RESEARCH, TESTING AND DEVELOPMENT

SUSTAINABILITY

KWAZAMOKUHLE AIR QUALITY REPORT

JULY 2016

EXECUTIVE SUMMARY

This monthly report covers the ambient air quality data for July 2016 as monitored at KwaZamokuhle monitoring site.

There were twenty-six exceedances of the national ambient air quality for PM_{10} daily limit of 75µg/m³ and twenty-six of the $PM_{2.5}$ daily limit of 40µg/m³ recorded. There were nine exceedances of the national ambient air quality limits for SO_2 10 minutes. There were six exceedances of national ambient air quality for SO_2 hourly and six exceedances of the national ambient air quality limits for SO_2 daily. There were eighty-one exceedances for Ozone 8-hourly average. There were no exceedances of national ambient air quality for NO_2 hourly recorded during the monitoring period under review**.**

Both SO_2 and NO_2 ambient concentrations at KwaZamokuhle monitoring site are influenced by the combination of low-level sources and tall stack emitters. Ambient fine particulate matter concentrations indicate the influence of low-level source emissions at KwaZamokuhle, probably domestic burning.

There is non-compliance with the daily PM_{10}, $PM_{2.5}$ and SO_2 ambient standards in KwaZamokuhle. This is a clear indication of a need for air quality improvement interventions that are focused on reducing particulate matter levels in the area.

The dominant winds during the day were from east-north-east, south-west, south-south-east and north-west sectors. The dominant winds during the night were from south-south-east, south, east-north-east and east sectors.

The overall percentage data recovered from the monitoring station during the reporting period was 85.8 % and station availability was 96.8%. The majority of the parameters monitored at site meet the SANAS requirement of 90% data recovery per parameter with the exception of the NOx, SO_2 and O_3. The NO_X analyser was removed for repairs, SO_2 analyser and O_3 analyser were affected by the power outage at the site.

1. INTRODUCTION

The KwaZamokuhle monitoring station is equipped to continuously monitor ambient concentrations of sulphur dioxide (SO_2), nitrogen oxides (NO, NO_2 and NO_x), ozone (O_3), fine particulate matter (FPM) of particulate size <10µm in diameter (PM_{10}) and fine particulate matter (FPM) of particulate size <2.5µm in diameter ($PM_{2.5}$). In addition, meteorological parameters of wind speed (WSP), wind direction (WDR), solar radiation (RAD), relative humidity (HUM), rainfall (RFL), pressure (PRS) and ambient temperature (TMP) are also recorded.

The monitoring site was established as part of a greater air quality offset pilot study. The objective of the pilot study is to test the effectiveness of the most promising household emission offset interventions identified during Eskom's pre-feasibility study. This includes identifying the possible improvement in ambient air quality resulting from emission reductions at a household level. Data measured at KwaZamokuhle will represent baseline and post intervention implementation ambient air quality**.**

2. SITE LOCATION

The KwaZamokuhle monitoring site is located in Hendrina about 22.5 km south-south-west of Arnot power station, 27.3 km east-south-east of Komati power station and 18.3 km south-east of Hendrina power station. (Co-ordinates: -26.138252, 29.738953)

Figure 1: KwaZamokuhle air quality monitoring station in relation to Komati, Hendrina and Arnot Power Stations

3. DATA RECOVERY

Data was analysed for completeness against a required SANAS guideline of 90% per parameter monitored and is represented in Table 1 for the KwaZamokuhle monitoring site.

Table1. Percentage data recovered per parameter for July 2016

NO	NO_2	NO_x	O_3	PRS	RAD	RFL	SO_2	TMP	WDR	WSP	WVL	$PM_{2.5}$	PM_{10}	HUM	Data Recovery	Station Availability
34	34	34	89.4	99.9	98.5	99.9	81.7	99.9	99.39	99.9	99.9	96.6	95.2	99.9	85.8	96.8

The overall percentage data recovered from the monitoring station during the reporting period was 85.8 % and station availability was 96.8%. The majority of the parameters monitored at site meet the SANAS requirement of 90% data recovery per parameter with the exception of the NOx, SO_2 and O_3. NO_X analyser was removed for repairs, SO_2 analyser and O_3 analyser were affected by the power outage at the site.

4. SUMMARY OF RESULTS FOR REPORTED PERIOD

The National Department of Environmental Affairs (DEA) has set the South African Ambient Air Quality Standards for the criteria pollutants as illustrated in Table 2.

Table 2: South African National Ambient Air Quality Standards

Pollutant	Averaging Period	Concentration	Allowed Frequency of Exceedances
NO_2	1 hour 1 year	106 ppb 21 ppb	88 0
SO_2	10 minute average 1 hour 24 hours 1 year	191 ppb 134 ppb 48 ppb 19 ppb	526 88 4 0
O_3	8 hours (running ave)	61 ppb	11
PM_{10}	24 hours	75 µg/m^3	4
	1 year	40 µg/m^3	0
$PM_{2.5}$	24 hours	40 µg/m^3 (1)25 µg/m^3	0 0
	1 year	20 µg/m^3 (1)15 µg/m^3	0 0

(1)Compliance required by 1 January 2030

Table 3 is a summary report presenting highest mean concentrations and the number of exceedances of the respective National Ambient Air Quality Standards as monitored at KwaZamokuhle during the June 2016 monitoring period.

Table 3: Summary report

Pollutant	Highest Hourly Mean	No of Hourly National Limit Exceedances	Highest Daily Mean	No of Daily National Limit Exceedances	No of 8hr Moving Average Limit	Highest 10min Mean	No of 10min National Limit Exceedances
$PM_{2.5}$ (µg/m^3)	488.9		115.2	26		520.8	
PM_{10} (µg/m^3)	481.7		204	26		544.8	
NO (ppb)	50.6		17.7			107.5	
NO_2 (ppb)	51.8	0	22.2			62.1	
NOx (ppb)	99.3		34.5			145.6	
OZN (ppb)	103.1		68.6		81	113.9	
SO_2 (ppb)	189.5	6	93.1	6		219.2	9
TMP (°C)	22.5		11.1			22.6	
WSP (m/s)	9.7		7.2			10.5	
WVL (m/s)	9.5		7.1			10.3	

There were twenty-six exceedances of the national ambient air quality for PM_{10} daily limit of 75µg/m³ and twenty-six of the $PM_{2.5}$ daily limit of 40µg/m³ recorded. There were nine exceedances of the national ambient air quality limits for SO_2 10 minutes. There were six exceedances of national ambient air quality for SO_2 hourly and six exceedances of the national ambient air quality limits for SO_2 daily. There were eighty-one exceedances for Ozone 8-hourly average. There were no exceedances of national ambient air quality for NO_2 hourly recorded during the monitoring period under review**.**

Table 4: Exceedances for the National Ambient Air Quality Standards.

	SO_2 hourly averages exceedances						
Limit	**Day**	**Month**	**Year**	**Time**	**Conc**	**Wind Dir**	**Wind v**
134	01	July	2016	18:00	160.57	W	1.37
134	03	July	2016	18:00	172.39	NW	1.33
134	03	July	2016	19:00	171.22	NNE	0.46
134	15	July	2016	19:00	163.32	NW	0.96
134	20	July	2016	19:00	189.50	SW	1.11
134	20	July	2016	20:00	152.39	SSW	0.54
SO_2 10-minutes averages exceedances							
Limit	**Day**	**Month**	**Year**	**Time**	**Conc**	**Wind Dir**	**Wind v**
191	03	July	2016	18:00	205.96	N/A	N/A
191	03	July	2016	18:20	198.16	N/A	N/A
191	03	July	2016	18:30	198.36	N/A	N/A
191	03	July	2016	18:10	199.36	N/A	N/A
191	20	July	2016	18:40	191.67	N/A	N/A
191	20	July	2016	18:30	206.57	N/A	N/A
191	20	July	2016	18:50	194.77	N/A	N/A
191	19	July	2016	12:20	219.17	N/A	N/A
191	23	July	2016	18:20	194.3	N/A	N/A
SO_2 daily averages exceedances							
Limit	**Day**	**Month**	**Year**	**Conc**	**Time**	**Wind Dir**	**Wind v**
48	01	July	2016	70.7	N/A	N/A	N/A
48	02	July	2016	68.7	N/A	N/A	N/A
48	03	July	2016	93.1	N/A	N/A	N/A
48	04	July	2016	81.6	N/A	N/A	N/A
48	15	July	2016	51.4	N/A	N/A	N/A
48	20	July	2016	50.1	N/A	N/A	N/A
$PM_{2.5}$ daily exceedances							
Limit	**Day**	**Month**	**Year**	**Conc**	**Time**	**Wind Dir**	**Wind v**

40	01	July	2016	105.2	N/A	N/A	N/A
40	02	July	2016	53.2	N/A	N/A	N/A
40	04	July	2016	67	N/A	N/A	N/A
40	05	July	2016	109.6	N/A	N/A	N/A
40	06	July	2016	88.6	N/A	N/A	N/A
40	07	July	2016	41.8	N/A	N/A	N/A
40	08	July	2016	55.7	N/A	N/A	N/A
40	09	July	2016	44.2	N/A	N/A	N/A
40	10	July	2016	48.8	N/A	N/A	N/A
40	11	July	2016	50.4	N/A	N/A	N/A
40	12	July	2016	57.9	N/A	N/A	N/A
40	13	July	2016	65.4	N/A	N/A	N/A
40	15	July	2016	109.6	N/A	N/A	N/A
40	16	July	2016	72.3	N/A	N/A	N/A
40	17	July	2016	46	N/A	N/A	N/A
40	18	July	2016	56.7	N/A	N/A	N/A
40	19	July	2016	115.2	N/A	N/A	N/A
40	20	July	2016	86.6	N/A	N/A	N/A
40	21	July	2016	61.3	N/A	N/A	N/A
40	22	July	2016	63.9	N/A	N/A	N/A
40	23	July	2016	104	N/A	N/A	N/A
40	26	July	2016	47.9	N/A	N/A	N/A
40	27	July	2016	48.2	N/A	N/A	N/A
40	28	July	2016	57.1	N/A	N/A	N/A
40	29	July	2016	53	N/A	N/A	N/A
40	30	July	2016	67.8	N/A	N/A	N/A

PM_{10} daily exceedances

Limit	Day	Month	Year	Conc	Time	Wind Dir	Wind v
75	01	July	2016	79.8	N/A	N/A	N/A
75	02	July	2016	93.6	N/A	N/A	N/A
75	04	July	2016	121.9	N/A	N/A	N/A
75	05	July	2016	117.3	N/A	N/A	N/A
75	06	July	2016	78.2	N/A	N/A	N/A
75	08	July	2016	91.5	N/A	N/A	N/A
75	09	July	2016	102.9	N/A	N/A	N/A
75	10	July	2016	104	N/A	N/A	N/A
75	10	July	2016	141.8	N/A	N/A	N/A
75	12	July	2016	172.6	N/A	N/A	N/A
75	13	July	2016	122.4	N/A	N/A	N/A
75	14	July	2016	83.7	N/A	N/A	N/A
75	15	July	2016	106.1	N/A	N/A	N/A
75	16	July	2016	94.7	N/A	N/A	N/A
75	17	July	2016	97.6	N/A	N/A	N/A
75	18	July	2016	89.5	N/A	N/A	N/A
75	19	July	2016	136.3	N/A	N/A	N/A
75	20	July	2016	85.7	N/A	N/A	N/A
75	21	July	2016	77.9	N/A	N/A	N/A
75	22	July	2016	95.5	N/A	N/A	N/A
75	23	July	2016	83.8	N/A	N/A	N/A
75	24	July	2016	186.2	N/A	N/A	N/A
75	25	July	2016	95.5	N/A	N/A	N/A
75	27	July	2016	112.8	N/A	N/A	N/A
75	28	July	2016	162.7	N/A	N/A	N/A
75	29	July	2016	90.1	N/A	N/A	N/A
75	30	July	2016	90.1	N/A	N/A	N/A

5. METEOROLOGICAL OBSERVATIONS

The distribution of wind direction and wind speed for daytime and night-time hours for the reporting period are summarised on polar diagrams in Figure 2. The centre of the wind rose depicts the position of the air quality-monitoring site. The positions of the spokes in the polar diagram represent directions from which the wind was blowing. The length of the segment indicates the percentage of the time the wind blew from that direction and the speed in the various categories are denoted by colours and width.

The dominant winds during the day were from east-north-east, south-west, south-south-east and north-west sectors. The dominant winds during the night were from south-south-east, south, east-north-east and east sectors.

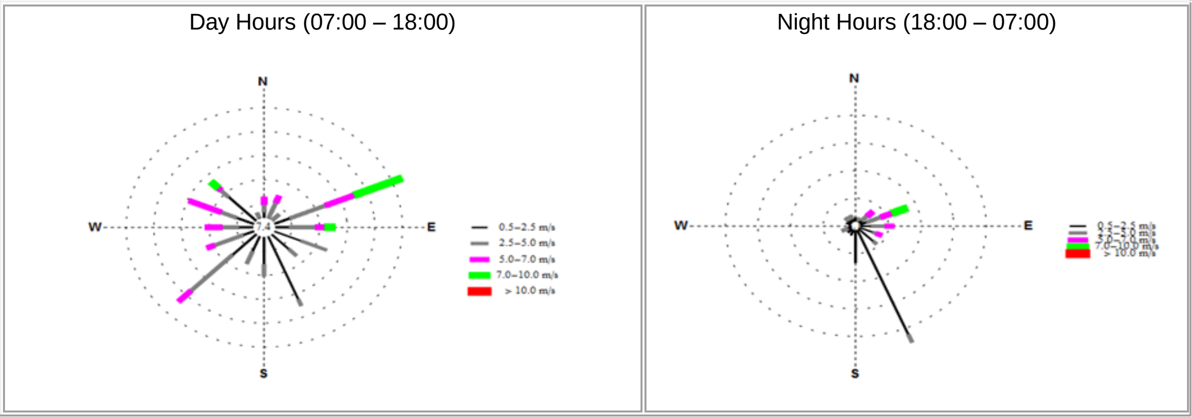


Figure 2: Wind profile at KwaZamokuhle monitoring site

6. DISCUSSION OF POLLUTANTS

Emissions of primary pollutants such as PM_{10}, SO_2, and NO_X from low level sources such as domestic combustion and motor vehicles are expected to impact at ground level more significantly during the evening and early morning hours as a result of temperature inversion. Emissions of such pollutants from tall stacks (power stations and other industries), are expected to have a more significant impact at ground level during the day between 09:00 and 16:00, due to atmospheric turbulence influences.

6.1. SULPHUR DIOXIDE (SO_2).

6.1.1. Source Identification by SO_2 Hourly Diurnal Variations.

Figure 3 illustrates SO_2 concentrations increasing from the morning, the concentrations continue to rise throughout the afternoon until maximum peak is reached at 20h00. The morning and evening peaks are from low-level sources, probably domestic coal burning, and the higher concentrations in the afternoon are indicative of tall stack sources.

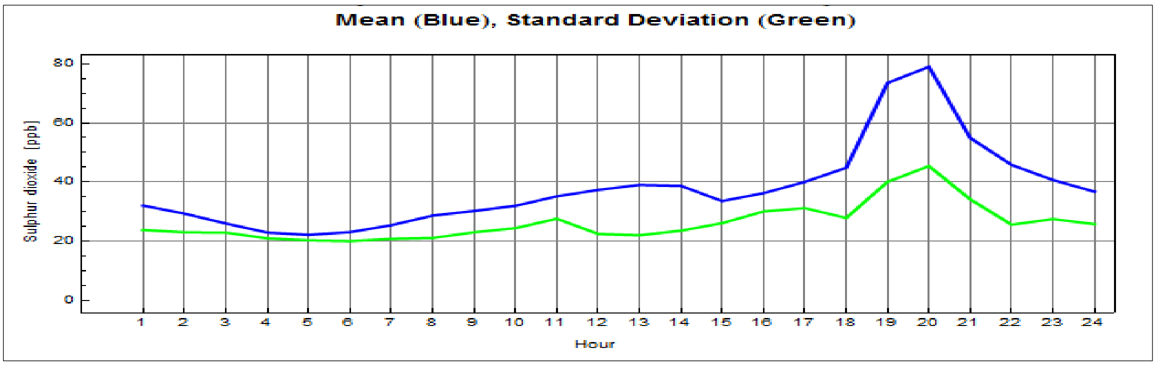


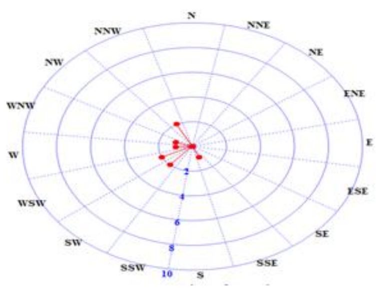
Figure 3: Diurnal variation of SO_2 hourly at KwaZamokuhle for July 2016

6.1.2 Sulphur Dioxide 10-minutes and Hourly Event Roses

There were nine exceedances of the national ambient air quality limits for SO_2 10 minutes. There were six exceedances of national ambient air quality for SO_2 hourly and six exceedances of the national ambient air quality limits for SO_2 daily. Figure 4 show the exceedance roses to indicate the sectors where the highest 10-minutes limit concentrations were coming from during the day and the night.

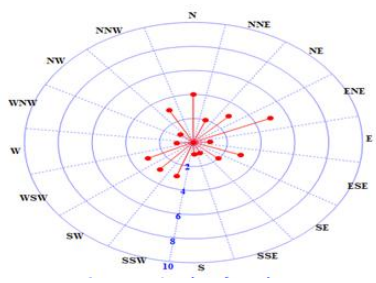
During daytime, there were six exceedances of concentrations for SO_2 10-minutes limit that were recorded one from south-south-east, two from west-south-west, two from west, one from west-north-west and two from north-north-west sectors (Table 5). During the nighttime, the highest mean concentrations of SO_2 10-minutes limit for the 98th percentile (Table 6) were recorded in the in all sectors with the exception of west-north-west sector. Komati Power Station is about 27.3 km west-north-west and Hendrina power station about 18.3 km north-west of the monitoring site and the Kwazamokuhle township is on the surroundings of north to south sector of the monitoring site this could have impacted on the monitoring site. Local SO_2 emissions from domestic coal burning probably make the greatest contribution to SO_2 levels in KwaZamokuhle.

Day hours (07h – 18h)



SO_2 limit = 191 ppb

Night hours (18h – 07h)



SO_2 limit = 191 ppb

Figure 4: SO_2 10-minutes limit for exceedance roses for July 2016

Table 5: SO_2 day-time 10-minutes limit for exceedance table

Dir.	N	NNE	NE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
Exc	0	0	0	0	0	0	1	0	0	0	2	2	1	0	2
%	0	0	0	0	0	0	11.11	0	0	0	22.22	22.22	11.11	0	22.22

Table 6: SO_2 night-time 10-minutes limit for exceedance table

Dir.	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
Eve	4	2	3	5	1	3	2	1	1	3	3	3	1	0	1	3
%	11.11	5.56	8.33	13.89	2.78	8.33	5.56	2.78	2.78	8.33	8.33	8.33	2.78	0	2.78	8.33

There were six exceedances of the national ambient air quality limits for SO_2 hourly. Figure 5 show the exceedance roses to indicate the sectors where the exceedances of hourly limit concentrations were coming from during the day and the night.

During daytime, there were two exceedances of concentrations for SO_2 hourly limit that were recorded, one exceedance from west, and one from north- west sectors (Table 7). During the nighttime, there were four exceedances of mean concentrations SO_2 hourly limit (Table 8) one exceedance was recorded in the north-north-east, one exceedance recorded from south-south-west, one from south-west and one from north-west sectors. Komati Power Station is about 27.3 km west-north-west and Hendrina power station about 18.3 km north-west of the monitoring site and the Kwazamokuhle township is on the surroundings of north to south sector of the monitoring site this could have impacted on the monitoring site. Local SO_2 emissions from domestic coal burning probably make the greatest contribution to SO_2 levels in KwaZamokuhle.

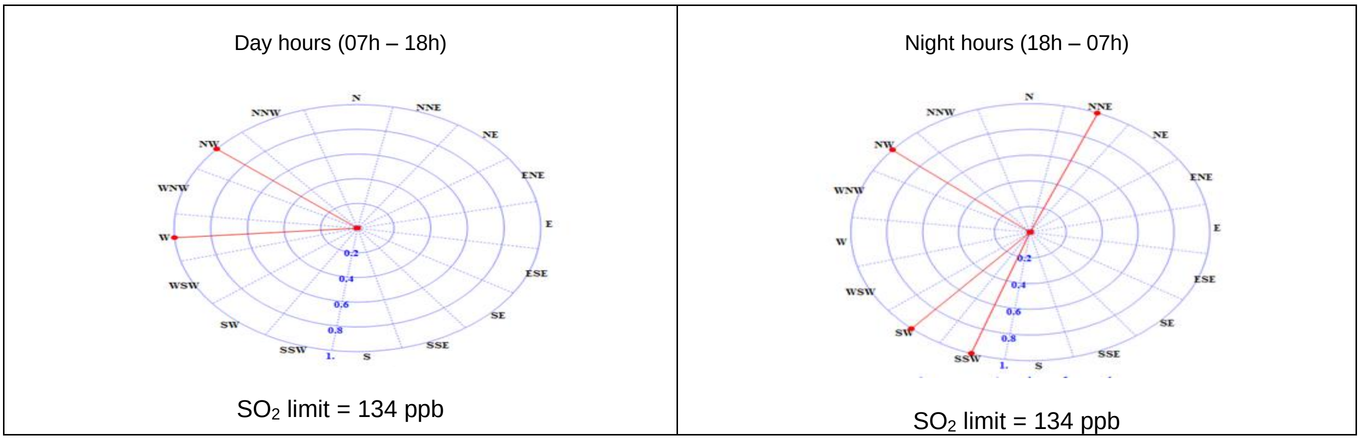


Figure 5: SO_2 hourly limit for exceedance roses for July 2016

Table 7: SO_2 day-time hourly limit for exceedance table

Dir.	N	NNE	NE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
Eve	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
%	0	0	0	0	0	0	0	0	0	0	0	50	0	50	0

Table 8: SO_2 night-time hourly limit for exceedance table

Dir.	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
Eve	0	1	0	0	0	0	0	0	0	1	1	0	0	0	1	0
%	0	25	0	0	0	0	0	0	0	25	25	0	0	0	25	0

6.2. Nitrogen Dioxide (NO_2)

6.2.1. Source identification by NO_2 diurnal variations

The NO_2 diurnal variation shows NO_2 concentrations reaching peaks at 08:00 in the morning, and 20:00 in the evening as indicated by Figure 6 below. The concentration peaks observed in the morning and evenings are associated with influence from low-level sources like domestic burning and vehicles.

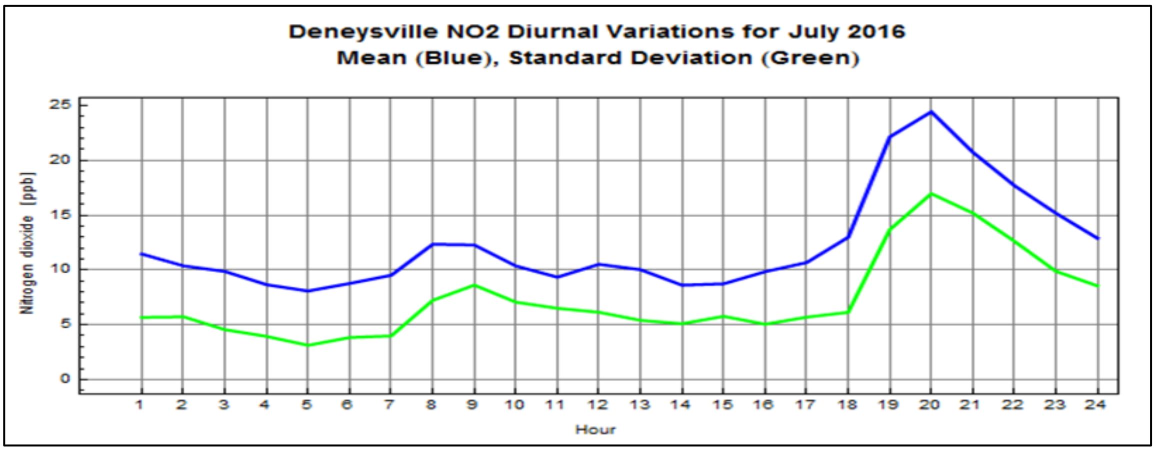


Figure 6: Diurnal variation of NO_2 hourly at KwaZamokuhle for July 2016

6.2.2 Nitrogen dioxide hourly event roses (98th percentile)

There were no exceedances of the NO_2 hourly limit of 106 ppb. Figure 6 shows the 98th percentile event roses indicating the sectors where highest hourly concentrations were coming from during the day and night. During the daytime the highest hourly mean concentrations above 38.49 ppb (Table 9) were recorded in the south-west, west-north-west and north-west sectors. The hourly mean concentrations above 48.78 ppb (Table 10) during the night-time were recorded in the north-west and north-north-west sectors. There is Coalfields located east-south-east of the monitoring site which might have an influence on the monitoring site.

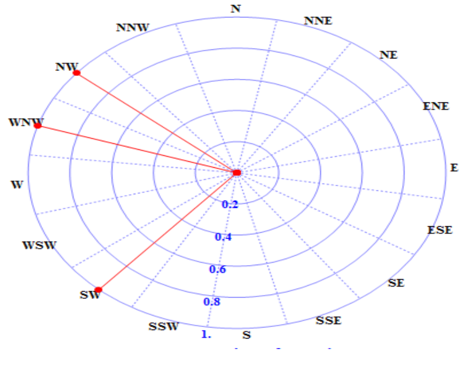
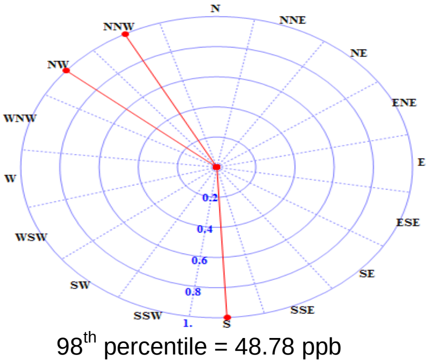
Day hours (07h – 18h)	Night hours (18h – 07h)
	
98th percentile = 38.49 ppb	98th percentile = 48.78 ppb

Figure 7: NO_2 hourly mean 98th percentile event roses during day and night times

Table 9: NO_2 day time hourly mean 98th percentile event table

Dir.	N	NNE	NE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
Eve	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0

%	0	0	0	0	0	0	0	0	0	33.33	0	0	33.33	33.33	0

Table 10: NO_2 night-time hourly mean 98th percentile event table

Dir	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
Eve	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1
%	0	0	0	0	0	0	0	0	33.33	0	0	0	0	0	33.33	33.33

6.3. Fine Particulate Matter (PM_{10} and $PM_{2.5}$).

6.3.1. Source identification by PM_{10} and $PM_{2.5}$ diurnal variations.

The $PM_{2.5}$ and PM_{10} diurnal variations (Figures 8 and 9) display a similar pattern indicative of low-level emission sources. The concentrations increase from 02:00 and peak at 07:00 in the morning. Thereafter they decrease until 12:00 and remain low throughout the afternoon. The concentrations increase again from 17:00, reaching a maximum peak at 20:00 and decrease throughout the evening. These peaks observed in the morning and evenings are typical of emissions from low-level sources, probably domestic combustion in KwaZamokhule.

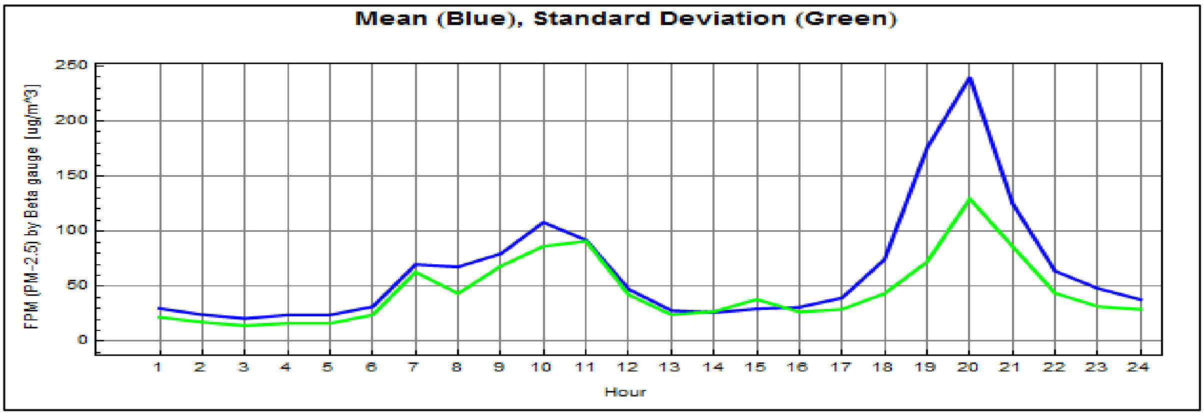


Figure 8: Diurnal variation of $PM_{2.5}$ concentrations at KwaZamokuhle for July 2016

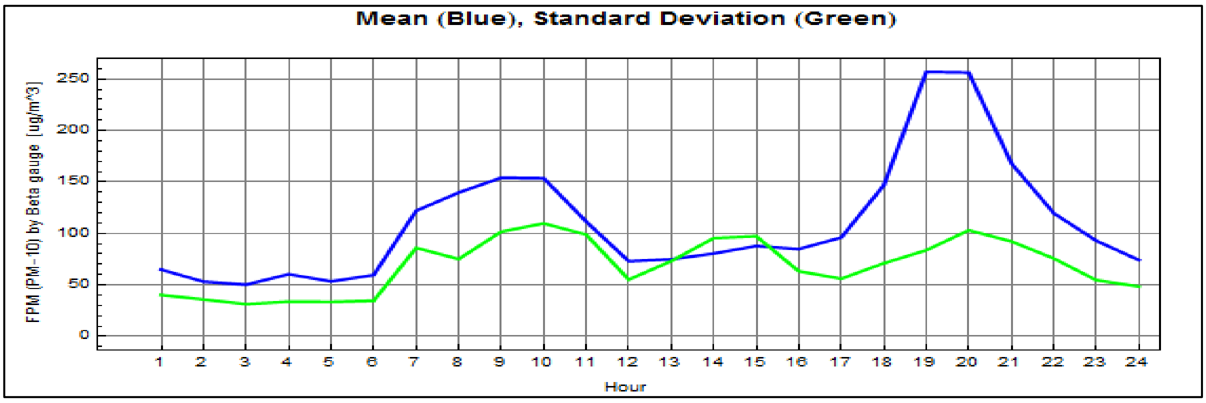


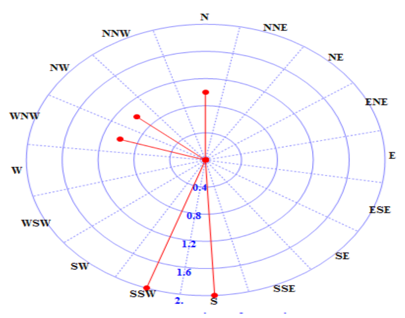
Figure 9: Diurnal variation of PM_{10} concentrations at KwaZamokuhle for July 2016

6.3.2 Particulate fine matter hourly 98th percentile event roses

As there are no national hourly PM standards, the hourly mean 98th percentile daytime and night-time event roses are presented to identify the wind sectors from which the highest hourly concentrations were derived from during the monitoring period.

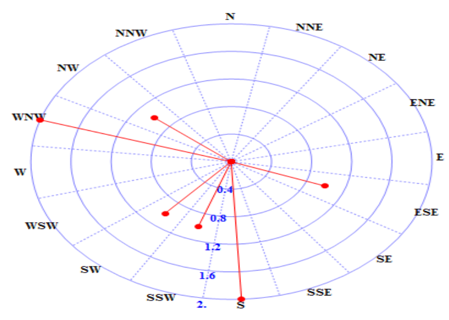
Figure 10 shows the $PM_{2.5}$ hourly mean 98th percentile event roses during day and night times. During the daytime the $PM_{2.5}$ hourly mean sector concentrations above 270.22 µg/m^3 (Table 11) were recorded in the north, south, south-south-west, west-north-west and north-west sectors. The hourly mean sector concentrations above 350.28 µg/m^3 (Table 12) during the night-time were recorded in east-south-east, south-south-west, south-west and north-west sectors.

Day hours (07h – 18h)



98th percentile = 270.22 µg/m^3

Night hours (18h – 07h)



98th percentile = 350.28 µg/m^3

Figure 10: $PM_{2.5}$ hourly mean 98th percentile event roses during day and night times

Table 11: $PM_{2.5}$ daytime hourly mean 98th percentile event table

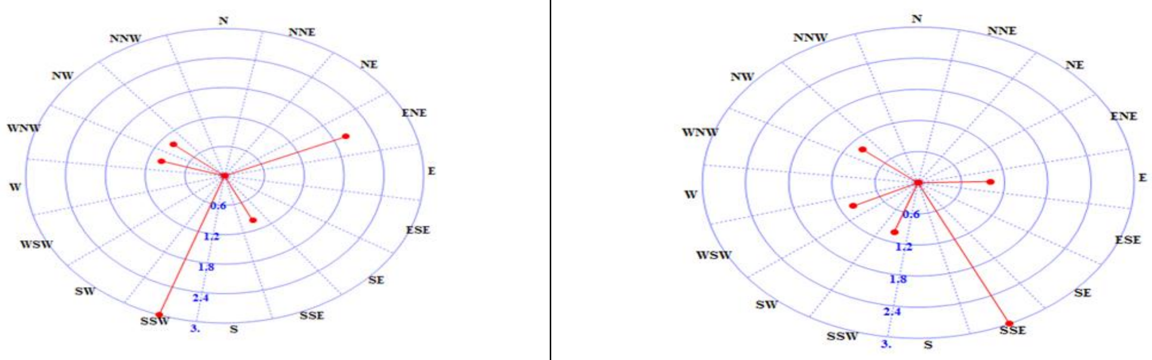
Dir	N	NNE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
Eve	1	0	0	0	0	0	0	2	2	0	0	0	1	1	0
%	14.29	0	0	0	0	0	0	28.57	28.57	0	0	0	14.29	14.29	0

Table 12: $PM_{2.5}$ night time hourly mean 98th percentile event table

Dir	N	NNE	NE	E	ENE	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
Eve	0	0	0	0	0	1	0	0	2	1	1	0	0	2	1	0
%	0	0	0	0	0	12.5	0	0	25	12.5	12.5	0	0	25	12.5	0

Figure 11 shows the PM_{10} hourly mean 98th percentile event roses during day and night times. PM_{10} hourly mean sector concentrations above 398.88 µg/m^3 (Table 13) were recorded in the east-north-east, south-south-east, west-north-west and north-west sectors during the daytime. During the night, the hourly mean concentrations above 361.32 µg/m^3 (Table 14) were recorded in the east, south-south-east, south-south-west, west-south-west and north-west sectors. Domestic burning in KwaZamokuhle is probably the largest source of PM.

Day hours (07h – 18h)	Night hours (19h – 07h)



98th percentile = 398.88 µg/m^3

98th percentile = 361.32 µg/m^3

Figure 11: PM_{10} hourly mean 98th percentile event roses during day and night times

Table 13: PM_{10} daytime hourly mean 98th percentile event table

Dir	N	NNE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
Eve	0	0	2	0	0	0	1	0	0	0	0	0	1	1	0
%	0	0	25	0	0	0	12.5	0	0	0	0	0	12.5	12.5	0

Table 14: PM_{10} night time hourly mean 98th percentile event table

Dir	N	NNE	NE	E	ENE	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
Eve	0	0	0	1	0	0	0	3	0	1	0	1	0	0	1	0
%	0	0	0	14.29	0	0	0	42.86	0	14.29	0	14.29	0	0	14.29	07

6.4. OZONE (O_3)

6.4.1. Source identification by O_3 diurnal variations

The O_3 hourly mean diurnal variations show low concentrations in the morning with an increase from 08:00 in the morning due to the break of the inversion layer when the sun goes up. The concentrations increase throughout the day as a result of photochemical reaction, peaking at 15:00 before decaying rapidly due to the lack of sunlight during the night-time period shown in Figure 12.

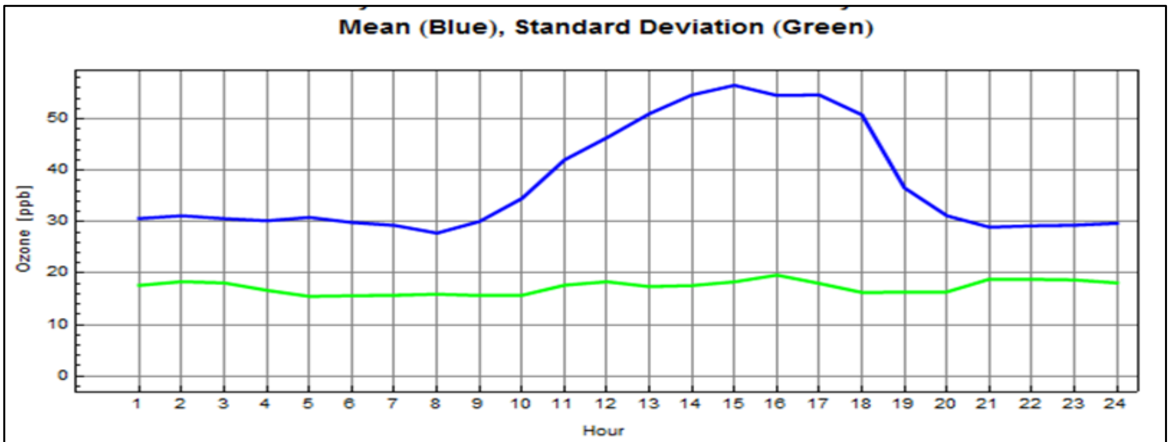


Figure 12: Diurnal variation of Ozone concentrations at KwaZamokuhle for July 2016

7. MONTHLY MEANS FOR THE CURRENT CALENDAR YEAR

7.1. TRENDS OVER THE REPORTING PERIOD (Jan 2015 – July 2016)

Time series graphs for each pollutant with respect to the national ambient limits are represented from the beginning of each month for the reporting period or since inception of the monitors. The resultant period may vary for each analyser, depending on when it was installed.

Figures 13 - 17 show seasonal trends where high concentrations were recorded from May to August 2015 (winter season) and low concentrations are also recorded from January – April 2016 (summer season) and May 2016 the winter season has started and we observe high concentrations for the parameters monitored at the site. Gaps in the data are as a result of the analysers being out of service due to faults experienced, tripping of circuit breakers and incoming power interruptions. There is no distinct trend observed on the O_3 8hourly moving average monthly concentrations during the 2015 and 2016 monitoring period (Figure 18).

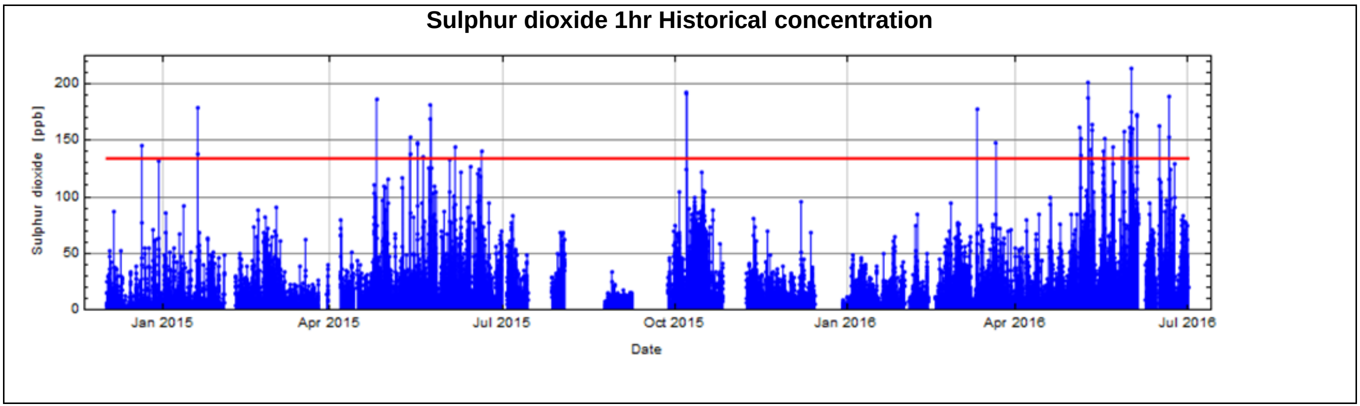


Figure 13: SO_2 1hr mean concentration

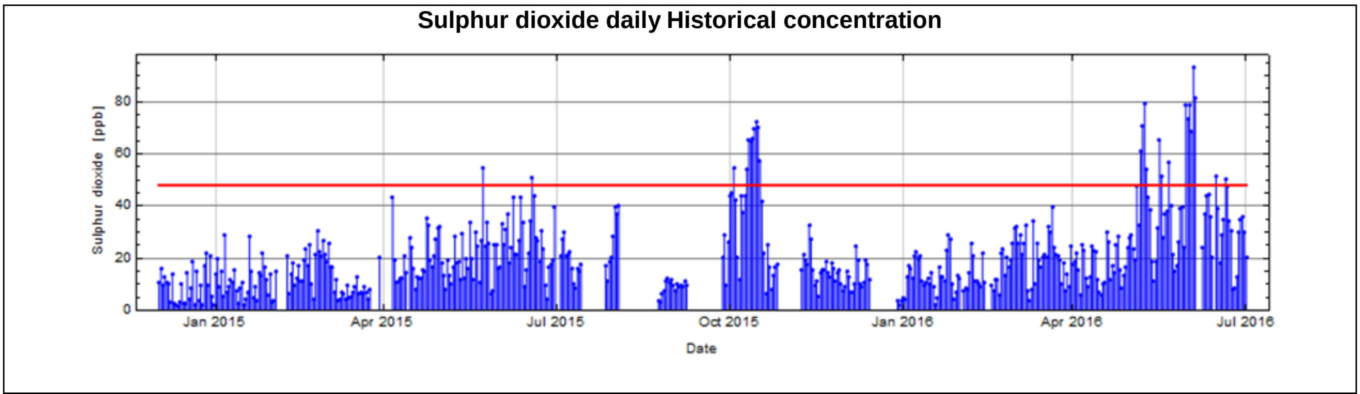


Figure 14: SO_2 daily monthly concentrations

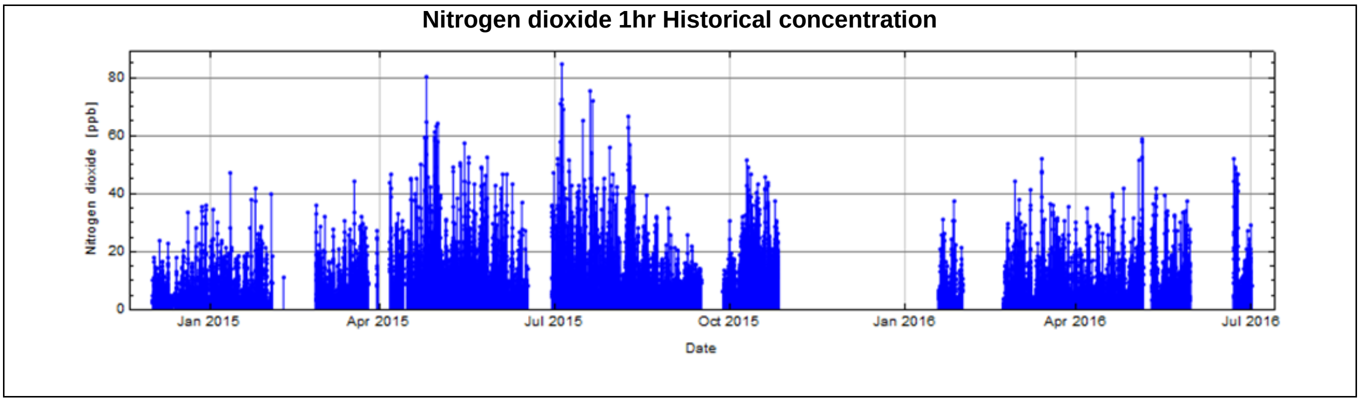


Figure 15: NO_2 1hr monthly concentration

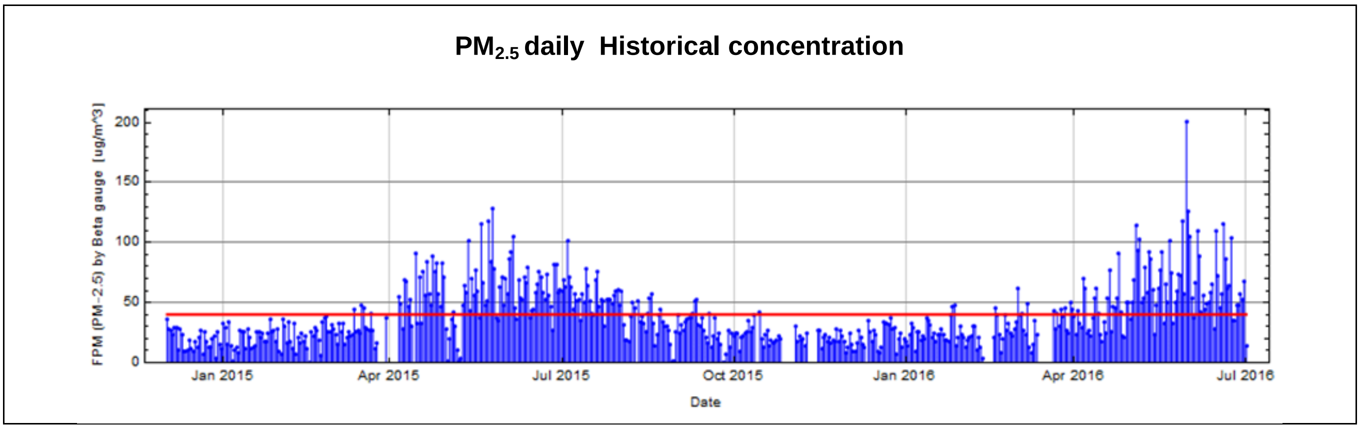


Figure 16: $PM_{2.5}$ daily monthly concentration

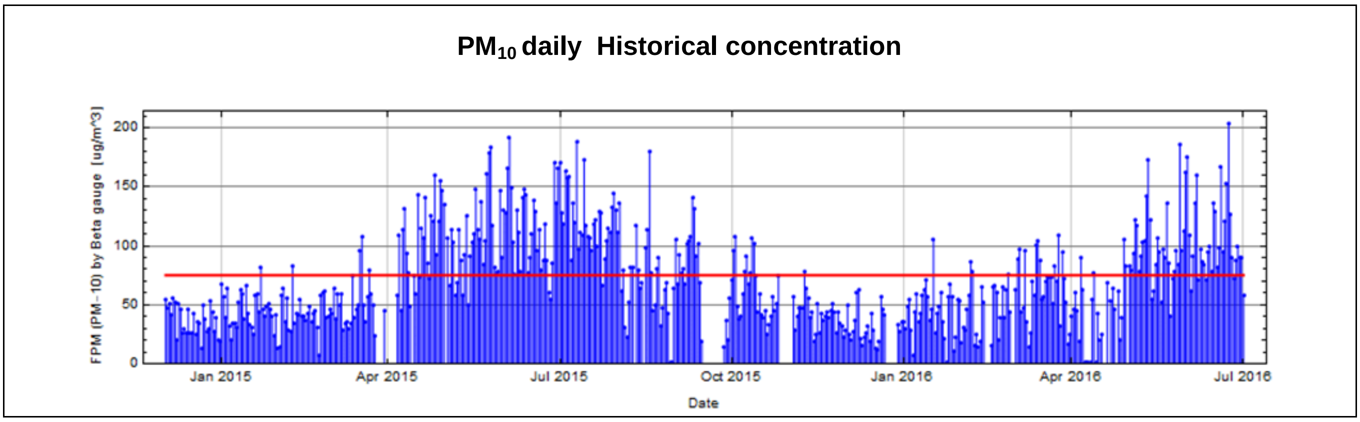


Figure 17: $PM_{2.5}$ daily monthly concentrations

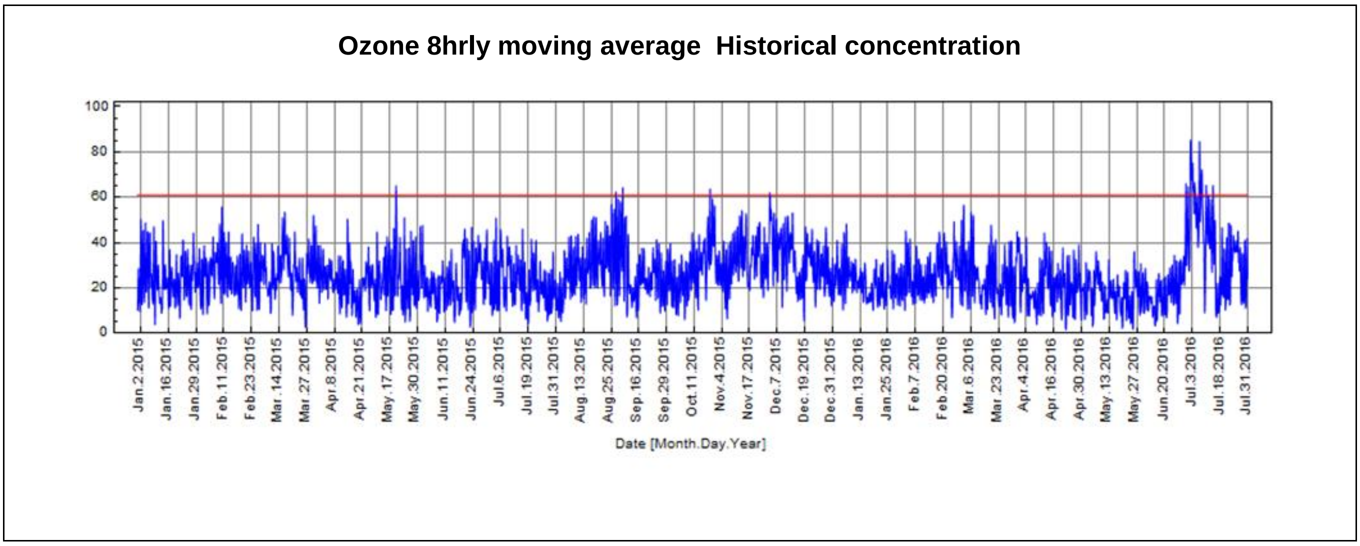


Figure 18: O_3 8hrs moving average

Table 15: Monthly means for the calendar year 2016

Parameter measured	January	February	March	April	May	June	July
$PM_{2.5}$ (µg/m³)	21	25.2	25.5	32.6	41.6	72.4	63.9
PM_{10} (µg/m³)	32.5	44.1	47.9	67	43	99.8	107.5
NO_2 (ppb)	-	8.2	9.7	10.1	8.3	11.2	12.4
O_3 (ppb)	22.4	25.5	23.5	20.3	17.2	18.7	37.5
SO_2 (ppb)	10.9	13.7	16	20.6	17.3	39.7	38

The monthly means show the trends of the pollutant monitored at the site from January to July 2016.

Table 16: Number of exceedances of the National Ambient Air Quality Limits

	SO_2 hourly	SO_2 10-nimutes	SO_2 daily	NO_2 hourly	PM_{10} daily	$PM_{2.5}$ daily	O_3 8-Hourly
Jan 2016	0	0	0	0	0	0	0
Feb 2016	0	0	0	0	1	2	0
March 2016	0	0	0	0	3	2	0
April	2	3	0	0	9	8	0
May	0	0	0	0	5	16	0
June	18	21	9	0	25	27	3
July	6	9	6	0	26	26	81
Total	**24**	**30**	**15**	**0**	**69**	**81**	**84**
Allowed no of exceedances	88	526	4	88	4	4	11

There is non-compliance with SO_2 daily, PM10 daily and PM2.5 daily standards in KwaZamokuhle. This is a clear indication of a need for air quality improvement interventions that are focused on reducing particulate matter levels in the area.

8. CONCLUSION

There were twenty-six exceedances of the national ambient air quality for PM_{10} daily limit of 75µg/m³ and twenty-six of the $PM_{2.5}$ daily limit of 40µg/m³ recorded. There were nine exceedances of the national ambient air quality limits for SO_2 10 minutes. There were six exceedances of national ambient air quality for SO_2 hourly and six exceedances of the national ambient air quality limits for SO_2 daily. There were eighty-one exceedances for Ozone 8-hourly average. There were no exceedances of national ambient air quality for NO_2 hourly recorded during the monitoring period under review.

Both SO_2 and NO_2 ambient concentrations at KwaZamokuhle monitoring site are influenced by the combination of low-level sources and tall stack emitters. Ambient fine particulate matter concentrations indicate the influence of low-level source emissions at KwaZamokuhle, probably domestic burning.

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9. DISTRIBUTION LIST

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ABBREVIATIONS

µg/m³	Microgram per cubic meter
DEA	Department of Environmental Affairs
deg	Degree
deg C	Degree Celsius
E	East
ENE	East-north-east
ESE	East-south-east
FPM	Fine particulate matter
HUM	Humidity
m/s	Meters per second
MWP	Megawatt Park
N	North
NE	North-east
NNE	North-north-east
NNW	North-north-west
NO_1	Nitric oxide
NO_2	Nitrogen dioxide
NO_X	Oxides of nitrogen
NW	North-west
Ozn/O_3	Ozone
PM-$_{10}$	Particulate matter < 10 microns in diameter
PM-$_{2.5}$	Particulate matter < 2.5 microns in diameter
ppb	Parts per billion
ppm	Parts per million
PRS	Pressure
RAD	Solar Radiation
RFL	Rain Fall
RT&D	Research, Testing and Development
S	South
SANAS	South African National Accreditation System
SE	South-east
SGT	Sigma theta
SO_2	Sulphur Dioxide
SSE	South-south-east
SSW	South-south-west
SW	South-west
TMP	Ambient temperature
W	West
WDR	Wind direction from true North
WNW	West-north-west
WSP	Wind speed
WSW	West-south-west
WVL	Wind velocity