REPORT

ROSALIND PARK GAS PLANT TEG REBOILER SO3 EMISSION LIMIT REVIEW

AGL Energy Ltd

Job No: **3786**

13 April 2010

PROJECT TITLE:	**ROSALIND PARK GAS PLANT TEG REBOILER SO3 EMISSION LIMIT REVIEW**
JOB NUMBER:	**3786**
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1 INTRODUCTION

This report has been prepared by PAEHolmes for AGL Energy Ltd (AGL). The purpose of the report is to provide an air quality assessment in support of an application by AGL for a modification to the existing development consent (DA 282-6-2003i) and a variation to Environment Protection Licence No. 12003 (EPL 12003) for the Rosalind Park Gas Plant (RPGP).

The modification to the consent and EPL variation request are for an increase of the current emission limit of sulfur trioxide (SO_3) for the TEG reboiler stack (Point 4) from 1 mg/m^3 to 10 mg/m^3 and also for the Compressor Engines (Points 1 to 3) from 3.1 mg/m^3 to 10 mg/m^3. The proposed emission limits are 1/10th of the *Protection of the Environment Operations (Clean Air) Amendment (Industrial and Commercial Activities and Plant) Regulation 2005* emission limit for SO_3, which is 100 mg/m^3 for general plant and equipment that came in to operation after 1 January 1972.

The assessment is based on the use of a computer-based air dispersion model, in accordance with the *Approved Methods for Modelling and Assessment of Air Pollutants in NSW* (**DEC, 2005**). It assesses the likely air quality impacts of the proposed emission limit concentration of 10 mg/m^3 SO_3 from Points 1, 2, 3 and 4 by predicting maximum hourly ground level concentrations of sulfuric acid (H_2SO_4). SO_3 is emitted from the stacks and reacts with water vapour (H_2O) to form H_2SO_4. As the reaction takes place rapidly, it is assumed that all of the SO_3 is present as H_2SO_4 by the time it is released from the stacks. The predicted maximum hourly H_2SO_4 concentrations have been compared with relevant criteria to assess the potential impact that the emissions would have on air quality.

In summary, this report provides information on the following:

- Description of the RPGP and local setting;
- Relevant air quality criteria;
- Meteorological conditions for the area;
- A discussion of the existing ambient air quality for the area;
- The methods used to estimate emissions of SO_3 / H_2SO_4; and
- Assessment of dispersion model predictions against relevant air quality criteria.

2 LOCAL SETTING AND PROJECT DESCRIPTION

The RPGP is located approximately 7 km southwest of Campbelltown in the south-western suburbs of Sydney. **Figure 2.1** shows the location of the RPGP and its site boundary.

Land use in the immediate surrounds largely consists of cleared land used for agricultural purposes. Adjacent to the site is a rock quarry and further to the west is the Nepean River which drains much of the region. The closest urban area is St Helen's park, approximately 2.5 km northeast of RPGP. There is also a small number of farming residences located in the vicinity with the closest residence located approximately 750 m southwest.

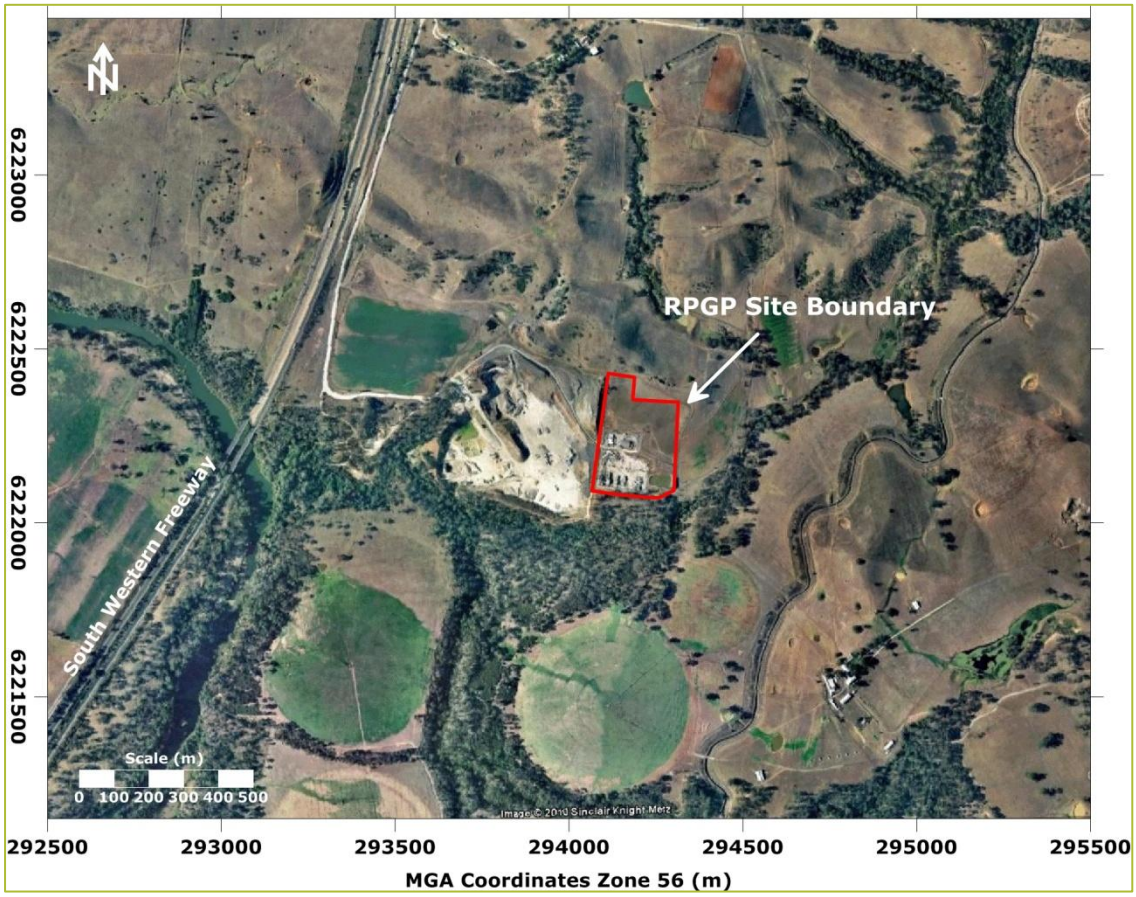


Figure 2.1: Location of Rosalind Park Gas Plant

Figure 2.2 presents a pseudo 3-dimensional plot of the local terrain in the study area. The terrain immediately surrounding the Project is gently undulating resulting in a number of creeks and watercourses.

Figure 2.3 shows the layout of the existing RPGP site. The site emits emissions containing SO_3 from a maximum of three compressor engines, a reboiler flue and a reflux column. In brief, the RPGP receives gas that has been extracted from the coal seam and gathered via a network of wells and gas gathering lines. The gas is then treated and compressed in the gas plant before an odorant is added (for safety) and it is sent to market via a highly compressed gas pipeline.

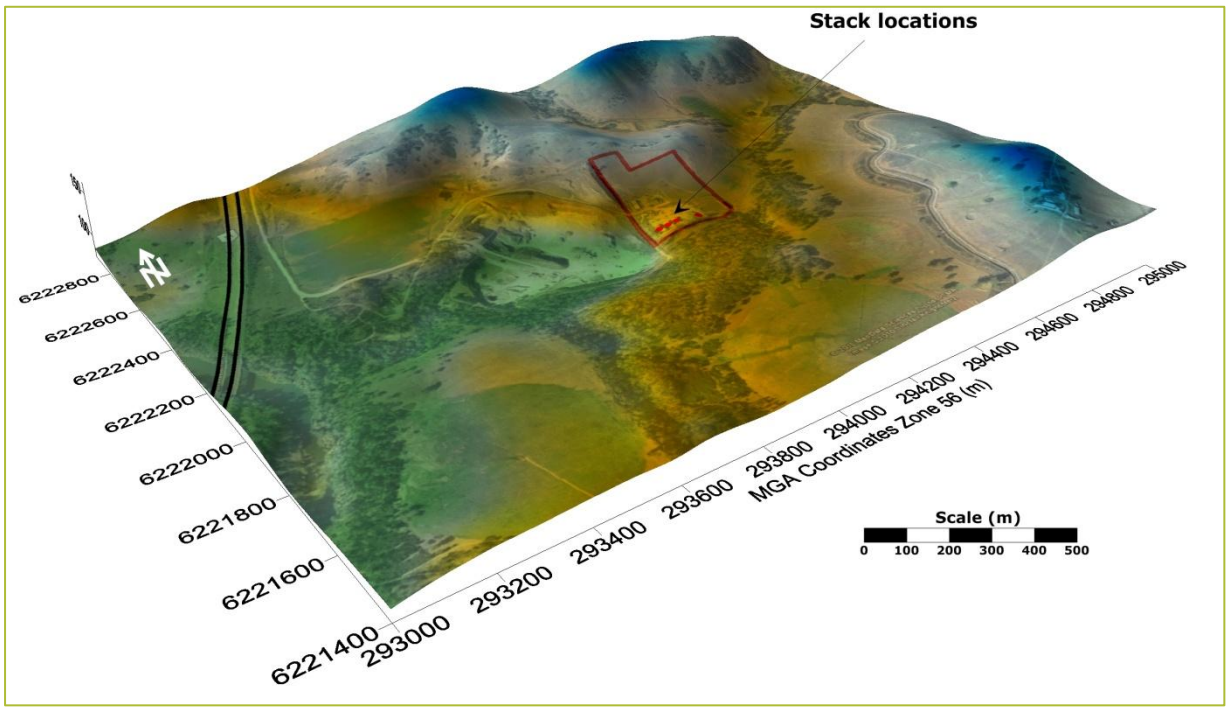


Figure 2.2: Pseudo 3-dimensional representation of the RPGP site

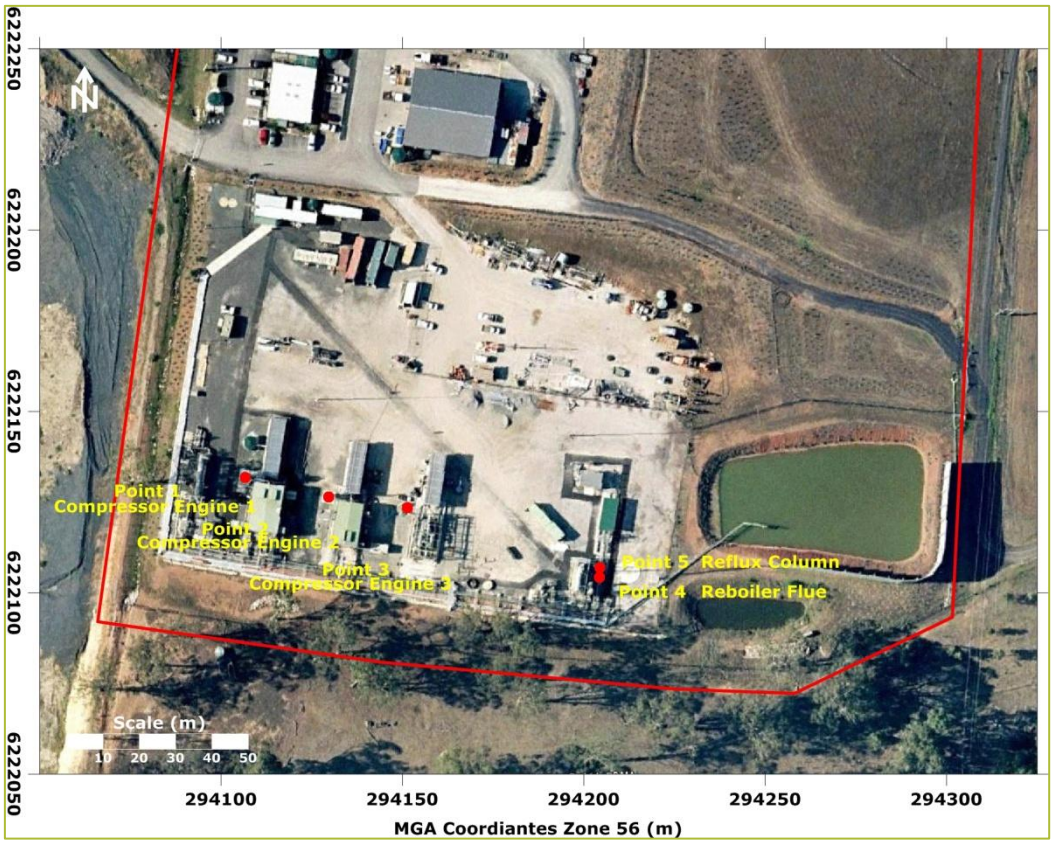


Figure 2.3: RPGP site layout

3 AIR QUALITY CRITERIA

There are two types of air quality criteria relevant to sulfur trioxide (SO_3) emissions from industrial plants such as the RPGP in NSW, i.e.

- *Emission Standards* - maximum allowable pollutant emission concentrations (stack concentrations) specified for particular types of equipment; and
- *Air Impact Assessment Criteria* – criteria designed for use in air dispersion modelling studies and air quality impact assessments for new or modified emission sources.

In general, emission standards and ambient air quality design criteria are used to evaluate the predicted impact of air emissions on air quality and the effectiveness of plant design and any associated mitigation measures. The main objective of these criteria is to ensure that the resulting local and regional ambient air quality meets the relevant ambient air quality standards.

3.1 Emission Standards

The *Protection of the Environment Operations (Clean Air) Amendment (Industrial and Commercial Activities and Plant) Regulation 2005*, came into force under the *Protection of the Environment Operations Act 1997* on 1 September 2005. It sets a maximum limit for emissions of sulfuric acid mist (H_2SO_4) or sulfur trioxide (SO_3) or both, as SO_3 equivalent for any activity or plant that came into operation on or after 1 January 1972, as 100 mg/m^3 (stack concentration).

The RPGP has existing emission limits for SO_3 set out in EPL 12003 for Points 1 to 5. The proposal is to increase the emission limit for Point 4 (i.e. the reboiler stack) from 1 mg/m^3 to 10 mg/m^3 and also for the Points 1 to 3 (i.e. the compressor engines) from 3.1 mg/m^3 to 10 mg/m^3.

3.2 Air Impact Assessment Criteria

The *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* ("the Approved Methods") was revised by the Department of Environment, Climate Change and Water (DECCW) (then Department of Environment and Conservation (DEC)) on 26 August 2005. The Approved Methods provides guidance for the selection and configuration of air dispersion models, methodologies to be used to compile meteorological datasets and emissions data, and specifies the assessment criteria to be used to evaluate compliance.

The DECCW impact assessment criteria for H_2SO_4 is shown in Table 3.1.

Table 3.1: NSW DECCW Assessment Criteria for H_2SO_4

Pollutant	Concentration (mg/m^3)	Averaging Period
Sulfuric Acid (H_2SO_4)	0.018	1 hour

4 LOCAL DISPERSION CONDITIONS

The dispersion model used for this assessment, AUSPLUME v6.0 (**VEPA, 1986**), requires information about the dispersion characteristics of the area. In particular, data are required on wind speed, wind direction, temperature, atmospheric stability class[a] and mixing height[a].

[a] In dispersion modelling stability class is used to categorise the rate at which a plume will disperse. In the Pasquill-Gifford-Turner stability class assignment scheme there are six stability classes A through to F. Class A relates to unstable conditions such as

ERM operate a weather station on behalf of AGL Energy Ltd which is located approximately 700 m to the southeast of the RPGP site. However the data from this meteorological station did not meet the DECCW's 90 % data retrieval criterion. Data are also available from the West Camden Sewage Treatment Plant (West Camden STP) located approximately 10 km to the northwest of the proposed site. Data from West Camden STP are available from 21 March 1992 to 20 March 1993 and are considered representative meteorological data for the area.

Annual and seasonal windroses prepared from the West Camden STP data are shown in **Figure 4.1**. The windroses indicate that light southerly winds dominate during the times of poor dispersion, i.e. during autumn and winter. The annual average wind speed is 2.15 m/s.

Table 4.1 compares the percentage of calm periods at West Camden during different seasons. Autumn and winter have the highest percentage of calm atmospheric conditions.

Table 4.1: Percentage of calm periods (wind speed less than or equal to 0.5 m/s)

Period	Frequency (%)
All	12.1
Summer	10.1
Winter	13.8
Autumn	15.6
Spring	8.9

Table 4.2 shows the frequency of occurrence of the different stability categories expected in the area. The highest frequency of occurrence are E and F class stabilities. Under these stable atmospheric conditions, emissions disperse more slowly however stable atmospheric conditions occur predominantly outside daylight hours when people are usually inside or asleep.

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

Table 4.2: Frequency of occurrence of stability classes at West Camden STP

Stability Class	Frequency (%)
A	23.7
B	6.9
C	8.4
D	11.1
E	11.0
F	38.8
Total	100

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.

[a] 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.

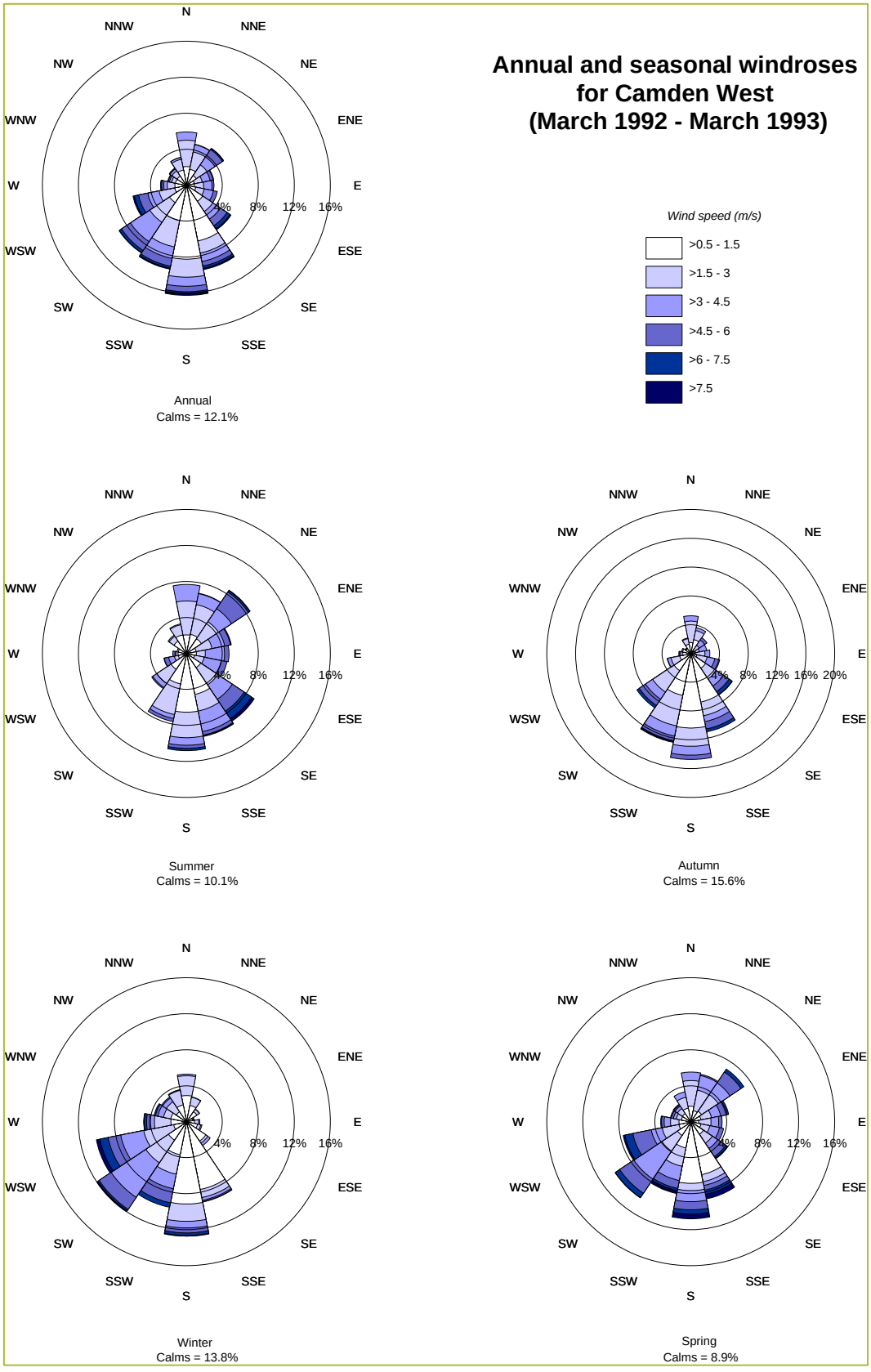


Figure 4.1: Windroses for West Camden STP meteorological data (March 1992 to March 1993)

5 APPROACH TO ASSESSMENT

This section provides a brief description of the methods used to model the H_2SO_4 emissions. In August 2005, the NSW DECCW (then DEC) published new guidelines, i.e. the 'Approved Methods' for the assessment of air pollution sources using dispersion models (**DEC, 2005**). The guidelines specify how assessments based on the use of air dispersion models should be undertaken. They include guidelines for the preparation of meteorological data to be used in dispersion models, the way in which emissions should be estimated and the relevant air quality criteria for assessing the significance of predicted concentration and deposition rates from the proposal. The approach taken in this assessment follows the approaches suggested by the guidelines.

Off-site pollutant concentrations due to the operation of the RPGP have been predicted using AUSPLUME. AUSPLUME (Version 6.0) is an advanced Gaussian dispersion model developed on behalf of the Victorian EPA (**VEPA, 1986**) and is based on the United States Environmental Protection Agency's Industrial Source Complex (ISC) model. It is widely used throughout Australia and is regarded as a "state-of-the-art" model. AUSPLUME is the default model required for use by the NSW DECCW unless project characteristics dictate otherwise (**DEC, 2005**).

The modelling was undertaken using the meteorological data from West Camden STP (see **Section 4**) and the emissions data described in **Section 6**. The modelling has taken account of SO_3 emitted from each stack and how the concentration of H_2SO_4 impacts at ground-level. The RPGP was assumed to be in operation for all hours in the day. Receptor spacing was set to 25 m and terrain has been included.

6 EMISSIONS

Reliable stack testing of SO_3 has been conducted from the reboiler stack and each of the three compressor engines at the RPGP, since September 2006. These results are summarised in **Table 6.1**. It can be seen from **Table 6.1** that there have been a number of exceedances of the current 1 mg/m^3 stack concentration limit.

Table 6.1: Stack testing results for SO_3 from Points 1 to 4 (compressor engines and reboiler flue) at RPGP

Date	Point 1	Point 2	Point 3	Point 4
Sep-06	**3.1**	**3.6**	Not Operating	Not Operating
Dec-06	<0.8	<13.6	Not Operating	Not Operating
Mar-07	**1.2**	0.9	Not Operating	Not Operating
Jun-07	<0.73	1.1	0.7	Not Operating
Aug-07	<0.9	Not Operating	<0.9	<0.7
Dec-07	**1.9**	<2.88	**4.15**	Not Operating
Feb-08	**1.45**	<2.82	Not Operating	**17.12**
Apr-08	<0.68	<1.74	**4.06**	Not Operating
Oct-08	0.12	0.23	Not Operating	0.25
Dec-08	<0.059	0.13	Not Operating	0.28
May-09	0.085	0.44	Not Operating	0.42
Aug-09	<0.099	0.21	Not Operating	0.78
Oct-09	**1.3**	0.73	0.21	Not Operating
Dec-09	0.071	0.0074	Not Operating	0.17

For stack sources, AUSPLUME requires information on the source location and height, internal source tip diameter, temperature and exit velocity of emissions and the mass emission rate of the pollutants to be assessed. Temperature, exit velocity and mass emission rates can be provided to the model as hourly records for an entire year (variable emissions) or as constant emissions.

Table 6.2 shows the technical data of the RPGP stacks required for dispersion modelling using AUSPLUME. This information was provided by AGL from recent stack test reports.

For this assessment, the proposed stack emission limit for SO_3, i.e. 10 mg/m^3, has been set for the reboiler stack (Point 4) and the compressor engines (Points 1 to 3) and potential impacts on air quality have been assessed by setting the remaining stack (Point 5, i.e. the reflux column) so that emit SO_3 at their respective emission limits in EPL 12003. Therefore, the maximum allowable load of SO_3 from the site (including the proposed increase at Points 1 to 4) has been assessed. It is also been assumed that 100% conversion of SO_3 to H_2SO_4 has occurred at the point of release.

Table 6.2: Emissions data to be used in dispersion modelling

Stack	Point 1	Point 2	Point 3	Point 4	Point 5
Easting (MGA, m)	294107	294130	294151	294204	294204
Northing (MGA, m)	6222132	6222126	6222123	6222104	6222107
Height (m)	11.95	11.95	11.95	8.19	12.47
Diameter (m)	0.385	0.385	0.385	0.26	0.1
Base Elevation (m)	100	104	106	109	109
Emission Temperature (°C)	384	384	384	238	81
Exit Velocity (m/s)	14	14	14	2.9	1.2
SO_3 concentration (stack) (mg/m^3)	10 (2)	10 (2)	10 (2)	10 (2)	35 (1)
H_2SO_4 emission rate (g/s)	0.0072	0.0072	0.0072	0.00095	0.000125

1. Existing EPL SO_3 limit
2. Proposed EPL SO_3 limit

7 ASSESSMENT OF IMPACTS

The predicted maximum 1-hour average H_2SO_4 concentration anywhere on the modelled domain is 0.006 mg/m^3, which is well below the DECCW criterion of 0.018 mg/m^3.

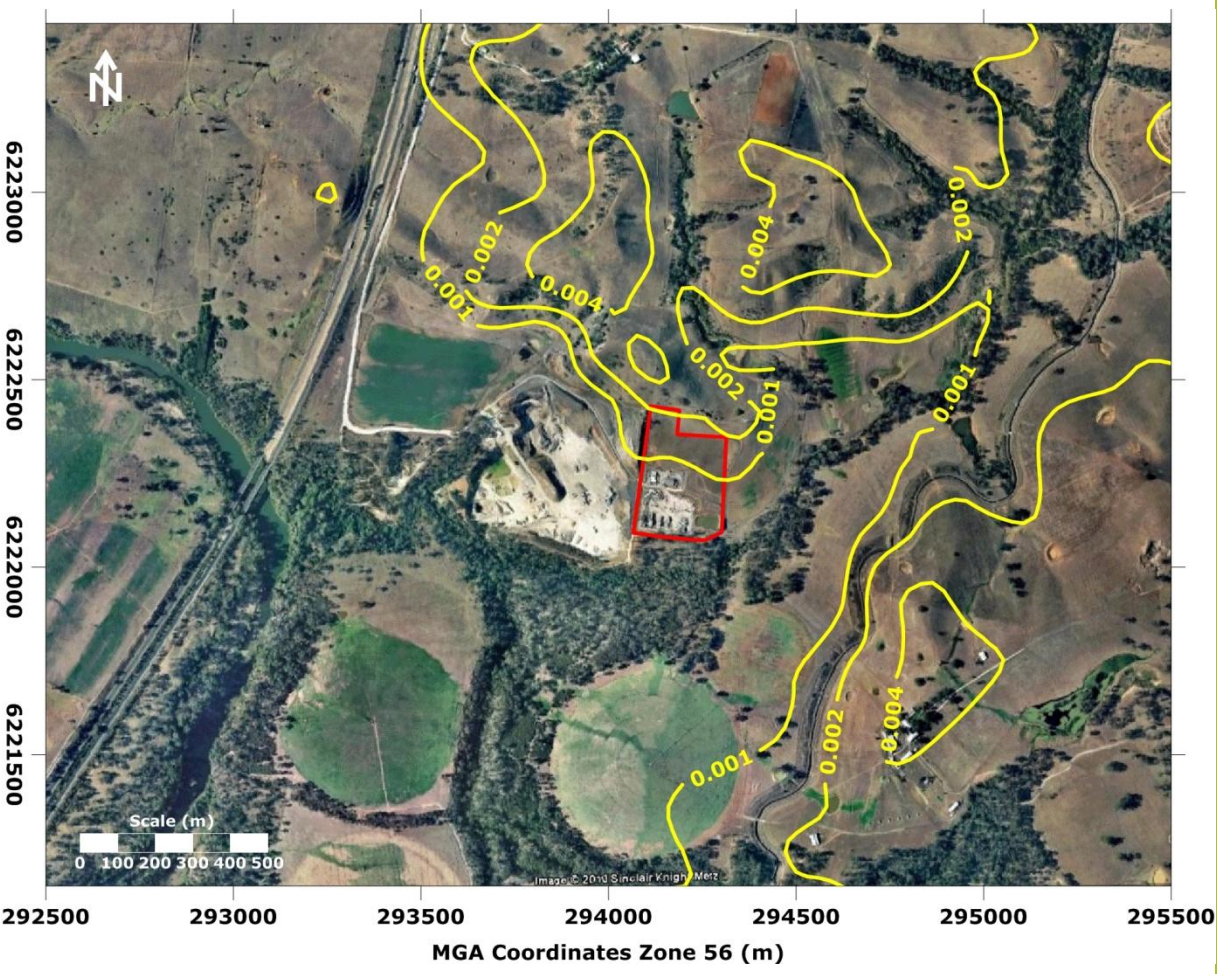
Figure 7.1 presents the maximum predicted 1-hour average H_2SO_4 concentrations for the assessment. It should be noted that plots do not represent the dispersion pattern for any particular day, but show the highest predicted 1-hour average concentration that would occur at each location for the worst hour in the year. The maxima are used to show concentrations which can possibly be reached under the modelled conditions.

It is important to note that the isopleth figures are presented to provide a visual representation of the predicted impacts. To produce the isopleths it is necessary to make interpolations, and as a result the isopleths will not always match exactly with predicted impacts at any specific location.

Table 7.1 presents the results from the dispersion modelling at the nearest residences to the RPGP with the stack concentrations set at 10 mg/m3. These residences are also shown in **Figure 7.1**.

Table 7.1: Predicted concentrations of H_2SO_4 at nearest residences to RPGP

Residence ID	Easting	Northing	DECCW Criterion for 1 hour average (mg/m^3)	Predicted 1 hour average Concentration (mg/m^3)
1	294549	6221273	0.018	0.0022
2	294763	6221539	0.018	0.0046
3	294999	6221764	0.018	0.0044
4	293980	6223340	0.018	0.0034
5	293665	6223386	0.018	0.0020



Species: H_2SO_4	**Averaging Time:** 1-hour	**Percentile:** Maximum	**Scenario:** Increase of emission limit to 10 mg/m^3	**Location:** RPGP
Model Used: AUSPLUME v.6.0	**Units:** mg/m^3	**Criterion:** 0.018	**Met Data:** West Camden STP	**Plot:** J. Beaney

Figure 7.1: Predicted 1-hour average H_2SO_4 concentrations due to emissions from RPGP

8 CONCLUSIONS

This report has assessed the potential air quality impacts of increasing the emission limit for SO_3 in EPL 12003 for the reboiler stack (Point 4) and the compressor engines (Points 1 to 3). The proposed increases are from 1 mg/m^3 to 10 mg/m^3 (Point 4) and from 3.1 mg/m^3 to 10 mg/m^3 (Points 1 to 3), which more accurately reflects normal operating conditions whilst still ensuring adequate protection of air quality for the surrounding receptors.

Dispersion modelling has been used to predict ground-level H_2SO_4 concentrations due to emissions from the three compressor engines, a reflux column and the reboiler flue at the RPGP.

A worst-case approach was adopted for the assessment which assumed that the stacks were emitting at maximum allowable emissions continuously for all hours of the year.

Modelling results show that predicted 1-hour average concentrations of H_2SO_4 are well below the relevant criteria of 0.018 mg/m^3 anywhere in the modelled domain. It can therefore be concluded that increasing the emission limit of SO_3 for the reboiler stack and the compressor engines to 10 mg/m^3 would not adversely impact air quality of the surrounding environment.

9 REFERENCES

DEC (2005) *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*, NSW Department of Environment and Conservation, August 2005.

NEPC, (1998) Environment Protection and Heritage Council website, www.ephc.gov.au

VEPA (1986) *The Ausplume Gaussian Plume Dispersion Model*, Environment Protection Authority, Olderfleet Buildings, 477 Collins Street, Melbourne Victoria 3000, Publication Number 264.

APPENDIX A

Joint Wind Speed, Wind Direction and Stability Class for West Camden STP

STATISTICS FOR FILE: C:\Jobs\Westbrook_Rd\Met\CAM9293_rev.aus
MONTHS: All
HOURS : All
OPTION: Frequency

PASQUILL STABILITY CLASS 'A'

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	0.009366	0.012728	0.003002	0.000120	0.000000	0.000000	0.000000	0.000000	0.025216
NE	0.008165	0.008165	0.001081	0.000240	0.000000	0.000000	0.000000	0.000000	0.017651
ENE	0.004323	0.003002	0.000841	0.000600	0.000000	0.000000	0.000000	0.000000	0.008766
E	0.004443	0.003362	0.001921	0.000240	0.000000	0.000000	0.000000	0.000000	0.009966
ESE	0.004083	0.003842	0.001681	0.000000	0.000000	0.000000	0.000000	0.000000	0.009606
SE	0.006604	0.004563	0.000600	0.000360	0.000000	0.000000	0.000000	0.000000	0.012128
SSE	0.012608	0.003963	0.001321	0.000480	0.000000	0.000120	0.000000	0.000000	0.018492
S	0.007565	0.002762	0.001801	0.000000	0.000120	0.000000	0.000000	0.000000	0.012248
SSW	0.004203	0.003963	0.001081	0.000240	0.000000	0.000120	0.000000	0.000000	0.009606
SW	0.003602	0.002642	0.003602	0.000360	0.000000	0.000000	0.000000	0.000000	0.010207
WSW	0.002402	0.003963	0.003242	0.000480	0.000000	0.000000	0.000000	0.000000	0.010086
W	0.001921	0.001801	0.001201	0.000480	0.000000	0.000000	0.000000	0.000000	0.005403
WNW	0.003242	0.001441	0.001561	0.000480	0.000240	0.000000	0.000000	0.000000	0.006964
NW	0.003842	0.003482	0.001441	0.000360	0.000000	0.000000	0.000000	0.000000	0.009126
NNW	0.007205	0.006724	0.000480	0.000000	0.000000	0.000000	0.000000	0.000000	0.014409
N	0.011167	0.017291	0.003482	0.000000	0.000000	0.000000	0.000000	0.000000	0.031940
CALM									0.025576
TOTAL	0.094741	0.083694	0.028338	0.004443	0.000360	0.000240	0.000000	0.000000	0.237392

MEAN WIND SPEED (m/s) = 1.78
NUMBER OF OBSERVATIONS = 1977

PASQUILL STABILITY CLASS 'B'

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	0.000360	0.001201	0.002402	0.000000	0.000000	0.000000	0.000000	0.000000	0.003963
NE	0.000240	0.001081	0.002402	0.000480	0.000000	0.000000	0.000000	0.000000	0.004203
ENE	0.000120	0.000600	0.001801	0.000120	0.000120	0.000000	0.000000	0.000000	0.002762
E	0.000000	0.000360	0.003362	0.000240	0.000000	0.000000	0.000000	0.000000	0.003963
ESE	0.000000	0.000600	0.002402	0.000480	0.000000	0.000000	0.000000	0.000000	0.003482
SE	0.000600	0.001321	0.001561	0.000600	0.000240	0.000000	0.000000	0.000000	0.004323
SSE	0.001561	0.000841	0.000961	0.000961	0.000240	0.000000	0.000000	0.000000	0.004563
S	0.001201	0.000360	0.001201	0.001081	0.000000	0.000360	0.000000	0.000000	0.004203
SSW	0.000120	0.001321	0.001441	0.000360	0.000240	0.000360	0.000000	0.000000	0.003842
SW	0.000000	0.000841	0.003722	0.002161	0.000600	0.000360	0.000000	0.000000	0.007685
WSW	0.000240	0.000961	0.002642	0.004203	0.001801	0.000480	0.000000	0.000000	0.010327
W	0.000120	0.000240	0.000841	0.000841	0.000480	0.000120	0.000000	0.000000	0.002642
WNW	0.000000	0.000000	0.000240	0.000720	0.000360	0.000000	0.000000	0.000000	0.001321
NW	0.000360	0.000240	0.000600	0.000120	0.000240	0.000000	0.000000	0.000000	0.001561
NNW	0.000240	0.000841	0.000720	0.000120	0.000000	0.000000	0.000000	0.000000	0.001921
N	0.000240	0.004083	0.003482	0.000000	0.000000	0.000000	0.000000	0.000000	0.007805
CALM									0.000120
TOTAL	0.005403	0.014890	0.029779	0.012488	0.004323	0.001681	0.000000	0.000000	0.068684

MEAN WIND SPEED (m/s) = 3.79
NUMBER OF OBSERVATIONS = 572

PASQUILL STABILITY CLASS 'C'

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	0.000000	0.000480	0.000841	0.000120	0.000000	0.000000	0.000000	0.000000	0.001441
NE	0.000000	0.000360	0.001561	0.003602	0.000000	0.000000	0.000000	0.000000	0.005524
ENE	0.000000	0.000360	0.002161	0.001321	0.000360	0.000000	0.000000	0.000000	0.004203
E	0.000000	0.001081	0.001921	0.001321	0.000000	0.000000	0.000000	0.000000	0.004323
ESE	0.000000	0.000480	0.003242	0.003122	0.000000	0.000000	0.000000	0.000000	0.006844

SE	0.000120	0.001561	0.003842	0.004803	0.002522	0.000360	0.000000	0.000000	0.013208
SSE	0.000841	0.000961	0.001561	0.001561	0.000600	0.000720	0.000120	0.000000	0.006364
S	0.000961	0.001201	0.002402	0.002161	0.001201	0.000720	0.000240	0.000000	0.008886
SSW	0.000600	0.001681	0.002402	0.002642	0.000720	0.000360	0.000000	0.000000	0.008405
SW	0.000000	0.000961	0.004203	0.005644	0.001561	0.000120	0.000000	0.000000	0.012488
WSW	0.000000	0.000120	0.000720	0.002402	0.001921	0.000480	0.000120	0.000240	0.006004
W	0.000000	0.000240	0.000120	0.000240	0.000360	0.000000	0.000000	0.000000	0.000961
WNW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
NW	0.000120	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000120
NNW	0.000120	0.000720	0.000480	0.000000	0.000000	0.000000	0.000000	0.000000	0.001321
N	0.000120	0.002161	0.001681	0.000000	0.000000	0.000000	0.000000	0.000000	0.003963
CALM									0.000240
TOTAL	0.002882	0.012368	0.027137	0.028939	0.009246	0.002762	0.000480	0.000240	0.084294

MEAN WIND SPEED (m/s) = 4.51
NUMBER OF OBSERVATIONS = 702

PASQUILL STABILITY CLASS 'D'

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	0.000720	0.001681	0.001201	0.000240	0.000000	0.000000	0.000000	0.000000	0.003842
NE	0.000000	0.002161	0.003722	0.005403	0.001441	0.000120	0.000000	0.000000	0.012848
ENE	0.000000	0.001561	0.002161	0.001081	0.000120	0.000000	0.000000	0.000000	0.004923
E	0.000000	0.001921	0.000360	0.000240	0.000000	0.000000	0.000000	0.000000	0.002522
ESE	0.000120	0.001681	0.002161	0.000600	0.000000	0.000000	0.000000	0.000000	0.004563
SE	0.000120	0.001201	0.002281	0.002642	0.001321	0.000600	0.000000	0.000000	0.008165
SSE	0.001801	0.001081	0.003122	0.001681	0.001441	0.000120	0.000360	0.000000	0.009606
S	0.007085	0.005764	0.002762	0.002161	0.000600	0.000120	0.000120	0.000000	0.018612
SSW	0.001441	0.008525	0.006604	0.004563	0.001081	0.000360	0.000000	0.000000	0.022574
SW	0.000240	0.007565	0.005403	0.002522	0.000720	0.000000	0.000000	0.000000	0.016451
WSW	0.000120	0.001921	0.000120	0.000000	0.000000	0.000000	0.000000	0.000000	0.002161
W	0.000240	0.000360	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000600
WNW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
NW	0.000360	0.000120	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000480
NNW	0.000480	0.000600	0.000120	0.000000	0.000000	0.000000	0.000000	0.000000	0.001201
N	0.000360	0.001441	0.000120	0.000000	0.000000	0.000000	0.000000	0.000000	0.001921
CALM									0.000720
TOTAL	0.013088	0.037584	0.030139	0.021134	0.006724	0.001321	0.000480	0.000000	0.111191

MEAN WIND SPEED (m/s) = 3.48
NUMBER OF OBSERVATIONS = 926

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	0.001801	0.001441	0.000600	0.000000	0.000000	0.000000	0.000000	0.000000	0.003842
NE	0.000360	0.000720	0.001561	0.000240	0.000000	0.000000	0.000000	0.000000	0.002882
ENE	0.000360	0.001321	0.001201	0.000240	0.000000	0.000000	0.000000	0.000000	0.003122
E	0.000600	0.001921	0.000961	0.000000	0.000000	0.000000	0.000000	0.000000	0.003482
ESE	0.000480	0.001921	0.000961	0.000240	0.000000	0.000000	0.000000	0.000000	0.003602
SE	0.000720	0.001801	0.001561	0.000480	0.000000	0.000120	0.000000	0.000000	0.004683
SSE	0.007805	0.003122	0.002041	0.000360	0.000120	0.000120	0.000000	0.000000	0.013569
S	0.011047	0.004323	0.001321	0.000360	0.000480	0.000000	0.000000	0.000000	0.017531
SSW	0.003242	0.006604	0.000961	0.000720	0.000120	0.000000	0.000000	0.000000	0.011647
SW	0.001201	0.006964	0.007685	0.001081	0.000000	0.000000	0.000000	0.000000	0.016931
WSW	0.000841	0.004203	0.003842	0.002522	0.000841	0.000240	0.000000	0.000000	0.012488
W	0.000720	0.001201	0.000240	0.000360	0.000240	0.000000	0.000000	0.000000	0.002762
WNW	0.000480	0.000240	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000720
NW	0.000000	0.000841	0.000120	0.000120	0.000000	0.000000	0.000000	0.000000	0.001081
NNW	0.001321	0.001321	0.000360	0.000000	0.000000	0.000000	0.000000	0.000000	0.003002
N	0.001201	0.002161	0.000240	0.000000	0.000000	0.000000	0.000000	0.000000	0.003602
CALM									0.004683
TOTAL	0.032181	0.040106	0.023655	0.006724	0.001801	0.000480	0.000000	0.000000	0.109630

MEAN WIND SPEED (m/s) = 2.43
NUMBER OF OBSERVATIONS = 913

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	0.006004	0.002041	0.000240	0.000000	0.000000	0.000000	0.000000	0.000000	0.008285
NE	0.004323	0.001801	0.000120	0.000120	0.000000	0.000000	0.000000	0.000000	0.006364
ENE	0.004083	0.002041	0.000720	0.000000	0.000120	0.000000	0.000000	0.000000	0.006964
E	0.003482	0.001681	0.000841	0.000120	0.000000	0.000000	0.000000	0.000000	0.006124
ESE	0.005644	0.001081	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.006724
SE	0.013208	0.003122	0.000360	0.000000	0.000000	0.000120	0.000000	0.000000	0.016811
SSE	0.038305	0.003722	0.000600	0.000120	0.000000	0.000000	0.000000	0.000000	0.042747
S	0.054035	0.005644	0.000600	0.000240	0.000120	0.000000	0.000000	0.000000	0.060639
SSW	0.030139	0.007805	0.000480	0.000360	0.000000	0.000000	0.000000	0.000000	0.038785
SW	0.017771	0.007445	0.001201	0.000120	0.000000	0.000000	0.000000	0.000000	0.026537
WSW	0.009846	0.006604	0.002161	0.000720	0.000240	0.000000	0.000000	0.000000	0.019573
W	0.009966	0.004683	0.001441	0.000360	0.000000	0.000000	0.000000	0.000000	0.016451
WNW	0.008886	0.002642	0.000720	0.000120	0.000000	0.000000	0.000000	0.000000	0.012368
NW	0.007925	0.002161	0.000480	0.000240	0.000000	0.000000	0.000000	0.000000	0.010807
NNW	0.008045	0.001921	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.009966
N	0.007805	0.002161	0.000120	0.000000	0.000000	0.000000	0.000000	0.000000	0.010086
CALM									0.089577
TOTAL	0.229467	0.056556	0.010086	0.002522	0.000480	0.000120	0.000000	0.000000	0.388809

MEAN WIND SPEED (m/s) = 1.10
NUMBER OF OBSERVATIONS = 3238

ALL PASQUILL STABILITY CLASSES

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	0.018252	0.019573	0.008285	0.000480	0.000000	0.000000	0.000000	0.000000	0.046590
NE	0.013088	0.014289	0.010447	0.010086	0.001441	0.000120	0.000000	0.000000	0.049472
ENE	0.008886	0.008886	0.008886	0.003362	0.000720	0.000000	0.000000	0.000000	0.030740
E	0.008525	0.010327	0.009366	0.002161	0.000000	0.000000	0.000000	0.000000	0.030379
ESE	0.010327	0.009606	0.010447	0.004443	0.000000	0.000000	0.000000	0.000000	0.034822
SE	0.021374	0.013569	0.010207	0.008886	0.004083	0.001201	0.000000	0.000000	0.059318
SSE	0.062920	0.013689	0.009606	0.005163	0.002402	0.001081	0.000480	0.000000	0.095341
S	0.081892	0.020053	0.010086	0.006004	0.002522	0.001201	0.000360	0.000000	0.122118
SSW	0.039745	0.029899	0.012968	0.008886	0.002161	0.001201	0.000000	0.000000	0.094861
SW	0.022815	0.026417	0.025817	0.011888	0.002882	0.000480	0.000000	0.000000	0.090298
WSW	0.013449	0.017771	0.012728	0.010327	0.004803	0.001201	0.000120	0.000240	0.060639
W	0.012968	0.008525	0.003842	0.002281	0.001081	0.000120	0.000000	0.000000	0.028818
WNW	0.012608	0.004323	0.002522	0.001321	0.000600	0.000000	0.000000	0.000000	0.021374
NW	0.012608	0.006844	0.002642	0.000841	0.000240	0.000000	0.000000	0.000000	0.023175
NNW	0.017411	0.012128	0.002161	0.000120	0.000000	0.000000	0.000000	0.000000	0.031820
N	0.020893	0.029299	0.009126	0.000000	0.000000	0.000000	0.000000	0.000000	0.059318
CALM									0.120917
TOTAL	0.377762	0.245197	0.149135	0.076249	0.022935	0.006604	0.000961	0.000240	1.000000

MEAN WIND SPEED (m/s) = 2.15
NUMBER OF OBSERVATIONS = 8328

FREQUENCY OF OCCURENCE OF STABILITY CLASSES

A : 23.7%
B : 6.9%
C : 8.4%
D : 11.1%
E : 11.0%
F : 38.9%

STABILITY CLASS BY HOUR OF DAY

Hour	A	B	C	D	E	F
01	0000	0000	0000	0036	0056	0255
02	0000	0000	0000	0032	0046	0269
03	0000	0000	0000	0038	0057	0252
04	0000	0000	0000	0038	0045	0264
05	0000	0000	0000	0038	0045	0264
06	0040	0007	0008	0032	0043	0217

```
  07 0125 0015 0025 0029 0023 0130
  08 0220 0026 0037 0023 0004 0037
  09 0251 0034 0048 0013 0000 0001
  10 0241 0043 0050 0013 0000 0000
  11 0222 0060 0061 0004 0000 0000
  12 0221 0066 0050 0010 0000 0000
  13 0194 0078 0065 0010 0000 0000
  14 0186 0068 0078 0015 0000 0000
  15 0155 0084 0082 0026 0000 0000
  16 0087 0057 0111 0040 0025 0027
  17 0027 0033 0073 0090 0063 0061
  18 0008 0001 0014 0100 0110 0114
  19 0000 0000 0000 0096 0079 0172
  20 0000 0000 0000 0061 0079 0207
  21 0000 0000 0000 0052 0072 0223
  22 0000 0000 0000 0050 0061 0236
  23 0000 0000 0000 0039 0055 0253
  24 0000 0000 0000 0041 0050 0256
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STABILITY CLASS BY MIXING HEIGHT
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Mixing height    A    B    C    D    E    F
    <=500 m    0000 0000 0000 0000 0000 0000
   <=1000 m    1977 0572 0702 0926 0913 3238
   <=1500 m    0000 0000 0000 0000 0000 0000
   <=2000 m    0000 0000 0000 0000 0000 0000
   <=3000 m    0000 0000 0000 0000 0000 0000
    >3000 m    0000 0000 0000 0000 0000 0000

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MIXING HEIGHT BY HOUR OF DAY
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       0000  0100  0200  0400  0800  1600  Greater
        to    to    to    to    to    to    than
Hour   0100  0200  0400  0800  1600  3200  3200
  01   0000  0000  0000  0000  0347  0000  0000
  02   0000  0000  0000  0000  0347  0000  0000
  03   0000  0000  0000  0000  0347  0000  0000
  04   0000  0000  0000  0000  0347  0000  0000
  05   0000  0000  0000  0000  0347  0000  0000
  06   0000  0000  0000  0000  0347  0000  0000
  07   0000  0000  0000  0000  0347  0000  0000
  08   0000  0000  0000  0000  0347  0000  0000
  09   0000  0000  0000  0000  0347  0000  0000
  10   0000  0000  0000  0000  0347  0000  0000
  11   0000  0000  0000  0000  0347  0000  0000
  12   0000  0000  0000  0000  0347  0000  0000
  13   0000  0000  0000  0000  0347  0000  0000
  14   0000  0000  0000  0000  0347  0000  0000
  15   0000  0000  0000  0000  0347  0000  0000
  16   0000  0000  0000  0000  0347  0000  0000
  17   0000  0000  0000  0000  0347  0000  0000
  18   0000  0000  0000  0000  0347  0000  0000
  19   0000  0000  0000  0000  0347  0000  0000
  20   0000  0000  0000  0000  0347  0000  0000
  21   0000  0000  0000  0000  0347  0000  0000
  22   0000  0000  0000  0000  0347  0000  0000
  23   0000  0000  0000  0000  0347  0000  0000
  24   0000  0000  0000  0000  0347  0000  0000
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