Report: Air quality monitoring

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Richards Bay Clean Air Association

Annual Report: 2001

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RICHARDS BAY
CLEAN AIR ASSOCIATION
An Association Incorporated under Section 21

Reference: AS002.2002 v1

For and on behalf of
ECOSERV (Pty) Ltd.

Approved by : Lisa Guastella

Signed :

Position : Consultant

Date : 24 March 2002

Executive Summary

This report highlights the activities and monitoring results of the Richards Bay Clean Air Association (RBCAA) for the Year 2001. The meteorological conditions, sulphur dioxide (SO_2) and ozone (O_3) trends for the year are presented in the body of the report.

For the year 2001 there was one exceedance of the Department of Environmental Affairs and Tourism (DEAT) instantaneous SO_2 guideline of 600 ppb and four exceedances of the World Health Organisation (WHO) 10-minute average SO_2 guideline of 191 ppb, all recorded at the Hillside station. Air quality was worst at Hillside, which is consistent with previous findings, but annual averages for all stations fell below 46% of the WHO guideline. There has been no significant variation in the SO_2 annual average concentrations reported for the last five years. In terms of SO_2, the air quality, defined by the British Department of Environment, in the study area is regarded as "very good". While pollution levels were largely dependent on the station locality relative to sources and prevailing winds, there was generally a slight increase in pollution concentrations during winter mornings as a result of inversion conditions.

The RBCAA achieved all 2001 stated objectives, apart from achieving SO_2 data capture above 90%. There was a 5% drop in the overall annual SO_2 data capture rate compared to the previous year, mainly as a result of analyser malfunctions following power failures. The overall 79.3% of SO_2 data captured for the year was marginally below quality assurance (80% data capture) for the system, however overall system reliability was 90.9%. The monitoring system was ISO Guide 25 accredited in March of 1999. Annual re-accreditation was conducted in September 2001.

The HAWK model operated within acceptable model parameters for stations in residential and agricultural areas and has become a useful tool in the analysis of peaks and complaints. The number of complaints logged with the RBCAA increased from 40 last year to 54 during 2001, and were mostly from the residential areas of Veldenvlei and Meerensee, and from the CBD.

Table of Contents

1 Introduction

This is the 5th Annual Report for the Richards Bay Clean Air Association. The report details the annual averages, along with monthly and daily average trends of monitored pollutants in the Richards Bay area. Basic statistical analyses are discussed before the meteorological results for the year are laid out. A list of objectives for the coming year and achievement of stated objectives for the previous year are also discussed.

The Richards Bay Clean Air Association (RBCAA) continued monitoring of sulphur dioxide (SO_2) and ozone (O_3) in the Richards Bay area during 2001. The monitoring network consists of five monitoring stations for SO_2, while O_3 is measured at one station (Veldenvlei). The SO_2 concentrations reported are determined by a United States Environmental Protection Agency (USEPA) equivalent method. At the Arboretum, Wildenweide and Hillside stations the equivalent method number is EQSA-0193-092, at the Caravan the equivalent method number is EQSA-0495-100 and at Veldenvlei the equivalent method number is EQSA-1086-061. The results pertain to instantaneous samples drawn from air passing the above fixed stations, and care should be taken when extrapolating these results to surrounding areas. Data is recorded as 5-minute averages.

In March 1999, after a successful audit in December 1998, the Richards Bay Clean Air Association was awarded SANAS accreditation as a set of chemical-testing laboratories. This provides the Association with a set of guidelines with which it can ensure a high quality of data captured. Accreditation is ongoing and renewed annually after a performance audit. The system was audited during September 2001 and following recommendations, the mobile Caravan was moved away from it's position alongside the Transitional Local Council (TLC) building to a locality 80 m to the north-west. During the reporting period the RBCAA decided to use the World Health Organisation (WHO) SO_2 guidelines as a gauge of air quality, which resulted in the reporting structure changing to report short-term peaks as 10-minute averages, as opposed to the previous 5-minute averages. The WHO guidelines were later adopted by the National Department of Environment and Tourism (DEAT) (refer Chapter 2).

2 Pollution Monitoring

The SO_2 and O_3 monitoring results for January to December 2001 are summarised in the following sections. The National Department of Environment and Tourism (DEAT) guidelines for SO_2, as promulgated in 1965, were repealed on 21 December 2001 and revised guidelines, equivalent to the World Health Organisation (WHO) guidelines, were passed on the same date (Government Notice No. 1387 of Government Gazette 22491, 21 December 2001). As the period of monitoring falls within an overlap of legislation, both the repealed National DEAT and WHO SO_2 guidelines are listed in Table 1. The DEAT Guidelines for ozone O_3 are also provided.

Table 1: SO_2 and O_3 guideline values

Period	DEAT SO_2 (ppb) guideline (pre- 21 Dec 2001)	WHO SO_2 (ppb) guideline	DEAT O_3 (ppb) guideline
Instantaneous	600	191 (10-min ave)	260
Hourly average	300	n/a	120
Daily average	100	48	n/a
Monthly average	50	n/a	n/a
Annual average	30	19	n/a

2.1 Compliance Figures

There were four exceedances of the WHO 10-minute average guideline (191 ppb) and one exceedance of the National instantaneous (600 ppb) SO_2 guidelines during 2001 (Table 2). No exceedances of the instantaneous or hourly average O_3 guidelines were recorded during 2001. All SO_2 exceedances were recorded at Hillside station, usually at a similar time of day (afternoon), during a wind shift from south-west through to south-east and then to north-east. The fact that the exceedances were recorded during south-easterly winds indicates that the most likely source in all cases was IOF (now called Foskor).

Table 2a: Exceedances of the National instantaneous guideline (600 ppb)

Date	Time	Station	SO_2 concentration	Wind direction	Wind speed
02/03/01	15h10	Hillside	736 ppb	099^{o} (E)	2.3 m/s

Table 2b: Exceedances of the WHO 10-minute guideline (191 ppb)

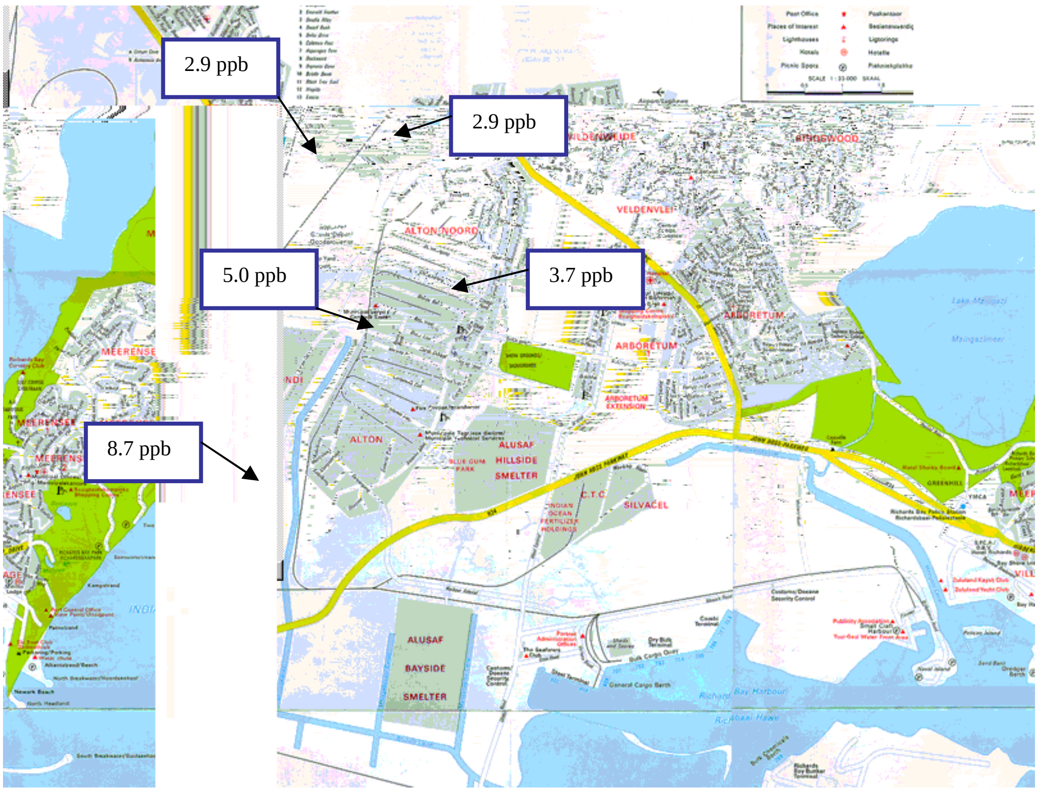
Time period	Date & Time	Station	SO_2 concentration	Wind direction	Wind speed
02/03/01	15h00-15h10	Hillside	486 ppb	099° - 128°	2.0 - 2.3 m/s
17/10/01	14:01 - 14:10	Hillside	325.5 ppb	139° (SE)	1.9 m/s
17/10/01	14:11 - 14:20	Hillside	249.6 ppb	139° (SE)	1.8 m/s
28/12/01	14:01 - 14:10	Hillside	335.1 ppb	124° (SE)	1.8 m/s

2.2 Trends and Mean Results

The trends of SO_2 in the Richards Bay region are presented in this section. Although quality assurance limits require 80% for statistical analysis, only two stations, viz. the Caravan and Wildenweide, achieved compliance during 2001. As the quality assurance requirements are quite rigorous (other organisations have been known to require only 50% data capture) and the other stations achieved data capture rates relatively close to compliance, the annual averages for the non-complaint stations are also included. Data capture rates are discussed in Chapter 6.3 and periods for which data are missing are detailed in Appendix 1.

2.2.1 Annual Mean

Figure 1: Annual mean SO_2 as measured at the monitoring stations



The annual average SO_2 concentrations for 2001 at all the stations are displayed in Figure 1. Table 3 lists the 2001 averages along with those of 1997 to 2000 for comparison. The highest annual average SO_2 concentration was measured at the Hillside station. The Hillside annual average for 2001 was consistent with the previous two years and was 46% of the revised National/WHO guideline. The Wildenweide annual average SO_2 for 2001 was the same as the previous year, while that at Arboretum also showed relatively good agreement with previous years. Annual averages at the Caravan and Veldenvlei also showed good agreement with measurements made during 2000, even though data capture was less than 50% for 2000, owing to station moves. The average SO_2 at Veldenvlei for the period 1 June to 31 December 2000 was 3.8 ppb and for the Caravan (TLC offices) for the period 20 July to 31 December 2000 was 5.7 ppb. The Esikhawini and Umhlatuze stations were discontinued during 2000 and moved to Veldenvlei and the Caravan, respectively.

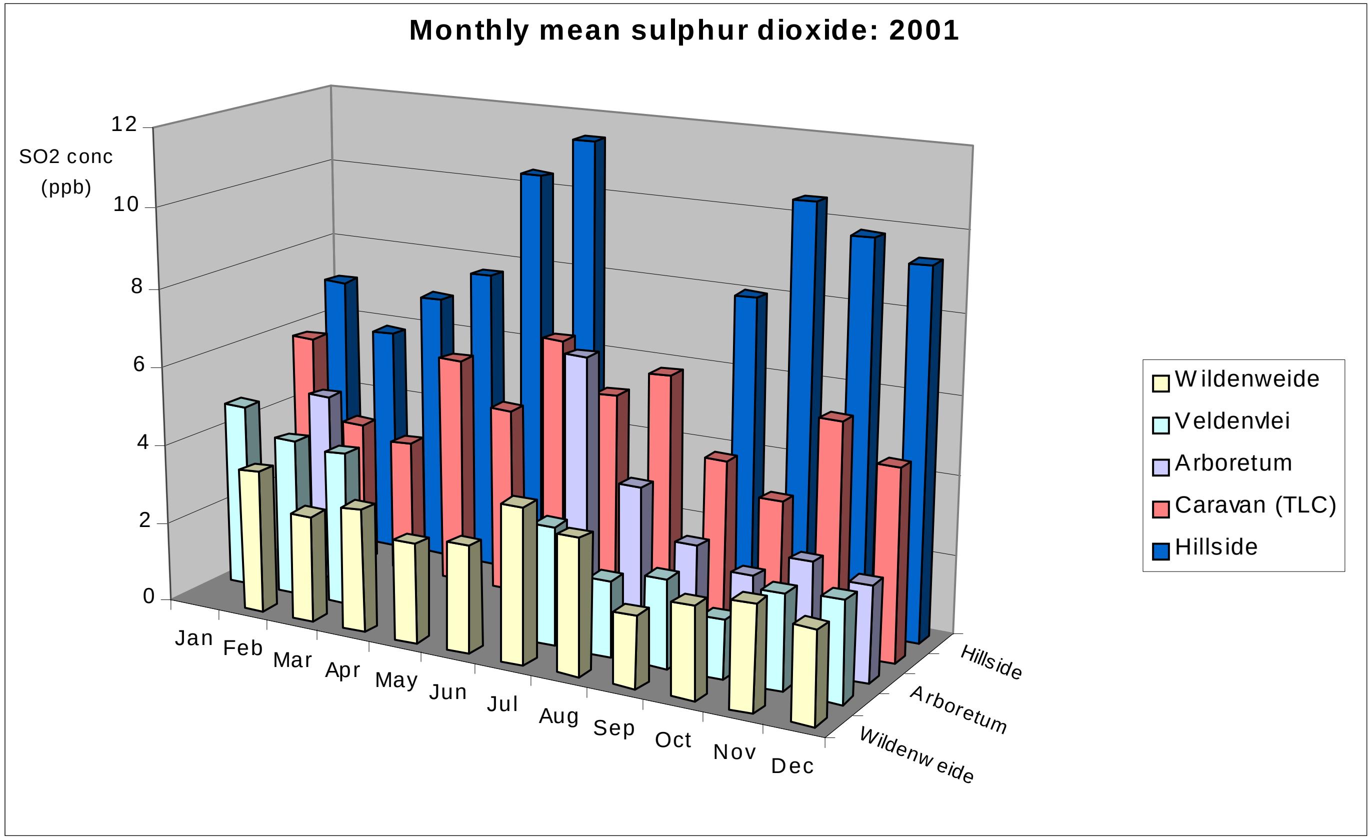
Table 3: Comparison of 1997 to 2001 annual averages. WHO/Revised DEAT guideline is 19 ppb.

Station Name	Units	1997	1998	1999	2000	2001
Arboretum SO_2	ppb	1.9	4.0	3.0	3.5	3.7
Wildenweide SO_2	ppb	2.4	2.2	3.7	2.9	2.9
Hillside SO_2	ppb	9.8	5.8	8.9	8.9	8.7
Caravan (TLC) SO_2	ppb	-	-	-	-	5.0
Veldenvlei SO_2	ppb	-	-	-	-	2.9
Veldenvlei O_3	ppb	-	-	-	-	
Esikhawini SO_2	ppb	<0.5	1.6	2.1	-	-
Esikhawini O_3	ppb	-	17.0	-	-	-
Umhlatuze SO_2	ppb	4.2	2.8	2.4	-	-
Hillside PM_{10}	$\mu g/m^3$	-	30.0	39.9	-	-

Figure 2 depicts monthly average SO_2 per station during the reporting period. Annual and monthly averages (Fig. 2) were highest at the Hillside station. This is considered to be due to the location of the station relative to the Hillside and Bayside Aluminium and Indian Ocean Fertilisers (IOF), now Foskor, plants. The monthly and annual averages were below the old National and WHO guidelines. The highest annual average (8.7 ppb), recorded at Hillside was 46% of the WHO, and now revised National, guideline of 19 ppb. The highest monthly average of 11.4 ppb was measured at Hillside during June and was 23% of the National guideline (50 ppb). Monthly average SO_2 at Hillside tended to increase towards winter. The trends in monthly average SO_2 at Wildenweide, Veldenvlei, Arboretum and the Caravan (TLC building) were similar for those periods where data is comparable. This is considered to be due to the station locations, north-east of the major industries, thus all four stations measure increased SO_2 during winds from the south-west sector. Averages at the Caravan were usually higher than at the other three stations due to the closer proximity of the site (TLC building) to industry. The annual averages at Wildenweide and Veldenvlei were the same.

2.2.2 Monthly Mean Sulphur Dioxide

Figure 2: Monthly mean SO_2 measured at the five monitoring stations



2.2.3 Daily Mean

Figure 3(a): Daily mean SO_2 measured at Arboretum

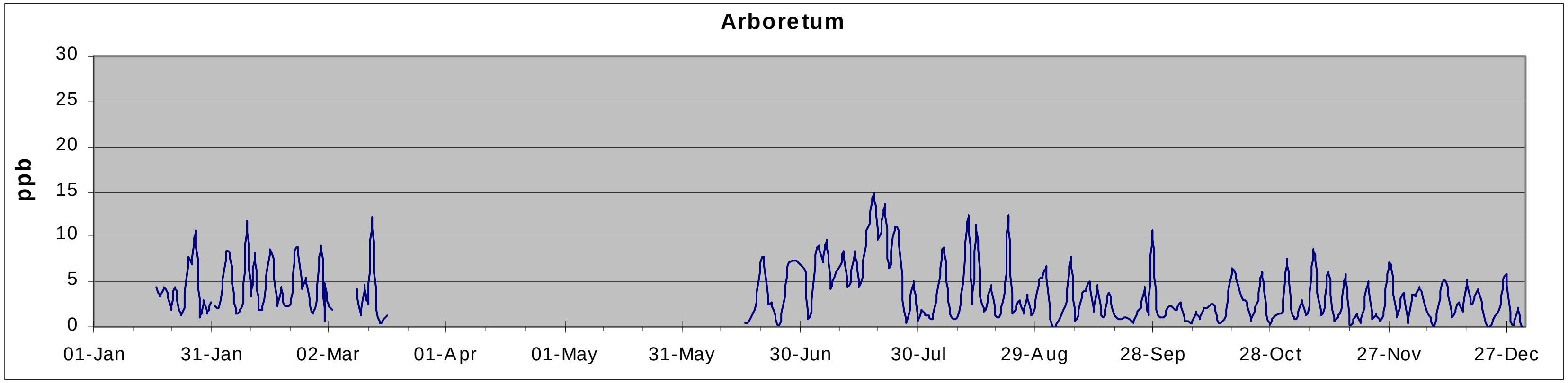


Figure 3(b): Daily mean SO_2 measured at Wildenweide

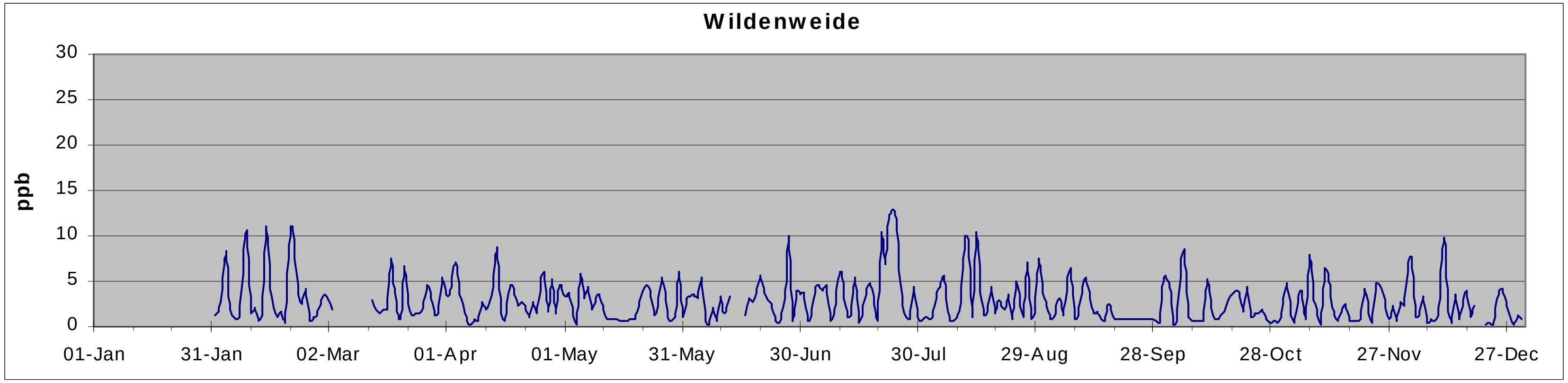


Figure 3(c): Daily mean SO_2 measured at the Caravan (TLC building)

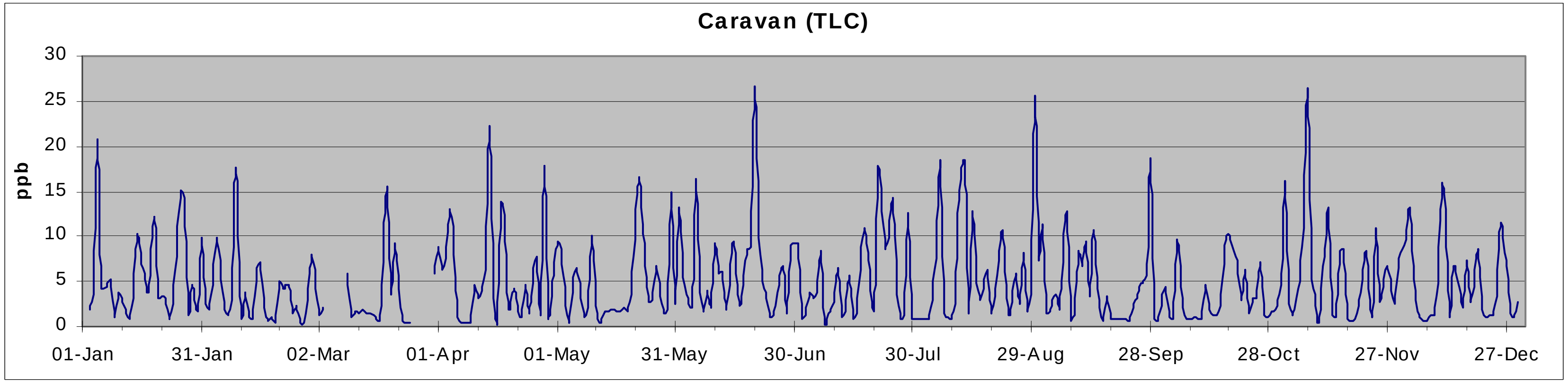


Figure 3(d): Daily mean SO_2 measured at Veldenvlei

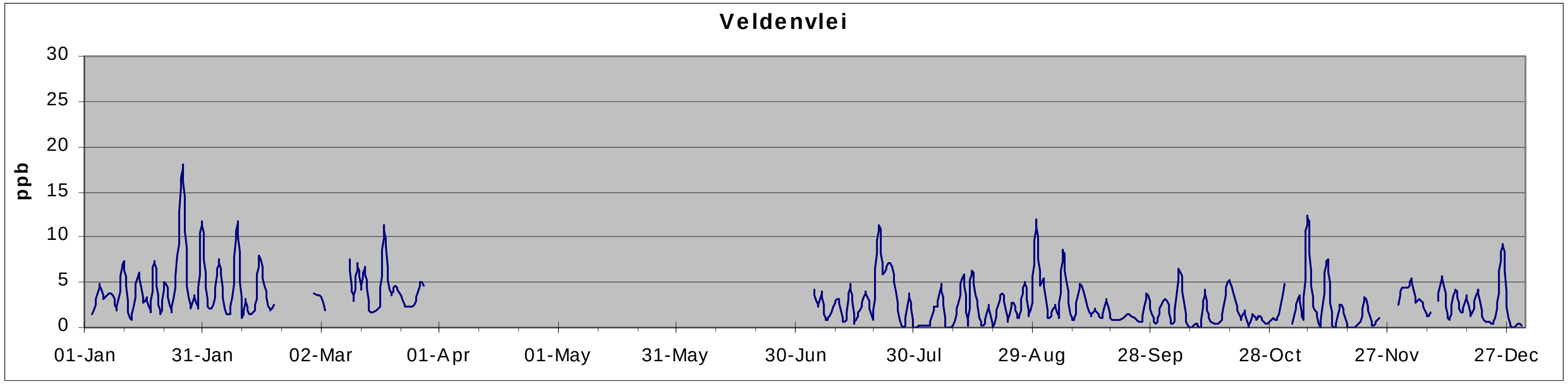


Figure 3(e): Daily mean SO_2 measured at the Hillside station

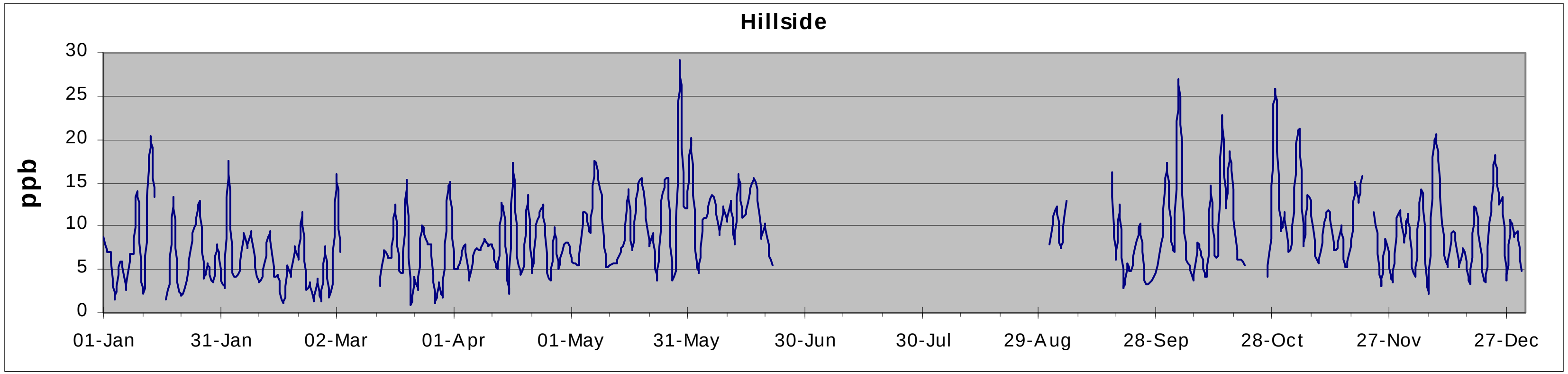
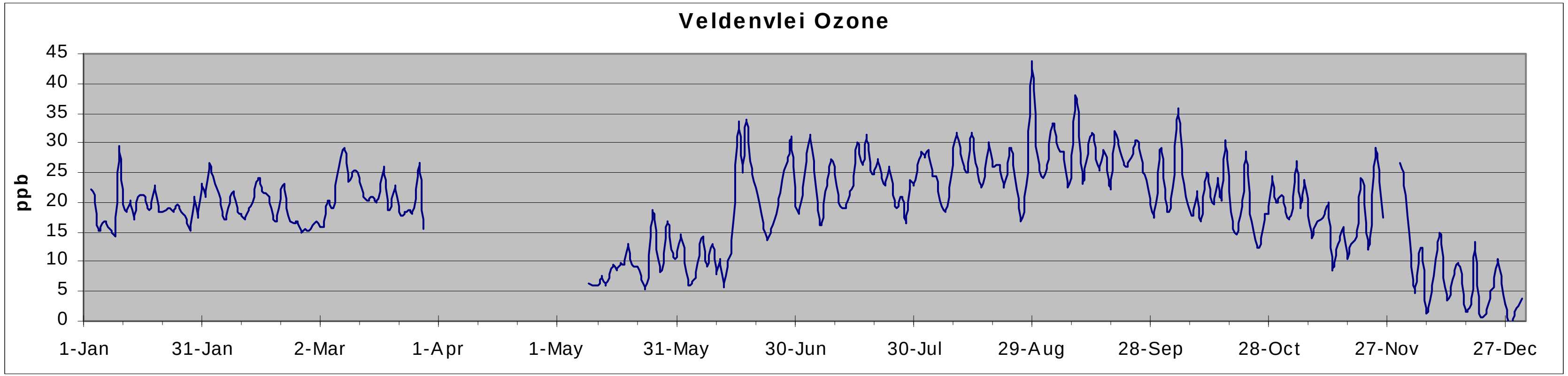


Figure 3(f): Daily mean O_3 measured at Veldenvlei



Arboretum

The trend in daily average SO_2 at Arboretum (Fig. 3a) was discontinuous at times (refer Appendix 1). Elevated SO_2 concentrations were generally recorded during moderate west-south-west to south-westerly winds, between 220º and 260º, with the highest daily averages recorded during July (Fig. 2). Peaks associated with this wind field generally originate from the Hillside Aluminium site or the IOF acid plant stack, although Bayside Aluminium may also contribute to a lesser extent. Elevated SO_2 was also recorded during westerly winds on occasions, in this case the most likely source being Mondi Kraft. An extended period of elevated daily averages was recorded from 17 to 25 July, during which the maximum daily average for the year was recorded on the 19th (refer Table 6). Winds on 17 to 19 July were mainly moderate from the west, which suggests Mondi was the major source. This period was followed by a an extended period of fresh to strong south-westerly to WSW winds from 21 to 25 July, which accompanied a well developed cold front, and which transported SO_2 from the direction of Hillside and Bayside Aluminium and IOF (Foskor). Elevated daily averages were recorded on 11 to 12 and 22 August, associated with WSW to SSW winds. The peak on 14 August was measured during light WSW winds and most likely resulted from Hillside Aluminium emissions. Mondi was on shutdown during this time.

Wildenweide

Maximum daily average SO_2 was recorded on 24 July and elevated daily averages were also recorded the day before, on the 23rd. The period shows good agreement with the peaks at Arboretum during this time and was similarly associated with fresh south-westerly to WSW winds. The most likely source at Wildenweide was Mondi. The three peaks during February 9th, 14th and 20th were all associated with fresh south-westerly winds, which suggests the most likely main sources were Mondi and/or Hillside Aluminium. Peaks in SO_2 were also recorded during SSW to south-westerly winds, e.g. 27 June, which indicates Hillside and/or Bayside Aluminium as possible contributors. The elevated daily average SO_2 on 11 to 12 August showed good agreement with that recorded at Arboretum. The peak on 14 August differed in that it was recorded during light wind speeds, after a wind shift from WSW to north-east. In this case the SO_2 may have been redistributed across the area following the wind shift or may have been from an unknown source, such as a fire.

Caravan (TLC building)

SO_2 averages were usually higher at the Caravan site, adjacent to the TLC offices, than at Arboretum, Wildenweide and Veldenvlei. This is to be expected considering the closer proximity of the Caravan to the main industrial sources compared to the other stations (excluding Hillside). Most peaks in daily average SO_2 were associated with moderate to fresh west-south-west to south-westerly winds, which corresponds to the vectors from Mondi, Hillside and Bayside Aluminium and, to a lesser extent, IOF (Foskor). The peaks in daily average SO_2 on 20 June, 30 August and 7 November were all associated with such winds. The peak on 5 January was measured during WSW to west winds, which corresponds with the vector from Mondi, although the possibility of the AECI boiler as a source should not be excluded it is located on a similar vector to the station. The peak on 14 April was associated with strong south-westerly winds, which suggests the major source was Hillside Aluminium. The elevated SO_2 from 21 to 25 July was also evident at Arboretum (Fig. 3 (a)). The major source at the Caravan was most likely Hillside and Bayside Aluminium.

Veldenvlei

Elevated average SO_2 at Veldenvlei was also generally correlated with moderate to fresh south-westerly to west-south-westerly winds, the main sources from this vector being Mondi and Hillside Aluminium. The maximum daily average on 26 January (Table 6) was associated with fresh south-westerly winds, which suggests Hillside Aluminium was the main source of SO_2. The period of elevated daily average SO_2 from 21 to 25 July shows good agreement with Wildenweide, Arboretum and the Caravan. The peaks on 9 February, 30 August and 7 November also show good agreement with the Caravan.

Hillside

The SO_2 daily averages recorded at this station were generally higher than the averages recorded at the other stations. This is mainly due to the closer proximity of the station to sources of SO_2. Elevated daily average SO_2 at Hillside was mainly associated with light to moderate north-north-easterly winds, which corresponds to the vector from the Hillside FTC. Peaks on 13 January, 4, 15 and 27 October, 4 November and 8 to 9 and 25 December were associated with such wind fields. The maximum daily average on 29 May was associated with a combination of light to moderate northerly to NNE winds and poor dispersion conditions, which acted to trap pollutants below the inversion level. Again, the main source was most likely the Hillside FTC. Elevated levels are possible during land breeze circulation and poor dispersion conditions. This was generally more common during the winter months, especially May (e.g. 16^{th} and 26^{th}) and June (e.g. 17^{th}). The main source in this case is the Hillside GTC4, located north-west of the measurement station. Elevated SO_2 concentrations are also associated with south-westerly winds, which transport SO_2 from Bayside Aluminium, although concentrations tend to be lower than those associated with the NNE winds. Short-term peaks were noted during SSE winds (refer Chapter 3), usually associated with an anticlockwise turning of the winds from south-west, through south to south-east and eventually north-east as low pressure systems move eastwards and are replaced by high pressure systems. The most likely source during these wind shifts is from IOF (Foskor). Owing to the short-term nature of winds specific to this direction, the influence on the daily average concentrations is not significant. However, concentration levels during such conditions were sufficiently high on 8 May to result in a peak in daily average SO_2.

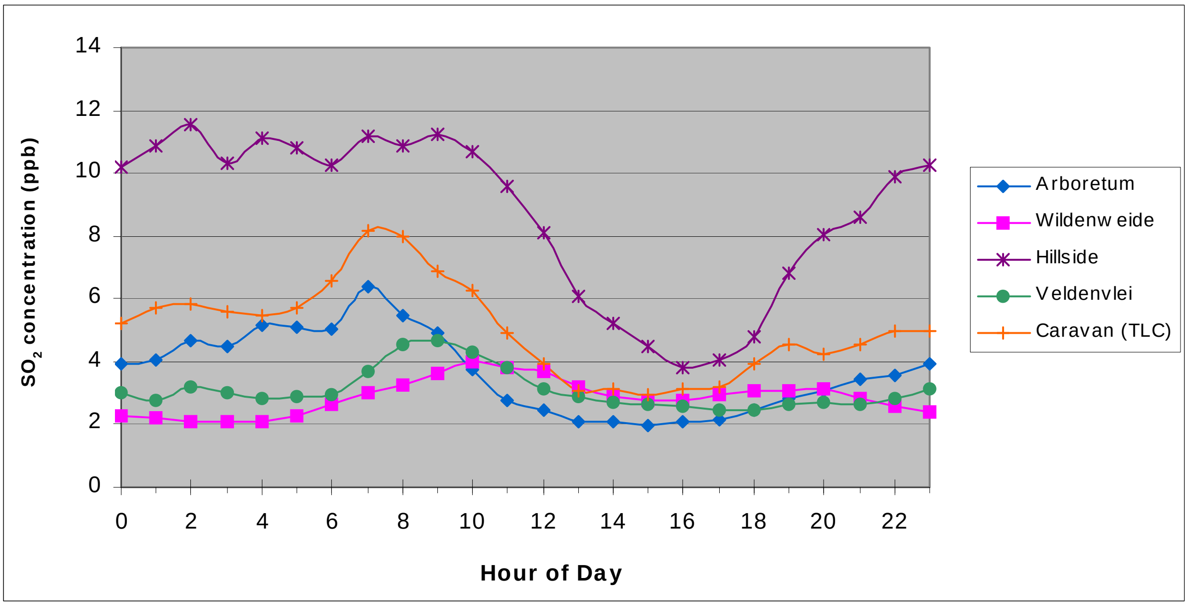
Veldenvlei Ozone

Daily average O_3 concentrations during May to mid-June were considerably lower than during the beginning of the year and from 15 June to early December. It may be possible that the analyser took time to stabilise subsequent to power interruption following the vandalism on 29 March. The analyser was also reading low following a period when moisture entered the sample line during late November. The two periods of below average daily averages should be interpreted with caution. The peak in daily average O_3 at the end of August coincides with the last day of forest burning, during which three fires were noted north of Richards Bay. Elevated O_3 at Veldenvlei was generally associated with NNE to north-easterly winds.

2.2.4 Diurnal Trends

Diurnal trends indicate the variation in SO_2 concentration with time of the day. The diurnal trend in SO_2 for each station for 2001 is shown in Figure 4**.**

Figure 4: Diurnal trend for the period January to December 2001



The diurnal trends were fairly similar to those observed in previous years. The station at Hillside showed the strongest diurnal trend, with peak SO_2 concentrations from late evening to mid-morning, after which concentrations decreased to a minimum during late afternoon when dispersion was at its best. The evening to early morning concentrations coincide mainly with the land breeze circulation (north-westerly), which transports SO_2 mainly from the Hillside GTC4, combined with the effects of poor dispersion conditions. The elevated mid-morning concentrations result mainly from the onset of diurnal north-easterly winds, which transport SO_2 from the direction of the Hillside FTC. Even though south-easterly winds during the afternoon lead to the highest instantaneous peaks (refer Chapter 3), the winds are not prolonged enough to sustain high concentrations at the station.

The Caravan (TLC building) and Arboretum stations showed like trends, although concentrations at Arboretum were weaker than at the Caravan. Peak SO_2 concentrations were measured during the morning, particularly between 07h00 and 08h00, and minimum concentrations occurred during the afternoon. Both stations tend to record increased SO_2 during west-south-westerly to south-westerly winds. Afternoon levels tend to be lower as dispersion, particularly during summer, is improved. In addition, during inclement weather events the diurnal winds tend to rotate anticlockwise, from south-westerly to southerly, during daytime, slightly off the vector to the main sources relative to the stations.

The trends at Veldenvlei and Wildenweide were also fairly similar, although there was a time lag in the morning maximum of one to two hours from Veldenvlei to Wildenweide. The trends, particularly that of Wildenweide, were weaker than at the Caravan and Arboretum. Peak concentrations were similarly recorded during south-westerly to west-south-westerly winds.

2.2.5 Frequency Distribution of Results

Daily averages

A frequency analysis of environmental data is customarily performed in order to classify the air pollution for a region. It is also useful when working with large data sets. A frequency distribution of the data reveals the predominant SO_2 concentrations (as categories) over a period of time. The frequency distribution (histogram graph) and cumulative percent (line graph) of daily mean SO_2 data is given in Figures 5 (a) - (e). Note the variation in the X-axis scale. The X-axis scale indicates the upper SO_2 concentration, i.e. 2 ppb refers to the range of concentrations > 0 ppb and <= 2 ppb. A steep curve indicates a predominance of daily averages of low concentrations (i.e. air quality is very good), while a gentler curve indicates a more even frequency distribution of concentrations and poorer air quality. The mode (most frequently occurring category) was the 0-2 ppb class (denoted as 2 ppb on the graphs) at Arboretum, Wildenweide the Caravan and Veldenvlei. The cumulative percentage curve at the Caravan was gentler than for the other three stations, indicating e tendency for higher daily averages compared to the other three stations. The histogram supports this, with a secondary peak in the Caravan frequency distribution for the 4 to 6 ppb class (Fig. 5 (c)) and a relatively higher frequency of occurrences of the higher concentration classes compared to the other three stations. The trend at Hillside (Fig. 5 (e)) differs somewhat to the other stations in that the mode was the 4 to 6 ppb class, not the lowest 0 to 2 ppb class, as with the other four stations, indicating a tendency for higher daily average SO_2. A secondary peak occurred in the 8 to 10 ppb range, giving rise to a stepped cumulative percentage distribution.

Figure 5 (a): Frequency distribution of daily mean data at Arboretum for the period January to December 2001 (n = 268)

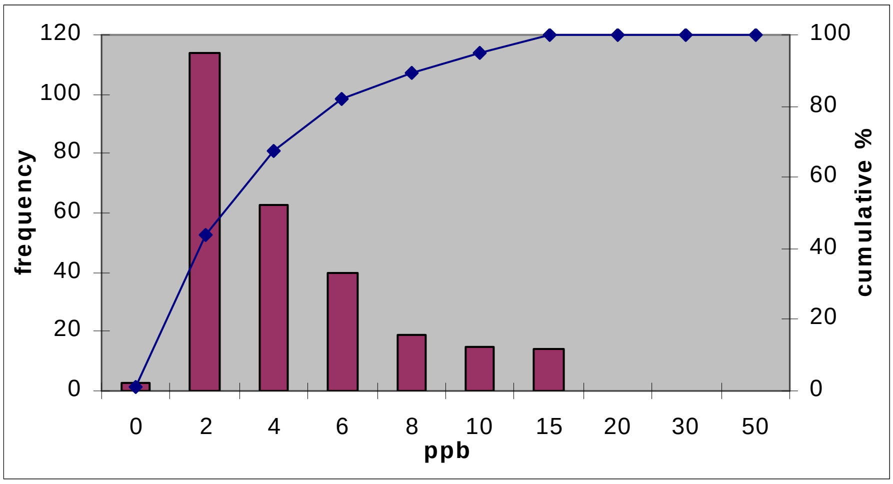


Figure 5 (b): Frequency distribution of daily mean data at Wildenweide for the period January to December 2001 (n = 330)

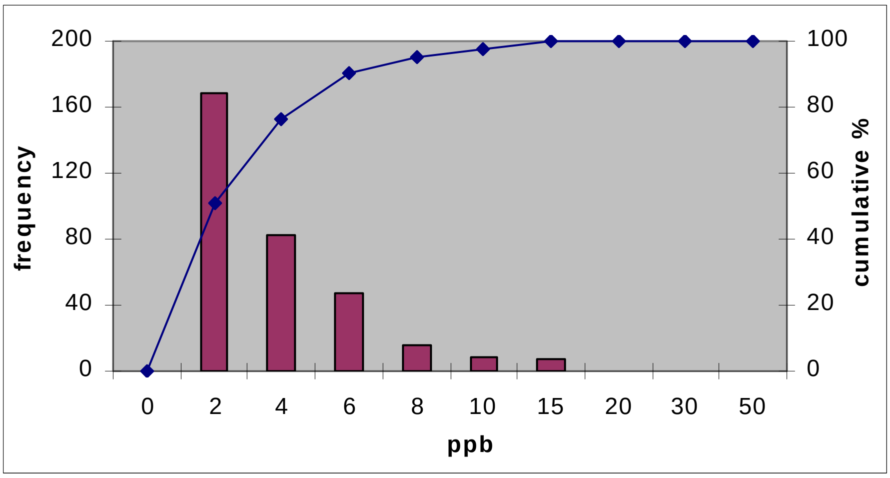


Figure 5 (c): Frequency distribution of daily mean data at the Caravan (TLC offices) for the period January to December 2001 (n = 360)

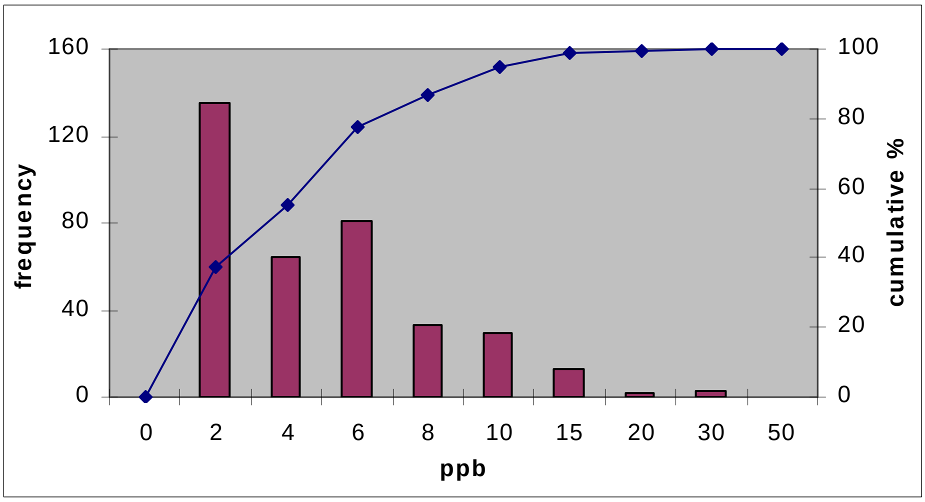


Figure 5 (d): Frequency distribution of daily mean data at Veldenvlei for the period January to December 2001 (n = 258)

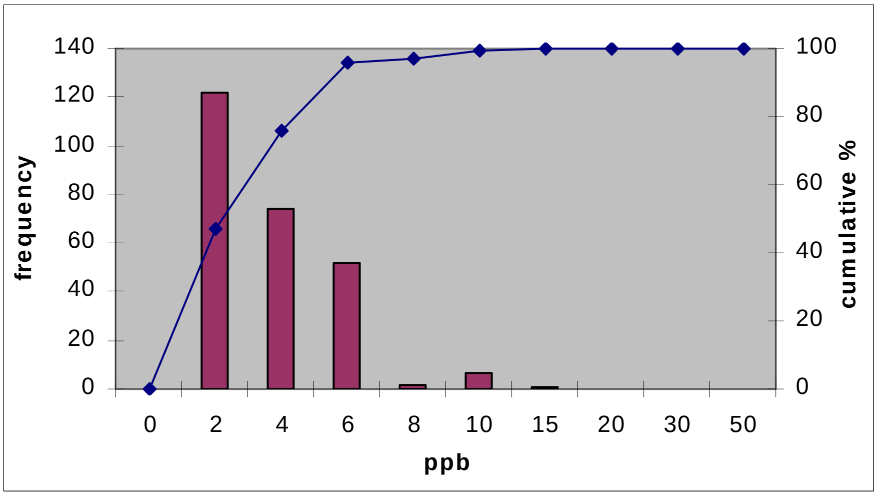
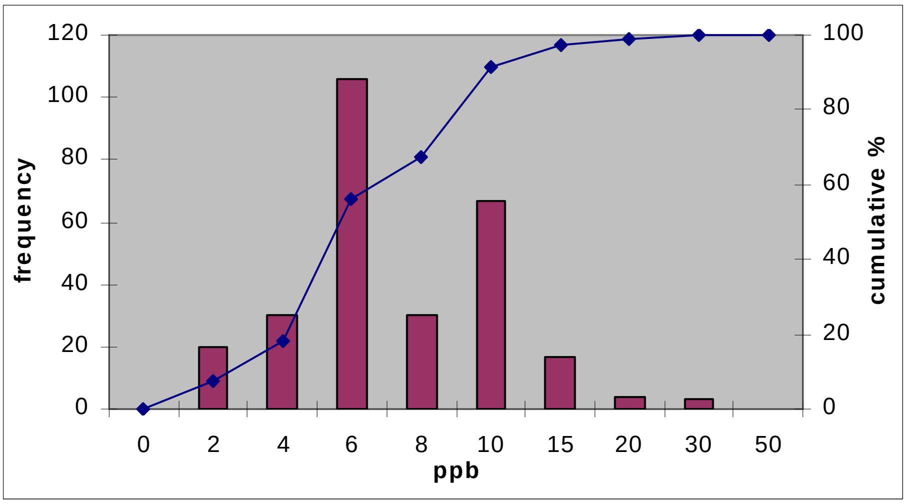


Figure 5 (e): Frequency distribution of daily mean data at Hillside for the period January to December 2001 (n = 277)



Percentiles of daily averages

Percentiles show the spread of the data by giving an indication of the concentration below which the specified percentage of the data occurs. 95^{th} Percentiles of the daily mean data from all the monitoring stations are shown in Table 4. The 95^{th} percentile was highest at Hillside, i.e. 95% of SO_2 daily averages at Hillside were less than 17.2 ppb, conversely, 5% of daily averages were above 17.2 ppb.

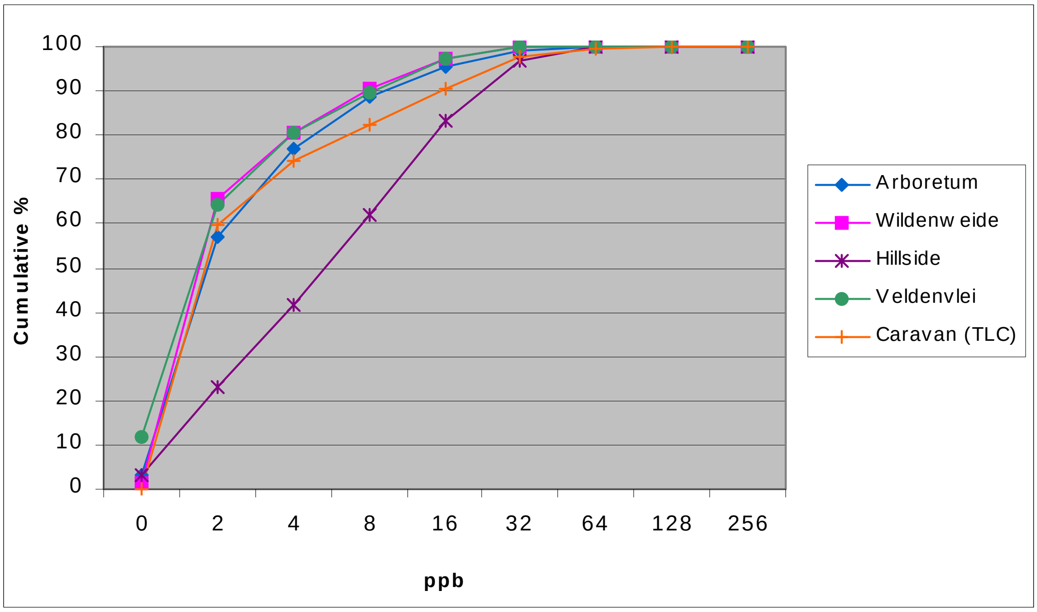
Table 4: Percentiles for the daily mean SO_2 at each station

Percentile	SO_2 (ppb)				
	Arboretum	Wildenweide	Hillside	Veldenvlei	Caravan
95^{th}	10.2	7.9	17.2	7.5	15.0

Hourly averages

The cumulative percentage of hourly mean data at all stations is provided in Figure 6. The curve at the Caravan was gentler than that for Arboretum, Wildenweide and Veldenvlei, indicating a tendency for a higher proportion of hourly averages at higher concentration ranges, e.g. 4 to 32 ppb classes. The slope at Hillside was considerably different to the other four stations, again indicating a tendency for higher hourly average SO_2.

Figure 6: Cumulative percent of Hourly Mean data for the period January to December 2001



Note: Hillside, Arboretum and Veldenvlei curves are based on less than 80% data capture for the year

Percentiles

Percentiles of the hourly mean data from all the monitoring stations are shown in Table 5.

Table 5: Percentiles for the hourly mean SO_2 at each station

Percentile	SO_2 (ppb)				
	Arboretum	Wildenweide	Hillside	Veldenvlei	Caravan
95^{th}	15.5	12.1	27.4	12.5	23.3
75^{th}	3.6	3.0	12.2	2.9	4.3
50^{th}	1.7	1.2	5.5	1.3	1.5

Note: statistics for Hillside, Arboretum and Veldenvlei are based on annual data capture rates of less than 80%.

The British Department of Environment's classification scheme suggests that, for SO_2, a 95th hourly average percentile less than 60 ppb is classified as *Very Good*, between 60 and 124 ppb is classified as *Good*, between 125 and 399 ppb is classified as *Poor* and greater than or equal to 400 ppb is classified as *Very Poor*. According to this scheme, the air quality, in terms of SO_2, at all the stations may be regarded as *Very Good*. The air quality was poorest at the Hillside station, where the percentiles were consistently the highest of all stations. Hourly average SO_2 reached above 125 ppb on two occasions at Hillside.

3 Maximum SO_2 Concentrations

The maximum SO_2 concentrations (in ppb) measured during 2001 are shown in Table 6. The maximum is reflected as a percentage of the WHO/revised DEAT guidelines. Note that there is no revised hourly average SO_2 guideline. More detailed descriptions of the maxima are available in the weekly and monthly reports. Maximum hourly and daily average O_3 measured at Veldenvlei is also provided.

Over the short-term, maximum 10-minute average SO_2 at the TLC building, Arboretum and Wildenweide was all recorded on the morning of 14 August. Winds were light, predominantly from the WSW. Peak analysis, using the Hawk dispersion model and based on average emission rates, indicated the most likely source at the Caravan was Bayside Aluminium and IOF, however, considering the predominant WSW direction, the possibility of contributions from Hillside Aluminium cannot be excluded. Mondi was on shutdown during this period. The maximum 10-minuite average occurred at Hillside on 2 March, associated with moderate winds, varying from 99 to 128^o (Table 2). The maximum hourly average at Hillside was associated with the same incident, which was also examined in detail using the Hawk. The model indicated that IOF (Foskor) was the most likely source. A sulphur fire had occurred at the plant, contributing to the elevated concentrations.

The maximum hourly average at the Caravan on 7 September was associated with moderate WSW winds, which suggested Mondi and/or Hillside Aluminium as the most likely source/s. The maximum hourly average at Arboretum on 27 November was also associated with moderate WSW winds and the Hawk predicted sources were mainly Hillside Aluminium and IOF (Foskor).

Table 6: Highest SO_2 and O_3 concentrations (ppb) measured at each station during 2001 and percent of WHO/revised National guideline

STATION	DAILY AVERAGE		HOURLY AVERAGE		10-MIN AVERAGE	
	SO_2 (ppb)	Date	SO_2 (ppb)	Date & time	SO_2 (ppb)	Date & time
Arboretum	15	19/07	72	27/11 04h00	89	14/08 09:55
% of guideline	31%		n/a		47%	
Wildenweide	13	24/07	56	14/08 10h00	92	14/08 10:35
% of guideline	26%		n/a		48%	
Veldenvlei	18	26/01	45	15/08 04h00	62	13/03 16:30
% of guideline	38%		n/a		33%	
Caravan (TLC)	27	20/06	91	15/08 04h00	161	14/08 09:35
% of guideline	56%		n/a		84%	
Hillside	29	29/05	171	02/03 15h00	486	02/03 15h10
% of guideline	60%		n/a		254%	
Veldenvlei O_3	44	29/08	73	05/10 14h00		
% of guideline	n/a		61%			

4 Complaints

A total of 54 complaints were lodged with the RBCAA during the year 2001. The monthly breakdown is shown in Table 7 and an area breakdown is shown in Table 8. Details are provided in each monthly report.

Table 7: Number of complaints logged with the RBCAA during the year.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
11	4	3	3	3	8	2	0	2	14	1	3

Table 8: Most common locality of complaints.

Location	Compaints Total for 2001
Veldenvlei	13
Meerensee	11
CBD	7
Arboretum	3
Arboretum xtn	3
Enseleni	3
Birdswood	3
Hillside	3
Other	8

Most of the complaints were from the residential areas of Veldenvlei and Meerensee, followed by the Central Business District (CBD). Most complaints were logged during October, with nine complaints relating to the same incident on 22 October, which related to a strong chemical smell in the Meerensee and Birdswood areas during moderate west to WSW winds. The incident was investigated and, while the Hawk indicated Hillside Aluminium, IOF (Foskor) and Mondi as possible sources, the smell may have originated from an effluent spillage or increased emissions from Mondi as a result of a power failure. The numerous complaints during January varied in nature, date and locality and are detailed in the January monthly report.

5 Atmospheric Data

5.1 Weather Summary

Figure 7 gives the daily average lapse rate measured at the Bayside Aluminium tower. The lapse rate is the difference between the measured temperatures at 2 m and 70m. If the lapse rate is negative, it indicates warm air above cool air, and hence stable atmospheric conditions. If the lapse rate is positive this indicates warm air below cool air, and neutral to unstable atmospheric conditions. Figure 8 indicates the average diurnal trend in lapse rate for the year. Unfortunately electronic instrument failure towards the latter part of the year means that the trend is incomplete. Nonetheless, it can be seen that the lapse rate during the summer was positive, thus atmospheric conditions are more turbulent and dispersion of pollution is generally favourable. The lapse rate progressively tended to become more negative with the approach of autumn and winter, which indicates a stable atmosphere. It is during this time that dispersion is worst. The daily average lapse rate was predominantly negative from 17 April to 15 July, after which data capture was incomplete. Stable overall conditions were experienced on 7 May, 17 June and 15 July. The period for which the lapse rate data is valid from 9 October to 16 November showed a return to positive and more unstable conditions during spring.

Figure 7: Daily Average Lapse Rate at the Bayside Tower (T2m – T70m)

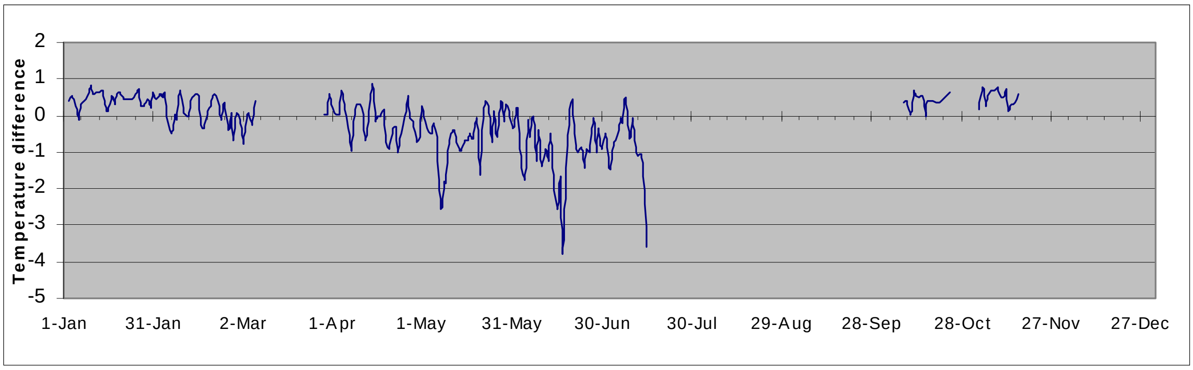
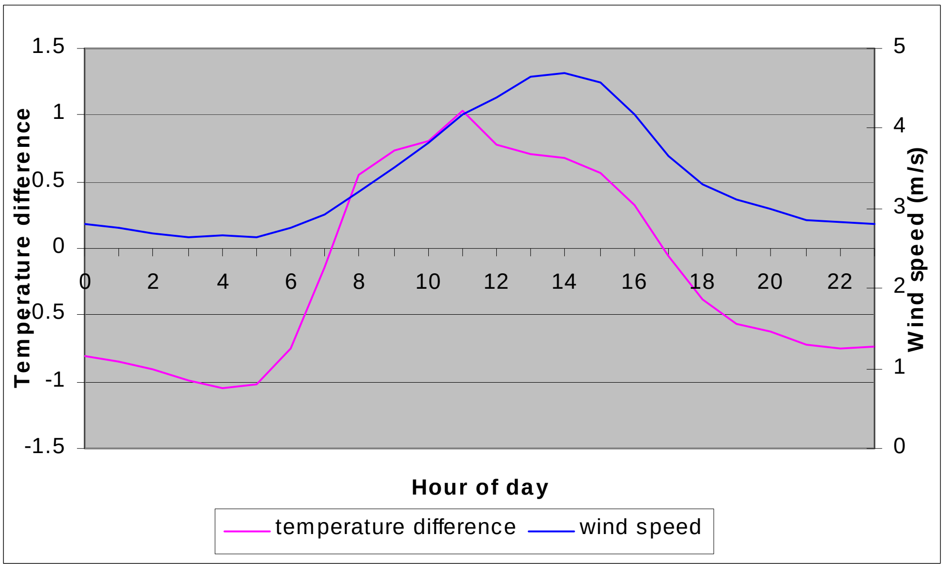


Figure 8: Average Diurnal Lapse Rate at the Bayside Tower (T2m – T70m) and wind speed at the Arboretum tower (18 m)



The diurnal lapse rate was very similar to that of 2000, even though temperature data capture at the Bayside tower for the year was only 54%. The lapse rate is generally negative overnight, indicating stable conditions. After the onset of diurnal heating during the day, the lapse rate becomes positive, which leads to unstable conditions. The diurnal trend of SO_2 is influenced by the temperature lapse rate, in that stable conditions will provide less chance of dispersion. The effect is a general increase in the SO_2 concentrations at night and early morning and a decrease in the SO_2 concentrations during the day when dispersion is enhanced (refer Fig 6). Diurnal wind speeds (Fig. 8) follow a similar trend, with wind speeds generally increasing during the day after sunrise and peaking during the afternoon, after which they decrease again towards nightfall.

The annual wind frequency given in Figure 9 plots the frequency of speed and direction from which the winds blow. The highest frequency of winds were of the moderate speed category (1.5 to 5.0 m/s) from the north to NNE and, to a lesser extent, from the south-west. Higher speed winds (> 5 m/s) were predominantly from the SSW to south-west, associated with the passage of coastal low pressure systems or cold fronts. Low speed winds (< 1.5 m/s) blew mainly from the WNW to north-east, although the NNW to north sector predominated. Winds from this sector were more frequent at nighttime and early morning during the colder months, in the form of a land breeze. Seabreezes or onshore flow from the NNE to north-east generally starts after the effect of daytime heating has been felt and the overnight surface inversion is raised or eliminated.

Figure 9: Wind Rose for 2001 at the Aboretum tower (18 m)

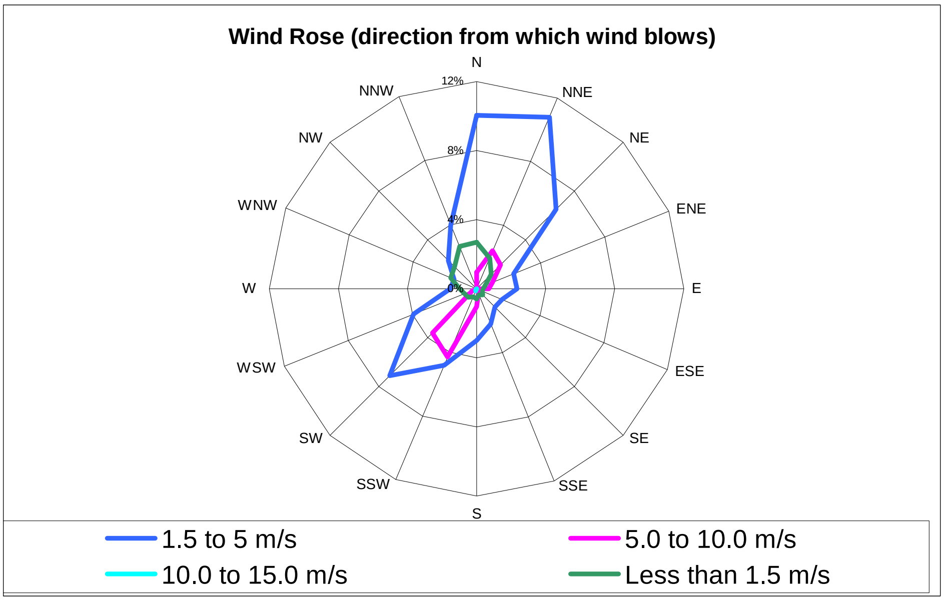
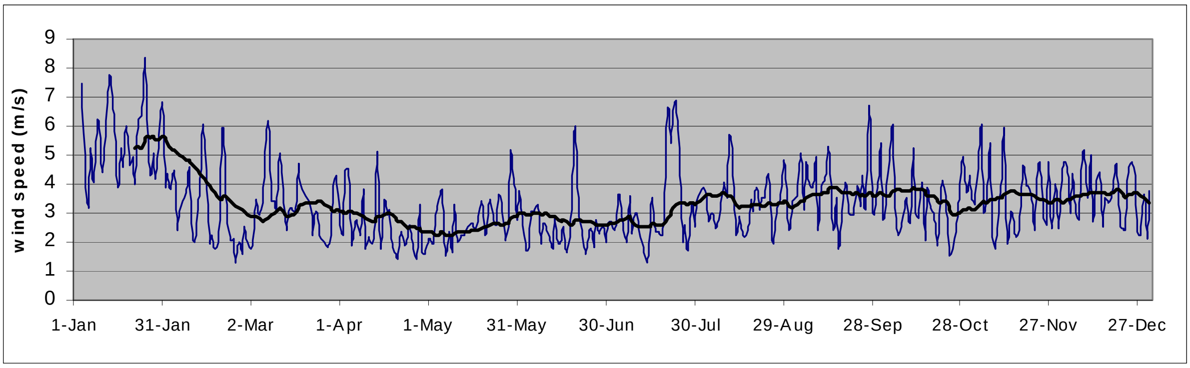


Figure 10 shows the daily average wind speed and the moving average at Richards Bay. The data is mainly from the Arboretum tower (18 m), although data for January 2001 was taken from the Bayside tower (21 m), as data capture at Arboretum was below quality assurance (48%) as a result of power supply problems (see Appendix 1). The Bayside tower is slightly higher and located in a more exposed area than Arboretum. As a result the winds for January tend to be higher than the other months when winds from Arboretum were used. The wind speeds were noted to gradually decrease as conditions become more stable towards autumn. Winter wind speeds were generally light, apart from a few peaks related to fresh to strong south-westerly to SSW winds, associated with the passage of cold fronts. Wind speeds generally increased towards spring (August to November) as a result of an increased frequency of NNE winds, but also south-westerly winds associated with the passage of coastal lows and cold fronts.

Figure 10: Average Daily Wind Speeds



6 Quality Assurance Report

6.1 Calibration of Equipment

The ambient air monitoring stations are SANAS accredited laboratories. The meteorological equipment was calibrated semi-annually by Inteltronics, and ESKOM TSI performed quarterly calibrations of the continuous air pollution monitors. Precision checks were performed before and after the calibrations to determine the error of each analyser before the calibration. Results of the pre-calibration checks are given in Appendix 2. Analyser span and zero checks are alternated with precision checks, using an external calibrator, on a weekly basis.

6.2 Quality Assurance system and ISO Guide 25 Accreditation

A quality assurance document, detailing procedures and quality control limits for the Richards Bay Clean Air Association was drawn up and implemented in 1997 and 1998. This document formed the basis of the application to the South African National Accreditation System (SANAS) for ISO Guide 25 accreditation. Each monitoring station is regarded as a separate laboratory for accreditation purposes. The quality control checks made to the data are presented in Appendix 3. The monitoring system was accredited by SANAS during March 1999. Accreditation is now reviewed annually. The system was re-assessed during September 2001. Three major non-conformances and several minor non-conformances were found and rectified and accreditation was approved. Among the major non-conformances was the siting of the mobile Caravan adjacent to the TLC building. It was recommended that the caravan be moved away from the building to a distance of twice the building height to avoid the effect of the building. The Caravan was moved some 80 m in a north-west direction from the original location on 7 November 2001. It is doubtful that the move will have any significant affect on measured SO_2 concentrations as the building was north-east of the caravan, while most major sources are to the SSW to WSW of the station. There are no significant industrial sources north-east of the Caravan.

6.3 Data Capture rates of SO_2 Monitoring Stations

The system reliability (Table 9) provides the percentage of time that the stations, as a whole, were operational. Overall system reliability was 90.9%, marginally above the data capture goal of 90%. The Caravan, Wildenweide and Arboretum stations performed the best. The Veldenvlei station performance was lower as a result of vandalism to the station at the end of March, while Hillside's overall performance was marginally below quality assurance as a result of power failures associated with site maintenance.

SO_2 data capture for the monitoring sites is presented in Table 10 for the period January to December 2001. The overall SO_2 data capture for the year was 79.3%, which was marginally below quality assurance requirements (80%) and below the data capture goal of 90%. Reasons for periods of lower data capture are presented in *Appendix 1: Missing Data*. The most common cause of data loss was related to power failures and analyser performance thereafter. Only two stations easily exceeded quality assurance requirements during 2001, viz. the Caravan and Wildenweide. SO_2 data capture at Hillside was relatively close to quality assurance, but was adversely affected by power failures associated with site maintenance. The analyser, nonetheless, performed to specification. Arboretum SO_2 data capture was below quality assurance mainly as a result of the analyser drifting negative subsequent to a power failure during March. Data capture was lowest at Veldenvlei due to vandalism of the station and a manifold pump failure.

Table 9: System reliability at the RBCAA Monitoring Stations during 2001

Hillside	Arboretum	Wildenweide	Veldenvlei	Caravan (TLC)	Average
78.6	95.2	96.5	86.3	98.0	90.9

Table 10: SO_2 Data Capture at the RBCAA Monitoring Stations during 2001

Month	Hillside	Arboretum	Wildenweide	Veldenvlei	Caravan (TLC)	Average
Jan	94.7	47.6	0	91.7	91.2	65.0
Feb	93.4	98.4	98.4	69.8	98.5	91.7
Mar	77.1	47.9	74.1	79.3	75.6	70.8
Apr	99.7	18.8	98.6	0	99.6	63.3
May	99.5	0	99.6	0	99.2	59.7
Jun	72.1	45.1	96.6	0	92.6	61.3
Jul	0	98.8	99.7	88	99.6	77.2
Aug	0	99.6	99.5	99.3	99.5	79.6
Sep	77.1	98.9	96.8	98.9	99.2	94.2
Oct	88.2	99.8	99.9	99.9	99.8	97.5
Nov	88.2	99.8	99.9	87.1	99.8	95.0
Dec	99.2	98.1	92.5	91.6	99	96.1
% of year	74.1	71.1	88.0	67.1	96.1	79.3

7. Network Report

7.1 Network Description

The RBCAA monitoring network consists of five SO_2 monitoring stations at Hillside, Wildenweide, Arboretum, Veldenvlei and a mobile Caravan situated near the TLC building in the CBD. In addition, meteorological data is measured at a 70 m tower at Bayside Aluminium, at Richards Bay Minerals (RBM2) and at the airport (RBM1). Data is transmitted as 5-minute averages by radio telemetry to the base station at the RBCAA offices in the TLC building. Pollen monitoring, which was conducted at Veldenvlei, was expanded during the year. Analysis of these results falls under the auspices of Wits University.

Outstations

Power failures were the most common cause of downtime at stations during the course of 2001. The Veldenvlei station was vandalised on 29 March and, after repairs and maintenance, was restored on 9 May. The SO_2 analyser subsequently drifted out of specification (see Appendix 2) and the manifold pump required replacing, therefore SO_2 data from the station was only valid again from 4 July. The analysers at both Arboretum and Wildenweide drifted out of specification following power failures and were removed for servicing (see Appendix 2). Following recommendations by SANAS, the Caravan was moved some 80 m in a north-west direction from the original location on 7 November 2001. Minor adjustments to the SO_2 data were necessary for Wildenweide, Veldenvlei and Hillside for various periods during 2001, mainly to compensate for slight positive or negative analyser drift or channel offsets. These adjustments were documented in the monthly reports and are summarised in Appendix 4.

The ozone analyser was located at Veldenvlei during 2001. The analyser started reading low during December and was unstable during instrument checks, therefore caution should be exercised in data interpretation in the latter part of the year. The accuracy will be assessed during the March 2002 calibrations. The PM_{10} analyser has not been repaired until such time as a formal policy on particulate monitoring had been finalised by the RBCAA. Meteorological data from the Bayside tower was invalidated for much of the second half of the year owing to an electronic fault in the instrumentation.

Master Station

The master station at the Richards Bay TLC office building functioned well during 2001.

Base Station

Base station power failures occurred during March, which resulted in some loss of data as the data could not be recovered manually from the dataloggers owing to the laptop computer being sent in for repairs at the same time.

8. Summary

- The air quality at the monitored sites in the Richards Bay region in terms of SO_2 for the year of 2001 is classified as "very good" (in terms of the British Department of Environment guidelines for air quality.).

- Annual average SO_2 for 2001 was in the same range as previous years, for those stations which are comparable, with no significant variation.

- Air quality was poorest at the Hillside station in terms of SO_2, which is not surprising considering the closer proximity of the station to industrial sources.

- One exceedance of the National instantaneous DEAT guideline of 600 ppb and four exceedances of the WHO 10-minute average guideline of 191 ppb were recorded during 2001 at Hillside.

- A total of 54 complaints were logged with the RBCAA during the year, mostly from the residential areas of Veldenvlei and Meerensee and the CBD area.

- SO_2 data availability was 5% lower than the previous year and marginally below quality assurance (80%). Overall system reliability was, however, above quality assurance. The main reason for overall data loss was power failures.

9. Objectives for 2002

- Improve SO_2 data reliability to greater than 90% for the year.
- Maintenance of the SANAS ISO Guide 25 accreditation.
- Policy regarding expansion of the systems.
- Move of the Veldenvlei station to a more secure site.
- Finalise web site.

10. Achievement of 2001 Objectives

2001 Objectives	Objective Status
♦ Strive to achieve data capture to greater than 90% for the year.	♦ While overall data capture did achieve this figure (90.9%), the capture of SO_2 data was marginally below quality assurance (80%). The main reason was analyser failure, particularly subsequent to power failures.
♦ Change the averaging period of SO_2 measurements from 5 minutes to 10 minutes to allow for comparison with WHO guidelines	♦ Database sequel queries were compiled to facilitate the analysis of 10-minute averages. While the weekly report trends continued to reflect 5-minute averaging times, reporting in the monthly report was changed to consider 10-minute averages.
♦ Maintenance of SANAS accreditation.	♦ SANAS re- accreditation audits in September 2001.
♦ Improvement of the complaints procedure	♦ The complaints procedure was considerably improved and, in most cases, case studies were performed within 24 hours of the complaint being logged.
♦ Hawk model validation completion	♦ Hawk model validation expected by 26 March 2002.

APPENDIX 1 : MISSING DATA

FROM		TO		
DATE	**HR**	**DATE**	**HR**	**REASON/COMMENTS**
All stations				
04-Mar	08h00	05-Mar	12h00	Base station power failure
06-Mar	21h00	08-Mar	21h00	Base station power failure
Arboretum				
01-Jan	00h00	17-Jan	00h00	Power supply problems
19-Mar	05h00	16-Jun	01h00	Power failure after which analyser drifted negative and removed for service
Wildenweide				
01-Jan	00h00	1-Feb	00h00	Analyser out of specification subsequent to power failure
06-Mar	21h00	12-Mar	12h00	Base station power failure
19-Dec	17h00	20-Dec	18h00	Power failure
Hillside				
14-Jan	20h58	16-Jan	10h00	Power failure
15-Feb	00h15	16-Feb	10h50	Power failure
06-Mar	21h00	12-Mar	12h00	Base station power failure
22-Jun	15h00	30-Aug		Power failures associated with site maintenance
22-Oct	03h00	25-Oct	13h00	Power failure
21-Nov	01h00	22-Nov	12h00	Power failure
Veldenvlei				
19-Feb	08h20	27-Feb	10h45	Air conditioner malfunction, hut temperature > EPA requirements
29-Mar	01h00	04-Jul	16h00	Station vandalised, manifold pump required replacement
26-Nov	13h00	30-Nov	09h00	Moisture entered sample line

APPENDIX 2 : ANALYSER CALIBRATION RESULTS FOR 2001

Station	March '01	June '01	September '01	December '01
Arboretum sn 93b	n/a	13.2% low	1.2% low	1.2% high
Caravan sn 281	2.5% low	6.2% high	5.7% low	5.5% high
Hillside sn 85b	1.6% high	2.8%	7.9% low	3.2% low
Wildenweide sn 141	5.3% high	24.7% low	3.2% low	9.9% low
Veldenvlei sn 291	14.4% high	59% low	24% low	6.0% low
Veldenvlei O_3	13.0% high	1.6% high	4.0% low	6.0% low

APPENDIX 3 : QUALITY CONTROL CHECKS MADE TO RBCAA DATA

Tolerance Check	<10ppb from zero	>10ppb from zero	Actions		
			>±5%	>±10%	>±15%
Zero (with reference calibrator)	adjust if >5ppb	multipoint calibration	-	-	-
Level I Span	-	-	adjust	multipoint calibration	multipoint calibration and invalidate data
Multipoint Calibration	-	adjust zero	adjust	adjust	adjust and invalidate
Audit Span	-	-	-	multipoint	multipoint calibration and invalidate data
Precision check					Level I span. If analyser is still out of specification replace or perform a multipoint calibration. Data is to be invalidated going back to last valid precision check.
Accuracy check					Replace and repair analyser. Data is to be invalidated going back to last valid calibration.
Tolerance Check	**Data quality objective**		**Actions if data quality objective is not achieved**		
Completeness	> 80 %		Invalidate time averaged data for which completeness is not 80 %. i.e. hourly averages are to be invalidated if less than 48 minutes of data is received and daily averages are to be invalidated if less than 19.2 hours of data is available.		

APPENDIX 4 : SO_2 DATA ADJUSTMENTS

FROM	**TO**		
DATE	DATE	Adjustment	REASON/COMMENTS
Veldenvlei SO2			
24-Jan	31-Jan	- 1 ppb	+ve drift of analyser
01-Feb	07-Feb	- 1.5 ppb	+ve drift of analyser
08-Feb	13-Feb	- 2 ppb	+ve drift of analyser
14-Feb	19-Feb	- 3 ppb	+ve drift of analyser
05-Jul	13-Sep	+ 2.25 ppb	-ve drift of analyser
14-Sep	27-Sep	+ 2.25 ppb + 25%	-ve drift of analyser and analyser drift 25% low
02-Nov	14-Nov	+ 1 ppb	-ve drift of analyser
14-Nov	19-Nov	+ 1 ppb + 26%	-ve drift of analyser and analyser drift 26% low
19-Nov	30-Nov	+ 1.5 ppb + 26%	-ve drift of analyser and analyser drift 26% low
01-Dec	04-Dec	+ 1.75 ppb + 36%	-ve drift of analyser and analyser drift 26% low
Arboretum			
17-Jan	22-Jan	+ 6 ppb	-ve drift of analyser
23-Jan	27-Jan	+ 5 ppb	-ve drift of analyser
28-Jan	13-Feb	+ 4 pbb	-ve drift of analyser
14-Feb	19-Mar	+ 3.5 ppb	-ve drift of analyser
Wildenweide			
01-Feb	01-Feb	+ 5.25 ppb	-ve drift of analyser
02-Feb	06-Feb	+ 5 ppb	-ve drift of analyser
07-Feb	13-Feb	+ 4 ppb	-ve drift of analyser
14-Feb	15-Feb	+ 3.5 ppb	-ve drift of analyser
16-Feb	31-Mar	+ 3 ppb	-ve drift of analyser
01-Apr	15-May	+ 2 ppb	-ve drift of analyser
16-May	31-May	+ 1.5 ppb	-ve drift of analyser
01-Jun	19-Dec	+ 1 ppb	-ve drift of analyser
22-Dec	22-Dec	+ 2.5 ppb	-ve drift of analyser
23-Dec	31-Dec	+ 1.6 ppb	-ve drift of analyser
Hillside			
01-Sep	02-Sep	+ 9.5 ppb	-ve drift of analyser
03-Sep	04-Sep	+ 5 ppb	-ve drift of analyser
05-Sep	05-Sep	+ 4.5 ppb	-ve drift of analyser
06-Sep	06-Sep	+ 3.7 ppb	-ve drift of analyser
17-Sep	21-Sep	+ 5.6 ppb	-ve drift of analyser
22-Sep	22-Sep	+ 4.6 ppb	-ve drift of analyser
23-Sep	23-Sep	+ 3.5 ppb	-ve drift of analyser
24-Sep	31-Dec	+ 3 ppb	-ve database response