
AIR QUALITY IMPACT ASSESSMENT
Wallis Lake Dredging

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Prepared for
Geolyse Pty Ltd

by

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1. INTRODUCTION

This report has been prepared for Geolyse Pty Ltd. Its purpose is to examine the air quality effects of the proposed dredging of approximately 8 ha of oyster lease at Wallis Lake in Tuncurry, NSW, and the subsequent dewatering, stockpiling and transport of the dredged material off-site.

The main source of emissions from the proposal will be dust emissions. The purpose of this report is to quantitatively assess dust impacts that may be associated with the stockpiling site. The dredged material is primarily fine to medium grained sand and therefore the potential for odour impacts are minimal.

The assessment is based on the use of a computer-based dispersion model to predict ground-level dust concentrations and deposition levels in the vicinity of the stockpiling site. To assess the effect that the dust emissions would have on existing air quality, the dispersion model predictions have been compared to relevant air quality goals. Dispersion modelling procedures follow NSW Department of Environment and Conservation (DEC) guidelines (**NSW DEC, 2005**).

Predictions of dust concentration and deposition levels have been made using the US EPA's short-term industrial source complex dispersion model known as ISCST3 (**US EPA, 1995a**).

2. LOCAL SETTING AND DESCRIPTION OF PROJECT

Terrain in the area is generally flat and for the most part the land has been cleared. The predominant land use of the current site is low intensity cattle grazing.

The location of the proposed stockpiling site is shown in **Figure 1**, which also shows the location of nearby residences.

It is proposed that approximately 120,000 – 160,000 m³ of material would be dredged from the oyster bed over a period of approximately seven months.

The dredged material would be pumped in a slurry form (approximately 33% solids) via a pipeline to the onshore treatment facility, located 2 km north of the oyster lease area.

Due to the distance between the dredging area and the proposed stockpile area, four 180 hp diesel powered booster pumps would be required along the pipe route. One pump will be located on the Wallamba River, while the other three pumps will be located on land (see **Figure 1**).

The slurry would be pumped into a series of three settling ponds. **Figure 2** shows the site layout. The coarse fraction would settle out quickly with the suspended fines diverted into a series of sediment basins. Once settled, the excess waters would be returned to the Wallamba River. The dewatered sands and silts would then be stockpiled and sold to market on-demand.

There are initially four stockpile areas but towards the end of the life of the project Pond 1 will become an additional stockpile.

3. AIR QUALITY ASSESSMENT METHODS AND CRITERIA

In its modelling and assessment guidelines, New South Wales Department of Environment and Conservation (NSW DEC) specifies air quality assessment criteria relevant for assessing impacts from dust generating activities (NSW DEC, 2005). The assessment criteria are summarised in Table 1, Table 2 and Table 3.

These criteria are consistent with the National Environment Protection Measures for Ambient Air Quality (referred to as the Ambient Air-NEPMs (see NEPC, 1998)). However, the NSW DEC's criteria include averaging periods, which are not included in the Air-NEPMs and references to other measures of air quality, namely dust deposition and total suspended particulate matter (TSP).

Pollutant	Averaging period	Concentration	
		Parts per hundred million (pphm)	mg/m ³
PM ₁₀	1-day	-	50*
	annual	-	30
SO ₂	10 minutes	25	712
	1-hour	20	570
	1-day	8	228
	1-year	2	60
NO ₂	1-hour	12	246
	1-year	3	62
		ppm	mg/m ³
CO	15 minutes	87	100
	1-hour	25	30
	8-hours	9	10

* Non-cumulative for purposes of impact assessment

In addition, the guidelines provide the criteria for TSP (see Table 2) and for the insoluble component of deposited dust (see Table 3).

Pollutant	Averaging period	Concentration
TSP	Annual	90 µg/m ³

Pollutant	Averaging period	Maximum increase in deposited	Maximum total dust deposition
Deposited dust (insoluble)	Annual	2 g/m ² /month	4 g/m ² /month

In May 2003, NEPC released a variation to the NEPM (NEPC, 2003). The advisory reporting standards for PM_{2.5} are a 24-hour average of 25 µg/m³ and an annual average of 8 µg/m³. There is no time line for compliance. The goal was to gather sufficient data nationally to facilitate the review of the Air Quality NEPM which commenced in 2005 and is due to be completed during 2006. The variation includes a protocol setting out monitoring and reporting requirements for particles as PM_{2.5}.

At this stage, the advisory reporting PM_{2.5} standards are not part of the NSW DEC assessment criteria for projects and therefore have not been considered further in this assessment.

The booster pumps proposed for use are similar in size to those used to power a truck. The sulphur content of Australian diesel is too low to cause sulphur dioxide (SO₂) goals to be exceeded from the operation of the booster pumps. For this reason, no detailed study is required to demonstrate that emissions of SO₂ from the booster pumps would not significantly affect ambient SO₂ concentrations. Similarly, NO_x and CO emissions will be too small and too widely dispersed across the four proposed sites to require a detailed modelling assessment.

Thus, the focus of the study is on the potential effects of PM emissions. PM has the capacity to affect human health and to cause nuisance effects.

To assist in interpreting the significance of predicted concentration and deposition levels some background discussion on the potential harmful effects is provided below.

The suite of ambient air quality criteria used in the assessment is comprehensive and would be expected to protect against all harmful effects of the emissions from the Proposal including health and nuisance effects.

4. EXISTING ENVIRONMENT

This section describes the dispersion meteorology, local climatic conditions and existing dust levels in the area.

4.1 Dispersion Meteorology

The Gaussian dispersion model used for this assessment, ISCST3, requires information about the dispersion characteristics of the area. In particular, data are required on topography, wind speed, wind direction, atmospheric stability class¹ and mixing height².

The dispersion model used in this assessment requires a year of meteorological data. The nearest site for which this kind of data is available is at Pacific Palms (**Holmes Air Sciences, 2000**).

Mixing height was determined using a scheme defined by **Powell (1976)** for daytime conditions and an approach described by **Venkatram (1980)** for night time conditions.

Annual and seasonal windroses produced from these data for 1996 are presented in **Figure 3**.

On an annual basis, the dominant winds at the proposed site are from the northern and southwestern quadrants. In summer, the northeasterly seabreezes prevail, although there are still a significant percentage of winds from the southwest. In winter the westerlies dominate. The annual average wind speed for the area is estimated to be 2.1 m/s.

¹ In dispersion modelling stability class is used to categorise the rate at which a plume will disperse. In the Pasquill-Gifford stability class assignment scheme, as used in this study, there are six stability classes A through to F. Class A relates to unstable conditions such as might be found on a sunny day with light winds. In such conditions plumes will spread rapidly. Class F relates to stable conditions, such as occur when the sky is clear, the winds are light and an inversion is present. Plume spreading is slow in these circumstances. The intermediate classes B, C, D and E relate to intermediate dispersion conditions.

² The term mixing height refers to the height of the turbulent layer of air near the earth's surface into which ground-level emissions will be rapidly mixed. A plume emitted above the mixed-layer will remain isolated from the ground until such time as the mixed-layer reaches the height of the plume. The height of the mixed-layer is controlled mainly by convection (resulting from solar heating of the ground) and by mechanically generated turbulence as the wind blows over the rough ground.

4.2 Atmospheric stability

Table 4 presents a frequency of atmospheric stability classes at the site.

Pasquill Gifford stability class	Frequency (%)
A	0.0
B	0.7
C	4.0
D	55.1
E	29.2
F	11.0
TOTAL	100.0

Joint wind speed, wind direction and stability class frequency tables for the stockpile site are presented in **Appendix A**.

Due to the low occurrence of unstable conditions in the meteorological file from Pacific Palms, a set of site-specific, synthetic meteorological data was created for comparison using The Air Pollution Model (TAPM) (Version 3) developed by CSIRO.

TAPM is a prognostic model which includes synoptic information determined from the six hourly Limited Area Prediction System (LAPS) (Puri et al., 1997). The model is discussed further in the accompanying user manual (see Hurley, 2003).

Pasquill Gifford stability class	Frequency (%)
A	0.2
B	8.7
C	14.3
D	32.4
E	12.9
F	31.5
TOTAL	100.0

These data show a higher percentage of unstable conditions. **Figure 4** presents annual and seasonal windroses produced from these data. They show a similar dispersion to the Pacific Palms data, however on an annual basis there are a higher percentage of winds from the west-south-west in the Pacific Palms data (the wind direction that will take dust from the site to the residences).

Dispersion modelling showed the Pacific Palm data to provide the more conservative predictions and therefore these are the results presented in **Section 7**.

4.3 Climate data

Climatic data collected over an extensive period are available from the Bureau of Meteorology monitoring station located at Taree. This provides information on the long-term average values of climatic elements such as temperature, humidity, rainfall, the number of raindays per year etc.

Table 6 presents average temperature, humidity and rainfall data collected at the Taree site from 1881 to 2004 (**Bureau of Meteorology, 2006**). Temperature and humidity data consist of monthly averages of 9 am and 3 pm readings. Also presented are monthly averages of maximum and minimum temperatures. Rainfall data consist of mean and median monthly rainfall and the average number of raindays per month.

The annual average maximum and minimum temperatures experienced at Taree are 24.3°C and 12.0°C respectively. On average January is the hottest month with an average maximum temperature of 29.0°C. July is the coldest month, with average minimum temperature of 5.9°C.

The annual average humidity reading collected at 9 am at Taree is 74 percent, and at 3 pm the annual average is 58 percent. The month with the highest humidity on average is February with a 9 am average of 80 percent, and the lowest is August with a 3 pm average of 51 percent.

Rainfall data collected at Taree shows that March is the wettest month, with an average rainfall of 152.2 mm over 12.3 days. The average annual rainfall is 1174.9 mm with an average of 113.2 raindays.

Table 6: Temperature, humidity and rainfall data for Taree													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
9 am Mean Dry-bulb and Wet-bulb Temperatures (°C) and Relative Humidity (%)													
Dry-bulb	23.2	22.5	21.4	18.8	15.2	12.5	11.3	12.8	16.4	19.5	20.9	22.8	18.1
Wet-bulb	20.2	20.2	19	16.4	13.1	10.6	9.3	10.3	13	15.7	17.3	19.1	15.4
Humidity	75	80	79	77	78	78	77	71	67	66	68	70	74
3 pm Mean Dry-bulb and Wet-bulb Temperatures (°C) and Relative Humidity (%)													
Dry-bulb	27.5	27.2	25.9	23.6	20.6	18.0	17.8	19.2	21.1	22.9	24.5	26.5	22.8
Wet-bulb	22.0	21.9	20.8	18.4	15.9	13.7	12.9	13.6	15.3	17.4	18.9	20.7	17.5
Humidity	61	62	63	59	60	60	54	51	52	58	57	59	58
Daily Maximum Temperature (°C)													
Mean	29.0	28.6	27.3	24.8	21.5	19.1	18.5	19.9	22.7	24.9	26.8	28.4	24.3
Daily Minimum Temperature (°C)													
Mean	17.5	17.6	16.0	12.9	9.8	7.3	5.9	6.4	8.6	11.4	14.1	16.4	12.0
Rainfall (mm)													
Mean	121.0	137.4	152.2	115.5	97.8	96.7	74.0	61.8	60.1	73.6	84.4	100.5	1174.9
Raindays (Number)													
Mean	10.5	10.9	12.3	10.3	9.3	8.8	7.3	7.6	7.4	9.1	9.5	10.2	113.2

Station number 060030; Commenced: 1881, Last record: 2004; Latitude (deg S): -31.8986; Longitude (deg E): 152.4834
 Source: **Bureau of Meteorology (2006)**

4.4 Existing air quality

Air quality standards and goals refer to pollutant levels which include the project and existing sources. To fully assess impacts against all the relevant air quality standards and goals (detailed in **Section 3**) it is necessary to have information or estimates on existing dust concentration and deposition levels in the area in which the project is likely to contribute to these levels.

There are no direct measurements of dust, PM₁₀ or TSP concentrations in the area. Local air quality will be adversely affected periodically due to bushfires but otherwise there are no significant local sources of particulate matter.

The closest DEC monitoring station is at Beresfield, north-west of Newcastle. The annual average PM₁₀ concentration measured at Beresfield over the twelve month period 1 August 2004 to 31 July 2005 was 19 µg/m³. This is likely to be a conservative estimate of the PM₁₀ concentrations at the proposed stockpile site.

In areas where the predominant sources of dust are mining, quarrying or agriculture, annual average TSP and PM₁₀ concentrations can be inferred from deposition data by noting the relationship that applies. In these circumstances it has been found that an annual average deposition level of 4 g/m²/month corresponds to an annual average TSP concentration of 90 µg/m³ and an annual PM₁₀ concentration of 36 µg/m³ level.

In the absence of other data, it has been assumed that these relationships also apply in this location. Therefore, based on the assumption that the annual average PM₁₀ concentration is 19 µg/m³, the annual average TSP and dust deposition would have been approximately 45 µg/m³ and 2 g/m²/month respectively. Both of these are below the DEC's assessment criteria.

It has been therefore conservatively assumed that the following background concentrations apply at the nearest residences.

- Annual average TSP of 45 µg/m³
- Annual average PM₁₀ of 19 µg/m³
- Annual average dust deposition of 2 g/m²/month

In addition, the DEC guideline requires an assessment against 24-hour PM₁₀ concentrations. This assessment adopts the approach that the predicted 24-hour average PM₁₀ concentration from the development should be less than 50 µg/m³ at the nearest residences.

5. ESTIMATED EMISSIONS OF PARTICULATE MATTER

Dust emissions are likely to be minimal from the operation of the stockpile site.

A worst-case approach assessment has been considered which assumes the following:

- the transfer of the coarse sand from Pond 1 to the stockpiles will not generate any dust emissions (the dredged material will be approximately 70% water, therefore the moisture content of the sand on transfer from Pond 1 is likely to be greater than 10%)
- dust emissions will arise from the transfer of the sand from the stockpiles to the haul trucks and haulage of the sand off-site
- the stockpile area consists of the four original areas plus Pond 1

The operations which apply in each case have been combined with emission factors developed, both locally and by the US EPA, to estimate the amount of dust produced by each activity. These emission factors applied are considered to be the most up-to-date methods for determining dust generation rates.

Details on the activities and estimated dust emissions are presented below in **Table 7**. These estimates assume an appropriate level of control of dust emissions is achievable through the use of watering carts on all unsealed areas of the active area. Details of the calculations of the dust emissions are presented in **Appendix B**.

ACTIVITY	Worst-case
Bulldozer activity (clearing vegetation for two days)	145
FEL loading sand to trucks for haulage	701
Transporting sand off-site by road (unsealed rd)	12,839
Transporting blended sand product off-site by road (sealed rd)	3,852
Wind erosion from stockpiles	10,512
TOTAL	28,084

6. APPROACH TO ASSESSMENT

6.1 Introduction

This section provides a brief explanation of how the dust modelling was undertaken. It is provided so that technical reviewers can appreciate how the modelling of different particle size categories was carried out.

The model used was the US EPA ISCST3 model. The model is fully described in the user manual and the accompanying technical description (**US EPA, 1995a**).

A geotechnical analysis by Geolyse of the material to be dredged provided a particle size analysis which indicated the following:

- Silt/clay fraction – mean 5.25%
- Sand fraction (fine to coarse sands) – mean 93.94%
- Fine to medium gravel – mean 0.81%

The particle size of the material in-situ will not be the same as the particle size of the material when it is airborne.

Based on monitoring in the Hunter Valley, the modelling has been based on the use of three particle-size categories (0 to 2.5 μm - referred to as $\text{PM}_{2.5}$, 2.5 to 10 μm - referred to as CM (coarse matter) and 10 to 30 μm - referred to as the Rest). Mass emission rates in each of these size ranges have been determined using the factors derived from the **SPCC (1986)** study and TSP emission rates calculated using emission factors derived from **US EPA (1985)** and **NERDDC (1988)** work for emissions from open cut coal mines in the Hunter Valley.

The distribution of particles in each particle size range is as follows:

- $\text{PM}_{2.5}$ (FP) is 4.68% of TSP
- $\text{PM}_{2.5-10}$ (CM) is 34.4% of TSP
- PM_{10-30} (Rest) is 60.9% of TSP.

Analysis of the estimated dust emissions from the site (see **Section 5**), shows that the majority of emissions are due to wind erosion and haulage activities. Therefore, in the absence of any other data, it was assumed that this distribution applies.

Modelling was done using three ISC source groups. Each group corresponded to a particle size category. Each source in the group was assumed to emit at the full TSP emission rate and to deposit from the plume in accordance with the deposition rate appropriate for particles with an aerodynamic diameter equal to the geometric mean of the limits of the particle size range, except for the $\text{PM}_{2.5}$ group, which was assumed to have a particle size of 1 μm . The predicted concentration in the three plot output files for each group were then combined according to the weightings above to determine the concentration of PM_{10} and TSP.

Dust concentrations and deposition rates have been predicted in the vicinity of the project site for the two stages of the proposed operations. Although the terrain is generally flat, it has been taken into consideration for the modelling.

The modelling has been performed using the meteorological data discussed in **Section 4.1** and the dust emission estimates from **Section 5**.

As an example the ISCST3 input file is provided in **Appendix C**.

6.2 Assessing worst-case 24-hour PM₁₀ concentrations

The ISC model also has the capacity to take into account emissions that vary in time, or with meteorological conditions. This has proved particularly useful for simulating emissions on material operations where wind speed is an important factor in determining the rate at which dust is generated. The same considerations would apply in the current assessment.

For the current study the stockpile site was represented by a series of volume sources (shown in **Figure 5**). Each volume source was a combination of all dust emissions from activities in the general area. Estimates of emissions for each volume were developed on an hourly time step. Thus, for each source, for each hour, an emission rate was determined which depended upon the level of activity and the wind speed. It is important to do this in the ISC model to ensure that long-term average emission rates are not combined with worst-case dispersion conditions which are associated with light winds. For surface sources, light winds correspond with periods of low dust generation (because wind erosion and other wind dependent emissions rates will be low) and also correspond with periods of poor dispersion. If these measures are not taken then the model has the potential to significantly overstate impacts.

Experience has shown that the ISCST3 model tends to over-estimate 24-hour concentrations. To attempt to compensate for this effect, several calibration studies have been undertaken for mining studies by comparing the predicted maximum 24-hour average PM₁₀ and TSP concentrations at monitors in the Bulga/Warkworth area. (**Holmes Air Sciences, 2002; Holmes Air Sciences, 2003; Hansen Consulting, 2006**). The type of dust measured was predominantly from overburden operations handling sandstone. The distances from the main sources of dust to the monitors were 1000 to 3000 metres. In the absence of any other data the results of this study are deemed appropriate for application to this study.

The calibration studies have yielded ratios of between 1.6 and 4.1. The lowest factor of 1.6 was used to adjust the model predictions downwards to obtain a calibrated prediction of the worst-case 24-hour PM₁₀ concentrations.

7. ASSESSMENT OF IMPACTS

This section provides an interpretation of the predicted dust concentrations and deposition levels. The model runs were undertaken using the meteorological data described in **Section 4.1** and the emissions data described in **Section 5**. Receptors were positioned across a grid 4 km by 5 km in size with the project in the approximate centre. Additional receptors were positioned at the closest residences as shown in **Figure 2**.

Dust concentrations and deposition rates due to the stockpile operations for the existing and proposed operations have been presented as isopleth diagrams showing the following:

1. Predicted maximum 24-hour average PM₁₀ concentration;
2. Predicted annual average PM₁₀ concentration;
3. Predicted annual average TSP concentration; and
4. Predicted annual average dust deposition.

The maximum 24-hour average contour plots do not represent the dispersion pattern for any particular day, but show the highest predicted 24-hour average concentration that occurred at each location over the year. The maxima are used to show concentrations which can possibly be reached under the modelled conditions.

The model ISCST3 was used in this instance as it has been the most widely used model in NSW for assessing the dust impacts of extractive industries. Dust impacts and model predictions using ISCST3 are presented in **Figure 6** to **Figure 9** and are discussed below.

Table 8 summarises the model predictions at each of the residential receptors due to dust emissions from the project.

Figure 6 shows the maximum predicted 24-hour average PM₁₀ concentrations. The closest residences are predicted to experience a maximum of 8.4 µg/m³. It is unlikely that the DEC 24-hour average goal of 50 µg/m³ would be exceeded due to the proposed operations even with existing PM₁₀ concentrations.

Annual average PM₁₀ concentrations are shown in **Figure 7**. The residences are predicted to experience a maximum of 5.8 µg/m³. It is unlikely that the DEC annual average goal of 30 µg/m³ would be exceeded due to the proposed operations even with existing annual average PM₁₀ concentrations which have been estimated to be 19 µg/m³.

Annual average TSP concentrations at the nearest residences are shown in **Figure 8**. The maximum predicted concentration at the residences is 8.5 µg/m³. It is unlikely that the 90 µg/m³ NHMRC goal would be exceeded due to the existing operations even with existing annual average TSP concentrations which have been estimated to be 45 µg/m³.

Figure 9 shows the predicted annual average dust deposition levels. Levels at the nearest residence are predicted to be a maximum of 0.9 g/m²/month. Compliance with the DEC goals of less than 2 g/m²/month increment and a total of 4 g/m²/month would therefore be anticipated.

Table 8: Summary of dispersion model predictions due to project						
			PM ₁₀ (mg/m ³)		TSP (mg/m ³)	Dust deposition (g/m ² /month)
Averaging period			24-hour	Annual	Annual	Annual
Air quality goal			50	30	90	4
ID	X (m)	Y (m)	Worst-case			
1	451624	6441274	20.0	5.8	8.5	0.9
2	451659	6441376	13.1	3.6	5.0	0.4
3	451609	6441406	12.7	3.3	4.6	0.4
4	451791	6441284	8.8	2.7	3.6	0.4
5	451875	6441282	7.6	2.0	2.6	0.3

8. MITIGATION

8.1 Introduction

The modelling results presented above are based on the assumption that the Proponent applies control measures to minimise dust emissions. This section outlines procedures proposed for the management and control of dust emissions.

Proposed dust management and control procedures

The following procedures are proposed for the management of dust emissions from the site. The aim of these procedures is to minimise the emission of dust and the effects of these are included in the model simulations. Dust can be generated from two primary sources, these being:

- i) wind blown dust from exposed areas, and
- ii) dust generated by site activities.

The different sources of wind blown and site activity generated dust respectively, and the proposed controls are listed below:

- Vegetation stripping should be undertaken either during damp conditions or when the winds are not from the southwest.
- Maintain stockpiles in a moist condition to minimise wind blown and traffic generated dust.
- Water all roads and trafficked areas to minimise the generation of dust.

9. CONCLUSIONS

This study has assessed air quality impacts due to the proposed stockpile activity from the dredging of an oyster lease in Wallis Lake, Tuncurry. The emissions of dust from the proposed activities have been the focus of this assessment. The primary sources of dust would be loading the sand to the trucks, transporting the sand off-site, and wind erosion. Potential air quality impacts of PM₁₀, TSP and deposition of insoluble solids due to dust emissions from the proposed operations have been assessed. Computer-based dispersion modelling has been used for predicting the dust impacts due to the site operations.

Results from the dispersion modelling indicated that off-site dust concentrations and dust deposition levels at all nearby residences due to the proposed operations would be below relevant air quality goals. The assessment presents worst-case scenarios.

Emissions from the booster pumps along the transfer pipeline are predicted to be minimal.

10. REFERENCES

- Bureau of Meteorology (2006)
Climatic Averages Australia, Bureau of Meteorology website
<http://www.bom.gov.au/climate/averages/>
- Hansen Consulting (2006)
"Bengala Mining Company- Statement of Environmental Effects – Modifications to Mining Operations" February 2006
- Holmes Air Sciences (2000)
"Air Quality Impact Assessment: Proposed Upgrade of Tuncurry Sewage Treatment Plant". Prepared for Mid-Coast Water, April 2000.
- Holmes Air Sciences (2002)
"Air Quality: Additional Information Requested by NSW EPA for Ashton Project Assessment" Prepared for HLA-Envirosciences, February 2002.
- Holmes Air Sciences (2003)
"Air Quality Assessment: Mt Owen Operations" Prepared for Umwelt (Australia) Pty Ltd by Holmes Air Sciences, Suite 2B, 14 Glen Street, Eastwood, NSW 2122. December 2003.
- Hurley, P J (2005)
"The Air Pollution Model (TAPM) Version 3 : User Manual", CSIRO Research Internal Paper No. 31, April 2005
- NEPC (1998)
"National Environmental Protection Measure and Impact Statement for Ambient Air Quality". National Environment Protection Council Service Corporation, Level 5, 81 Flinders Street, Adelaide SA 5000.
- NEPC (2003)
"Variation to the National Environment Protection (Ambient Quality) Measure for Particles as PM_{2.5}", May 2003.
- NERDDC (1988)
"Air pollution from surface coal mining: Volume 2 Emission factors and model refinement", National Energy Research and Demonstration Council, Project 921.
- NSW DEC, 2005
"Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW", August 2005
- Puri, K., Dietachmayer, G. S., Mills, G. A., Davidson, N. E., Bowen, R. A., and Logan, L. W. (1997)
"The BMRC Limited Area Prediction System, LAPS". Aust. Met. Mag., **47**, 203-223
- SPCC (1983)
"Air Pollution from Coal Mining and Related Developments". State Pollution Control Commission. December 1983.

SPCC (1986)

"Particle size distributions in dust from open cut coal mines in the Hunter Valley", Report Number 10636-002-71, Prepared for the State Pollution Control Commission of NSW (now EPA) by Dames & Moore, 41 McLaren Street, North Sydney, NSW 2060.

US EPA (1985)

"Compilation of Air Pollutant Emission Factors", AP-42, Forth Edition United States Environmental Protection Agency, Office of Air and Radiation Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina 27711.

US EPA (1995a)

"User's Guide for the Industrial Source Complex (ISC3) Dispersion Models - Volume 1 User's Instructions" US Environmental Protection Agency, Office of Air Quality Planning and Standards Emissions, Monitoring and Analysis Division, Research Triangle Park, North Carolina 27711.

US EPA, 1995b

"AP-42, 5th Edition, Volume 1, Chapter 11". Section 11.9, Table 11.9-2. October 1998.

US EPA 1995c

"AP-42, 5th Edition, Volume 1, Chapter 13". Section 13.2.4. January 1995.

US EPA 2004

"AP-42, 5th Edition, Volume 1, Chapter 13". Section 11.19.2. Table 11.19.2-1. August 2004.

Venkatram (1980)

"Estimating the Monin-Obukhov Length in the Stable Boundary Layer for Dispersion Calculations", Boundary-Layer Meteorology, Volume 19, 481-485.

Powell, D C (1976)

"A Formulation of Time-varying Depths of Daytime Mixed Layer and Nighttime Stable Layer for use in Air Pollution Assessment Models", Annual Report for 1976 Part 3, Battelle PNL Atmospheric Sciences, 185-189.

Appendix A: Joint wind speed, wind direction and stability class tables for Pacific Palms meteorological station

STATISTICS FOR FILE: C:\Jobs\Wallis\Met\PAC96_rev.AUS
 MONTHS: All
 HOURS : All
 OPTION: Frequency

PASQUILL STABILITY CLASS 'A'

		Wind Speed Class (m/s)								
		0.50	1.50	3.00	4.50	6.00	7.50	9.00	GREATER	
WIND		TO	TO	TO	TO	TO	TO	TO	THAN	
SECTOR		1.50	3.00	4.50	6.00	7.50	9.00	10.50	10.50	TOTAL
NNE		0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
NE		0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ENE		0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
E		0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ESE		0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
SE		0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000114
SSE		0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
S		0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
SSW		0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
SW		0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000114
WSW		0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
W		0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
WNW		0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
NW		0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
NNW		0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
N		0.000000	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000114
CALM										0.000000
TOTAL		0.000228	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000342
MEAN WIND SPEED (m/s) = 1.20										
NUMBER OF OBSERVATIONS = 3										

PASQUILL STABILITY CLASS 'B'

		Wind Speed Class (m/s)								
		0.50	1.50	3.00	4.50	6.00	7.50	9.00	GREATER	
WIND		TO	TO	TO	TO	TO	TO	TO	THAN	
SECTOR		1.50	3.00	4.50	6.00	7.50	9.00	10.50	10.50	TOTAL
NNE		0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
NE		0.000000	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000114
ENE		0.000000	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000114
E		0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000114
ESE		0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000114
SE		0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
SSE		0.000000	0.000455	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000455
S		0.000114	0.001025	0.000228	0.000000	0.000000	0.000000	0.000000	0.000000	0.001366
SSW		0.000114	0.001252	0.000228	0.000000	0.000000	0.000000	0.000000	0.000000	0.001594
SW		0.000342	0.000228	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.000683
WSW		0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000114
W		0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
WNW		0.000000	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000114
NW		0.000114	0.000342	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000455
NNW		0.000114	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000228
N		0.000228	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000228
CALM										0.001366
TOTAL		0.001366	0.003757	0.000569	0.000000	0.000000	0.000000	0.000000	0.000000	0.007058
MEAN WIND SPEED (m/s) = 1.77										
NUMBER OF OBSERVATIONS = 62										

PASQUILL STABILITY CLASS 'C'

		Wind Speed Class (m/s)								
		0.50	1.50	3.00	4.50	6.00	7.50	9.00	GREATER	
WIND	TO	TO	TO	TO	TO	TO	TO	TO	THAN	
SECTOR	1.50	3.00	4.50	6.00	7.50	9.00	10.50	10.50	TOTAL	
NNE	0.000114	0.000000	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000228
NE	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000114
ENE	0.000000	0.000000	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000114
E	0.000114	0.000000	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000228
ESE	0.000114	0.000228	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000342
SE	0.000455	0.000455	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000911
SSE	0.000797	0.001935	0.000797	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003529
S	0.000797	0.004212	0.001252	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.006261
SSW	0.001366	0.004098	0.001025	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.006489
SW	0.001594	0.008424	0.002277	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.012409
WSW	0.001025	0.002960	0.001252	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005237
W	0.000114	0.000569	0.000455	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001138
WNW	0.000000	0.000114	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000228
NW	0.000228	0.000569	0.000228	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001025
NNW	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000114
N	0.000342	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000342
CALM										0.001252
TOTAL	0.007286	0.023566	0.007741	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.039959

MEAN WIND SPEED (m/s) = 2.29
NUMBER OF OBSERVATIONS = 351

PASQUILL STABILITY CLASS 'D'

		Wind Speed Class (m/s)								
		0.50	1.50	3.00	4.50	6.00	7.50	9.00	GREATER	
WIND	TO	TO	TO	TO	TO	TO	TO	TO	THAN	
SECTOR	1.50	3.00	4.50	6.00	7.50	9.00	10.50	10.50	TOTAL	
NNE	0.004326	0.009904	0.012409	0.016166	0.004895	0.000911	0.000114	0.000000	0.000000	0.048725
NE	0.001594	0.004098	0.008424	0.006831	0.003188	0.000683	0.000000	0.000000	0.000000	0.024818
ENE	0.002277	0.006831	0.006148	0.002505	0.000683	0.000000	0.000000	0.000000	0.000000	0.018443
E	0.001708	0.006717	0.009791	0.001708	0.000342	0.000000	0.000000	0.000000	0.000000	0.020264
ESE	0.001025	0.007172	0.008880	0.002846	0.000569	0.000000	0.000000	0.000000	0.000000	0.020492
SE	0.004326	0.019467	0.017190	0.000797	0.000000	0.000000	0.000000	0.000000	0.000000	0.041781
SSE	0.006603	0.014686	0.006489	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.027778
S	0.010360	0.016963	0.005578	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.032901
SSW	0.016166	0.010018	0.001821	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.028005
SW	0.020606	0.028575	0.005237	0.000228	0.000000	0.000000	0.000000	0.000000	0.000000	0.054645
WSW	0.007286	0.034039	0.021972	0.005237	0.000455	0.000228	0.000000	0.000000	0.000000	0.069217
W	0.002732	0.009221	0.012637	0.007969	0.000911	0.000228	0.000000	0.000000	0.000000	0.033698
WNW	0.003188	0.006261	0.002960	0.002277	0.000683	0.000114	0.000000	0.000000	0.000000	0.015483
NW	0.003188	0.005464	0.004781	0.003415	0.001480	0.000000	0.000000	0.000000	0.000000	0.018329
NNW	0.003871	0.012067	0.007400	0.002049	0.000000	0.000000	0.000000	0.000000	0.000000	0.025387
N	0.006148	0.014230	0.010474	0.005692	0.000797	0.000000	0.000000	0.000000	0.000000	0.037341
CALM										0.033811
TOTAL	0.095401	0.205715	0.142190	0.057719	0.014003	0.002163	0.000114	0.000000	0.000000	0.551116

MEAN WIND SPEED (m/s) = 2.78
NUMBER OF OBSERVATIONS = 4841

PASQUILL STABILITY CLASS 'E'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.003074	0.006034	0.010815	0.002618	0.000000	0.000000	0.000000	0.000000	0.022541
NE	0.001594	0.004781	0.005920	0.000342	0.000000	0.000000	0.000000	0.000000	0.012637
ENE	0.001935	0.002960	0.002960	0.000569	0.000000	0.000000	0.000000	0.000000	0.008424
E	0.001708	0.003871	0.003188	0.000228	0.000000	0.000000	0.000000	0.000000	0.008994
ESE	0.001480	0.004781	0.003188	0.000342	0.000000	0.000000	0.000000	0.000000	0.009791
SE	0.002732	0.006261	0.003415	0.000000	0.000000	0.000000	0.000000	0.000000	0.012409
SSE	0.002960	0.002049	0.000342	0.000000	0.000000	0.000000	0.000000	0.000000	0.005351
S	0.007855	0.004212	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.012067
SSW	0.011726	0.004895	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.016621
SW	0.010701	0.003871	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.014686
WSW	0.006831	0.014230	0.007058	0.000455	0.000000	0.000000	0.000000	0.000000	0.028575
W	0.004554	0.008994	0.009563	0.001821	0.000000	0.000000	0.000000	0.000000	0.024932
WNW	0.002049	0.002618	0.002277	0.000455	0.000000	0.000000	0.000000	0.000000	0.007400
NW	0.003871	0.003757	0.003415	0.000000	0.000000	0.000000	0.000000	0.000000	0.011043
NNW	0.005009	0.004668	0.006034	0.000455	0.000000	0.000000	0.000000	0.000000	0.016166
N	0.006148	0.009677	0.014800	0.001138	0.000000	0.000000	0.000000	0.000000	0.031762
CALM									0.048270
TOTAL	0.074226	0.087659	0.073087	0.008424	0.000000	0.000000	0.000000	0.000000	0.291667

MEAN WIND SPEED (m/s) = 2.10
NUMBER OF OBSERVATIONS = 2562

PASQUILL STABILITY CLASS 'F'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.003529	0.003415	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.006944
NE	0.000911	0.000228	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001138
ENE	0.000455	0.000228	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000683
E	0.000342	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000342
ESE	0.000911	0.000342	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001252
SE	0.000911	0.000342	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001252
SSE	0.000455	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000569
S	0.001821	0.000455	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002277
SSW	0.002732	0.000455	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003188
SW	0.002391	0.000455	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002846
WSW	0.001594	0.000342	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001935
W	0.000797	0.000911	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001708
WNW	0.001252	0.000797	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002049
NW	0.002505	0.002960	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005464
NNW	0.006261	0.011043	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.017304
N	0.007628	0.014913	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.022541
CALM									0.038365
TOTAL	0.034495	0.036999	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.109859

MEAN WIND SPEED (m/s) = 1.22
NUMBER OF OBSERVATIONS = 965

ALL PASQUILL STABILITY CLASSES

WIND SECTOR	Wind Speed Class (m/s)								TOTAL
	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	
NNE	0.011043	0.019353	0.023338	0.018784	0.004895	0.000911	0.000114	0.000000	0.078438
NE	0.004212	0.009221	0.014344	0.007172	0.003188	0.000683	0.000000	0.000000	0.038821
ENE	0.004668	0.010132	0.009221	0.003074	0.000683	0.000000	0.000000	0.000000	0.027778
E	0.003985	0.010587	0.013092	0.001935	0.000342	0.000000	0.000000	0.000000	0.029941
ESE	0.003643	0.012523	0.012067	0.003188	0.000569	0.000000	0.000000	0.000000	0.031990
SE	0.008538	0.026526	0.020606	0.000797	0.000000	0.000000	0.000000	0.000000	0.056466
SSE	0.010815	0.019240	0.007628	0.000000	0.000000	0.000000	0.000000	0.000000	0.037682
S	0.020947	0.026867	0.007058	0.000000	0.000000	0.000000	0.000000	0.000000	0.054872
SSW	0.032104	0.020719	0.003074	0.000000	0.000000	0.000000	0.000000	0.000000	0.055897
SW	0.035747	0.041553	0.007741	0.000342	0.000000	0.000000	0.000000	0.000000	0.085383
WSW	0.016849	0.051571	0.030282	0.005692	0.000455	0.000228	0.000000	0.000000	0.105077
W	0.008197	0.019695	0.022655	0.009791	0.000911	0.000228	0.000000	0.000000	0.061475
WNW	0.006489	0.009904	0.005351	0.002732	0.000683	0.000114	0.000000	0.000000	0.025273
NW	0.009904	0.013092	0.008424	0.003415	0.001480	0.000000	0.000000	0.000000	0.036316
NNW	0.015369	0.027892	0.013434	0.002505	0.000000	0.000000	0.000000	0.000000	0.059199
N	0.020492	0.038934	0.025273	0.006831	0.000797	0.000000	0.000000	0.000000	0.092327
CALM									0.123065
TOTAL	0.213001	0.357810	0.223588	0.066257	0.014003	0.002163	0.000114	0.000000	1.000000
MEAN WIND SPEED (m/s) = 2.38									
NUMBER OF OBSERVATIONS = 8784									

FREQUENCY OF OCCURENCE OF STABILITY CLASSES

A : 0.0%
 B : 0.7%
 C : 4.0%
 D : 55.1%
 E : 29.2%
 F : 11.0%

Appendix B: Dust emission calculations

WALLIS LAKE STOCKPILE AREA

DUST EMISSIONS INVENTORY

Introduction

The proponent proposes to separate and stockpile the sands pumped from the oyster lease at a site located at Tuncurry.

The dust emission inventory has been formulated based on the description of the activities provided on behalf of the proponent and summarised below. Emission factors have been developed using emission factor equations provided in the **US EPA (1985)** (and subsequent updates) publication referred to as AP-42 and from factors determined by **SPCC (1983)**.

Estimated emissions are presented for all significant dust generating activities associated with the extraction and processing operations.

It has been assumed that activities occur 11 hours a day. Dust from wind erosion is assumed to occur over 24 hours per day.

Extraction and processing methods

A bulldozer would be used to clear a small area of vegetation and topsoil.

The sand being removed from Pond 1 using an extractor and stored in stockpiles. It is assumed that no dust is generated in this process as there will be a high moisture content.

From the stockpile the sand would be loaded by front-end loader into haulage trucks for transport off-site.

A maximum of 160,000 m³ of sand would be transferred over a seven month period. At an average dry density of 1.45 t/m³, this equates to 232,000 t/seven months (398,000 tonnes per year (t/y)).

A dust inventories has been prepared for the worst-case scenario of the project, based on Pond 1 being a stockpile in addition to the original four stockpiles and the average moisture content of the stockpiles being 2%. It has been assumed that the haul roads are watered.

Emission estimates

Estimated emissions are presented for all significant dust generating activities associated with the operations. The relevant emission factors used for the study are described below.

Bulldozer activity

Bulldozers will be used to clear vegetation and topsoil in preparation for stockpiles. It is assumed that bulldozers will be used for a total of 16 h/y.

The rate at which dust will be generated by a bulldozer working is calculated using **Equation 1 (US EPA, 1995b)**.

Equation 1

$$E_{\text{TSP}} = \frac{2.6 \times s^{1.2}}{M^{1.3}} \quad \text{kg/hour}$$

where,

s = silt content (%), and

M = moisture content (%)

It was assumed that the moisture content is 2% and that the silt content is 6%.

Loading material with FELs

Each tonne of material loaded will generate a quantity of TSP that will depend on the wind speed and the moisture content. **Equation 2** shows the relationship between these variables (**US EPA, 1995c**).

Equation 2

$$E_{TSP} = k \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2} \right)^{1.3}}{\left(\frac{M}{2} \right)^{1.4}} \right) \quad \text{kg/t}$$

where :

E_{TSP} = emission factor (TSP)

$k = 0.74$

U = wind speed (m/s)

M = moisture content (%)

[where $0.25 \leq M \leq 4.8$]

The wind speed value was taken from the Pacific Palms 1996-1997 meteorological dataset. The moisture content was assumed to be 2%. The total sand loaded was assumed to be 160,000 m³ over a seven month period, which equates to approximately 275,000 m³ over a 12 month period. A density of 1.45 t/m³ was assumed.

Hauling material on unsealed surfaces

Haul trucks with an average capacity of 31t will be used to take the product off-site. The uncontrolled emission factor is 4.0 kg/VKT, and it has been assumed there is control of 75% due to the application of water.

Wind erosion from exposed areas

The **SPCC (1983)** emission factor for wind erosion is 0.4kg/h/ha.

Hauling material on sealed surfaces

Haul trucks with an average capacity of 31t will be used to take the product off-site. The emission factor is 1.0 kg/VKT.

Emission estimates from activity at Wallis Lake Stockpile site													
ACTIVITY	TSP (kg/y)	Intensity	Units	Emission factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 3	Units
Bulldozer activity (clearing vegetation)	145	16	h/y	9.1	kg/h	6	silt content in %	2	moisture content (%)				
FEL loading sand to trucks for haulage	701	398,000	t/y	0.00176	kg/t	1.487	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)				
Transporting sand off-site by road (unsealed rd)	12,839	398,000	t/y	0.12903	kg/t	31	t/truck load	1	km/return trip	4.0	kg/VKT	75	% control
Transporting blended sand product off-site by road (sealed rd)	3,852	398,000	t/y	0.0097	kg/t	31	t/truck load	1.5	km/return trip	0.2	kg/VKT		
Wind erosion from stockpiles	10,512	3.00	ha	0.4	kg/ha/h	8760	h						

This section of the Appendix shows the estimated dust emission calculated using the emission factors discussed above and the quantities of material handled.

Apart from the first block of data, each successive block shows the estimated annual average emission in kg/y for each activity and nominates if the activity is (1) insensitive to wind speed (2) sensitive to wind speed (3) or is a wind erosion source. In addition the blocks specify how many sources the dust emission is assumed to be spread over and which sources have been used to specify the locations of the emissions. For example the numbers 13 to 18 in the second block below mean that the emissions for bulldozer activity have been assigned to the source numbers 13 to 18 as shown in Figure 4.

```
ACTIVITY NAME : Wind erosion from
stockpiles
ACTIVITY TYPE : Wind erosion
DUST EMISSION : 10512 kg/y
FROM SOURCES : 18
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
18
HOURS OF DAY :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
1 1
```

DUST EMISSION CALCULATIONS V2

```
Output emissions file :
C:\Jobs\Wallis\ISC\emission.dat
Meteorological file :
C:\Jobs\Wallis\Met\PAC96.isc
Number of dust sources : 42
Number of activities : 5
No-blast conditions : None
Wind sensitive factor : 1.189 (1.487
adjusted for activity hours)
Wind erosion factor : 31.195
```

-----ACTIVITY SUMMARY-----

```
ACTIVITY NAME : Bulldozer activity
(clearing vegetation)
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 145 kg/y
FROM SOURCES : 6
13 14 15 16 17 18
HOURS OF DAY :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 0 0 0 0
0 0
```

```
ACTIVITY NAME : FEL loading sand to trucks
for haulage
ACTIVITY TYPE : Wind sensitive
DUST EMISSION : 701 kg/y
FROM SOURCES : 18
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
18
HOURS OF DAY :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 0 0 0 0
0 0
```

```
ACTIVITY NAME : Transporting sand off-site
by road (unsealed rd)
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 12839 kg/y
FROM SOURCES : 10
19 20 21 22 23 24 25 26 27 28
HOURS OF DAY :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 0 0 0 0
0 0
```

```
ACTIVITY NAME : Transporting blended sand
product off-site by road (sealed rd)
ACTIVITY TYPE : Wind insensitive
DUST EMISSION : 3852 kg/y
FROM SOURCES : 14
29 30 31 32 33 34 35 36 37 38 39 40 41 42
HOURS OF DAY :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 0 0 0 0
0 0
```

Appendix C: ISCST3 input file

** ISCST3 model input runstream : Dust

CO STARTING

TITLEONE ISCST3 Dust Model Run
MODELOPT RURAL CONC DDEP DRYDPLT
AVERTIME 24 PERIOD
POLLUTID TSP
ERRORFIL Error.MSG
TERRHGTS ELEV
RUNORNOT RUN

CO FINISHED

SO STARTING

LOCATION	POINT	VOLUME	451150.4726	6441195.503	3.271300288
LOCATION	POINT2	VOLUME	451198.0132	6441184.939	3.398512841
LOCATION	POINT3	VOLUME	451145.1903	6441159.848	3.233223264
LOCATION	POINT4	VOLUME	451192.731	6441147.962	3.361033789
LOCATION	POINT5	VOLUME	451138.5875	6441124.192	3.191030599
LOCATION	POINT6	VOLUME	451191.4104	6441112.307	3.335450283
LOCATION	POINT7	VOLUME	451266.6831	6441171.733	3.578606535
LOCATION	POINT8	VOLUME	451303.6591	6441165.13	3.676200688
LOCATION	POINT9	VOLUME	451262.7213	6441134.757	3.548254868
LOCATION	POINT10	VOLUME	451297.0562	6441126.833	3.639920071
LOCATION	POINT11	VOLUME	451260.0803	6441097.781	3.521390978
LOCATION	POINT12	VOLUME	451302.3385	6441088.537	3.636789981
LOCATION	POINT13	VOLUME	451093.688	6441290.584	3.180493451
LOCATION	POINT14	VOLUME	451124.0613	6441283.982	3.260005774
LOCATION	POINT15	VOLUME	451171.6018	6441278.699	3.387156906
LOCATION	POINT16	VOLUME	451209.8983	6441273.417	3.487844585
LOCATION	POINT17	VOLUME	451250.8362	6441265.493	3.590474317
LOCATION	POINT18	VOLUME	451286.4917	6441260.211	3.681341248
LOCATION	POINT19	VOLUME	451334.0322	6441206.068	3.773874968
LOCATION	POINT20	VOLUME	451363.0849	6441224.556	3.856760801
LOCATION	POINT21	VOLUME	451405.343	6441221.915	3.961936367
LOCATION	POINT22	VOLUME	451450.2427	6441212.67	4.066815033
LOCATION	POINT23	VOLUME	451479.2952	6441190.221	4.132317809
LOCATION	POINT24	VOLUME	451477.9746	6441138.719	4.12066246
LOCATION	POINT25	VOLUME	451474.0129	6441093.819	4.103341912
LOCATION	POINT26	VOLUME	451470.0513	6441040.996	4.08777416
LOCATION	POINT27	VOLUME	451467.4101	6441001.379	4.076441652
LOCATION	POINT28	VOLUME	451463.4484	6440963.082	4.063586581
LOCATION	POINT29	VOLUME	451517.5917	6440945.915	4.225981961
LOCATION	POINT30	VOLUME	451575.6969	6440934.03	4.405483867
LOCATION	POINT31	VOLUME	451643.0462	6440922.145	4.621052808
LOCATION	POINT32	VOLUME	451702.4719	6440911.58	4.818397929
LOCATION	POINT33	VOLUME	451753.9742	6440904.977	5.000749856
LOCATION	POINT34	VOLUME	451814.7206	6440895.733	5.226962788
LOCATION	POINT35	VOLUME	451876.7874	6440883.848	5.480683822
LOCATION	POINT36	VOLUME	451929.6103	6440877.245	5.698815982
LOCATION	POINT37	VOLUME	451965.2659	6440873.283	5.84868883
LOCATION	POINT38	VOLUME	452016.2229	6440865.36	6.06954937
LOCATION	POINT39	VOLUME	452069.0459	6440860.078	6.295407945
LOCATION	POINT40	VOLUME	452111.3041	6440852.154	6.485684005
LOCATION	POINT41	VOLUME	452158.8447	6440844.231	6.694793475
LOCATION	POINT42	VOLUME	452201.1029	6440833.666	6.895455767
LOCATION	POINT43	VOLUME	451150.4726	6441195.503	3.271300288
LOCATION	POINT44	VOLUME	451198.0132	6441184.939	3.398512841
LOCATION	POINT45	VOLUME	451145.1903	6441159.848	3.233223264
LOCATION	POINT46	VOLUME	451192.731	6441147.962	3.361033789
LOCATION	POINT47	VOLUME	451138.5875	6441124.192	3.191030599
LOCATION	POINT48	VOLUME	451191.4104	6441112.307	3.335450283
LOCATION	POINT49	VOLUME	451266.6831	6441171.733	3.578606535
LOCATION	POINT50	VOLUME	451303.6591	6441165.13	3.676200688
LOCATION	POINT51	VOLUME	451262.7213	6441134.757	3.548254868
LOCATION	POINT52	VOLUME	451297.0562	6441126.833	3.639920071
LOCATION	POINT53	VOLUME	451260.0803	6441097.781	3.521390978
LOCATION	POINT54	VOLUME	451302.3385	6441088.537	3.636789981
LOCATION	POINT55	VOLUME	451093.688	6441290.584	3.180493451
LOCATION	POINT56	VOLUME	451124.0613	6441283.982	3.260005774
LOCATION	POINT57	VOLUME	451171.6018	6441278.699	3.387156906
LOCATION	POINT58	VOLUME	451209.8983	6441273.417	3.487844585
LOCATION	POINT59	VOLUME	451250.8362	6441265.493	3.590474317
LOCATION	POINT60	VOLUME	451286.4917	6441260.211	3.681341248
LOCATION	POINT61	VOLUME	451334.0322	6441206.068	3.773874968
LOCATION	POINT62	VOLUME	451363.0849	6441224.556	3.856760801
LOCATION	POINT63	VOLUME	451405.343	6441221.915	3.961936367
LOCATION	POINT64	VOLUME	451450.2427	6441212.67	4.066815033

LOCATION	POINT65	VOLUME	451479.2952	6441190.221	4.132317809
LOCATION	POINT66	VOLUME	451477.9746	6441138.719	4.12066246
LOCATION	POINT67	VOLUME	451474.0129	6441093.819	4.103341912
LOCATION	POINT68	VOLUME	451470.0513	6441040.996	4.08777416
LOCATION	POINT69	VOLUME	451467.4101	6441001.379	4.076441652
LOCATION	POINT70	VOLUME	451463.4484	6440963.082	4.063586581
LOCATION	POINT71	VOLUME	451517.5917	6440945.915	4.225981961
LOCATION	POINT72	VOLUME	451575.6969	6440934.03	4.405483867
LOCATION	POINT73	VOLUME	451643.0462	6440922.145	4.621052808
LOCATION	POINT74	VOLUME	451702.4719	6440911.58	4.818397929
LOCATION	POINT75	VOLUME	451753.9742	6440904.977	5.000749856
LOCATION	POINT76	VOLUME	451814.7206	6440895.733	5.226962788
LOCATION	POINT77	VOLUME	451876.7874	6440883.848	5.480683822
LOCATION	POINT78	VOLUME	451929.6103	6440877.245	5.698815982
LOCATION	POINT79	VOLUME	451965.2659	6440873.283	5.84868883
LOCATION	POINT80	VOLUME	452016.2229	6440865.36	6.06954937
LOCATION	POINT81	VOLUME	452069.0459	6440860.078	6.295407945
LOCATION	POINT82	VOLUME	452111.3041	6440852.154	6.485684005
LOCATION	POINT83	VOLUME	452158.8447	6440844.231	6.694793475
LOCATION	POINT84	VOLUME	452201.1029	6440833.666	6.895455767
LOCATION	POINT85	VOLUME	451150.4726	6441195.503	3.271300288
LOCATION	POINT86	VOLUME	451198.0132	6441184.939	3.398512841
LOCATION	POINT87	VOLUME	451145.1903	6441159.848	3.233223264
LOCATION	POINT88	VOLUME	451192.731	6441147.962	3.361033789
LOCATION	POINT89	VOLUME	451138.5875	6441124.192	3.191030599
LOCATION	POINT90	VOLUME	451191.4104	6441112.307	3.335450283
LOCATION	POINT91	VOLUME	451266.6831	6441171.733	3.578606535
LOCATION	POINT92	VOLUME	451303.6591	6441165.13	3.676200688
LOCATION	POINT93	VOLUME	451262.7213	6441134.757	3.548254868
LOCATION	POINT94	VOLUME	451297.0562	6441126.833	3.639920071
LOCATION	POINT95	VOLUME	451260.0803	6441097.781	3.521390978
LOCATION	POINT96	VOLUME	451302.3385	6441088.537	3.636789981
LOCATION	POINT97	VOLUME	451093.688	6441290.584	3.180493451
LOCATION	POINT98	VOLUME	451124.0613	6441283.982	3.260005774
LOCATION	POINT99	VOLUME	451171.6018	6441278.699	3.387156906
LOCATION	POINT100	VOLUME	451209.8983	6441273.417	3.487844585
LOCATION	POINT101	VOLUME	451250.8362	6441265.493	3.590474317
LOCATION	POINT102	VOLUME	451286.4917	6441260.211	3.681341248
LOCATION	POINT103	VOLUME	451334.0322	6441206.068	3.773874968
LOCATION	POINT104	VOLUME	451363.0849	6441224.556	3.856760801
LOCATION	POINT105	VOLUME	451405.343	6441221.915	3.961936367
LOCATION	POINT106	VOLUME	451450.2427	6441212.67	4.066815033
LOCATION	POINT107	VOLUME	451479.2952	6441190.221	4.132317809
LOCATION	POINT108	VOLUME	451477.9746	6441138.719	4.12066246
LOCATION	POINT109	VOLUME	451474.0129	6441093.819	4.103341912
LOCATION	POINT110	VOLUME	451470.0513	6441040.996	4.08777416
LOCATION	POINT111	VOLUME	451467.4101	6441001.379	4.076441652
LOCATION	POINT112	VOLUME	451463.4484	6440963.082	4.063586581
LOCATION	POINT113	VOLUME	451517.5917	6440945.915	4.225981961
LOCATION	POINT114	VOLUME	451575.6969	6440934.03	4.405483867
LOCATION	POINT115	VOLUME	451643.0462	6440922.145	4.621052808
LOCATION	POINT116	VOLUME	451702.4719	6440911.58	4.818397929
LOCATION	POINT117	VOLUME	451753.9742	6440904.977	5.000749856
LOCATION	POINT118	VOLUME	451814.7206	6440895.733	5.226962788
LOCATION	POINT119	VOLUME	451876.7874	6440883.848	5.480683822
LOCATION	POINT120	VOLUME	451929.6103	6440877.245	5.698815982
LOCATION	POINT121	VOLUME	451965.2659	6440873.283	5.84868883
LOCATION	POINT122	VOLUME	452016.2229	6440865.36	6.06954937
LOCATION	POINT123	VOLUME	452069.0459	6440860.078	6.295407945
LOCATION	POINT124	VOLUME	452111.3041	6440852.154	6.485684005
LOCATION	POINT125	VOLUME	452158.8447	6440844.231	6.694793475
LOCATION	POINT126	VOLUME	452201.1029	6440833.666	6.895455767

** Point Source

QS RH IL IV

** Parameters

---- --- --- ---

HOUREMIS C:\Jobs\Wallis\ISC\emission.dat POINT1-POINT126

SRCPARAM	POINT1	1.0	2.0	20.	2.
SRCPARAM	POINT2	1.0	2.0	20.	2.
SRCPARAM	POINT3	1.0	2.0	20.	2.
SRCPARAM	POINT4	1.0	2.0	20.	2.
SRCPARAM	POINT5	1.0	2.0	20.	2.
SRCPARAM	POINT6	1.0	2.0	20.	2.
SRCPARAM	POINT7	1.0	2.0	20.	2.
SRCPARAM	POINT8	1.0	2.0	20.	2.
SRCPARAM	POINT9	1.0	2.0	20.	2.
SRCPARAM	POINT10	1.0	2.0	20.	2.
SRCPARAM	POINT11	1.0	2.0	20.	2.

SRCPARAM	POINT12	1.0	2.0	20.	2.
SRCPARAM	POINT13	1.0	2.0	20.	2.
SRCPARAM	POINT14	1.0	2.0	20.	2.
SRCPARAM	POINT15	1.0	2.0	20.	2.
SRCPARAM	POINT16	1.0	2.0	20.	2.
SRCPARAM	POINT17	1.0	2.0	20.	2.
SRCPARAM	POINT18	1.0	2.0	20.	2.
SRCPARAM	POINT19	1.0	2.0	20.	2.
SRCPARAM	POINT20	1.0	2.0	20.	2.
SRCPARAM	POINT21	1.0	2.0	20.	2.
SRCPARAM	POINT22	1.0	2.0	20.	2.
SRCPARAM	POINT23	1.0	2.0	20.	2.
SRCPARAM	POINT24	1.0	2.0	20.	2.
SRCPARAM	POINT25	1.0	2.0	20.	2.
SRCPARAM	POINT26	1.0	2.0	20.	2.
SRCPARAM	POINT27	1.0	2.0	20.	2.
SRCPARAM	POINT28	1.0	2.0	20.	2.
SRCPARAM	POINT29	1.0	2.0	20.	2.
SRCPARAM	POINT30	1.0	2.0	20.	2.
SRCPARAM	POINT31	1.0	2.0	20.	2.
SRCPARAM	POINT32	1.0	2.0	20.	2.
SRCPARAM	POINT33	1.0	2.0	20.	2.
SRCPARAM	POINT34	1.0	2.0	20.	2.
SRCPARAM	POINT35	1.0	2.0	20.	2.
SRCPARAM	POINT36	1.0	2.0	20.	2.
SRCPARAM	POINT37	1.0	2.0	20.	2.
SRCPARAM	POINT38	1.0	2.0	20.	2.
SRCPARAM	POINT39	1.0	2.0	20.	2.
SRCPARAM	POINT40	1.0	2.0	20.	2.
SRCPARAM	POINT41	1.0	2.0	20.	2.
SRCPARAM	POINT42	1.0	2.0	20.	2.
SRCPARAM	POINT43	1.0	2.0	20.	2.
SRCPARAM	POINT44	1.0	2.0	20.	2.
SRCPARAM	POINT45	1.0	2.0	20.	2.
SRCPARAM	POINT46	1.0	2.0	20.	2.
SRCPARAM	POINT47	1.0	2.0	20.	2.
SRCPARAM	POINT48	1.0	2.0	20.	2.
SRCPARAM	POINT49	1.0	2.0	20.	2.
SRCPARAM	POINT50	1.0	2.0	20.	2.
SRCPARAM	POINT51	1.0	2.0	20.	2.
SRCPARAM	POINT52	1.0	2.0	20.	2.
SRCPARAM	POINT53	1.0	2.0	20.	2.
SRCPARAM	POINT54	1.0	2.0	20.	2.
SRCPARAM	POINT55	1.0	2.0	20.	2.
SRCPARAM	POINT56	1.0	2.0	20.	2.
SRCPARAM	POINT57	1.0	2.0	20.	2.
SRCPARAM	POINT58	1.0	2.0	20.	2.
SRCPARAM	POINT59	1.0	2.0	20.	2.
SRCPARAM	POINT60	1.0	2.0	20.	2.
SRCPARAM	POINT61	1.0	2.0	20.	2.
SRCPARAM	POINT62	1.0	2.0	20.	2.
SRCPARAM	POINT63	1.0	2.0	20.	2.
SRCPARAM	POINT64	1.0	2.0	20.	2.
SRCPARAM	POINT65	1.0	2.0	20.	2.
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SRCPARAM	POINT67	1.0	2.0	20.	2.
SRCPARAM	POINT68	1.0	2.0	20.	2.
SRCPARAM	POINT69	1.0	2.0	20.	2.
SRCPARAM	POINT70	1.0	2.0	20.	2.
SRCPARAM	POINT71	1.0	2.0	20.	2.
SRCPARAM	POINT72	1.0	2.0	20.	2.
SRCPARAM	POINT73	1.0	2.0	20.	2.
SRCPARAM	POINT74	1.0	2.0	20.	2.
SRCPARAM	POINT75	1.0	2.0	20.	2.
SRCPARAM	POINT76	1.0	2.0	20.	2.
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SRCPARAM	POINT78	1.0	2.0	20.	2.
SRCPARAM	POINT79	1.0	2.0	20.	2.
SRCPARAM	POINT80	1.0	2.0	20.	2.
SRCPARAM	POINT81	1.0	2.0	20.	2.
SRCPARAM	POINT82	1.0	2.0	20.	2.
SRCPARAM	POINT83	1.0	2.0	20.	2.
SRCPARAM	POINT84	1.0	2.0	20.	2.
SRCPARAM	POINT85	1.0	2.0	20.	2.
SRCPARAM	POINT86	1.0	2.0	20.	2.
SRCPARAM	POINT87	1.0	2.0	20.	2.

```

SRCPARAM POINT88 1.0 2.0 20. 2.
SRCPARAM POINT89 1.0 2.0 20. 2.
SRCPARAM POINT90 1.0 2.0 20. 2.
SRCPARAM POINT91 1.0 2.0 20. 2.
SRCPARAM POINT92 1.0 2.0 20. 2.
SRCPARAM POINT93 1.0 2.0 20. 2.
SRCPARAM POINT94 1.0 2.0 20. 2.
SRCPARAM POINT95 1.0 2.0 20. 2.
SRCPARAM POINT96 1.0 2.0 20. 2.
SRCPARAM POINT97 1.0 2.0 20. 2.
SRCPARAM POINT98 1.0 2.0 20. 2.
SRCPARAM POINT99 1.0 2.0 20. 2.
SRCPARAM POINT100 1.0 2.0 20. 2.
SRCPARAM POINT101 1.0 2.0 20. 2.
SRCPARAM POINT102 1.0 2.0 20. 2.
SRCPARAM POINT103 1.0 2.0 20. 2.
SRCPARAM POINT104 1.0 2.0 20. 2.
SRCPARAM POINT105 1.0 2.0 20. 2.
SRCPARAM POINT106 1.0 2.0 20. 2.
SRCPARAM POINT107 1.0 2.0 20. 2.
SRCPARAM POINT108 1.0 2.0 20. 2.
SRCPARAM POINT109 1.0 2.0 20. 2.
SRCPARAM POINT110 1.0 2.0 20. 2.
SRCPARAM POINT111 1.0 2.0 20. 2.
SRCPARAM POINT112 1.0 2.0 20. 2.
SRCPARAM POINT113 1.0 2.0 20. 2.
SRCPARAM POINT114 1.0 2.0 20. 2.
SRCPARAM POINT115 1.0 2.0 20. 2.
SRCPARAM POINT116 1.0 2.0 20. 2.
SRCPARAM POINT117 1.0 2.0 20. 2.
SRCPARAM POINT118 1.0 2.0 20. 2.
SRCPARAM POINT119 1.0 2.0 20. 2.
SRCPARAM POINT120 1.0 2.0 20. 2.
SRCPARAM POINT121 1.0 2.0 20. 2.
SRCPARAM POINT122 1.0 2.0 20. 2.
SRCPARAM POINT123 1.0 2.0 20. 2.
SRCPARAM POINT124 1.0 2.0 20. 2.
SRCPARAM POINT125 1.0 2.0 20. 2.
SRCPARAM POINT126 1.0 2.0 20. 2.
PARTDIAM POINT1-POINT42 1.0
PARTDIAM POINT43-POINT84 5.0
PARTDIAM POINT85-POINT126 17.3
MASSFRAX POINT1-POINT126 1.0
PARTDENS POINT1-POINT126 2.5
SRCGROUP FP POINT1-POINT42
SRCGROUP CM POINT43-POINT84
SRCGROUP REST POINT85-POINT126
SO FINISHED

RE STARTING
RE DISCCART 451090.1251 6441323.076 3.2
RE DISCCART 451102.1586 6441308.636 3.2
RE DISCCART 451106.9715 6441296.602 3.2
RE DISCCART 451116.5979 6441284.569 3.2
RE DISCCART 451063.6522 6441284.569 3.1
RE DISCCART 451116.5979 6441308.636 3.3
RE DISCCART 451155.1051 6441291.789 3.4
RE DISCCART 451200.8308 6441262.909 3.5
RE DISCCART 451171.9515 6441306.229 3.4
RE DISCCART 451200.8308 6441294.196 3.5
RE DISCCART 451224.8979 6441306.229 3.5
RE DISCCART 451265.8108 6441272.536 3.6
RE DISCCART 451282.6572 6441250.876 3.7
RE DISCCART 451301.9108 6441265.316 3.7
RE DISCCART 451263.4044 6441299.009 3.6
RE DISCCART 451239.3372 6441265.316 3.6
RE DISCCART 451251.3708 6441205.149 3.6
RE DISCCART 451285.0637 6441164.237 3.6
RE DISCCART 451318.7572 6441137.764 3.7
RE DISCCART 451304.3172 6441084.817 3.6
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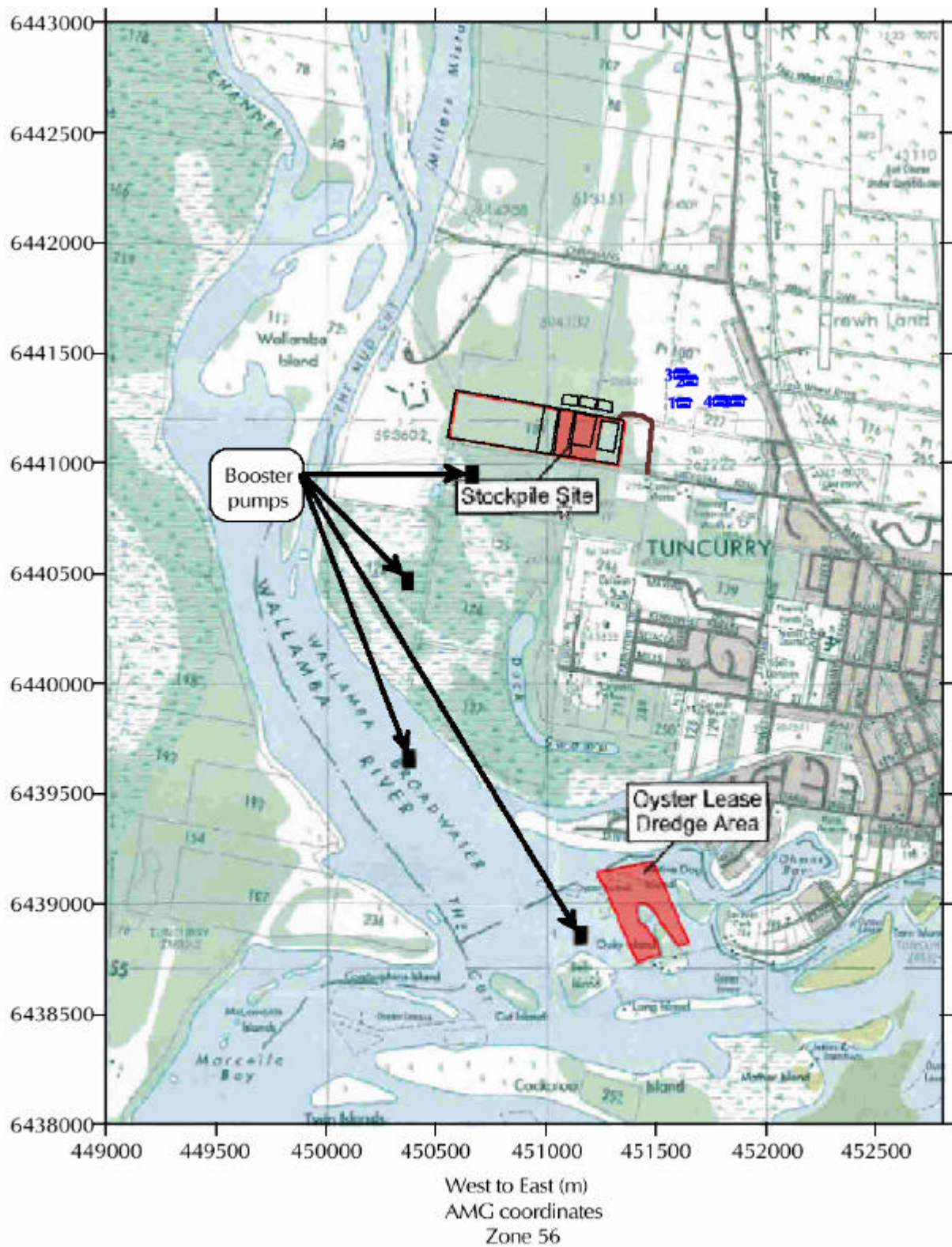
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FIGURES



Location of extraction site, stockpile site and residences

Figure 1: Site location

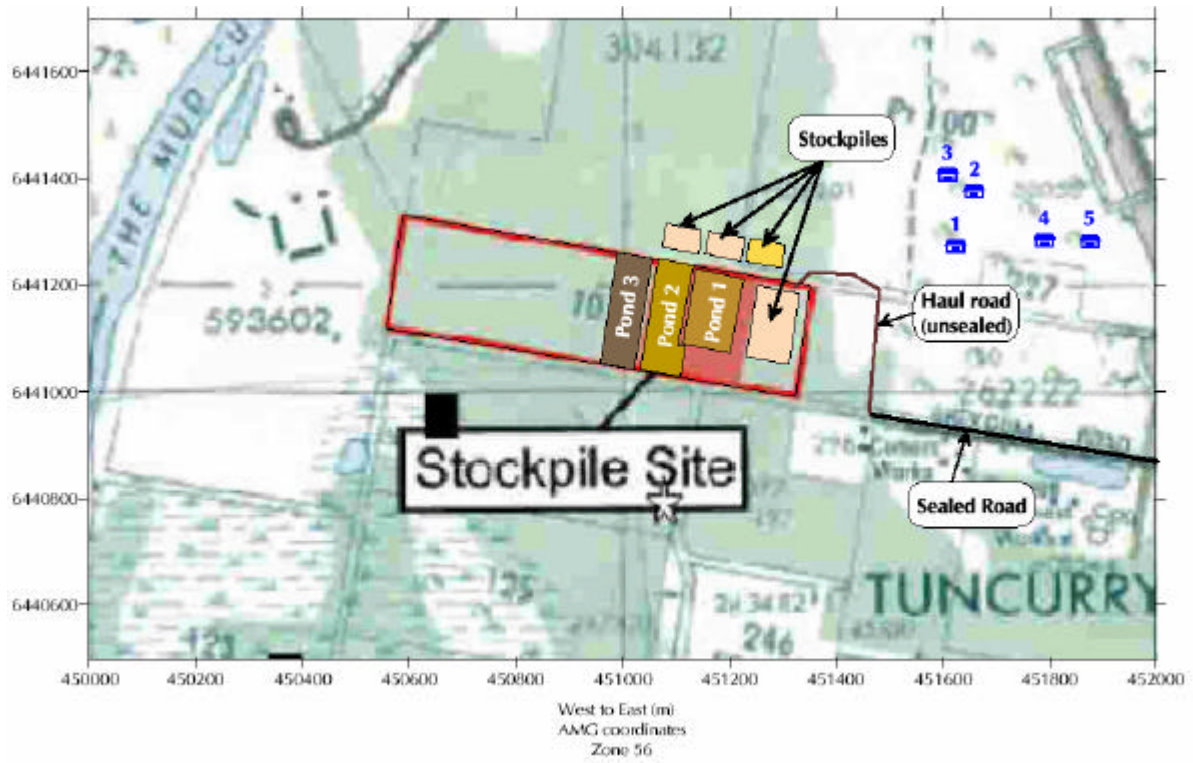


Figure 2: Site layout

Annual and seasonal windroses for Pacific Palms (1996 - 1997)

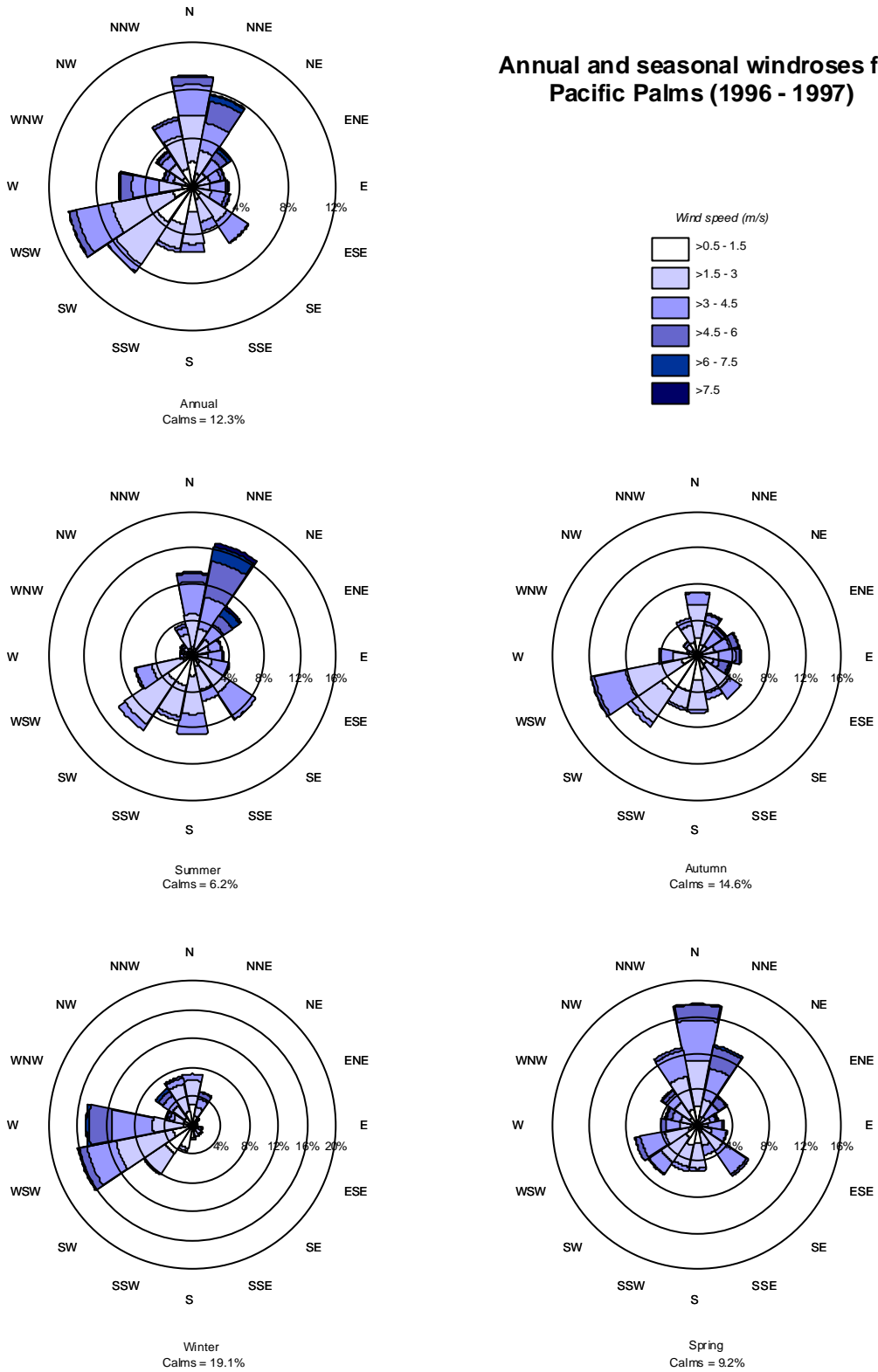
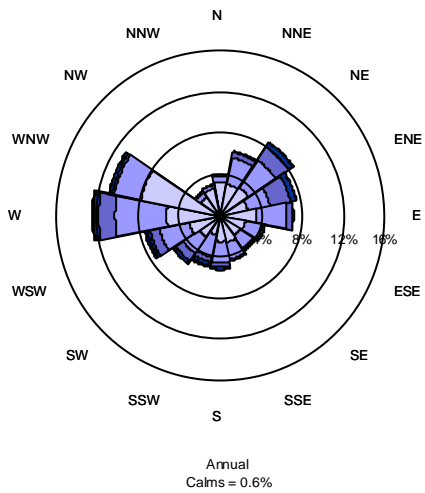


Figure 3: Annual and seasonal windroses for Pacific Palms



Annual and seasonal windroses for Wallis Lake (TAPM 2005)

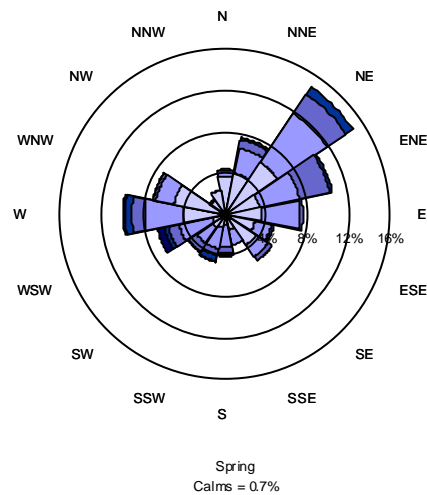
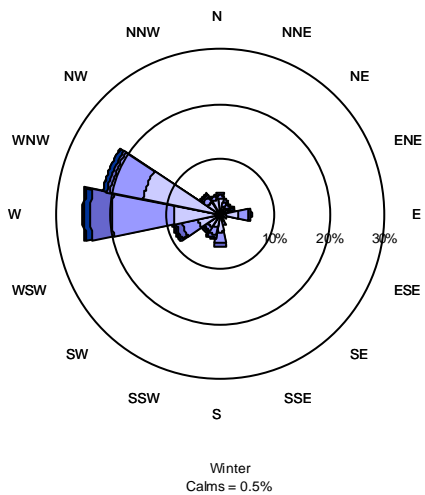
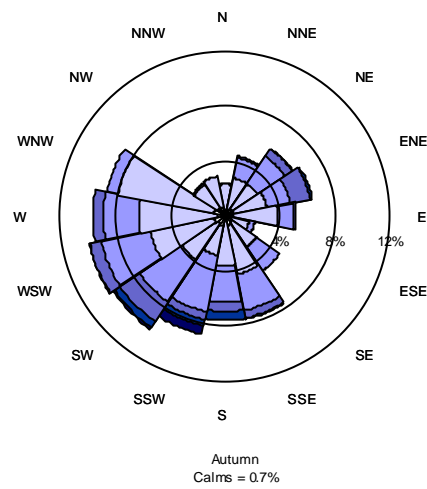
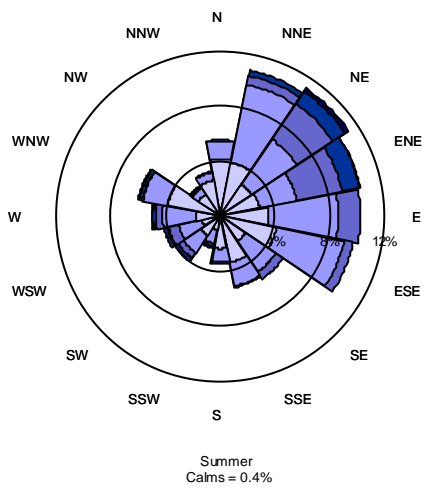
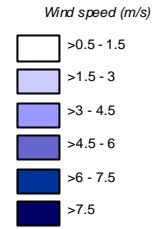


Figure 4: Annual and seasonal windroses for Wallis Lake

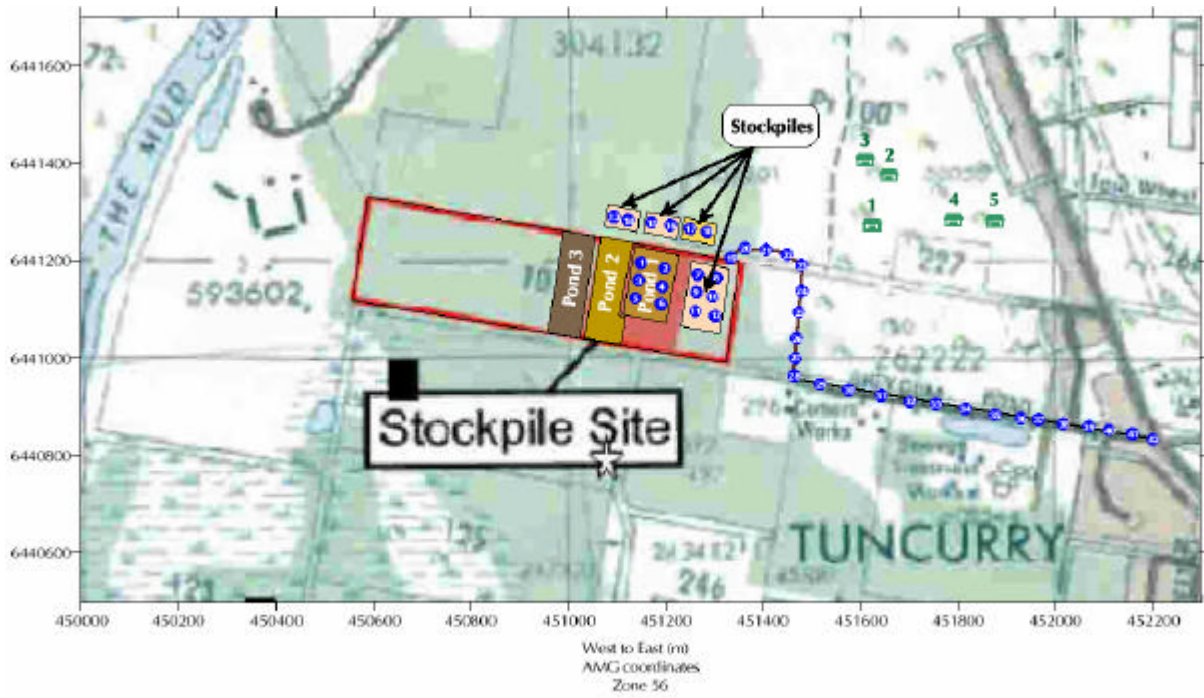
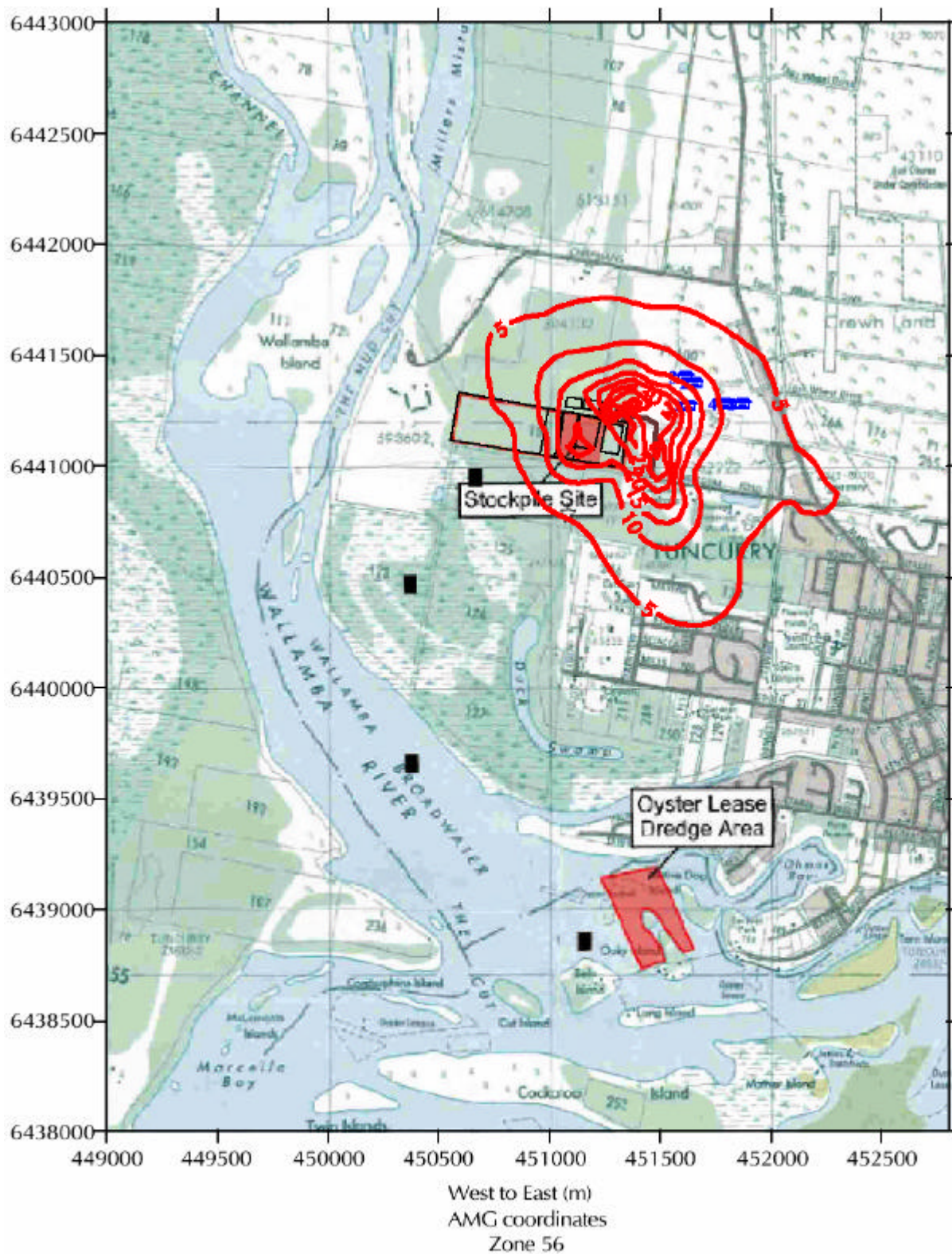
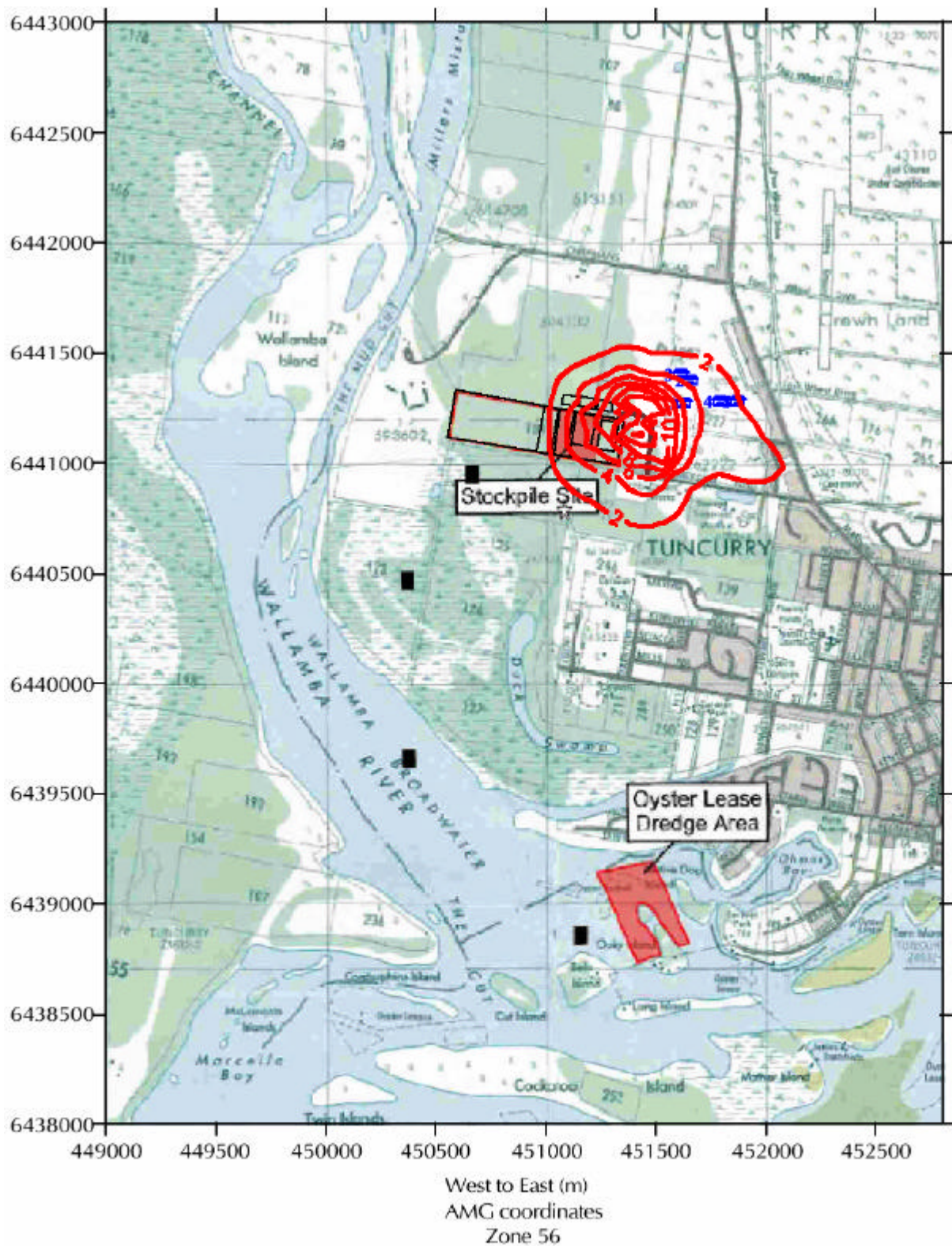


Figure 5: Source locations for dispersion modelling



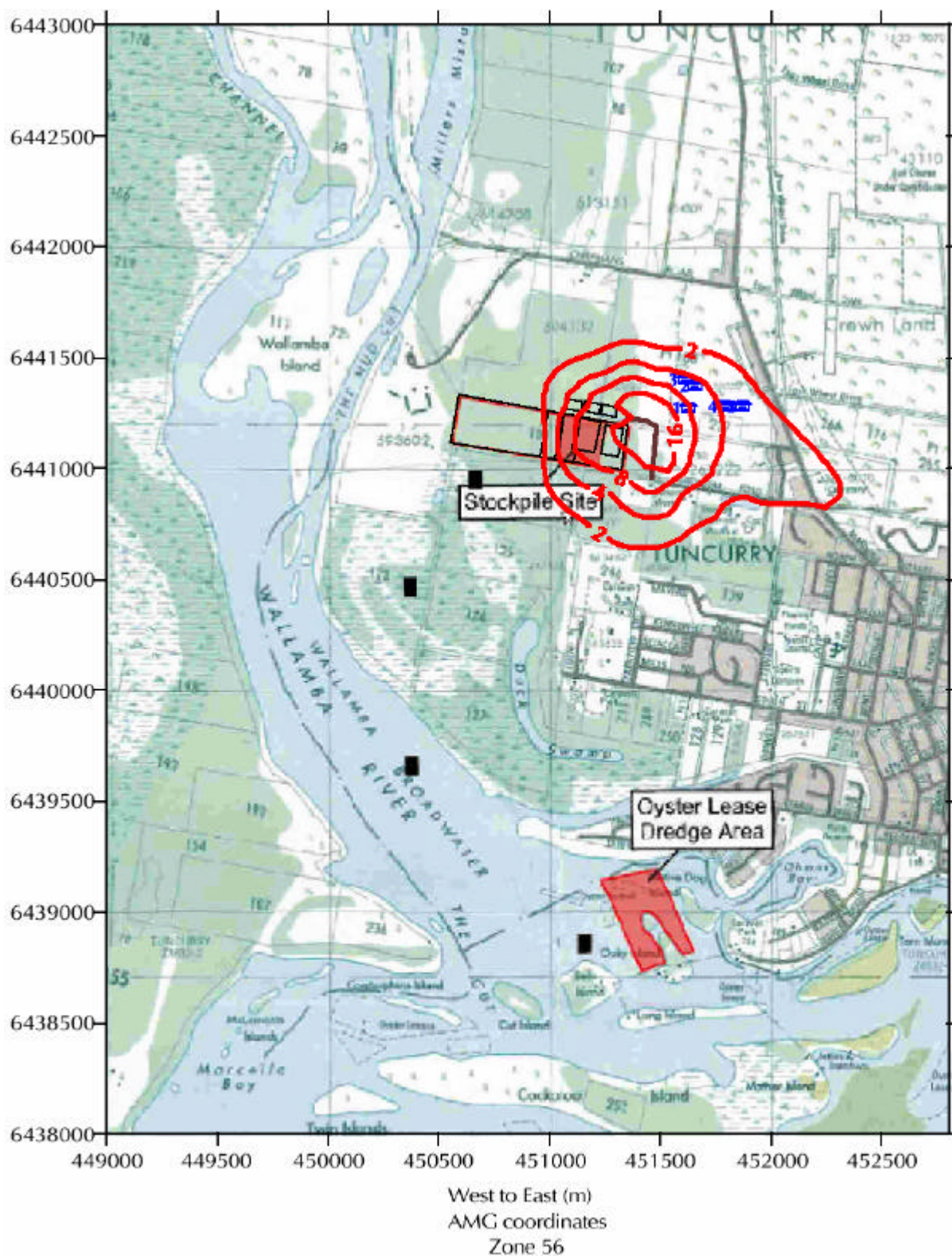
Predicted maximum 24-hour average PM_{10} concentration
due to emissions from the site ($\mu g/m^3$)

Figure 6: Predicted maximum 24-hour average PM_{10} concentration due to emissions from the site (mg/m^3)



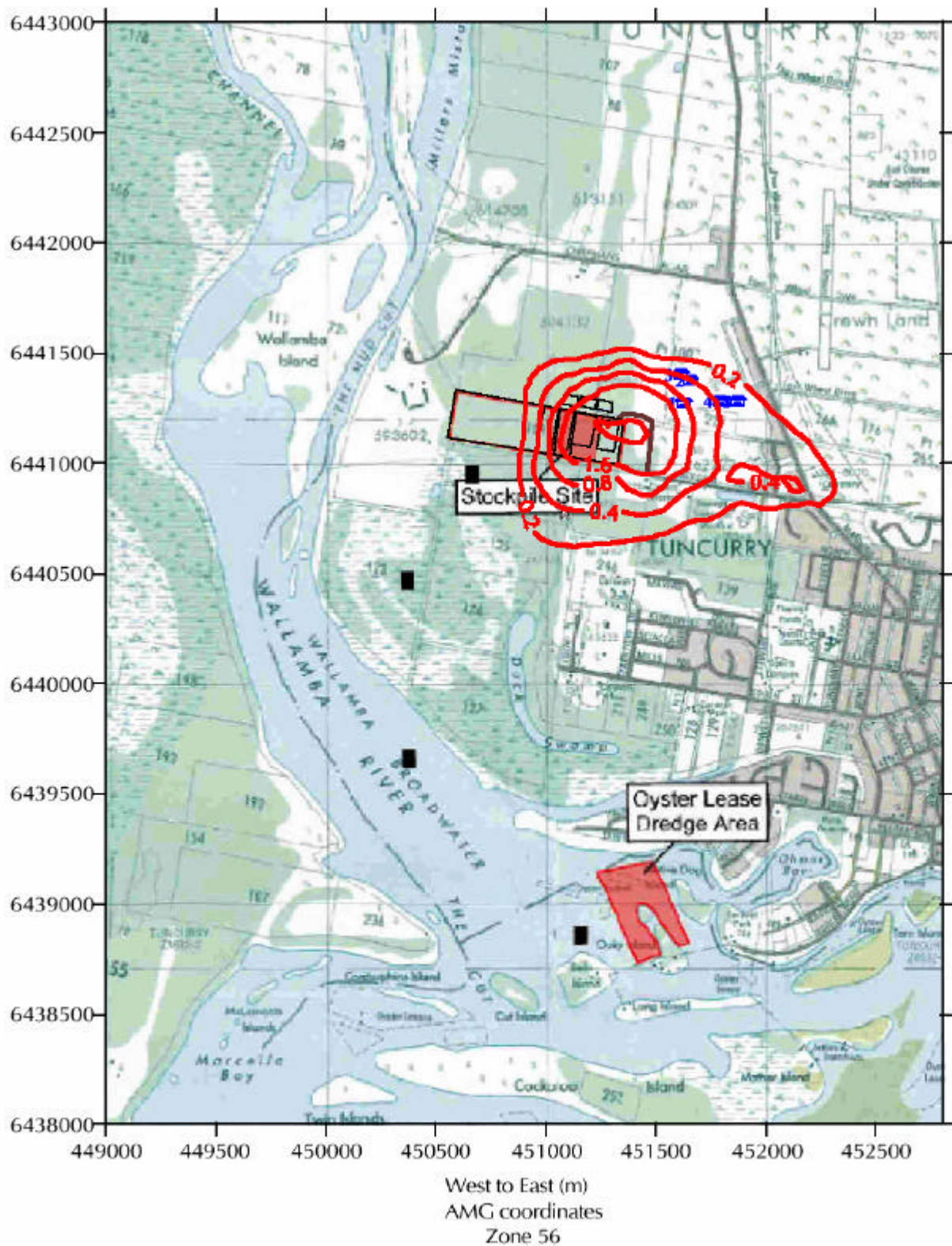
Predicted annual average PM_{10} concentration
due to emissions from the site ($\mu g/m^3$)

Figure 7: Predicted annual average PM_{10} concentration due to emissions from the site (mg/m^3)



Predicted annual average TSP concentration
 due to emissions from the site ($\mu\text{g}/\text{m}^3$)

Figure 8: Predicted annual average TSP concentration due to emissions from the site (mg/m^3)



Predicted annual average dust deposition
due to emissions from the site (g/m²/month)

Figure 9: Predicted annual average dust deposition due to emissions from the site (g/m²/month)