quality Modeling

Activity	TSP Emission Factor	PM_{10} Emission Factor	Emission Factor Units
Front-end loader operation within the extraction area	0.0008	0.0004	kg/t
Front-end loader loading sand to vibrating screen	0.0008	0.0004	kg/t
Front-end loader loading sand to trucks from extraction areas or stockpiles	0.0008	0.0004	kg/t
Wheel generated dust (haul truck movements)	0.9587	0.3021	kg/VKT
Sand processing using vibrating screen	0.0056	0.0042	kg/t
Front-end loader loading raw and product stockpiles	0.004	0.0017	kg/t
Wind entrainment from product stockpiles	0.4	0.2	kg/ha/h

5.4 Modelling Scenarios

The model was run to predict the air quality impacts of the proposed operations under two scenarios with the objective of developing suitable dust mitigation measures to ensure compliance with the air quality criteria outlined in **Section 3**. The scenarios modelled for the proposed operations are presented in **Table 5.2**.

Table 5.2 – Modelling Scenarios for Air Quality Modelling

Scenario	Description	Controls
1	Proposed operations without dust mitigation measures.	No dust suppression controls.
2	Proposed operations with haul road dust suppression at Lot 218 and Lot 220.	75% dust suppression along length of haul roads at Lot 218 and Lot 220.

The impacts of dust suppression sprays on haul roads were assessed using the assumptions outlined in the *Emissions Estimation Technique Manual for Mining*, Version 2.3 (EETMM) (NPI 2001). It was assumed dust suppression along the haul roads would result in a 75 per cent reduction in dust emissions for a water application rate of greater than 2 L/m^2 per hour.

5.5 Assumptions

The following assumptions have been made as part of the dispersion model for the proposed operations:

- annual production of 2 million tonnes per year, with 1 million tonnes per year produced from each lot;
- 50 per cent of sand from Lot 218 will be screened on-site and 50 per cent will be loaded directly into trucks for off-site transport;
- 10 per cent of sand from Lot 220 will be loaded for immediate off-site transport, 40 per cent will be screened prior to off-site transport and 50 per cent will be washed in the sand processing plant prior to off-site transport;
- all sand will be transported from the site using private haul roads;
- equipment for sand extraction, loading, screening and washing will operate 24 hours per day, 7 days per week;
- off-site transport of sand will occur 17 hours per day, 7 days per week;
- unsealed sections of private haul roads of 3325 metres for Lot 218 and 1855 metres for Lot 220;
- equipment operating at Lot 218 will comprise four front-end loaders, one truck and one vibrating screen;
- equipment operating at Lot 220 will comprise four front-end loaders, one truck, one vibrating screen and one processing plant;
- two front-end loaders will operate at the extraction face;
- one front-end loader will load the vibrating screen and one will load trucks;
- the vibrating screen will follow the extraction face;
- stockpiles will generate wind erosion emissions and include the following:
  - raw sand stockpile located before the vibrating screen;
  - product sand stockpile located near the vibrating screen; and
  - each stockpile will store up to 5,000 tonnes with calculated area of 0.04 hectares and height of 7 metres;
- in the absence of site-specific data, estimates of sand moisture and silt content were made as follows:
  - moisture content for wheel generated dust emission factor estimation assumed to be 16 per cent for dense uniform sand (*Emission Estimation Technique Manual for Fugitive Emissions* (NPI 2001);
  - silt content for wheel generated dust emission factor estimation assumed to be 6 per cent for sand soils (*Estimating soil particle size distribution and percent sand, silt and clay for six texture classes using the Australian Soil Resource Information System point database* (CSIRO 2001);
- trucks will have gross mass of 35 tonnes;

- total vehicle kilometres travelled (VKT) per annum was calculated based on the length of the private haul road and the total number of truck movements (round trip) estimated to transport the annual sand production;
- wheel generated dust from haul roads was modelled as a volume source in Ausplume; each volume source was located along the centreline of the haul road with a separation distance of less than one quarter of the distance to the nearest residential receiver; and
- dust emissions from the wash plant were considered to be negligible and were not modelled.

6.0 Air Impact Assessment

Dispersion modelling has been used to assess the potential air quality impacts associated with the proposed operations at the residential receivers outlined in **Section 2.4**. The model was run using the method and assumptions outlined in **Section 5**. The meteorological conditions outlined in **Section 4.1** were used in conjunction with the background air quality data from Beresfield and Newcastle meteorological stations to provide a comprehensive assessment of the potential air quality environment at the study area.

The modelling results for the 24-hour PM_{10}, annual average PM_{10}, TSP and dust deposition have been determined using the scenarios outlined in **Section 5.4**. Detailed modelling results are presented in **Attachment C**, with the results discussed in **Sections 6.1** to **6.5**.

6.1 24-hour Average PM_{10}

The predicted concentrations of 24-hour average PM_{10} for Scenarios 1 and 2 (refer to **Section 5.5**) are presented in **Attachment C**. The number of exceedances of the 24-hour average PM_{10} maximum criterion at each residential receiver for the scenarios is presented in **Table 6.1**.

The results presented in **Table 6.1** indicate that for Scenario 1, with no dust mitigation measures implemented, the proposed operations could result in a total of 230 exceedances of the maximum 24-hour PM_{10} criterion at residential receivers R8, R9 and R25. This operational scenario is predicted to result in approximately 170 exceedances at residence R9 annually.

Table 6.1 indicates that implementation of dust suppression along the length of the haul roads (Scenario 2: 75 per cent emission reduction (refer to **Figure 6.1**)) would result in a total number of eight exceedances of the 24-hour PM_{10} criterion at the nearest residential receivers, with up to seven exceedances occurring at residential receiver R9. The implementation of dust suppression along the length of the haul roads to achieve a 75 per cent reduction in emissions would ensure that no exceedances are recorded at residential receiver R25.

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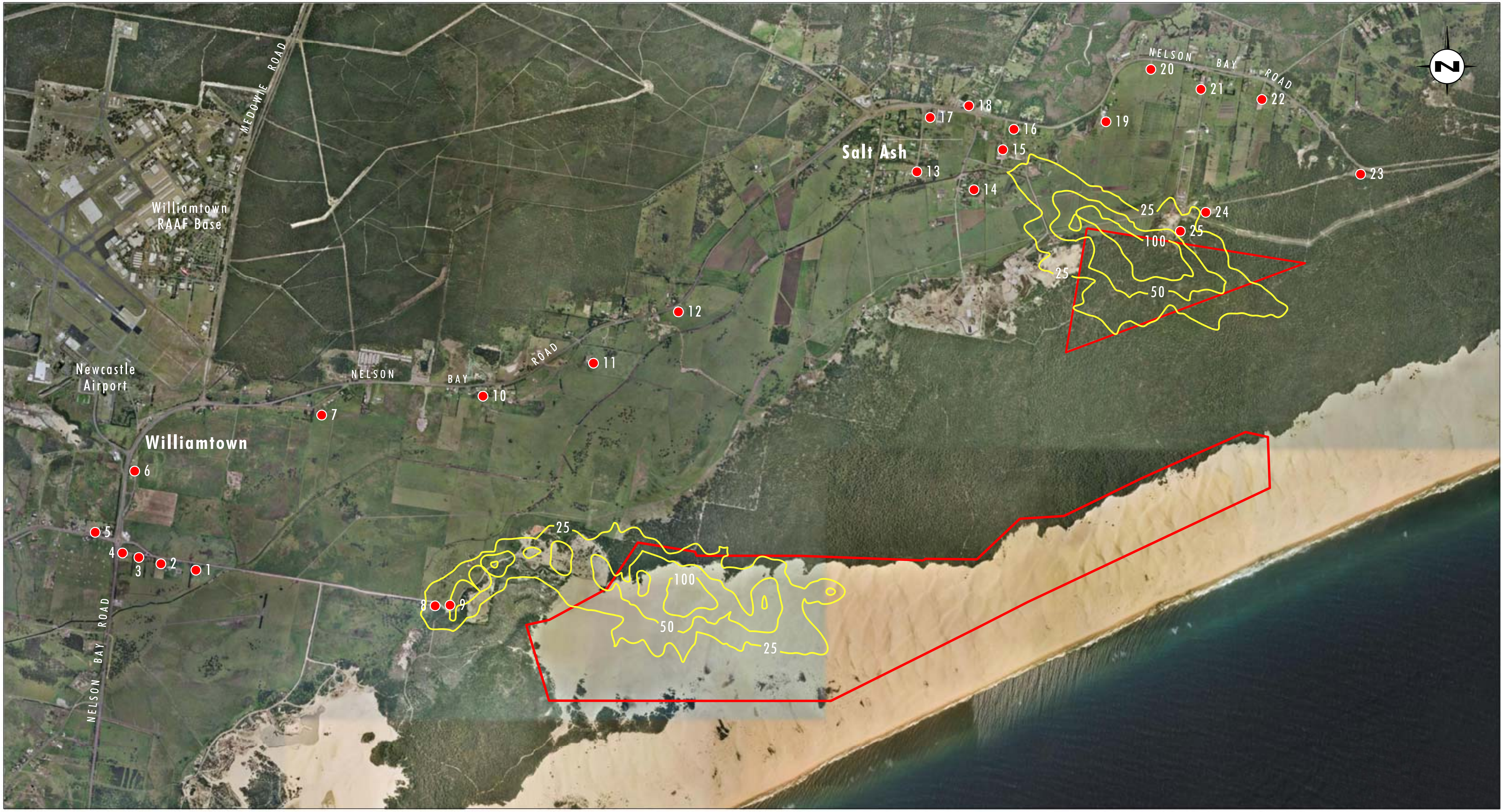

Source: Aerial: Google Earth 2008

0 0.5 1 2km
1:40 000

Legend

Lot Boundaries (218 & 220)
Air Receiver
PM10 ($\mu g/m^3$) Maximum Predicted Increment - 24 hour Average, Mitigation Measures: Haul Roads Dust Supression (75% Control)

FIGURE 6.1

PM10 ($\mu g/m^3$) Maximum Predicted Increment - 24 hour Average, Mitigation Measures: Haul Roads Dust Supression (75% Control)

Table 6.1 – Number of Annual Exceedences of 24-hour PM_{10} Criterion

Residence ID	Scenario 1		Scenario 2	
	Newcastle background + Predicted Increment	Beresfield background + Predicted Increment	Newcastle background + Predicted Increment	Beresfield background + Predicted Increment
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
6	0	0	0	0
7	0	0	0	0
8	28	33	1	0
9*	171	166	7	6
10	0	0	0	0
11	0	0	0	0
12	0	0	0	0
13	0	0	0	0
14	1	1	0	0
15	4	5	0	0
16	2	2	0	0
17	1	2	0	0
18	1	2	0	0
19	1	0	0	0
20	1	0	0	0
21	0	0	0	0
22	0	0	0	0
23	0	0	0	0
24	1	2	0	0
25	17	20	0	0

* this residence is part of the proposed development
Note: up to 5 exceedances are allowed per year in accordance with NEPC (1998)

6.2 Annual Average PM_{10}

The predicted concentrations of annual average PM_{10} for Scenarios 1 and 2 (refer to **Section 5.5**) are presented in **Attachment C**. The predicted increments at each residential receiver are summarised for Scenarios 1 and 2 in **Table 6.2**.

Table 6.2 – Annual Average PM_{10} ($\mu g/m^3$)

Residence ID	Scenario 1		Scenario 2	
	Newcastle background + Predicted Increment	Beresfield background + Predicted Increment	Newcastle background + Predicted Increment	Beresfield background + Predicted Increment
1	21.68	21.82	21.25	21.39
2	21.60	21.74	21.23	21.37
3	21.55	21.69	21.21	21.35
4	21.52	21.66	21.20	21.34
5	21.46	21.60	21.19	21.33
6	21.44	21.58	21.18	21.32
7	21.86	22.00	21.30	21.44
8	30.71	30.85	23.56	23.70
9*	50.47	50.61	28.57	28.71
10	22.28	22.42	21.43	21.57
11	22.11	22.25	21.38	21.52
12	21.93	22.07	21.34	21.48
13	21.91	22.05	21.33	21.47
14	22.41	22.55	21.48	21.62
15	23.00	23.14	21.66	21.80
16	22.71	22.85	21.58	21.72
17	22.09	22.23	21.39	21.53
18	22.23	22.37	21.44	21.58
19	22.70	22.84	21.58	21.72
20	21.94	22.08	21.36	21.50
21	21.92	22.06	21.35	21.49
22	21.81	21.95	21.31	21.45
23	21.85	21.99	21.33	21.47
24	24.63	24.77	22.30	22.44
25	31.30	31.44	25.32	25.46

* this residence is part of the proposed development
Note: up to 5 exceedances are allowed per year in accordance with NEPC (1998)

The results presented in **Table 6.2** indicate that for Scenario 1, with no dust mitigation measures implemented, the proposed operations will result in exceedances of the annual PM_{10} criterion at three residential receivers, R8, R9 and R25. Annual PM_{10} concentrations are predicted to record levels of up to 51 $\mu g/m^3$ at R9.

The implementation of dust suppression sprays along the haul roads (Scenario 2) will ensure that the annual PM_{10} criterion is complied with at all residential receiver locations (refer to **Figure 6.2**).

6.3 TSP

The predicted annual average TSP concentrations for Scenarios 1 and 2 (refer to **Section 5.5**) are presented in **Attachment C**. The predicted increments at each residential receiver are summarised for Scenarios 1 and 2 in **Table 6.3**

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Source: Aerial: Google Earth 2008

0 0.5 1 2km
1:40 000

Legend

- Lot Boundaries (218 & 220)
- Air Receiver
- PM10 ($\mu g/m^3$) Maximum Predicted Increment - Annual Average, Mitigation Measures: Haul Roads Dust Supression - 75% Control

FIGURE 6.2

PM10 ($\mu g/m^3$) Maximum Predicted Increment - Annual Average, Mitigation Measures: Haul Roads Dust Supression - 75% Control

Table 6.3 – Annual Average TSP (μg/m^3)

Residence ID	Scenario 1		Scenario 2	
	Newcastle background + Predicted Increment	Beresfield background + Predicted Increment	Newcastle background + Predicted Increment	Beresfield background + Predicted Increment
1	54.58	54.93	53.19	53.54
2	54.31	54.66	53.12	53.47
3	54.16	54.51	53.08	53.43
4	54.07	54.42	53.06	53.41
5	53.88	54.23	53.01	53.36
6	53.81	54.16	52.99	53.34
7	55.14	55.49	53.34	53.69
8	82.98	83.33	60.39	60.74
9*	147.58	147.93	76.58	76.93
10	56.41	56.76	53.71	54.06
11	55.86	56.21	53.56	53.91
12	55.28	55.63	53.42	53.77
13	55.24	55.59	53.40	53.75
14	56.80	57.15	53.83	54.18
15	58.59	58.94	54.35	54.70
16	57.68	58.03	54.10	54.45
17	55.79	56.14	53.56	53.91
18	56.20	56.55	53.69	54.04
19	57.64	57.99	54.09	54.44
20	55.28	55.63	53.45	53.80
21	55.25	55.60	53.43	53.78
22	54.92	55.27	53.34	53.69
23	55.02	55.37	53.38	53.73
24	63.28	63.63	55.92	56.27
25	80.18	80.53	61.15	61.50

* this residence is part of the proposed development
Note: up to 5 exceedances are allowed per year in accordance with NEPC (1998)

The results presented in **Table 6.3** indicate that for Scenario 1, with no dust mitigation measures implemented, the proposed operations will result in exceedances of the average annual TSP criterion at residential receiver R9. Concentrations of up to 149 μg/m^3 are predicted at R9.

The modelling results indicate that average annual TSP concentrations predicted at the residential receivers as a result of the proposed operations will comply with the average annual TSP criterion for Scenario 2. The application of dust suppression along the haul roads will ensure that predicted average annual TSP concentrations are reduced in Scenario 2 to approximately 77 μg/m^3 at R9 (refer to **Figure 6.3**).

Source: Aerial: Google Earth 2008

0 0.5 1 2km
1:40 000

Legend

- Lot Boundaries (218 & 220)
- Air Receiver
- TSP ($\mu g/m^3$) Maximum Predicted Increment - Annual Average Mitigation Measures: Haul Roads Dust Supression - 75% Control

FIGURE 6.3

TSP ($\mu g/m^3$) Maximum Predicted Increment - Annual Average
Mitigation Measures: Haul Roads Dust Supression - 75% Control

6.4 Dust Deposition

The predicted average monthly increase in dust deposition for Scenarios 1 and 2 (refer to **Section 5.5**) are presented in **Attachment C**. The predicted increments at each residential receiver are summarised for Scenarios 1 and 2 in **Table 6.4**.

Table 6.4 – Monthly Average Dust Deposition (g/m^2/month)

Residence ID	Scenario 1 - Predicted Increment	Scenario 2 – Predicted Increment
1	0.000	0.000
2	0.000	0.000
3	0.000	0.000
4	0.000	0.000
5	0.000	0.000
6	0.000	0.000
7	0.001	0.000
8	0.286	0.072
9*	3.933	0.983
10	0.003	0.001
11	0.002	0.001
12	0.001	0.000
13	0.001	0.000
14	0.005	0.001
15	0.006	0.002
16	0.005	0.001
17	0.001	0.000
18	0.002	0.001
19	0.009	0.003
20	0.002	0.001
21	0.001	0.000
22	0.001	0.000
23	0.000	0.000
24	0.024	0.009
25	0.027	0.013

* this residence is part of the proposed development
Note: up to 5 exceedances are allowed per year in accordance with NEPC (1998)

The results presented in **Table 6.4** indicate that for Scenario 1, with no dust mitigation measures implemented, the proposed operations will result in exceedances of the maximum average dust deposition level criterion at residential receiver R9. The monthly average dust deposition levels at residential receiver R9 are predicted to increase by up to 4 g/m^2/month.

The modelling results indicate that increases in average dust deposition levels predicted at the residential receivers as a result of the proposed operations will comply with the average dust deposition criterion for Scenario 2. The application of dust suppression along haul roads will ensure that predicted monthly average dust deposition concentrations are reduced in Scenario 2 to approximately 1 g/m^2/month at R9 (refer to **Figure 6.4**).

6.5 Modelling Results Discussion

The results of the dispersion modelling indicate that dust suppression controls along haul roads will be required at the proposed operations to ensure compliance with the project-specific air quality criteria for 24-hour PM_{10}, annual average PM_{10}, TSP and dust deposition. The modelling indicates that dust suppression resulting in 75 per cent reduction in dust emissions along haul roads will be suitable for the proposed operations. Exceedance of the 24-hour PM_{10} criterion is predicted to occur up to seven times per year at R9, although this property is part of the proposed development.

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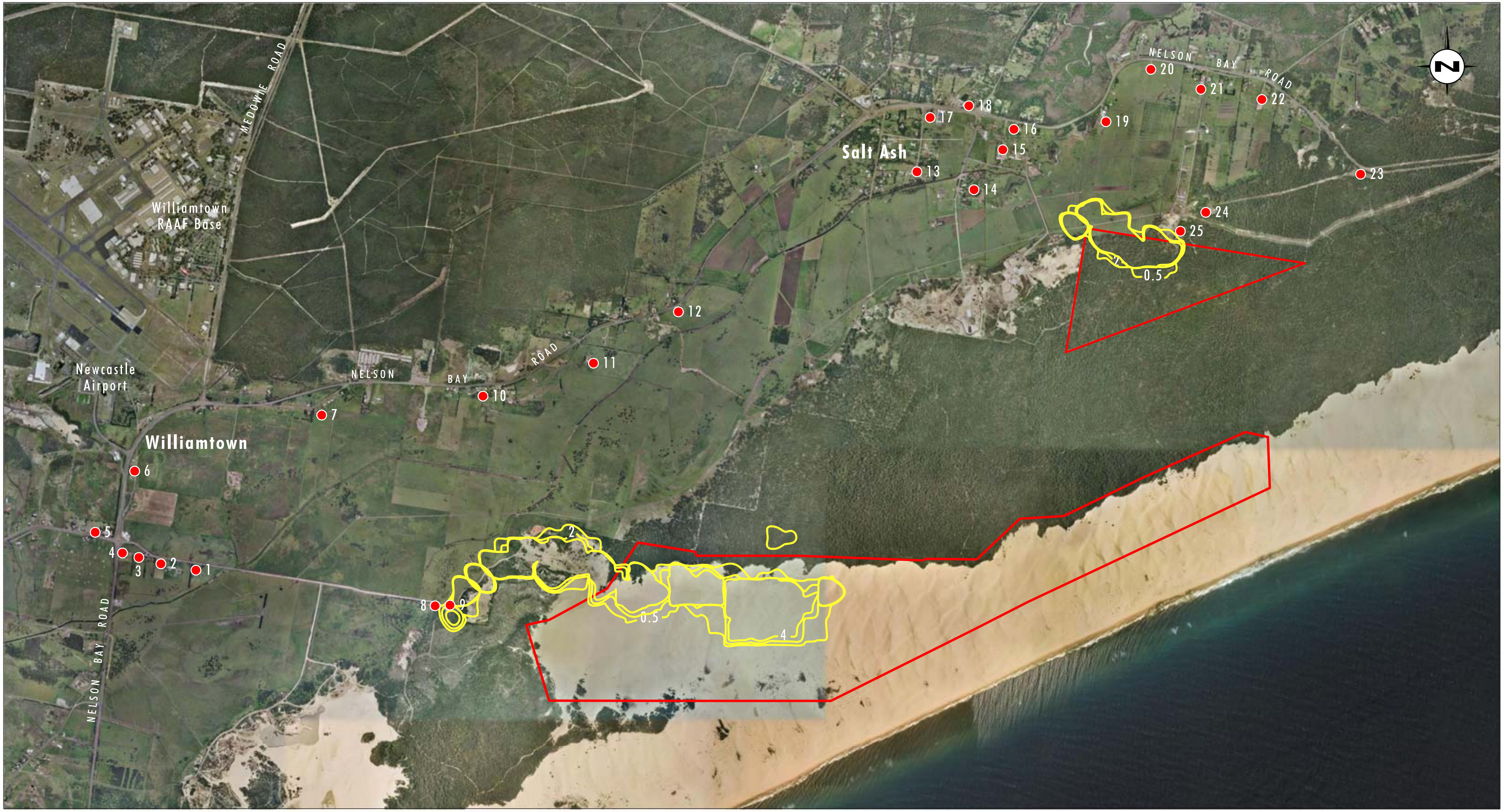

Source: Aerial: Google Earth 2008

0 0.5 1 2km
1:40 000

Legend

Lot Boundaries (218 & 220)
Air Receiver
Dust Deposition (g/m²/month) Maximum Predicted Increment - Monthly Average
Mitigation Measures: Haul Roads Dust Supression - 75% Control

FIGURE 6.4

Dust Deposition (g/m²/month) Maximum Predicted Increment - Monthly Average
Mitigation Measures: Haul Roads Dust Supression - 75% Control

File Name (A4): R11_V1/1646_113.dgn

7.0 Conclusion

The Air Quality Impact Assessment of the proposed sand extraction operations at Lots 218 and 220 was undertaken using the AUSPLUME Gaussian Plume Dispersion Model software developed by the Victorian EPA. In order to predict dust emission impacts, available meteorological information, background air quality records and digital terrain data were incorporated into the model.

The dispersion modelling predicted that the proposed operations will result in small incremental increases in particulate matter concentrations and dust deposition at the nearest residential receivers. The results indicate that in order to comply with DECC criteria for dust deposition, PM_{10} and TSP concentrations at the nearest residential receivers, dust suppression measures should be implemented along the Lot 218 and 220 access roads so that a 75 per cent reduction in dust emissions is achieved.

8.0 Abbreviations and Glossary

AMMAAP	Approved Methods for the Modeling and Assessment of Air Pollutants
AWS	Automatic Weather Station
DECC	Department of Environment and Climate Change
EPA	Environmental Protection Authority
HVAS	High Volume Air Sampler
km	Kilometres
m^3	Cubic metres
mAHD	Metres above Australian Height Datum
mg	Milligram
μγ	Microgram
Mt	Megatonnes
^oC	Degrees Celsius
oktas	Eight (Cloud cover scale used in meteorology)
PM_{10}	Particulate Matter in the size range of zero to ten microns in diameter
TEOM	Tapered Element Oscillating Microbalance
TSP	Total Suspended Particulate matter, usually in the size range of zero to 50 microns in diameter
VKT	Vehicle kilometres travelled

9.0 References

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NPI, 2001. *Emissions Estimation Technique Manual for Mining*, Version 2.3.

NPI, 2000. *Emission Estimation Technique Manual for Mining and Processing of Non-Metallic Minerals*, Version 2.0.

pDs Consultancy 2008. *Input Meteorological data file for Ausplume Williamtown – 2006*. Prepared for Umwelt.

ATTACHMENT A

pDS Meteorological Assessment for Williamtown for 2006

Input Meteorological data file for AUSPLUME

Williamtown-2006

This file was exclusively compiled for Umwelt Environmental consultants By pDs MultiMedia & Consultancy Service.

pDs Consultancy
@2008

Introduction

Gaussian plume models require hourly averaged meteorological data from a single site which is preferably in the model domain (site-specific data). While site-specific data is preferred, data from the nearest off-site meteorological station can be used when on-site data are not available. This data should represent the area of concern and the meteorological parameters should chracterise the transport and dispersion conditions of the area of concern.

Meteorological input is crucial in Gaussian plume modeling. Therefore compilation of input meteorological data files should be done meeting the procedures and algorithms set by environment regulators. It is always preferred to collect mandatory data such as wind speed, direction, sigamatheta (Calculated from Wind Direction measurements) and ambient temperature onsite. And again instrumentations and siting should meet Australian Standard (2923 -ambient air guide for measurement of horizontal wind for air quality applications).

Williamtown weather station found to be the best available data source maintained by Bureau of Meteorology to prepare input meteorological data file for **Ausplume**.

This file was complied following the set procedure and the algorithms recommended by EPA, Victoria.

LOCATION:

Metfile

Location
Williamtown, NSW

Data Source
BoM ,NSW Regional Office
BoM NCC,Melbourne

Longitude :151.84º E Easting 392000

Latitude :-32.79º S Northing 6370000

MultiMedia & Consultancy

DATA PROCESSING

Data Source

1. **Williamtown** AWS Data- BoM, NSW (Regional Office).

2. **Williamtown Cloud** data and **Williamtown** Airport Vertical temperature Profiles -National Climate Centre- Bureau of Meteorology, Melbourne.

Input Information

- Onsite (**Williamtown)** parameters
    a. Wind speed (km/h)
    b. Wind direction
    c. Ambient Temperature (C)
    d. Surface Pressure
    e. Dew point
    f. Total Clod amount

Wind was measured at 10m (Anemometer Height), surface roughness assumed to be 0.3m

- **Williamtown (NSW)**
    1. Vertical temperature profiles; Temperature, Dew point (1 profile per day)

Other Info:

Land use category: Mixed Rural
Surface Roughness: 0.3 m
Anemometre Height :10m

QA/QC on Raw data

This data set was treated as follows

- Incomplete days removed
- Suspected wind stalls (both wind direction and speed) removed
- Small gaps filled with previous or following data

- Pressure, Dew point Temperature and cloud amount were checked for unusual values
- Parameters checked for their ranges using long term averaged climatological values.
- Winds were double checked against BoM windroses constructing windroses of 2006 for 9:00AM and 3:00 PM

Williamtown (BoM)Vertical Temperature Profiles

- Gaps in vertical temperature profiles were filled with previous or following day data for the completeness.

DETERMINATION OF SECONDARY PARAMETERS

VERTICAL STABILITY

Solar Radiation for day time and Modified Pasquill Stability Class outlined in the reference, Davis and Singh, Jl of Hazardous Materials, 11 was used to determine night-time stability class. Solar radiation was theoretically calculated using off site cloud observations.

Table 1 for daytime and part of Table 2 for night-time were used.

TABLE 1: STABILITY CLASSIFICATION FOR DAYTIME USING SOLAR RADIATION AND WIND SPEED

	Solar Radiation (W/m²)			
Wind Speed(m/s)	≥925	≥675	≥175	< 175
< 2	A	A	B	D
< 3	A	B	C	D
< 5	B	B	C	D
< 6	C	C	D	D
≥ 6	C	D	D	D

Table 2: Modified Pasquill stability calsses

Surface Wind Speed (m/s) At 10m	Daytime incoming solar radiation				Within 1 Hour before sunset or after sunrise	Night-time cloud amount (Octas)		
	Strong (>600)	Moderate (300-600)	Slight (<300)	Overcast		0-3	4-7	8
< 2	A	A-B	B	D	D	F	F	D
< 3	A-B	B	C	D	D	F	E	D
< 5	B	B-C	C	D	D	E	D	D
< 6	C	C-D	D	D	D	D	D	D
≥ 6	C	D	D	D	D	D	D	D

Mixing height (Convective & Mechanical)

Definition:

The mixing height, the depth of the surface mixed layer is the height of the atmosphere above the ground, which is well mixed due either to mechanical turbulence or convective turbulence. The air layer above this height is stable.

The mixing height was determined by using the methodology of Benkley and Schulman (Journal of Applied Meteorology, Volume 18, 1979,pp 772-780). **Williamtown** upper air observation containing temperature and moisture profiles were used to determine daytime mixing height.

Surface wind speeds and roughness are used to calculate the depth of the mechanically forced boundary layer during the night time.

MixHm=0.185* Ustar/Cterm

Where Ustar=.35*Usfc/Ln (Htanemo/Z0)

Cterm = Coriolis Term =2 Ω Sin(ϕ)

Where Ω is the angular velocity of the earth

ϕ is the latitude

Htanemo= Anemometer Height, Z0 is the roughness

Height of the convective boundary layer was determined using daytime temperature sounding (Vertical temperature and dewpoint profiles) in between sunrise and sunset.

Analysis

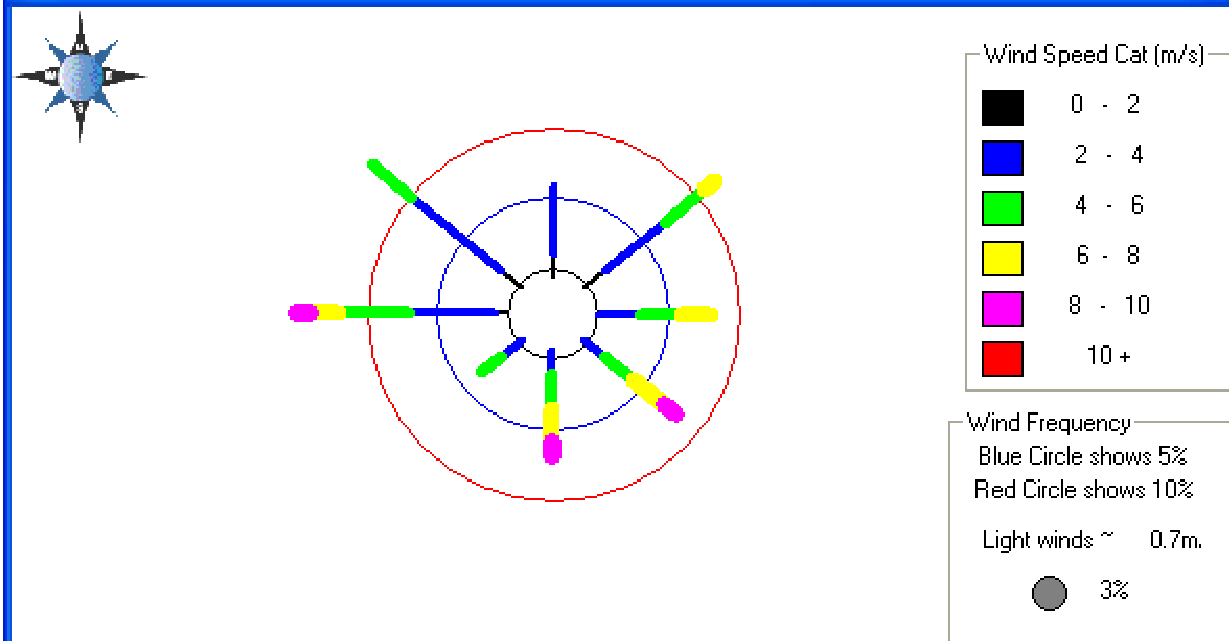
Data Coverage

Season	No. of Days	Percentage
Summer (90 days)	87	97%
Autumn (92 days)	92	100%
Winter(92 days)	92	100%
Spring (91 days)	91	100%
Annual (365 days)	362	99%

All seasons are well represented.

Annual WindRoses

Annual WindRoses for Annual WindRoses for Williamtown: 2006

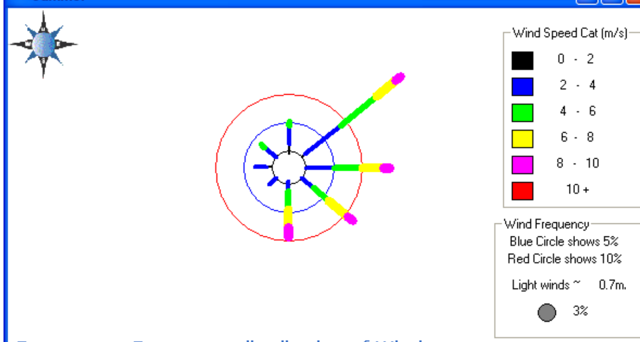


Percentage Frequency distribution of Winds

Speed Cat/Dir	NE	E	SE	S	SW	W	NW	N	Total Speed Freq
0 - 2	2.1	0.6	0.6	0.4	0.7	1.5	2.1	2.1	**10%**
2 - 4	6.6	3.5	2.6	2.1	2.4	7.0	9.7	6.2	**40%**
4 - 6	4.6	3.1	3.8	3.1	2.2	5.1	4.1	0.9	**27%**
6 - 8	1.7	2.1	3.4	3.3	0.9	2.9	1.0	0.1	**16%**
8 - 10	0.3	0.6	1.1	1.8	0.4	1.3	0.5	0.0	**6%**
10 +	0.0	0.0	0.3	0.5	0.2	0.3	0.2	0.0	**1%**
Total Dir Freq	**15%**	**10%**	**12%**	**11%**	**7%**	**18%**	**17%**	**9%**	

SEASONAL WINDROSES

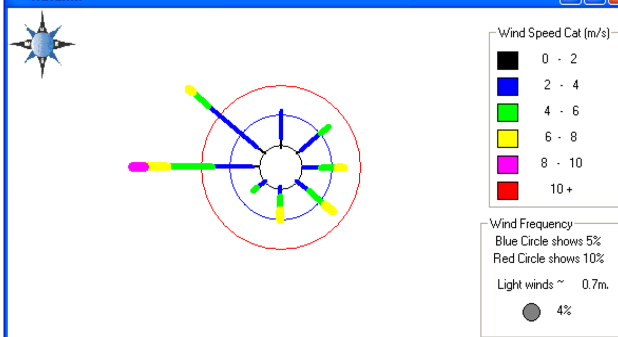
Summer



Percentage Frequency distribution of Winds

Speed Cat/Dir	NE	E	SE	S	SW	W	NW	N	Total Speed Freq
0 - 2	1.6	0.7	0.5	0.9	1.0	1.1	0.8	2.1	9%
2 - 4	9.1	6.0	3.5	2.3	2.3	3.0	3.5	4.9	35%
4 - 6	9.3	5.5	4.4	4.6	1.0	0.7	1.1	1.0	28%
6 - 8	5.3	4.7	5.1	4.0	0.2	0.3	0.3	0.2	20%
8 - 10	1.1	1.9	1.8	2.0	0.0	0.2	0.3	0.0	7%
10 +	0.1	0.0	0.4	0.8	0.1	0.0	0.0	0.0	1%
Total Dir Freq	27%	19%	16%	15%	5%	5%	6%	8%	

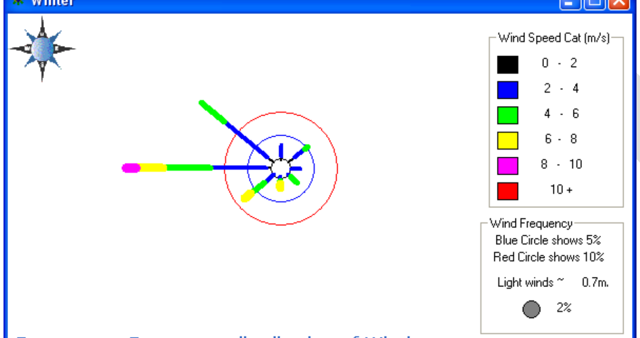
Autumn



Percentage Frequency distribution of Winds

Speed Cat/Dir	NE	E	SE	S	SW	W	NW	N	Total Speed Freq
0 - 2	1.9	0.2	1.0	0.2	0.9	1.6	2.5	2.1	11%
2 - 4	5.8	3.5	3.5	2.4	2.6	7.8	12.8	6.1	45%
4 - 6	2.4	3.2	4.5	3.1	1.9	8.1	4.5	0.5	28%
6 - 8	0.2	1.4	2.9	2.2	0.2	4.3	1.0	0.0	12%
8 - 10	0.0	0.2	0.6	0.9	0.1	2.1	0.4	0.0	4%
10 +	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	%
Total Dir Freq	10%	8%	12%	9%	6%	24%	21%	9%	

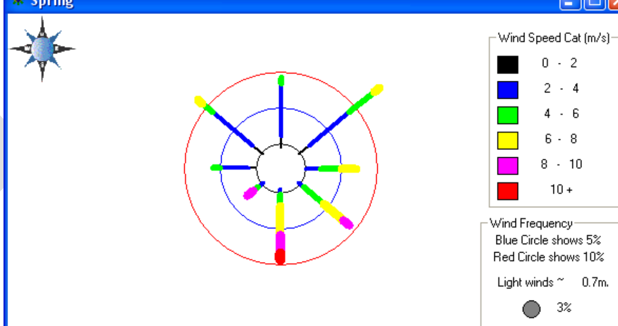
Winter



Percentage Frequency distribution of Winds

Speed Cat/Dir	NE	E	SE	S	SW	W	NW	N	Total Speed Freq
0 - 2	2.4	0.6	0.5	0.3	0.6	1.7	2.9	1.5	10%
2 - 4	3.5	2.0	1.8	1.9	3.4	12.4	13.9	3.8	43%
4 - 6	1.1	0.9	2.0	1.7	4.5	10.1	7.6	0.3	28%
6 - 8	0.1	0.5	0.8	1.6	2.5	6.0	1.0	0.0	13%
8 - 10	0.0	0.0	0.2	0.9	0.6	2.3	0.6	0.0	5%
10 +	0.0	0.0	0.1	0.3	0.1	0.7	0.4	0.0	2%
Total Dir Freq	7%	4%	5%	7%	12%	33%	26%	6%	

Spring



Percentage Frequency distribution of Winds

Speed Cat/Dir	NE	E	SE	S	SW	W	NW	N	Total Speed Freq
0 - 2	2.3	0.9	0.3	0.4	0.2	1.7	2.0	2.9	11%
2 - 4	8.2	2.5	1.5	1.8	1.3	4.6	8.1	9.8	38%
4 - 6	5.7	3.2	4.3	2.8	1.5	1.5	2.8	1.8	24%
6 - 8	1.5	2.1	4.9	5.6	0.7	0.9	1.5	0.1	17%
8 - 10	0.2	0.2	1.8	3.5	1.1	0.6	0.7	0.0	8%
10 +	0.0	0.0	0.5	1.1	0.4	0.3	0.4	0.0	3%
Total Dir Freq	18%	9%	13%	15%	5%	10%	16%	15%	

STATISTICS OF WILLIAMTOWN (NSW) INPUT METEOROLOGICAL DATA FILE-2006

Stab Cat	Stat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
A	Max of Temp	29.0	32.0	28.0		19.0			18.0	26.0	24.0	30.0	26.0	32.0
	Min of Temp	23.0	23.0	16.0		19.0			18.0	16.0	17.0	13.0	13.0	13.0
	Average of Temp	26.5	27.7	24.1		19.0			18.0	20.2	20.4	20.9	21.1	22.3
	Max of WS	2.5	2.5	2.5		1.4			1.4	2.5	2.5	2.5	2.5	2.5
	Min of WS	0.6	1.1	0.6		1.4			1.4	0.6	1.4	0.6	0.6	0.6
	Average of WS	2.0	2.0	1.8		1.4			1.4	1.4	2.0	1.7	2.0	1.8
	Max of MixH	882	1208	1106		957			1196	1640	1693	1563	1634	1693
	Min of MixH	287	413	299		957			1196	514	591	188	311	188
	Average of MixH	684	793	704		957			1196	907	1178	625	907	855
B	Max of Temp	34.0	37.0	34.0	28.0	21.0	17.0	17.0	21.0	29.0	30.0	33.0	34.0	37.0
	Min of Temp	17.0	18.0	14.0	15.0	9.0	8.0	8.0	6.0	9.0	6.0	10.0	10.0	6.0
	Average of Temp	25.3	25.9	23.4	21.1	17.6	13.4	12.9	16.3	19.0	20.2	21.0	21.2	21.3
	Max of WS	4.7	4.7	4.7	4.7	4.7	1.4	4.7	4.7	4.7	4.7	4.7	4.7	4.7
	Min of WS	0.6	0.6	0.6	1.1	0.6	0.6	1.1	1.1	0.6	1.1	0.6	0.6	0.6
	Average of WS	3.4	3.3	2.8	3.5	2.8	1.2	2.1	3.3	3.1	3.3	3.0	3.2	3.1
	Max of MixH	1685	2577	1810	2393	1713	714	1254	1465	1712	2826	1539	2015	2826
	Min of MixH	141	311	141	322	287	287	475	311	252	275	141	170	141
	Average of MixH	974	958	857	1144	929	497	790	985	884	1171	834	943	953
C	Max of Temp	42.0	38.0	34.0	31.0	24.0	19.0	19.0	23.0	33.0	35.0	36.0	34.0	42.0
	Min of Temp	16.0	17.0	12.0	6.0	7.0	5.0	7.0	5.0	10.0	7.0	7.0	9.0	5.0
	Average of Temp	24.4	24.2	22.3	18.0	16.0	13.4	13.6	14.7	17.7	20.2	21.5	21.6	19.1
	Max of WS	9.7	10.8	8.3	5.8	5.8	4.7	5.8	5.8	11.4	10.8	11.7	10.3	11.7
	Min of WS	2.2	1.4	2.2	2.2	2.2	2.2	1.1	1.4	2.2	1.4	2.2	0.6	0.6
	Average of WS	4.5	4.1	3.8	3.9	3.6	3.6	3.5	4.0	3.9	4.6	4.6	4.0	4.0
	Max of MixH	2583	2639	2163	2535	1828	1466	1646	2079	2297	2750	3022	2168	3022
	Min of MixH	439	370	357	504	451	480	375	393	422	439	422	141	141
	Average of MixH	1143	1109	1065	1110	1037	918	884	1092	1116	1342	1160	1037	1087
D	Max of Temp	43.0	39.0	35.0	32.0	26.0	19.0	23.0	25.0	35.0	36.0	37.0	33.0	43.0
	Min of Temp	16.0	14.0	12.0	4.0	4.0	2.0	3.0	3.0	6.0	5.0	7.0	9.0	2.0
	Average of Temp	24.6	24.6	23.0	18.8	14.7	12.3	12.8	14.1	16.9	18.6	19.6	21.0	18.4
	Max of WS	14.4	12.8	9.7	10.8	10.8	11.4	12.2	11.4	13.9	12.2	14.4	10.8	14.4
	Min of WS	0.6	0.6	0.6	1.1	0.6	0.6	0.6	1.1	0.6	0.6	0.6	0.6	0.6
	Average of WS	6.0	6.4	5.4	5.4	5.5	5.3	5.9	5.7	6.2	6.2	6.5	6.0	5.9
	Max of MixH	3375	2865	2215	2672	2338	2672	2730	2531	3094	2830	3252	2467	3375
	Min of MixH	234	200	141	328	141	287	264	258	141	200	141	141	141
	Average of MixH	1391	1503	1272	1272	1277	1232	1375	1330	1451	1494	1522	1394	1379

E	Max of Temp	38.0	30.0	30.0	26.0	20.0	15.0	17.0	21.0	28.0	28.0	29.0	27.0	38.0
	Min of Temp	20.0	19.0	16.0	9.0	5.0	4.0	3.0	5.0	9.0	7.0	11.0	12.0	3.0
	Average of Temp	23.0	23.0	22.0	15.8	11.8	9.3	9.9	11.1	15.8	17.8	20.3	19.3	16.2
	Max of WS	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
	Min of WS	2.2	3.1	2.2	2.2	2.2	2.2	2.2	2.2	3.1	3.1	3.1	2.5	2.2
	Average of WS	3.8	3.9	3.8	3.7	3.7	3.6	3.6	3.6	3.7	3.8	3.8	3.8	3.7
	Max of MixH	1377	1248	1283	1189	1230	1283	1541	1336	1201	1365	1312	1400	1541
	Min of MixH	510	592	480	463	516	469	422	504	574	527	639	539	422
	Average of MixH	890	910	899	860	866	837	837	856	856	886	905	901	873
F	Max of Temp	25.0	30.0	27.0	23.0	18.0	16.0	15.0	17.0	23.0	22.0	30.0	26.0	30.0
	Min of Temp	17.0	16.0	13.0	3.0	4.0	2.0	1.0	2.0	5.0	6.0	8.0	9.0	1.0
	Average of Temp	21.5	21.0	19.5	13.3	11.0	9.0	9.3	8.8	12.0	13.5	16.5	16.9	13.3
	Max of WS	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
	Min of WS	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
	Average of WS	2.3	1.9	1.9	1.9	1.7	1.9	1.9	1.8	1.8	1.9	2.1	1.7	1.9
	Max of MixH	943	756	1266	896	779	861	844	797	832	978	943	896	1266
	Min of MixH	200	141	141	141	141	141	141	141	141	141	188	141	141
	Average of MixH	575	481	468	492	430	489	469	459	449	478	530	419	471

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Annual Stability Distribution

Stability Category	% Distribution	Avg Wind Speed	Avg Temperature	Avg Mixing Height
A	1	1.8	22.3	855
B	6	3.1	21.3	953
C	15	4.	19.1	1087
D	43	5.9	18.4	1379
E	17	3.7	16.2	873
F	17	1.9	13.3	471

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ATTACHMENT B

Emission Inventory Estimation

ATTACHMENT B – Emission Inventory Estimation

Table B1 – Emission Inventory Estimation for Lot 220

Emitter ID	Emitter Name	Emission Factor			Material (tonne/year)	Vehicle Travel (km/year)	Area (ha)	Emission (tonne/year)		Control Measures	Modelled Working Days	Modelled Working Hours	Emission Rate (g/s)		Modelled Location*		
		TSP	PM_{10}	Units				TSP	PM_{10}				TSP	PM_{10}	Northing (m)	Easting (m)	Ground Elevation (mAHD)
1	FEL extraction area	0.0008	0.0004	kg/t	1000000	N/A	N/A	0.8	0.4		365	24	0.025	0.013	399516	6370503	8
2	FEL loading for screening &washing	0.0008	0.0004	kg/t	900000	N/A	N/A	0.72	0.36		365	24	0.023	0.011	399452	6370471	12
3	FEL loading trucks from stockpile	0.0008	0.0004	kg/t	900000	N/A	N/A	0.72	0.36		365	17	0.032	0.016	399318	6370468	25
4	FEL loading trucks directly	0.0008	0.0004	kg/t	100000	N/A	N/A	0.08	0.04		365	17	0.004	0.002	399242	6370500	25
5	Wheel generated dust (Haulage)	0.9587	0.3021	kg/VKT	N/A	112424	N/A	107.781	33.963		365	17	4.825	1.520			
5a	Wheel generated dust (Haulage) + dust suppression measures	0.9587	0.3021	kg/VKT	N/A	112424	N/A	26.945	8.491	75% Water Sprays	365	17	1.206	0.380			
6	Vibrating Screen	0.0056	0.0042	kg/t	900000	N/A	N/A	5.04	3.78		365	24	0.160	0.120	399388	6370465	14
7	Loading Product Stockpiles	0.004	0.0017	kg/t	900000	N/A	N/A	3.6	1.53		365	24	0.114	0.049	399353	6370465	20
8	Wind Entrainment Product Stockpiles	0.4	0.2	kg/ha/hr	N/A	N/A	0.04	0.140	0.07		365	24	0.004	0.002	399349	6370450	13
9	Wind Entrainment Raw Stockpiles	0.4	0.2	kg/ha/hr	N/A	N/A	0.04	0.140	0.07		365	24	0.004	0.002	399394	6370444	11

* - wheel generated dust is modelled as “volume sources” along unsealed road and includes several locations

Table B2 – Emission Inventory Estimation for Lot 218

Emitter ID	Emitter Name	Emission Factor			Material (tonne/year)	Vehicle Travel (km/year)	Area (ha)	Emission (tonne/year)		Control Measures	Modelled Working Days	Modelled Working Hours	Emission Rate (g/s)		Modelled Location*		
		TSP	PM_{10}	Units				TSP	PM_{10}				TSP	PM_{10}	Northing (m)	Easting (m)	Ground Elevation (mAHD)
1	FEL extraction area	0.0008	0.0004	kg/t	1000000	N/A	N/A	0.8	0.4		365	24	0.025	0.013	396058	6367986	18
2	FEL loading for screening &washing	0.0008	0.0004	kg/t	500000	N/A	N/A	0.4	0.2		365	24	0.013	0.006	395944	6367979	29
3	FEL loading trucks from stockpile	0.0008	0.0004	kg/t	500000	N/A	N/A	0.4	0.2		365	17	0.018	0.009	395783	6368030	29
4	FEL loading trucks directly	0.0008	0.0004	kg/t	500000	N/A	N/A	0.4	0.2		365	17	0.018	0.009	395793	6368075	29
5	Wheel generated dust (Haulage)	0.9587	0.3021	kg/VKT	N/A	201515	N/A	193.192	60.878		365	17	8.649	2.725			
5a	Wheel generated dust (Haulage) + dust suppression measures	0.9587	0.3021	kg/VKT	N/A	201515	N/A	48.30	15.22	75% Water Sprays	365	17	2.162	0.681			
6	Vibrating Screen	0.0056	0.0042	kg/t	900000	N/A	N/A	5.04	3.78		365	24	0.160	0.120	395906	6367980	30
7	Loading Product Stockpiles	0.004	0.0017	kg/t	500000	N/A	N/A	2.0	0.85		365	24	0.063	0.027	395824	6368021	30
8	Wind Entrainment Product Stockpiles	0.4	0.2	kg/ha/hr	N/A	N/A	0.04	0.140	0.07		365	24	0.004	0.002	395862	6367998	30
9	Wind Entrainment Raw Stockpiles	0.4	0.2	kg/ha/hr	N/A	N/A	0.04	0.140	0.07		365	24	0.004	0.002	395936	6368019	25

* - wheel generated dust is modelled as “volume sources” along unsealed road and includes several locations

ATTACHMENT C

Detailed Modelling Results from AUSPLUME

ATTACHMENT C – Detailed Modelling Results from AUSPLUME

Scenario 1 – No Dust Mitigation Measures

Table C1 – 24-hour Average PM_{10} ($\mu g/m^3$)

Residence ID	Date	Maximum Predicted Increment	Observed Background at Newcastle	Increment + Newcastle Background	Observed Background at Beresfield	Increment + Beresfield Background
1	17/09/2006	15.200	13.2	28.40	12.0	27.20
2	17/09/2006	11.900	13.2	25.10	12.0	23.90
3	17/09/2006	9.830	13.2	23.03	12.0	21.83
4	28/04/2006	8.910	18.7	27.61	23.5	32.41
5	28/04/2006	7.260	18.7	25.96	23.5	30.76
6	17/09/2006	3.690	13.2	16.89	12.0	15.69
7	15/05/2006	19.400	11.8	31.20	13.7	33.10
8	17/09/2006	97.300	13.2	110.50	12.0	109.30
9	12/04/2006	192.000	23.8	215.80	no data	no data
10	19/08/2006	18.100	14.9	33.00	18.7	36.80
11	08/12/2006	10.900	16.4	27.30	26.0	36.90
12	17/09/2006	13.900	13.2	27.10	12.0	25.90
13	09/10/2006	15.700	25.6	41.30	22.9	38.60
14	09/10/2006	27.300	25.6	52.90	22.9	50.20
15	19/08/2006	58.100	14.9	73.00	18.7	76.80
16	19/08/2006	51.100	14.9	66.00	18.7	69.80
17	15/05/2006	38.100	11.8	49.90	13.7	51.80
18	19/08/2006	42.900	14.9	57.80	18.7	61.60
19	08/12/2006	22.500	16.4	38.90	26.0	48.50
20	08/12/2006	13.600	16.4	30.00	26.0	39.60
21	30/12/2006	19.900	16.1	36.00	14.5	34.40
22	30/12/2006	18.600	16.1	34.70	14.5	33.10
23	01/03/2006	16.200	15.7	31.90	15.7	31.90
24	30/12/2006	33.900	16.1	50.00	14.5	48.40
25	30/12/2006	82.100	16.1	98.20	14.5	96.60

Table C2 – Number of Annual Exceedences of 24-hour PM_{10} Criterion

Residence ID	Newcastle Background + Predicted Increment	Beresfield Background + Predicted Increment
1	0	0
2	0	0
3	0	0
4	0	0
5	0	0
6	0	0
7	0	0
8	28	33
9	171	166
10	0	0
11	0	0
12	0	0
13	0	0
14	1	1
15	4	5
16	2	2
17	1	2
18	1	2
19	1	0
20	1	0
21	0	0
22	0	0
23	0	0
24	1	2
25	17	20

Table C3 – Annual Average PM_{10} ($\mu g/m^3$)

Residence ID	Predicted Increment	Observed Background at Newcastle	Increment + Newcastle Background	Observed Background at Beresfield	Increment + Beresfield Background
1	0.614	21.1	21.68	21.2	21.82
2	0.528	21.1	21.60	21.2	21.74
3	0.480	21.1	21.55	21.2	21.69
4	0.450	21.1	21.52	21.2	21.66
5	0.389	21.1	21.46	21.2	21.60
6	0.368	21.1	21.44	21.2	21.58
7	0.792	21.1	21.86	21.2	22.00
8	9.640	21.1	30.71	21.2	30.85
9	29.400	21.1	50.47	21.2	50.61
10	1.210	21.1	22.28	21.2	22.42
11	1.040	21.1	22.11	21.2	22.25
12	0.855	21.1	21.93	21.2	22.07
13	0.835	21.1	21.91	21.2	22.05
14	1.340	21.1	22.41	21.2	22.55
15	1.930	21.1	23.00	21.2	23.14

Table C3 – Annual Average PM_{10} (µg/m^3) (cont)

Residence ID	Predicted Increment	Observed Background at Newcastle	Increment + Newcastle Background	Observed Background at Beresfield	Increment + Beresfield Background
16	1.640	21.1	22.71	21.2	22.85
17	1.020	21.1	22.09	21.2	22.23
18	1.160	21.1	22.23	21.2	22.37
19	1.630	21.1	22.70	21.2	22.84
20	0.866	21.1	21.94	21.2	22.08
21	0.850	21.1	21.92	21.2	22.06
22	0.741	21.1	21.81	21.2	21.95
23	0.777	21.1	21.85	21.2	21.99
24	3.560	21.1	24.63	21.2	24.77
25	9.230	22.1	31.30	22.2	31.44

Table C4 – Annual Average TSP (µg/m^3)

Residence ID	Predicted Increment	Observed Background at Newcastle	Increment + Newcastle Background	Observed Background at Beresfield	Increment + Beresfield Background
1	1.900	52.7	54.58	53.0	54.93
2	1.630	52.7	54.31	53.0	54.66
3	1.480	52.7	54.16	53.0	54.51
4	1.390	52.7	54.07	53.0	54.42
5	1.200	52.7	53.88	53.0	54.23
6	1.130	52.7	53.81	53.0	54.16
7	2.460	52.7	55.14	53.0	55.49
8	30.300	52.7	82.98	53.0	83.33
9	94.900	52.7	147.58	53.0	147.93
10	3.730	52.7	56.41	53.0	56.76
11	3.180	52.7	55.86	53.0	56.21
12	2.600	52.7	55.28	53.0	55.63
13	2.560	52.7	55.24	53.0	55.59
14	4.120	52.7	56.80	53.0	57.15
15	5.910	52.7	58.59	53.0	58.94
16	5.000	52.7	57.68	53.0	58.03
17	3.110	52.7	55.79	53.0	56.14
18	3.520	52.7	56.20	53.0	56.55
19	4.960	52.7	57.64	53.0	57.99
20	2.600	52.7	55.28	53.0	55.63
21	2.570	52.7	55.25	53.0	55.60
22	2.240	52.7	54.92	53.0	55.27
23	2.340	52.7	55.02	53.0	55.37
24	10.600	52.7	63.28	53.0	63.63
25	27.500	52.7	80.18	53.0	80.53

Table C5 – Monthly Average Dust Deposition ($g/m^2/month$)

Residence ID	Predicted Increment
1	0.000
2	0.000
3	0.000
4	0.000
5	0.000
6	0.000
7	0.001
8	0.286
9	3.933
10	0.003
11	0.002
12	0.001
13	0.001
14	0.005
15	0.006
16	0.005
17	0.001
18	0.002
19	0.009
20	0.002
21	0.001
22	0.001
23	0.000
24	0.024
25	0.027

Scenario 2 – 75% Dust Suppression along Length of Haul Roads at Lot 218 and Lot 220

Table C6 – 24-hour Average PM_{10} (µg/m^3)

Residence ID	Date	Maximum Predicted Increment	Observed Background at Newcastle	Increment + Newcastle Background	Observed Background at Beresfield	Increment + Beresfield Background
1	17/09/2006	4.200	13.2	17.40	12.0	16.20
2	17/09/2006	3.320	13.2	16.52	12.0	15.32
3	17/09/2006	2.770	13.2	15.97	12.0	14.77
4	28/04/2006	2.620	18.7	21.32	23.5	26.12
5	28/04/2006	2.110	18.7	20.81	23.5	25.61
6	17/09/2006	1.290	13.2	14.49	12.0	13.29
7	15/05/2006	5.540	11.8	17.34	13.7	19.24
8	17/09/2006	27.100	13.2	40.30	12.0	39.10
9	12/04/2006	48.300	23.8	72.10	no data	no data
10	19/08/2006	6.860	14.9	21.76	18.7	25.56
11	08/12/2006	2.860	16.4	19.26	26.0	28.86
12	17/09/2006	4.870	13.2	18.07	12.0	16.87
13	09/10/2006	5.350	25.6	30.95	22.9	28.25
14	09/10/2006	9.140	25.6	34.74	22.9	32.04
15	15/05/2006	18.800	11.8	30.60	13.7	32.50
16	19/08/2006	17.600	14.9	32.50	18.7	36.30
17	15/05/2006	12.300	11.8	24.10	13.7	26.00
18	19/08/2006	13.700	14.9	28.60	18.7	32.40
19	08/12/2006	6.130	16.4	22.53	26.0	32.13
20	08/12/2006	4.710	16.4	21.11	26.0	30.71
21	30/12/2006	5.370	16.1	21.47	14.5	19.87
22	30/12/2006	6.170	16.1	22.27	14.5	20.67
23	01/03/2006	5.290	15.7	20.99	15.7	20.99
24	30/12/2006	19.200	16.1	35.30	14.5	33.70
25	30/12/2006	50.100	16.1	66.20	14.5	64.60

Table C7 – Number of Annual Exceedences of 24-hour PM_{10} Criterion

Residence ID	Newcastle Background + Predicted Increment	Beresfield Background + Predicted Increment
1	0	0
2	0	0
3	0	0
4	0	0
5	0	0
6	0	0
7	0	0
8	1	0
9	7	6
10	0	0
11	0	0
12	0	0
13	0	0
14	0	0
15	0	0
16	0	0
17	0	0
18	0	0
19	0	0
20	0	0
21	0	0
22	0	0
23	0	0
24	0	0
25	0	0

Table C8 – Annual Average PM_{10} (µg/m^3)

Residence ID	Predicted Increment	Observed Background at Newcastle	Increment + Newcastle Background	Observed Background at Beresfield	Increment + Beresfield Background
1	0.179	21.1	21.25	21.2	21.39
2	0.155	21.1	21.23	21.2	21.37
3	0.141	21.1	21.21	21.2	21.35
4	0.133	21.1	21.20	21.2	21.34
5	0.116	21.1	21.19	21.2	21.33
6	0.110	21.1	21.18	21.2	21.32
7	0.228	21.1	21.30	21.2	21.44
8	2.490	21.1	23.56	21.2	23.70
9	7.500	21.1	28.57	21.2	28.71
10	0.357	21.1	21.43	21.2	21.57
11	0.313	21.1	21.38	21.2	21.52
12	0.270	21.1	21.34	21.2	21.48
13	0.258	21.1	21.33	21.2	21.47
14	0.407	21.1	21.48	21.2	21.62
15	0.594	21.1	21.66	21.2	21.80
16	0.508	21.1	21.58	21.2	21.72
17	0.318	21.1	21.39	21.2	21.53
18	0.365	21.1	21.44	21.2	21.58
19	0.508	21.1	21.58	21.2	21.72
20	0.291	21.1	21.36	21.2	21.50
21	0.281	21.1	21.35	21.2	21.49
22	0.244	21.1	21.31	21.2	21.45
23	0.263	21.1	21.33	21.2	21.47
24	1.230	21.1	22.30	21.2	22.44
25	3.250	22.1	25.32	22.2	25.46

Table C9 – Annual Average TSP (µg/m^3)

Residence ID	Predicted Increment	Observed Background at Newcastle	Increment + Newcastle Background	Observed Background at Beresfield	Increment + Beresfield Background
1	0.518	52.7	53.19	53.0	53.54
2	0.447	52.7	53.12	53.0	53.47
3	0.407	52.7	53.08	53.0	53.43
4	0.381	52.7	53.06	53.0	53.41
5	0.331	52.7	53.01	53.0	53.36
6	0.314	52.7	52.99	53.0	53.34
7	0.666	52.7	53.34	53.0	53.69
8	7.710	52.7	60.39	53.0	60.74
9	23.900	52.7	76.58	53.0	76.93
10	1.030	52.7	53.71	53.0	54.06
11	0.887	52.7	53.56	53.0	53.91
12	0.746	52.7	53.42	53.0	53.77
13	0.723	52.7	53.40	53.0	53.75
14	1.150	52.7	53.83	53.0	54.18
15	1.670	52.7	54.35	53.0	54.70
16	1.420	52.7	54.10	53.0	54.45
17	0.887	52.7	53.56	53.0	53.91
18	1.010	52.7	53.69	53.0	54.04
19	1.410	52.7	54.09	53.0	54.44
20	0.778	52.7	53.45	53.0	53.80
21	0.758	52.7	53.43	53.0	53.78
22	0.660	52.7	53.34	53.0	53.69
23	0.700	52.7	53.38	53.0	53.73
24	3.240	52.7	55.92	53.0	56.27
25	8.470	52.7	61.15	53.0	61.50

Table C10 – Monthly Average Dust Deposition (g/m^2/month)

Residence ID	Predicted Increment
1	0.000
2	0.000
3	0.000
4	0.000
5	0.000
6	0.000
7	0.000
8	0.072
9	0.983
10	0.001
11	0.001
12	0.000
13	0.000
14	0.001
15	0.002
16	0.001
17	0.000
18	0.001
19	0.003
20	0.001
21	0.000
22	0.000
23	0.000
24	0.009
25	0.013