

Southlands Remediation and Development Project

Environmental Assessment

Project Application (MP 06_0191)

Appendix K: Regional Air Quality



**AIR QUALITY ASSESSMENT REPORT - DRAFT
SOUTHLANDS PROJECT**

November, 2007

Prepared for

DBL Property

by

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EXECUTIVE SUMMARY

This report has been prepared by Holmes Air Sciences on behalf of DBL Property, who in turn are acting for Orica Australia Pty Ltd and Goodman. The report presents an assessment of local and regional air quality issues related to the Southlands Development Project. The report has been prepared for inclusion in an Environmental Assessment (EA) for the project.

The Southlands site is located in Banksmeadow to the west of the Botany Industrial Park (BIP) and is to be developed for warehousing and ancillary commercial purposes in conjunction with site remediation works. This assessment is mainly concerned with air quality impacts following redevelopment and does not address issues associated with the site remediation which is addressed in the project Remediation Action Plan.

The report discusses the following issues:

- Local climate and meteorology;
- Local and regional air quality and air emission sources;
- Road traffic impacts; and
- Impacts of the developed site on local and regional air quality.

Air emissions from the proposal are likely to be very low and would not have an adverse affect on local or regional air quality. The design of the proposed Southlands facility will be consistent with the NSW Government "Action for Air" strategy for Sydney developed to manage air quality in Sydney. This includes the control of fugitive emissions, use of alternative fuels and landscaping.

Dust emissions will need to be managed during remediation and construction. The location of dust sensitive industries including food processing, pharmaceutical and electronic industries amongst others, may need to be considered during the staged development at the site.

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1 INTRODUCTION

This report has been prepared by Holmes Air Sciences on behalf of DBL Property, who in turn are acting for Orica Australia Pty Ltd and Macquarie Goodman. The report presents an assessment of local and regional air quality issues related to the Southlands Remediation and Development Project. The report has been prepared for inclusion in an Environmental Assessment (EA) for the project.

The Southlands site is located in Banksmeadow as shown in **Figure 1**. The site is to be developed for warehousing and ancillary commercial purposes in conjunction with site remediation works. This assessment is mainly concerned with air quality impacts following development.

The report discusses the following issues:

- Local climate and meteorology;
- Local and regional air quality and air emission sources;
- Road traffic impacts; and
- Impacts of the redeveloped site on local and regional air quality.

2 PROPOSED DEVELOPMENT

The Southlands site is to be developed for warehousing and ancillary commercial purposes. The proposed site layout is shown in **Figure 2**.

The site is owned by Orica Limited (Orica) and is situated to the west of the existing Botany Industrial Park. A staged development is proposed. It is proposed to build a new road to link McPherson Street and Botany Road (through the Macquarie Goodman Discovery Cove Industrial Estate to the south (see **Figure 3**)) to allow traffic between these two areas prior to Stage 2 of the development proceeding.

The Southlands site is affected by groundwater contamination which also has the potential for air emissions during remediation and occupation of the site. This is being addressed in a separate report by URS Australia who are preparing a Remedial Action Plan and Human Health Risk Assessment for the project.

This report focuses on the air quality issues associated with the operation of the site and also addresses the potential for dust impacts during construction.

3 METEOROLOGY AND CLIMATE

3.1 Meteorological data

The closest meteorological station is located at Sydney Airport to the west of the site. Annual and seasonal wind roses prepared from these data are shown in **Figure 4**. On an annual basis the predominant winds are from the NW, S and NE. In spring and summer the south easterlies predominate and in autumn and winter westerlies are the most common. This pattern is typical of the prevailing winds in the Sydney basin.

Atmospheric stability class¹ was determined by the method of **Turner (1970)** using cloud cover records from Mascot and wind speed information. **Table 1** shows the frequency of occurrence of the different stability categories expected in the area.

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

The high frequency of D class stability (55.9%), that is neutral stability with moderate turbulence, indicates that emissions from the various sources in the area will disperse relatively quickly for a significant proportion of the time.

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

Stability Class	Percentage Frequency
A	6.9
B	4.4
C	9.2
D	55.9
E	10.8
F	12.7
Total	100

3.2 Climate

Table 2 presents the temperature, humidity and rainfall data for Sydney Airport (**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 Sydney Airport are 22.1°C and 13.2°C respectively. On average January and February are the hottest months with an average maximum temperature of 26.3°C. July is the coldest month, with average minimum temperature of 6.9°C.

The annual average humidity reading collected at 9 am from the Sydney Airport site is 69 percent, and at 3 pm the annual average is 57 percent. The month with the highest humidity on average is June with a 9 am average of 75 percent, and the lowest is August with a 3 pm average of 50 percent.

Rainfall data collected at Sydney Airport shows that March is the wettest month, with an average rainfall of 119.5 mm over 12.3 days. The average annual rainfall is 1094 mm with an average of 128.7 raindays.

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.

Table 2 – Temperature, humidity and rainfall data for Sydney Airport													
(Station number 066037; Commenced: 1929, Last record: 2004; Latitude (°S): -33.9411; Longitude (°E): 151.1725)													
	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	22.3	22.3	21.1	18.2	14.5	11.8	10.6	12.4	15.5	18.3	19.8	21.6	17.3
Wet-bulb	18.7	19.1	18	15.2	12.1	9.6	8.3	9.4	11.7	14.1	15.7	17.6	14.1
Humidity	70	73	73	72	74	75	71	66	62	61	63	66	69
3 pm Mean Dry-bulb and Wet-bulb Temperatures (°C) and Relative Humidity (%)													
Dry-bulb	24.6	24.8	23.8	21.6	19	16.6	16	17.1	18.9	20.6	22	23.8	20.7
Wet-bulb	19.5	19.9	18.9	16.7	14.3	12.3	11.2	11.7	13.3	15	16.6	18.3	15.6
Humidity	61	63	62	59	58	57	53	50	51	54	57	58	57
Daily Maximum Temperature (°C)													
Mean	26.3	26.3	25.2	22.9	19.9	17.5	16.9	18.2	20.3	22.4	23.9	25.7	22.1
Daily Minimum Temperature (°C)													
Mean	18.7	18.9	17.4	14	10.8	8.4	6.9	7.9	10.2	13	15.2	17.4	13.2
Rainfall (mm)													
Mean	98.2	112.8	119.5	106.4	103.6	118.5	68.8	79.1	60.5	71.3	81.2	74.1	1094
Median	83.8	77	86.3	80	83.8	91.6	49.4	43.9	45.4	47.4	67.9	52.4	1073.9
Raindays (Number)													
Mean	11.3	11.5	12.3	10.9	11.3	10.9	9.2	9.4	9.4	10.7	11.3	10.5	128.7

Source: Bureau of Meteorology (2006)

4 LOCAL AND REGIONAL AIR QUALITY

4.3 Air quality monitoring data

The NSW Department of Environment and Climate Change (NSW DECC formerly NSW Department of Environment and Conservation) is responsible for the Sydney metropolitan air quality monitoring network. The network site nearest to the Southlands site is located at Randwick in the grounds of the Randwick Army Barracks. It is situated in a residential area and is at an elevation of 28 metres. Data have been collected at the Randwick monitoring station since 1995. The station measures nitrogen dioxide (NO₂), particulate matter with an aerodynamic diameter less than 10 µm (PM₁₀) and ozone (O₃).

Table 3 shows the annual average and maximum 1-hour values of NO₂ and PM₁₀ from the Randwick monitoring station between 1995 and 2005. The annual average NO₂ values have remained fairly stable over the 11 year monitoring period. The highest 1-hour values for each year have tended to decrease since 1995. The annual average PM₁₀ values have increased since 1995, but have remained stable at around 20 µg/m³ since 2002. The maximum 24-hour value of PM₁₀ was 146 µg/m³, in December 2002 and 68 µg/m³ in March 2003. It is most likely that these high values were due to the influence of smoke from bushfires that were burning in the Sydney region in December 2002, and dust storms that occurred in March 2003.

Year	NO ₂ (µg/m ³)		PM ₁₀ (µg/m ³)	
	Annual average	Maximum 1-hour value	Annual average	Maximum 24-hour value
1995	22.2	156	14.2	-
1996	19.5	146	13.4	-
1997	20.8	178	15.4	-
1998	21.2	154	15.8	-
1999	23.8	144	16.8	-
2000	24.4	135	17.5	-
2001	22.8	133	18.2	-
2002	22.8	111	20.3	146
2003	21.9	113	19.0	68
2004	19.3	117	19.9	49
2005	20.8	129	19.3	47
<i>DECC goal:</i>	<i>60</i>	<i>246</i>	<i>30</i>	<i>50</i>

Source: NSW DEC, 1995 to 2005

Long-term ambient monitoring has also been undertaken at Sydney Airport by Sydney Airport Corporation Limited (SACL). An analysis of the data is provided in a report by **Holmes Air Science (2003)** which forms a support document to the Sydney Airport Environment Strategy 2005-2010. In summary, as in the case of the DECC data, air quality goals are met at the airport site except on occasions when there is general widespread elevated air pollution levels in Sydney due to events such as bushfires or dust-storms.

4.4 Local emissions

The National Pollutant Inventory (NPI) provides a good estimate of the annual emissions from industry and other sources such as motor vehicles. **Table 4** summarises the total air emissions for all substances in Port Botany.

Motor vehicles account for approximately 85% of carbon monoxide, 22% of volatile organic compounds, 15% of oxides of nitrogen and PM₁₀, and about 2% of sulfur dioxide emissions. They also account for approximately half the BTEX (benzene, toluene, ethylbenzene, xylene) emissions in the local area.

Local air quality is therefore influenced by a range of activities including transport as well as industrial sources with sulfur dioxide and volatile organic hydrocarbon emissions. Local emissions of organic compounds will also be a source of odour in the area. The proposed Southlands development is unlikely to add substantially to air pollution levels in the local area.

Table 4 – Total air emissions	
Substance	Total air emissions(kg/year)
Carbon monoxide	2,000,000
Oxides of Nitrogen	1,300,000
Total Volatile Organic Compounds	950,000
Sulfur dioxide	360,000
Ethanol	86,000
Particulate Matter <10.0 µm	76,000
Toluene (methylbenzene)	24,000
Xylenes (individual or mixed isomers)	22,000
Benzene	14,000
Hydrochloric acid	13,000
Sulfuric acid	9,400
Methanol	7,500
Fluoride compounds	6,200
Methyl ethyl ketone	3,000
Ethylene oxide	2,800
Acetone	1,300
Tetrachloroethylene	820
Cumene (1-methylethylbenzene)	720
Methyl methacrylate	700
n-Hexane	560
Magnesium oxide fume	450
Mercury & compounds	370
Vinyl Chloride Monomer	270
1,2-Dichloroethane	270
Ethylene glycol (1,2-ethanediol)	230
Polycyclic aromatic hydrocarbons	220
Ammonia (total)	200
Ethylbenzene	150
Methyl isobutyl ketone	120
Acrylic acid	120
1,3-Butadiene (vinyl ethylene)	110
Manganese & compounds	98
Cyclohexane	90
Ethyl acetate	58
Dichloromethane	51
Trichloroethylene	26
Lead & compounds	21
Chromium (III) compounds	21
Arsenic & compounds	17
Styrene (ethenylbenzene)	17
Nitric acid	16
Nickel & compounds	14
Cobalt & compounds	13
Beryllium & compounds	9
Chloroform (trichloromethane)	5.1
Cadmium & compounds	4.8
Acetic acid (ethanoic acid)	4.8
Formaldehyde (methyl aldehyde)	4.3
Chromium (VI) compounds	3.6
Glutaraldehyde	1.6
Chlorine	0.91
Copper & compounds	0.57
Toluene-2,4-diisocyanate	0.4
Acrylamide	0.28
Phosphoric acid	0.11
Dibutyl phthalate	0.0043
Polychlorinated dioxins and furans	0.00039

5 AIR QUALITY ISSUES FOR SYDNEY

From an air quality perspective, the development of the Southlands site needs to be consistent with the DECC's Action for Air policy (**NSW EPA, 1998**) which has set a framework for development in Sydney with the aim of managing air pollution in a growing

city. The following section provides an overview of the policy with more detailed information provided in **Appendix B**.

Action for Air

In the early 1990's, the NSW EPA undertook a large airshed study in greater Sydney referred to as the Metropolitan Air Quality Study (MAQS). Ozone, its precursors and fine particulate matter have been targeted for control via a raft of measures. On the basis of the MAQS findings the NSW EPA/DECC developed a 25 year air quality management plan which is summarised in its publication *Action for Air (NSW EPA, 1998)*. This document sets out the DECC's priorities for maintaining and improving air quality in the greater metropolitan area of Sydney. An update to this was provided in 2002 reporting on the outcomes of a public forum held in 2001. A further forum was held in 2004, with an additional emphasis on greenhouse emissions.

The Action for Air plan encompassed both technological approaches as well as planning strategies. It was developed in response to a realisation on the part of government that while in the past the control of air quality has relied largely on technological solutions, a significant part of the equation in an urban environment like Sydney is the control of motor vehicle usage, both private and public. It includes the following actions:

- integration of air quality goals and urban transport planning;
- provision of more and better transport choices;
- making cars, trucks and buses cleaner,
- promoting cleaner business;
- promoting cleaner homes;
- management of the impact of open burning; and
- monitoring, reporting and review of air quality.

Specific strategies include the following:

- Adoption of new ambient air quality goals, drawing from those developed at a Federal level by the National Environment Protection Council (NEPC) which were ratified in 1999 and updated in 2003 and are referred to as the National Environment Pollution Measure for Ambient Air (NEPM). They have been adapted by the DECC for local use and are summarised in **Appendix B** along with other relevant goals applicable to the Southlands site.
- Reducing emissions from motor vehicles as high priority and this will be undertaken by improved transport options including new rail links, encouraging cycling and walking as well as integrating the planning of freight movement.
- Heavy duty diesel vehicles have been identified as a major source of NO_x and particulate emissions. These vehicles will be targeted by promoting the use of cleaner fuels and alternative technologies for trucks and buses.

6 AIR QUALITY ISSUES RELEVANT TO THE SOUTHLANDS SITE

Increased warehouse/commercial development brings with it inevitable increases in motor vehicle usage and energy consumption and attendant increases in air emissions. As discussed, the NSW Government has put in place planning strategies to manage the air quality impacts of Sydney's continued growth in terms of both population and commercial/industrial development with the aim of, at a minimum, containing the impact and

ultimately improving Sydney's air quality. In the planning stages of projects, Action for Air needs to be considered.

The proposed activities at the Southlands site include warehousing and limited ancillary commercial businesses. No processing or manufacturing of goods is proposed to take place on the site at this stage.

The proposed hours of operation are 24 hours a day, 7 days a week. The only likely activities which have the potential to result in air emissions are:

1. Staff and delivery vehicles into and out of the site.
2. Use of LPG powered fork lifts and other mobile plant
3. Windblown dust from paved surfaces

The following section discusses these issues.

6.5 Traffic

Traffic will be generated by the total (3 staged development) warehouse and commercial businesses that will operate on the Southlands site after remediation. In the morning peak hour there will be a total traffic volume of approximately 465 vehicles generated by the site. Of this number approximately 325 vehicles will be incoming comprising 260 cars and 65 trucks, and 140 vehicles will be outgoing of which 20% will be trucks. In the afternoon peak hour the incoming and outgoing traffic numbers will be reversed.

This is a relatively low number of vehicles and the exhaust emissions would make a very minor contribution to local air quality. The effect on regional air quality would also be small. There may be some benefit to regional air quality if truck movements to warehousing in the local area replace movements to western Sydney, thereby reducing vehicle kilometres travelled. This benefit will be small but consistent with Action for Air.

6.6 On-site operational activities

On-site air emissions generation will relate to warehousing activities such as forklift and other mobile plant operation. The use of LPG forklifts rather than diesel-powered vehicles will reduce emissions of fine particles.

Trucks moving on paved surface have the potential to cause dust emissions. These will be reduced by keeping the paved areas clean. The off-site impacts will also be reduced by landscaping which will help to filter the dust emissions.

Other general activities are not likely to be a source of air emissions. However, as the site becomes occupied, potential sources would need to be identified and assessed on a case-by-case basis.

6.7 Construction activities

There is potential for dust to be generated during the construction of the site buildings. The DECC has reviewed the environmental hazards associated with construction/excavation sites and prepared a general document containing safeguards to protect the environment during such activities. Many of these safeguards relate to controlling water pollution and run off. However, these procedures frequently assist in the control of air pollution. The recommendations of the DECC include the following mitigation measures:

- Watering of haul roads and sealing of roads where possible;

- Wind breaks composed of earth banks and other screens to protect areas by reducing capacity of the wind to raise dust;
- Trucks entering and leaving the site would be well-maintained in accordance with the manufacturer's specification to comply with all relevant regulations. Fines may be imposed on vehicles that do not comply with smoke emission standards. Truck movement would be controlled on site and restricted to designated roadways. Truck wheel washes or other dust removal procedures may need to be installed to minimise transport of dust offsite
- If necessary, amending of construction during periods of high wind; and
- Watering/revegetating of stockpiles and exposed areas.

The extent to which these measures are required will depend upon the dust generating potential of the construction activities. A dust control strategy and Air Quality Management Plan will need to be developed as part of the remediation phase of the project and dust management during construction could be included in this plan.

6.8 Summary of design features

In terms of the proposed development, the following table summarises appropriate design criteria which would address the NSW Government strategies to reduce air pollution. Also included are specific designs for the proposal considered here which are consistent with Action for Air.

Table 5 : Summary of Southlands design criteria which address NSW Government Strategies to reduce air pollution

Action for Air Objectives and Strategies	Southlands Design Criteria
<p>Objective 1. Integrate air quality goals and urban transport planning</p> <p>Objective: To reduce the growth in vehicle kilometres travelled (VKT) by effectively integrating urban and transport planning and improving transport choices.</p> <p>Strategy A. Integrate urban infrastructure and transport planning Action 1.1 Develop a transport plan to reduce VKT growth Action 1.2 Make the reduction of VKT a planning priority across government Action 1.3 Integrate transport issues in regional and local planning Action 1.4 Implement accessibility criteria for new residential development Action 1.5 Set targets for journey to work by public transport at key centres</p>	<ul style="list-style-type: none"> ➤ Location of the site close to Port Botany will help to reduce distance travelled to shipping containers if used by businesses accessing the Port.
<p>Objective 4. Promote cleaner businesses</p> <p>Objective: To improve the regulation of industrial emissions that contribute to air pollution.</p> <p>Strategy A. Reduce industrial emissions The industrial emissions are a relatively small proportion of total emissions of reactive organic compounds, oxides of nitrogen particles in the Sydney region. Government wishes to work with industry to reduce emissions. While the Action for Air focuses largely on the reduction of NO_x and VOC/ROC emissions which are not relevant to this development, any initiative by industry to reduce emissions falls within this context. Action 4.7 Negotiate reductions in plant emissions</p>	<p>Specific design for the Southlands site</p> <ul style="list-style-type: none"> ➤ Landscaping which will help to filter fugitive dust emissions. ➤ Access points to the warehouses are located to minimise the trip lengths and thereby reduce heavy duty vehicle emissions. ➤ Use of LPG powered fork lifts within the warehouses. This is consistent with Action for Air's recommended use of alternative fuels.

7 CONCLUSIONS

The design of the proposed Southlands facility will be consistent with the NSW Government "Action for Air" strategy for Sydney. This includes the control of fugitive emissions, use of alternative fuels and landscaping.

Air emissions from the proposal are likely to be very low and would not have an adverse affect on local or regional air quality. Dust emissions will need to be managed during remediation and construction. The location of dust sensitive industries including food processing, pharmaceutical and electronic industries amongst others, may need to be considered during the staged development at the site.

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APPENDIX A

**JOINT WIND SPEED, WIND DIRECTION AND STABILITY CLASS FREQUENCY
TABLES**

PASQUILL STABILITY CLASS 'A'

Wind Speed Class (m/s)

WIND SECTOR	0.50	1.50	3.00	4.50	6.00	7.50	9.00	GREATER THAN	TOTAL
	TO 1.50	TO 3.00	TO 4.50	TO 6.00	TO 7.50	TO 9.00	TO 10.50	10.50	
NNE	0.001526	0.002934	0.000587	0.000117	0.000000	0.000000	0.000000	0.000000	0.005164
NE	0.000469	0.001995	0.001291	0.000117	0.000000	0.000000	0.000000	0.000000	0.003873
ENE	0.000117	0.001056	0.000704	0.000000	0.000000	0.000000	0.000000	0.000000	0.001878
E	0.000352	0.000822	0.000352	0.000117	0.000000	0.000000	0.000000	0.000000	0.001643
ESE	0.000117	0.001174	0.000587	0.000117	0.000000	0.000000	0.000000	0.000000	0.001995
SE	0.000587	0.000235	0.000235	0.000000	0.000000	0.000000	0.000000	0.000000	0.001056
SSE	0.000587	0.001174	0.000822	0.000000	0.000000	0.000000	0.000000	0.000000	0.002582
S	0.000587	0.001056	0.000352	0.000352	0.000000	0.000000	0.000000	0.000000	0.002347
SSW	0.000469	0.001056	0.001643	0.000117	0.000000	0.000000	0.000000	0.000000	0.003286
SW	0.000704	0.001526	0.000939	0.000235	0.000000	0.000000	0.000000	0.000000	0.003404
WSW	0.000822	0.001056	0.000704	0.000000	0.000000	0.000000	0.000000	0.000000	0.002582
W	0.002230	0.003169	0.000352	0.000000	0.000000	0.000000	0.000000	0.000000	0.005751
WNW	0.004695	0.004812	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.009507
NW	0.004343	0.004695	0.000352	0.000000	0.000000	0.000000	0.000000	0.000000	0.009390
NNW	0.001408	0.005282	0.000587	0.000235	0.000000	0.000000	0.000000	0.000000	0.007512
N	0.001526	0.003873	0.000352	0.000117	0.000000	0.000000	0.000000	0.000000	0.005869
CALM									0.001643
TOTAL	0.020540	0.035915	0.009859	0.001526	0.000000	0.000000	0.000000	0.000000	0.069484
MEAN WIND SPEED (m/s) = 2.12									
NUMBER OF OBSERVATIONS = 592									

PASQUILL STABILITY CLASS 'B'

Wind Speed Class (m/s)

WIND SECTOR	0.50	1.50	3.00	4.50	6.00	7.50	9.00	GREATER THAN	TOTAL
	TO 1.50	TO 3.00	TO 4.50	TO 6.00	TO 7.50	TO 9.00	TO 10.50	10.50	
NNE	0.000117	0.001174	0.001526	0.000117	0.000000	0.000000	0.000000	0.000000	0.002934
NE	0.000000	0.000587	0.001878	0.000352	0.000000	0.000000	0.000000	0.000000	0.002817
ENE	0.000000	0.000235	0.001056	0.000117	0.000000	0.000000	0.000000	0.000000	0.001408
E	0.000117	0.000352	0.001174	0.000235	0.000000	0.000000	0.000000	0.000000	0.001878
ESE	0.000000	0.000469	0.001526	0.000117	0.000000	0.000000	0.000000	0.000000	0.002113
SE	0.000000	0.000117	0.001056	0.000117	0.000000	0.000000	0.000000	0.000000	0.001291
SSE	0.000000	0.000352	0.000587	0.000117	0.000000	0.000000	0.000000	0.000000	0.001056
S	0.000117	0.000352	0.000704	0.000352	0.000000	0.000000	0.000000	0.000000	0.001526
SSW	0.000000	0.000704	0.000469	0.000235	0.000000	0.000000	0.000000	0.000000	0.001408
SW	0.000000	0.000235	0.000704	0.000235	0.000000	0.000000	0.000000	0.000000	0.001174
WSW	0.000469	0.000939	0.000235	0.000117	0.000000	0.000000	0.000000	0.000000	0.001761
W	0.000235	0.001643	0.001408	0.000469	0.000000	0.000000	0.000000	0.000000	0.003756
WNW	0.001526	0.004343	0.001408	0.000587	0.000000	0.000000	0.000000	0.000000	0.007864
NW	0.001526	0.004695	0.001174	0.000235	0.000000	0.000000	0.000000	0.000000	0.007629
NNW	0.000235	0.001761	0.000939	0.000235	0.000000	0.000000	0.000000	0.000000	0.003169
N	0.000117	0.000939	0.001056	0.000469	0.000000	0.000000	0.000000	0.000000	0.002582
CALM									0.000117
TOTAL	0.004460	0.018897	0.016901	0.004108	0.000000	0.000000	0.000000	0.000000	0.044484
MEAN WIND SPEED (m/s) = 2.99									
NUMBER OF OBSERVATIONS = 379									

PASQUILL STABILITY CLASS 'C'

Wind Speed Class (m/s)

WIND SECTOR	0.50	1.50	3.00	4.50	6.00	7.50	9.00	GREATER THAN	TOTAL
	TO 1.50	TO 3.00	TO 4.50	TO 6.00	TO 7.50	TO 9.00	TO 10.50	10.50	
NNE	0.000000	0.000235	0.000939	0.000469	0.000000	0.000000	0.000000	0.000000	0.001643
NE	0.000000	0.000352	0.001995	0.002817	0.000000	0.000000	0.000000	0.000000	0.005164
ENE	0.000000	0.000235	0.002465	0.003638	0.000000	0.000000	0.000000	0.000000	0.006338
E	0.000000	0.000587	0.003404	0.003286	0.000000	0.000000	0.000000	0.000000	0.007277
ESE	0.000000	0.000235	0.003052	0.002582	0.000000	0.000000	0.000000	0.000000	0.005869
SE	0.000000	0.000117	0.000704	0.000704	0.000000	0.000000	0.000000	0.000000	0.001526
SSE	0.000000	0.000352	0.001643	0.002700	0.000000	0.000000	0.000000	0.000000	0.004695
S	0.000000	0.000704	0.002465	0.001526	0.000000	0.000000	0.000000	0.000000	0.004695
SSW	0.000000	0.000822	0.001995	0.000704	0.000000	0.000000	0.000000	0.000000	0.003521
SW	0.000117	0.001056	0.001291	0.001291	0.000000	0.000000	0.000000	0.000000	0.003756
WSW	0.000000	0.000822	0.001408	0.001291	0.000000	0.000000	0.000000	0.000000	0.003521
W	0.000352	0.003756	0.002817	0.002817	0.000000	0.000000	0.000000	0.000000	0.009742
WNW	0.002230	0.010329	0.002113	0.001643	0.000000	0.000000	0.000000	0.000000	0.016315
NW	0.000939	0.008568	0.001526	0.000587	0.000000	0.000000	0.000000	0.000000	0.011620
NNW	0.000469	0.000939	0.001174	0.000469	0.000000	0.000000	0.000000	0.000000	0.003052
N	0.000235	0.000587	0.001761	0.000352	0.000000	0.000000	0.000000	0.000000	0.002934
CALM									0.000117
TOTAL	0.004343	0.029695	0.030751	0.026878	0.000000	0.000000	0.000000	0.000000	0.091784
MEAN WIND SPEED (m/s) = 3.63									
NUMBER OF OBSERVATIONS = 782									

PASQUILL STABILITY CLASS 'D'

Wind Speed Class (m/s)

WIND SECTOR	0.50	1.50	3.00	4.50	6.00	7.50	9.00	GREATER THAN	TOTAL
	TO 1.50	TO 3.00	TO 4.50	TO 6.00	TO 7.50	TO 9.00	TO 10.50	TO 10.50	
NNE	0.000352	0.004812	0.006690	0.002113	0.000704	0.000117	0.000000	0.000000	0.014789
NE	0.000352	0.007746	0.017488	0.020423	0.019601	0.011268	0.004343	0.001056	0.082277
ENE	0.000235	0.002817	0.005751	0.006808	0.005869	0.001643	0.000117	0.000000	0.023239
E	0.000117	0.002700	0.003638	0.002347	0.000822	0.000117	0.000000	0.000000	0.009742
ESE	0.000000	0.001643	0.005164	0.002347	0.001526	0.000235	0.000117	0.000000	0.011033
SE	0.000117	0.001995	0.003404	0.005282	0.003521	0.000704	0.000117	0.000000	0.015141
SSE	0.000000	0.002465	0.006221	0.015258	0.017958	0.008920	0.002817	0.000352	0.053991
S	0.000000	0.001174	0.005164	0.018779	0.026995	0.020305	0.011385	0.008803	0.092606
SSW	0.000117	0.002817	0.010563	0.019014	0.020657	0.009742	0.002700	0.001995	0.067606
SW	0.000235	0.008803	0.011620	0.002465	0.002347	0.001526	0.000352	0.000000	0.027347
WSW	0.000469	0.004460	0.006338	0.003404	0.002113	0.000587	0.000000	0.000000	0.017371
W	0.002582	0.021009	0.012207	0.004108	0.002113	0.000822	0.000000	0.000000	0.042840
WNW	0.006103	0.037089	0.010446	0.001408	0.001878	0.000587	0.000000	0.000000	0.057512
NW	0.003873	0.017723	0.003052	0.001174	0.000469	0.000000	0.000000	0.000000	0.026291
NNW	0.001761	0.004577	0.002817	0.000352	0.000469	0.000235	0.000000	0.000000	0.010211
N	0.000469	0.002582	0.001995	0.000469	0.000117	0.000000	0.000000	0.000000	0.005634
CALM									0.001174
TOTAL	0.016784	0.124413	0.112559	0.105751	0.107160	0.056808	0.021948	0.012207	0.558803
MEAN WIND SPEED (m/s)	= 5.09								
NUMBER OF OBSERVATIONS	= 4761								

PASQUILL STABILITY CLASS 'E'

Wind Speed Class (m/s)

WIND SECTOR	0.50	1.50	3.00	4.50	6.00	7.50	9.00	GREATER THAN	TOTAL
	TO 1.50	TO 3.00	TO 4.50	TO 6.00	TO 7.50	TO 9.00	TO 10.50	TO 10.50	
NNE	0.000704	0.002582	0.000822	0.000000	0.000000	0.000000	0.000000	0.000000	0.004108
NE	0.001291	0.001995	0.000117	0.000235	0.000000	0.000000	0.000000	0.000000	0.003638
ENE	0.000704	0.000939	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001643
E	0.000235	0.000939	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001174
ESE	0.000000	0.001174	0.000469	0.000000	0.000000	0.000000	0.000000	0.000000	0.001643
SE	0.000000	0.000704	0.001761	0.000117	0.000000	0.000000	0.000000	0.000000	0.002582
SSE	0.000117	0.002582	0.004695	0.002700	0.000000	0.000000	0.000000	0.000000	0.010094
S	0.000117	0.001174	0.003404	0.001761	0.000000	0.000000	0.000000	0.000000	0.006455
SSW	0.000117	0.001056	0.001056	0.000352	0.000000	0.000000	0.000000	0.000000	0.002582
SW	0.000469	0.003756	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004225
WSW	0.000704	0.002700	0.000235	0.000000	0.000000	0.000000	0.000000	0.000000	0.003638
W	0.002934	0.007629	0.000117	0.000000	0.000000	0.000000	0.000000	0.000000	0.010681
WNW	0.007160	0.018075	0.001526	0.000000	0.000000	0.000000	0.000000	0.000000	0.026761
NW	0.006338	0.011972	0.000352	0.000000	0.000000	0.000000	0.000000	0.000000	0.018662
NNW	0.002230	0.002465	0.000117	0.000000	0.000000	0.000000	0.000000	0.000000	0.004812
N	0.000939	0.002700	0.000587	0.000000	0.000000	0.000000	0.000000	0.000000	0.004225
CALM									0.001408
TOTAL	0.024061	0.062441	0.015258	0.005164	0.000000	0.000000	0.000000	0.000000	0.108333
MEAN WIND SPEED (m/s)	= 2.26								
NUMBER OF OBSERVATIONS	= 923								

PASQUILL STABILITY CLASS 'F'

Wind Speed Class (m/s)

WIND SECTOR	0.50	1.50	3.00	4.50	6.00	7.50	9.00	GREATER THAN	TOTAL
	TO 1.50	TO 3.00	TO 4.50	TO 6.00	TO 7.50	TO 9.00	TO 10.50	TO 10.50	
NNE	0.003638	0.002465	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.006103
NE	0.002230	0.001056	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003286
ENE	0.000939	0.000822	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001761
E	0.000822	0.000587	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001408
ESE	0.000822	0.000939	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001761
SE	0.000939	0.000704	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001643
SSE	0.001291	0.000469	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001761
S	0.001056	0.000704	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001761
SSW	0.001408	0.002465	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003873
SW	0.002113	0.002465	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004577
WSW	0.004225	0.002113	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.006338
W	0.006455	0.004108	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.010563
WNW	0.012793	0.007629	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.020423
NW	0.021362	0.006455	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.027817
NNW	0.008803	0.004343	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.013146
N	0.004225	0.003756	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.007981
CALM									0.012911
TOTAL	0.073122	0.041080	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.127113
MEAN WIND SPEED (m/s)	= 1.31								
NUMBER OF OBSERVATIONS	= 1083								

ALL PASQUILL STABILITY CLASSES
Wind Speed Class (m/s)

WIND SECTOR	0.50	1.50	3.00	4.50	6.00	7.50	9.00	GREATER	TOTAL
	TO	TO	TO	TO	TO	TO	TO	THAN	
	1.50	3.00	4.50	6.00	7.50	9.00	10.50	10.50	
NNE	0.006338	0.014202	0.010563	0.002817	0.000704	0.000117	0.000000	0.000000	0.034742
NE	0.004343	0.013732	0.022770	0.023944	0.019601	0.011268	0.004343	0.001056	0.101056
ENE	0.001995	0.006103	0.009977	0.010563	0.005869	0.001643	0.000117	0.000000	0.036268
E	0.001643	0.005986	0.008568	0.005986	0.000822	0.000117	0.000000	0.000000	0.023122
ESE	0.000939	0.005634	0.010798	0.005164	0.001526	0.000235	0.000117	0.000000	0.024413
SE	0.001643	0.003873	0.007160	0.006221	0.003521	0.000704	0.000117	0.000000	0.023239
SSE	0.001995	0.007394	0.013967	0.020775	0.017958	0.008920	0.002817	0.000352	0.074178
S	0.001878	0.005164	0.012089	0.022770	0.026995	0.020305	0.011385	0.008803	0.109390
SSW	0.002113	0.008920	0.015728	0.020423	0.020657	0.009742	0.002700	0.001995	0.082277
SW	0.003638	0.017840	0.014554	0.004225	0.002347	0.001526	0.000352	0.000000	0.044484
WSW	0.006690	0.012089	0.008920	0.004812	0.002113	0.000587	0.000000	0.000000	0.035211
W	0.014789	0.041315	0.016901	0.007394	0.002113	0.000822	0.000000	0.000000	0.083333
WNW	0.034507	0.082277	0.015493	0.003638	0.001878	0.000587	0.000000	0.000000	0.138380
NW	0.038380	0.054108	0.006455	0.001995	0.000469	0.000000	0.000000	0.000000	0.101408
NNW	0.014906	0.019366	0.005634	0.001291	0.000469	0.000235	0.000000	0.000000	0.041901
N	0.007512	0.014437	0.005751	0.001408	0.000117	0.000000	0.000000	0.000000	0.029225
CALM									0.017371
TOTAL	0.143310	0.312441	0.185329	0.143427	0.107160	0.056808	0.021948	0.012207	1.000000
MEAN WIND SPEED (m/s)	= 3.87								
NUMBER OF OBSERVATIONS	= 8520								

FREQUENCY OF OCCURENCE OF STABILITY CLASSES

A : 6.9%
 B : 4.4%
 C : 9.2%
 D : 55.9%
 E : 10.8%
 F : 12.7%

STABILITY CLASS BY HOUR OF DAY

Hour	A	B	C	D	E	F
01	0000	0000	0000	0172	0091	0092
02	0000	0000	0000	0183	0064	0108
03	0000	0000	0000	0175	0070	0110
04	0000	0000	0000	0175	0078	0102
05	0000	0000	0000	0174	0091	0090
06	0011	0004	0020	0171	0075	0074
07	0031	0021	0042	0183	0036	0042
08	0057	0044	0084	0155	0006	0009
09	0062	0061	0091	0141	0000	0000
10	0079	0044	0104	0128	0000	0000
11	0090	0047	0093	0125	0000	0000
12	0083	0051	0072	0149	0000	0000
13	0059	0040	0078	0178	0000	0000
14	0053	0027	0064	0211	0000	0000
15	0045	0019	0055	0236	0000	0000
16	0020	0015	0052	0254	0006	0008
17	0001	0003	0023	0294	0017	0017
18	0001	0003	0004	0307	0016	0024
19	0000	0000	0000	0277	0036	0042
20	0000	0000	0000	0262	0044	0049
21	0000	0000	0000	0225	0055	0075
22	0000	0000	0000	0212	0075	0068
23	0000	0000	0000	0194	0078	0083
24	0000	0000	0000	0180	0085	0090

APPENDIX B

AIR QUALITY ISSUES IN SYDNEY

AIR QUALITY ISSUES IN SYDNEY

This section reviews the factors contributing to Sydney's air pollution and the strategies the New South Wales Environment Protection Authority (NSW EPA, now incorporated into the Department of Environment and Climate Change, DECC), in consultation with other Government Authorities including the former Department of Urban Affairs and Planning (DUAP), now Department of Planning (DoP), the Department of Transport (DoT) and the Roads and Traffic Authority (RTA), has developed to control air emissions into the Sydney airshed.

Review of current understanding of Sydney's air quality

In 1990, a report by **Hyde and Johnson** raised some concerns about the state of knowledge of air quality in the Sydney Basin. The following issues were identified:

- The EPA/DECC's air monitoring network may be underestimating the severity of photochemical smog in the Sydney Airshed, particularly in the west and southwest
- There were deficiencies in the knowledge of the causes and distribution of photochemical smog in Sydney
- That air quality goals for photochemical smog may not be sufficient to protect the community
- In the absence of further controls, smog concentrations in western Sydney would increase over the next 20 years as a result of urban growth
- There would be degradation of visual amenity in Western Sydney.

In the light of these concerns, the (then) NSW EPA commissioned the Metropolitan Air Quality Study (MAQS) to investigate air quality in the greater metropolitan area which included Sydney, Newcastle and Wollongong which contains about 70% of the State's population.

MAQS has upgraded and extended the EPA/DECC's air quality monitoring network over a much wider area. It has also further refined the understanding of the present chemistry and air movements in the Sydney airshed, developed an airshed model and updated the emissions inventory.

MAQS has confirmed that the most significant air pollution issues in Sydney are photochemical smog as measured by ozone concentrations, and fine particle pollution, with motor vehicle emissions making a major contribution to both. Ozone has been a long-term target for control, however fine particles have emerged relatively recently as a health issue rather than merely associated with loss of visual amenity.

Much of the recent concern over the health effects of fine particulate matter is based on investigations carried out in the US, with the view to quantifying the health risks associated with both long-term and short-term exposure to airborne particulate matter. The study is colloquially referred to as "The Six Cities Study" from the original work by **Dockery and others (1993)**, which determined a relationship between fine particulate matter (defined as particles smaller than 2.5 μm in diameter) in the air and mortality in six US cities.

The basic findings of the Six Cities Study is that there is an increase in mortality with increasing concentrations of fine particulate matter, with no safe threshold. The conclusions appear to be robust and have been supported by subsequent studies and as far as can be determined are not confounded by other known variables. The mechanism is still unknown, however it appears that asthmatics and those suffering from pulmonary and cardiovascular disease are most susceptible.

Air quality goals

In assessing any project with significant air emissions, it is necessary to compare the impacts of the project with relevant air quality goals.

Historically the EPA/DECC has noted air quality goals for nitrogen dioxide (NO₂), carbon monoxide (CO) and particulate matter (PM₁₀) determined by the World Health Organisation (WHO), the United States Environmental Protection Agency (US EPA) and the National Health and Medical Research Council of Australia (NHMRC). Air quality goals for hydrocarbons (HC) have been used previously, but these have been discarded by the EPA/DECC because they are not specific for reactive species which are the important elements in the formation of photochemical smog. Motor vehicle emissions and the formation of photochemical smog is a significant issue in Sydney.

More recently, the National Environment Protection Committee (NEPC) has determined a new set of air quality goals for adoption at a national level referred to as the Air NEPM (National Environment Protection Measures). The EPA/DECC proposed new air quality goals for particulate matter and nitrogen dioxide, some of which are consistent with the NEPM standards.

Table B1 lists the air quality goals noted by the DECC. Many of these pollutants are major emissions from motor vehicles. Also included are goals for air toxics and odorous compounds which are minor emissions from motor vehicles. .

These goals will be relevant for local air quality and general air quality in the area.

Table B1: NSW DECC Impact Assessment Criteria			
Pollutant	Goal	Averaging Period	Agency
Carbon monoxide	87 ppm or 100 mg/m ³ 25 ppm or 30 mg/m ³ 9 ppm or 10 mg/m ³	15-minute maximum 1-hour maximum 8-hour maximum	WHO WHO NEPC
Nitrogen dioxide	12 pphm or 246 µg/m ³ 3 pphm or 60 µg/m ³	1-hour maximum annual mean	NEPC NEPC
Total suspended particulate matter (TSP)	90 µg/m ³	Annual mean	NHMRC
Particulate matter < 10 µm (PM ₁₀)	30 µg/m ³ 50 µg/m ³	Annual mean 24-hour maximum	EPA NEPC
Lead	0.5 µg/m ³	annual average	NEPC
Ozone	10 pphm or 214 µg/m ³ 8 pphm or 171 µg/m ³	1-hour maximum 4-hour maximum	NEPC NEPC
Sulphur dioxide	25 pphm or 712 µg/m ³ 20 pphm or 570 µg/m ³ 8 pphm or 228 µg/m ³ 2 pphm or 60 µg/m ³	10-minute 1-hour maximum 1 day annual mean	NHMRC NEPC NEPC NEPC
Air toxics and odorous compounds Benzene 1,3-Butadiene Acetaldehyde Formaldehyde	0.009 ppm or 0.029 mg/m ³ 0.018 ppm or 0.04 mg/m ³ 0.023 ppm or 0.042 mg/m ³ 0.018 ppm or 0.02 mg/m ³	1-hour 1-hour 1-hour 1-hour	Victorian Government Gazette (2001)

µm - micrometre

ppm - part per million

µg/m³ - micrograms per cubic metre

ng/m³ - nanograms per cubic metre

mg/m³ - milligrams per cubic metre

Dust from construction activities

Particulate emissions from construction and earthmoving activities have the potential to affect amenity and, in extreme cases, health. The potential for health effects to occur depends on the size of the particles emitted. Particles larger than approximately 10 µm are effectively prevented from being inhaled by filtering afforded by the nose and upper airways. Smaller particles can reach the more sensitive parts of the respiratory system and can give rise to health impacts if concentrations are too high. Generally the coarser fraction of particle derived from crustal materials are too large to give rise to health impacts. The finer fraction, which arise primarily from combustion processes, for example, diesel equipment, spontaneous combustion of coal, wood fired heating equipment and bush fires are believed to have the greatest potential to give rise to health effects. Earthmoving activities and wind erosion give rise to dust emissions which are predominantly in the coarser fraction of the particle size range. The major effect of such activities is therefore to cause nuisance rather than to affect health.

The DECC sets goals for dust deposition, which is a measure of nuisance impacts. These goals are summarised in **Table B2** which shows the maximum acceptable increase in dust deposition over the existing dust levels. These criteria for dust fallout levels are set to protect against nuisance impacts (**NSW DEC, 2005**) and are applicable to this project.

Table B2:DECC criteria for dust fallout			
Pollutant	Averaging Period	Maximum increase in deposited dust level	Maximum total deposited dust level
Deposited dust	Annual	2 g/m ² /month	4 g/m ² /month

These goals are relevant to the quarrying activities currently occurring at the site and to construction activities which will occur. As noted, they refer to total deposition levels and not simply to a given activity in isolation

FIGURES

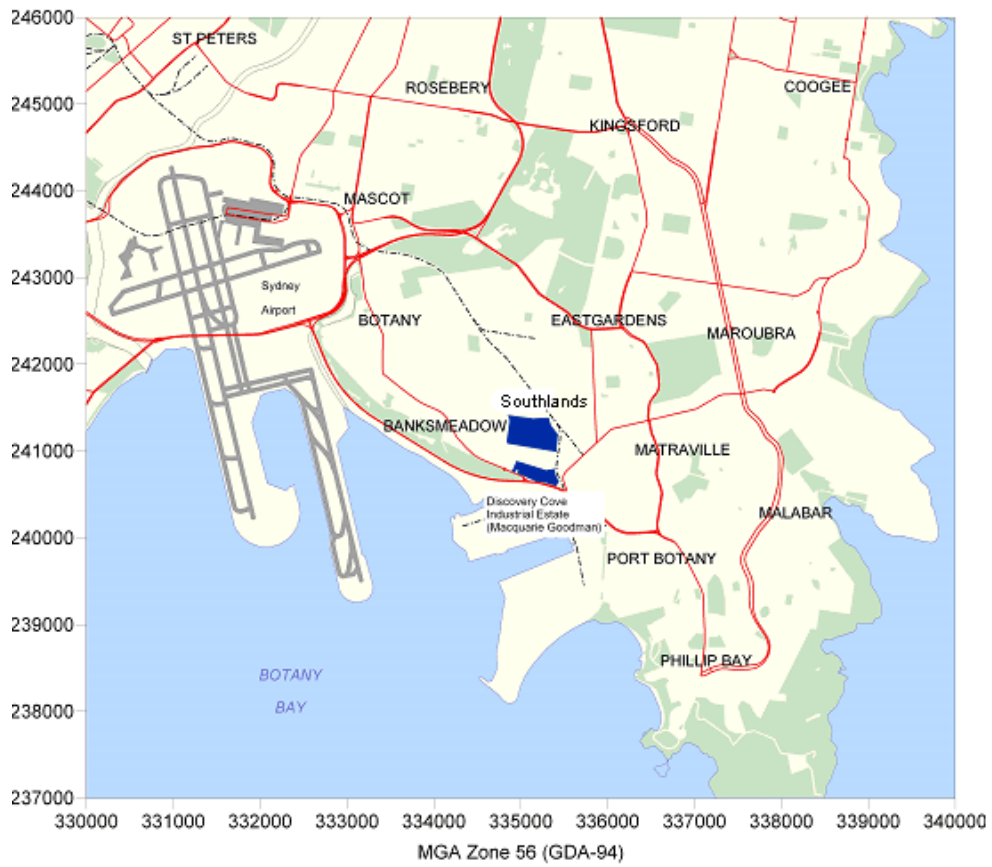


Figure 1 – Location of Southlands site



Figure 2– Proposed Southlands site layout

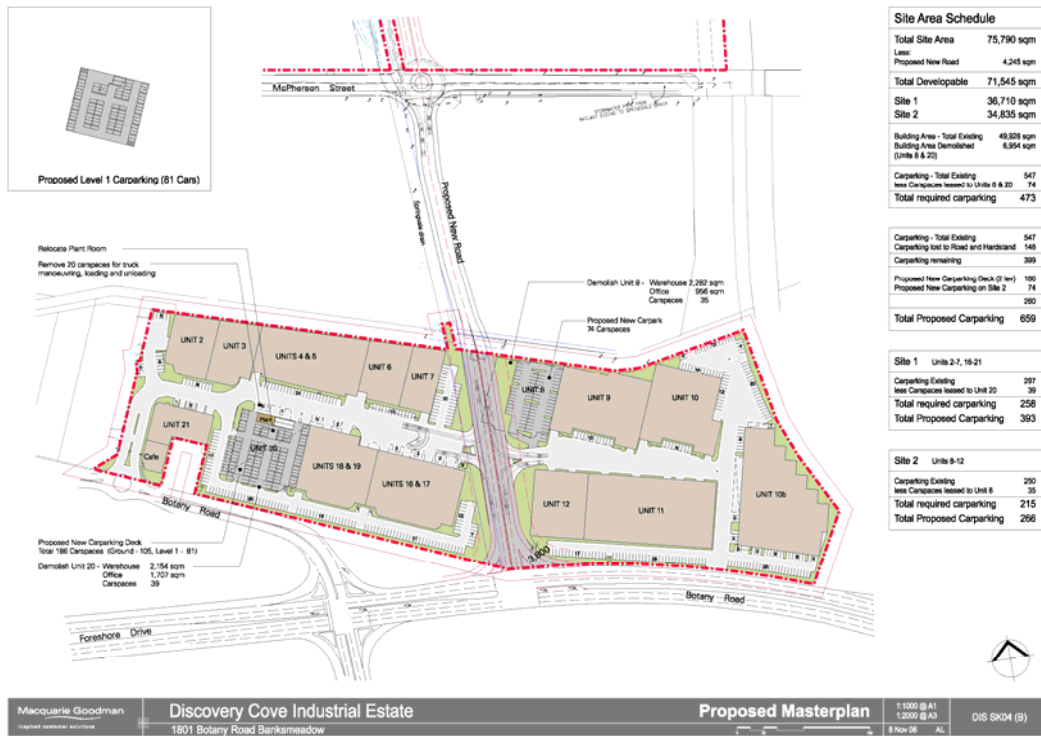


Figure 3 Proposed Future Road Alignment and Revised Layout of Discovery Cove Industrial Estate

Annual and seasonal windroses for Sydney Airport, 1997

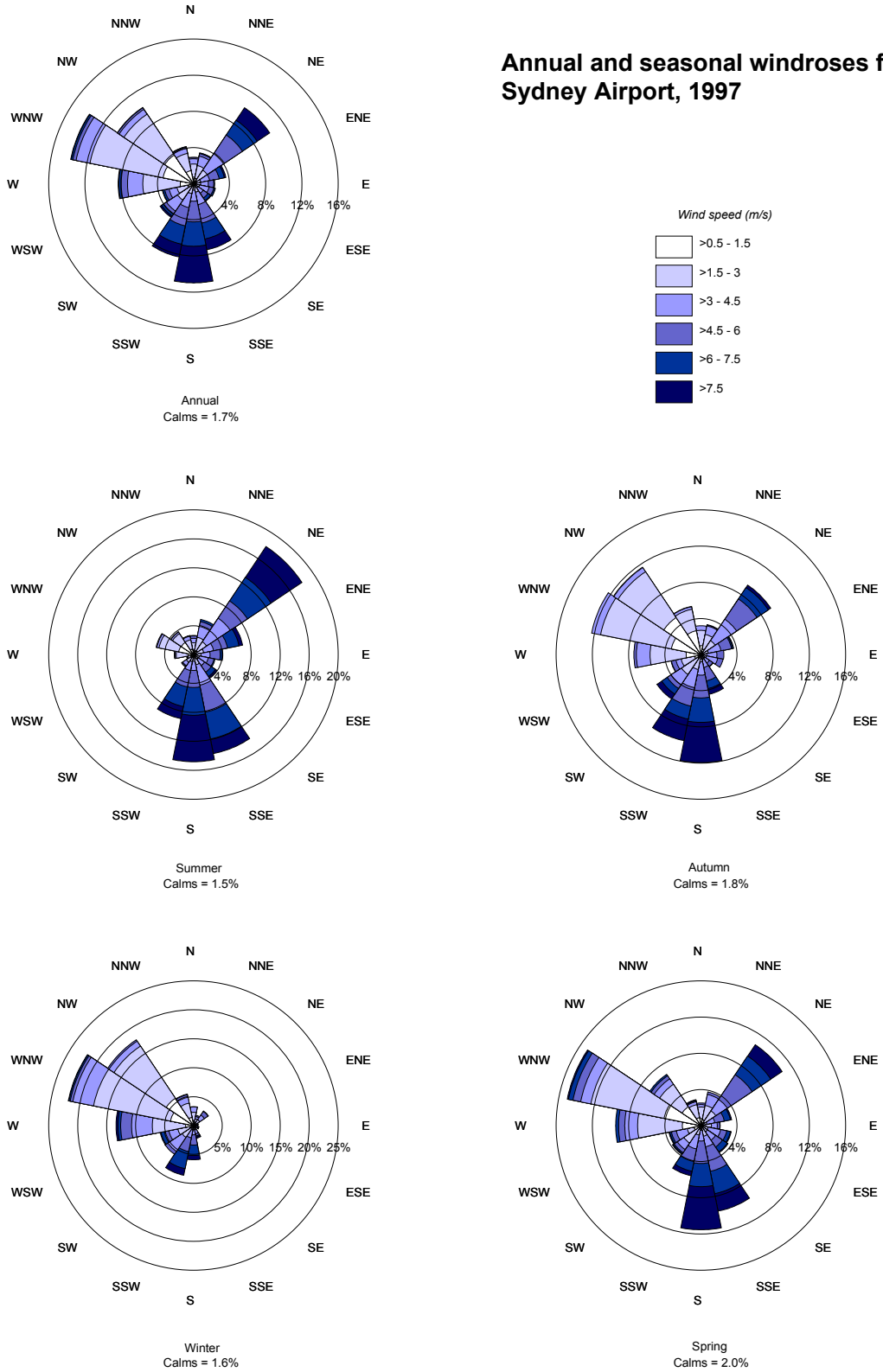


Figure 4 – Annual and seasonal windroses for Sydney Airport, 1997