Eskom

RESEARCH, TESTING AND DEVELOPMENT

SUSTAINABILITY

KWAZAMOKUHLE AIR QUALITY REPORT

JANUARY 2016

EXECUTIVE SUMMARY

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

There were no exceedances of the national ambient air quality limits for all the parameters monitored during the monitoring period under review**.**

SO_2 ambient air concentrations are impacted by tall stack emitters. Ambient fine particulate matter concentrations indicate the influence of low-level source emissions at KwaZamokuhle.

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

The overall percentage data recovered from the monitoring station during the reporting period was 97.1%. Some of the parameters monitored at site did not meet the SANAS requirement of 90% data recovery per parameter. The site caravan experienced high internal temperatures and this affected both NOx and SO_2 analysers. The NOx analyser was removed from site for repairs due to low flow and pressure alarms, the SO_2 analyser was faulty as the flow alarm was triggered and ahigh number of negative concentrations were recorded, which resulted in spurious data. Additionally the external pump of the PM_{10} analyser ceased, ultimately affecting data recovery.

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 research 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, about 27.3 km east-south-east of Komati power station and about 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 KwaZamokuhle monitoring site.

Table1. Percentage data recovered per parameter for January 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
0	0	0	96.6	99.9	99.5	99.9	48.6	99.9	99.9	99.9	99.9	93.3	75.8	99.9	97.1

The overall percentage data recovered from the monitoring station during the reporting period was 97.1%. Some of the parameters monitored at site did not meet the SANAS requirement of 90% data recovery per parameter. The site caravan experienced high internal temperatures and this affected both NOx and SO_2 analysers. The NOx analyser was removed from site for repairs due to low flow and pressure alarms, the SO_2 analyser was faulty as the flow alarm was triggered and a high number of negative concentrations were recorded, which resulted in spurious data. Additionally the external pump of the PM_{10} analyser ceased, ultimately affecting data recovery

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 January 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)	270.9		37.4	0		327.2	
PM_{10} (µg/m^3)	265.3		62.9	0		468.6	
NO (ppb)							
NO_2 (ppb)							
NOx (ppb)							
OZN (ppb)	63.6		30.3		0	65.2	
SO_2 (ppb)	96.2	0	24.4	0		0	0
TMP (°C)	35.7		26.5			36.1	
WSP (m/s)	8.4		5.8			10.8	
WVL (m/s)	7.8		5.4			10.6	

There were no exceedances of the national ambient air quality limits for all the parameters monitored during the monitoring period under review**.**

5. METEOROLOGICAL OBSERVATIONS

The distributions of wind direction and wind speed for daytime and night-time hours for the reporting period are summarised on polar diagrams. 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, east, west-north-west and north-west. The dominant winds during the night were from north-east, east-north-east, east and east-south-east sectors.

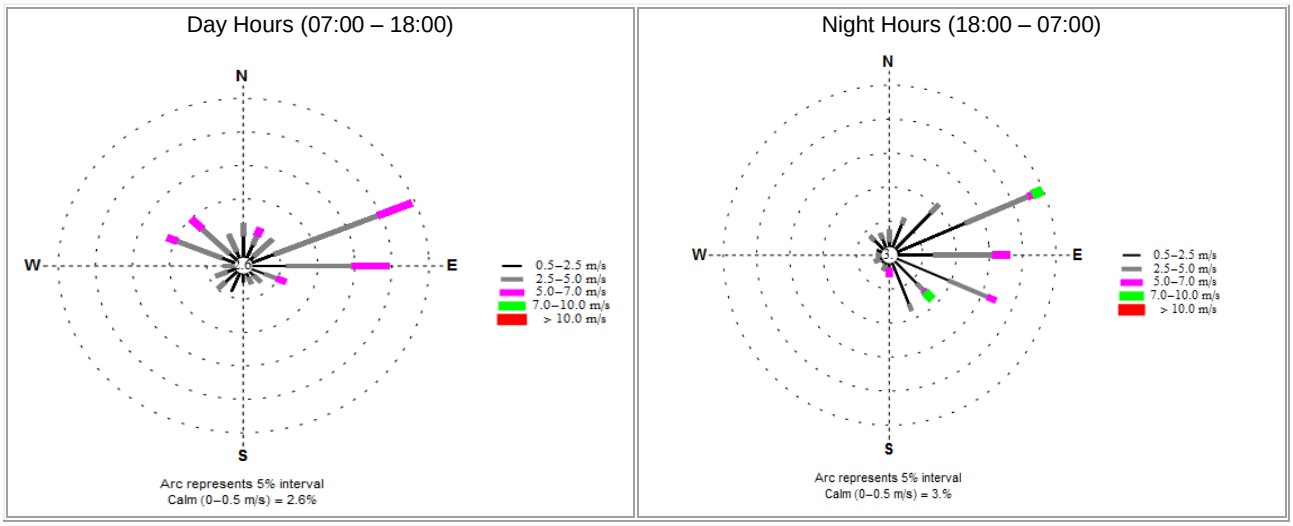

Figure 2: Wind profile at KwaZamokuhle monitoring site

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 andmotor 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 shows SO_2 concentrations increasing from the morning, with peaks observed at 10:00 in the morning and 12:00 in the afternoon. The concentrations dip and then increase steadily throughout the afternoon with a peak at 15:00. Concentrations reach a maximum peak at 17:00. The diurnal variation depicted indicates the influence of tall stack emissions.

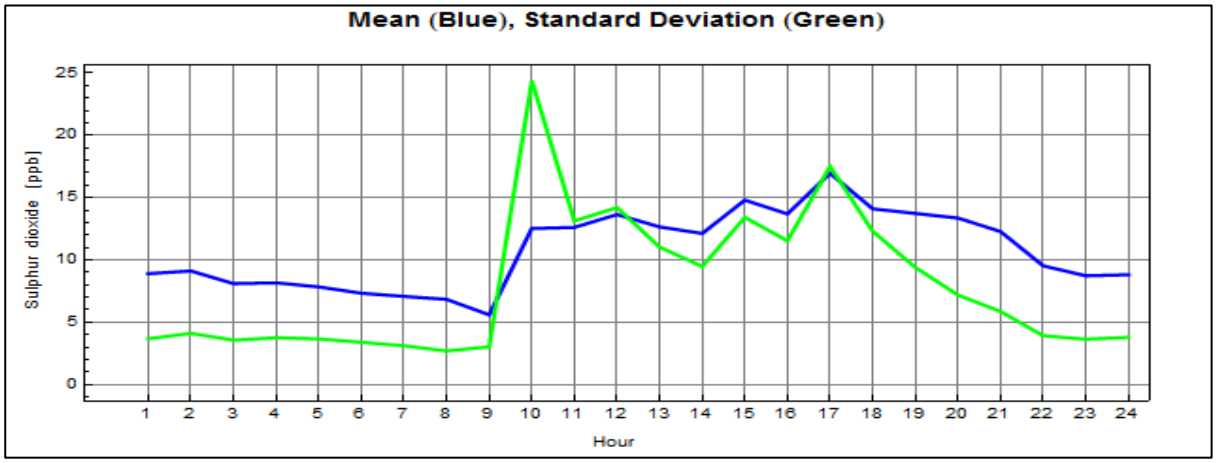

Figure 3: Diurnal variation of SO_2 hourly at KwaZamokuhle for January 2016

6.1.2 Sulphur dioxide hourly event roses

Since there were no exceedances of the SO_2 hourly limit of 134 ppb, 98th percentile event roses were drawn to indicate the sectors where highest hourly concentrations were coming from during the day and night as indicated by Figure 4. During the daytime the hourly mean concentrations above 44.36 ppb (98th percentile value) (Table 4) were recorded in the north-north-east, west-north-west and north-west sectors. Komati power station is about 27.3 km west-north-west of the monitoring site and Hendrina power station about 18.3 km north-west of the monitoring site. The hourly mean concentrations above 22.82 ppb (98th percentile value) (Table 5) during the night-time were recorded in the east-north-east and north-north-west sectors. Care should be taken when reporting using low data recovery (48.6%) since definite conclusions cannot be reached.

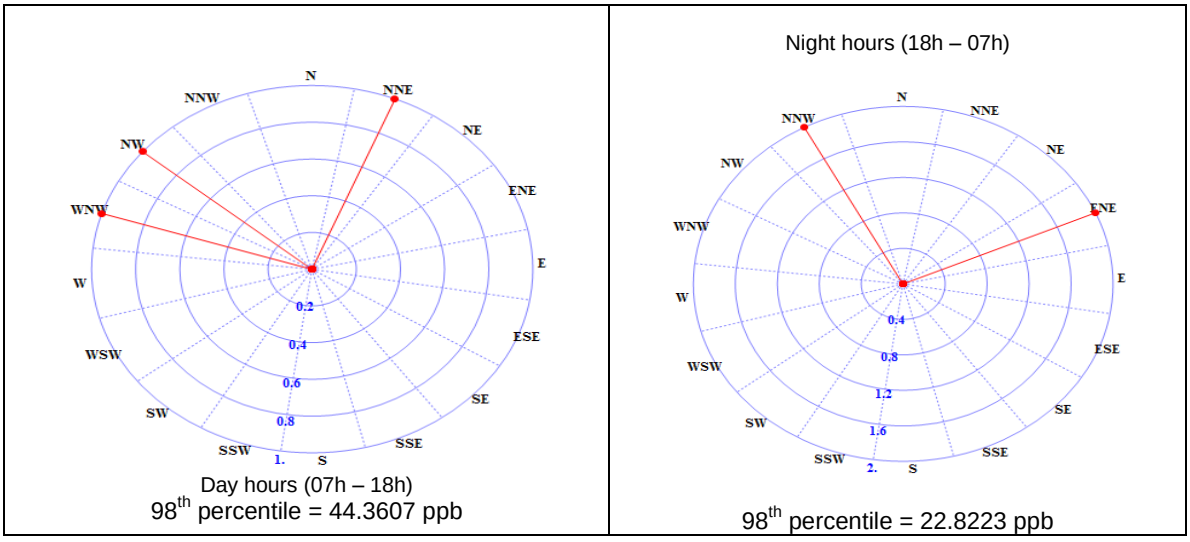

Figure 4: SO_2 hourly mean 98th percentile event roses during day and night times

Table 4: SO_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	1	0	0	0	0	0	0	0	0	0	0	1	1	0
%	0	33.33	0	0	0	0	0	0	0	0	0	0	33.33	33.33	0

Table 5: SO_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	2	0	0	0	0	0	0	0	0	0	0	0	2
%	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	50

6.2. Nitrogen Dioxide (NO_2)

6.2.1. Source identification by NO_2 diurnal variations

The NOx analyser was faulty. As such, no January 2016 NO_2 readings are available.

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 5 and 6) display a similar pattern that is an indicative of low-level emission source influence, with low concentrations in the morning. The concentrations increase from 06:00 and peak at 08:00 in the morning. They then decrease until 09:00 and continue to be low throughout the afternoon. They increase again from 14:00, reaching a maximum peak at 21:00 and decrease throughout the evening. These peaks observed in the morning and evening could be associated with emissions from low-level sources.

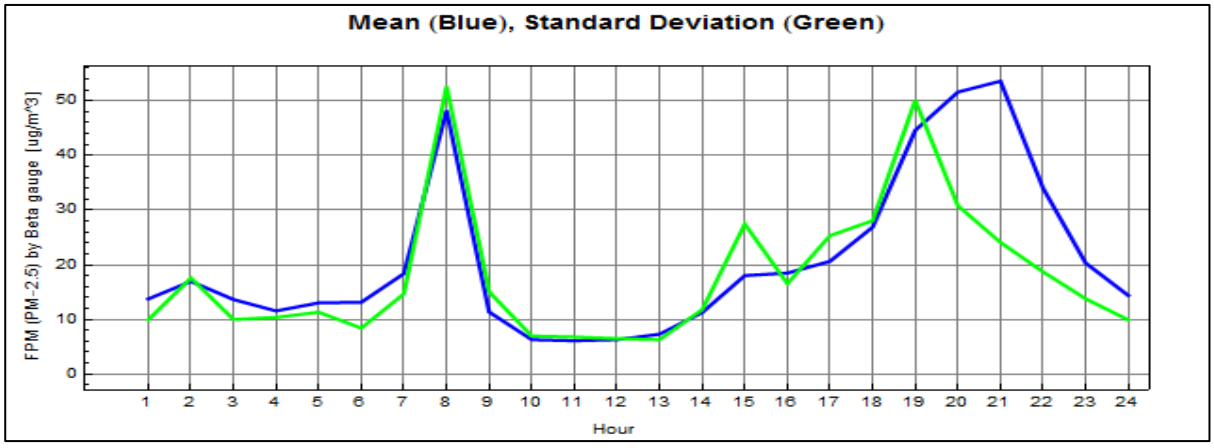

Figure 5: Diurnal variation of $PM_{2.5}$ concentrations at KwaZamokuhle for January 2016

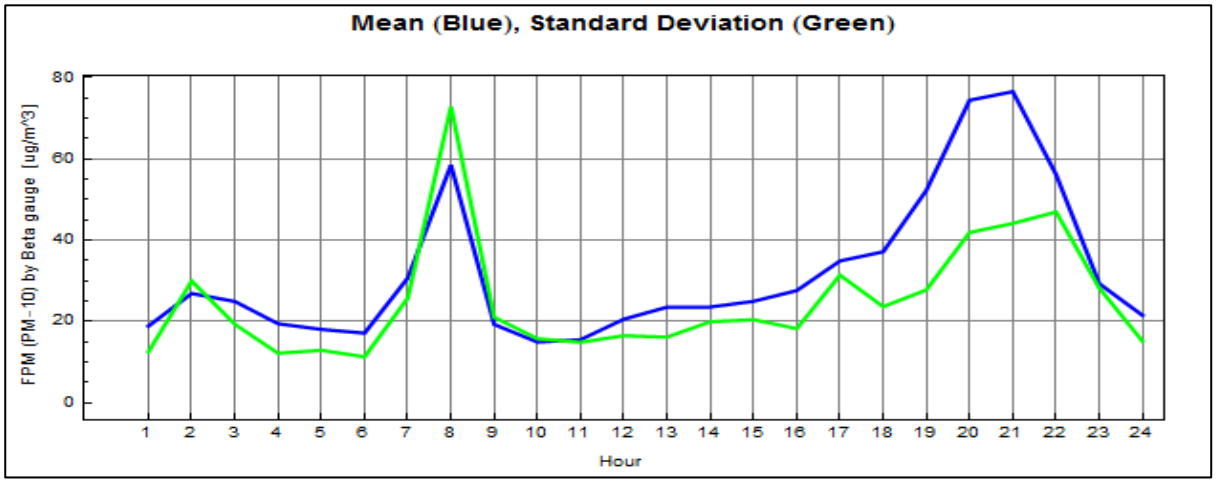

Figure 6: Diurnal variation of PM_{10} concentrations at KwaZamokuhle for January 2016

6.3.2 Particulate fine matter hourly 98th percentile event roses

Since 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 during the monitoring period.

Figure 7 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 123.33 µg/m^3 (98th percentile value) (Table 6) were recorded in the north-north-east, east-north-east, south-east, south-south-east and north-north-west sectors. The hourly mean sector concentrations above 87.84 µg/m^3 (98th percentile value) (Table 7) during the night-time were recorded in the north-north-east, north-east, east-north-east and south-south-east sectors.

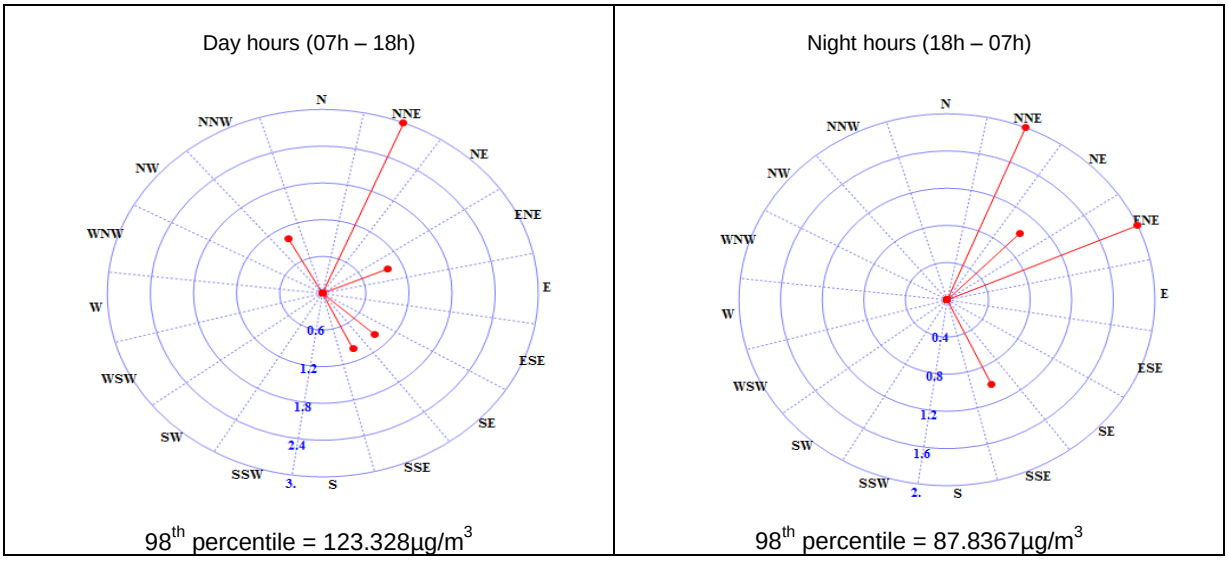

Figure 7: $PM_{2.5}$ hourly mean 98th percentile event roses during day and night times

Table 6: $PM_{2.5}$ daytime hourly mean 98th percentile event table

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

Table 7: $PM_{2.5}$ 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	2	1	0	2	0	0	1	0	0	0	0	0	0	0	0
%	0	33.33	16.67	0	33.33	0	0	16.67	0	0	0	0	0	0	0	0

Figure 8 shows the PM_{10} hourly mean 98th percentile event roses during day and night times. PM_{10} hourly mean sector concentrations above 100.378 µg/m^3 (98th percentile value) (Table 9) were recorded in the south-east, south-south-east, south-south-west, south-west and north- north-west sectors during the daytime. During the night, the hourly mean concentrations above 150.033 µg/m^3 (98th percentile value) (Table 10) were recorded in the north, north-north-east, east-north-east, south-east and north-north-west sectors. PM_{10} ambient concentrations might be contributed to by motor vehicle emissions and major roads in the township and Hendrina town.

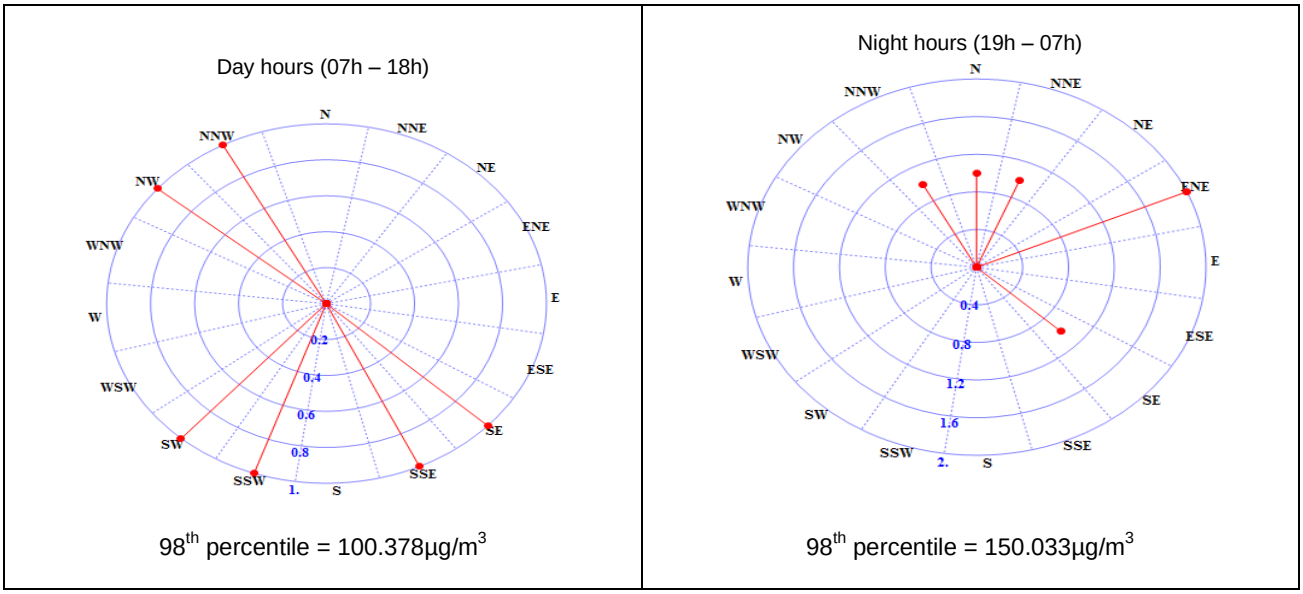

Figure 8: PM_{10} hourly mean 98th percentile event roses during day and night times

Table 8: 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	0	0	0	1	1	0	1	1	0	0	0	1	1
%	0	0	0	0	0	16.67	16.67	0	16.67	16.67	0	0	0	16.67	16.67

Table 9: 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	1	1	0	0	2	0	1	0	0	0	0	0	0	0	0	1
%	16.67	16.67	0	0	33.33	0	16.67	0	0	0	0	0	0	0	0	16.67

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 16:00 before decaying rapidly due to the lack of sunlight during the night-time period shown in Figure 9.

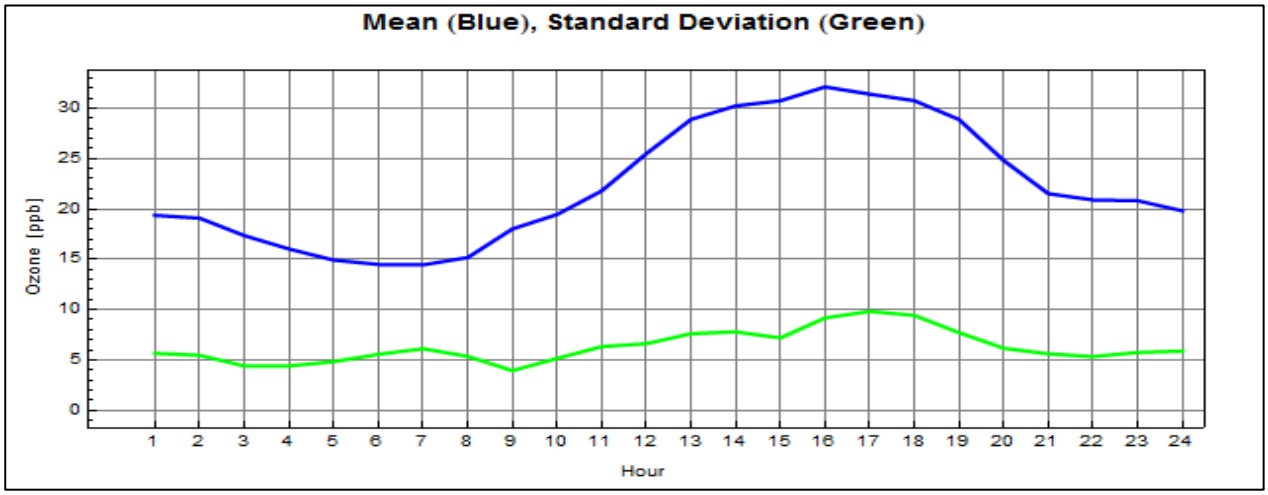

Figure 9: Diurnal variation of Ozone concentrations at KwaZamokuhle for January 2016

The daytime concentrations above 47.83 ppb (98th percentile value) were from south-south-east, south-south-west, south-west and west-south-west (Table 10). The night-time concentrations above 49.62ppb (98th percentile value) were from north, north-north-east, east-south-east, south, west-south-west and north-north-west (Table 11).

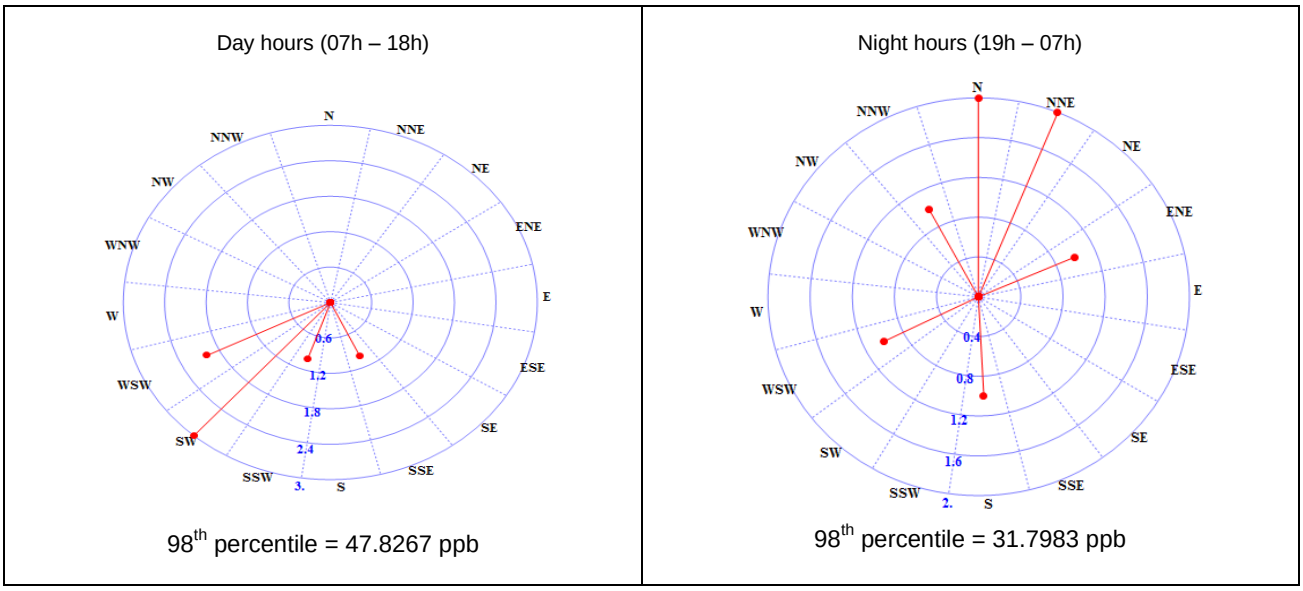

Figure 10: O_3 hourly mean 98th percentile event roses during day and night times

Table 10: O_3 day 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	1	0	1	3	2	0	0	0	0
%	0	0	0	0	0	0	0	14.29	0	14.29	42.86	28.57	0	0	0	0

Table 11: O_3 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	2	2	0	1	0	0	1	0	0	0	0	1	0	0	0	1
%	25	25	0	12.5	0	0	12.5	0	0	0	0	12.5	0	0	0	12.5

7. MONTHLY MEANS FOR THE CURRENT CALENDER YEAR

7.1. HISTORICAL TRENDS

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 11 - 15 show seasonal trends where high concentrations were recorded from April to August 2015 (winter season) 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 on them, as well as leakage trips and incoming power interruptions. There is no distinct trend observed on the O_3 8hourly moving average monthly concentrations during the 2015 monitoring period (Figure 16).

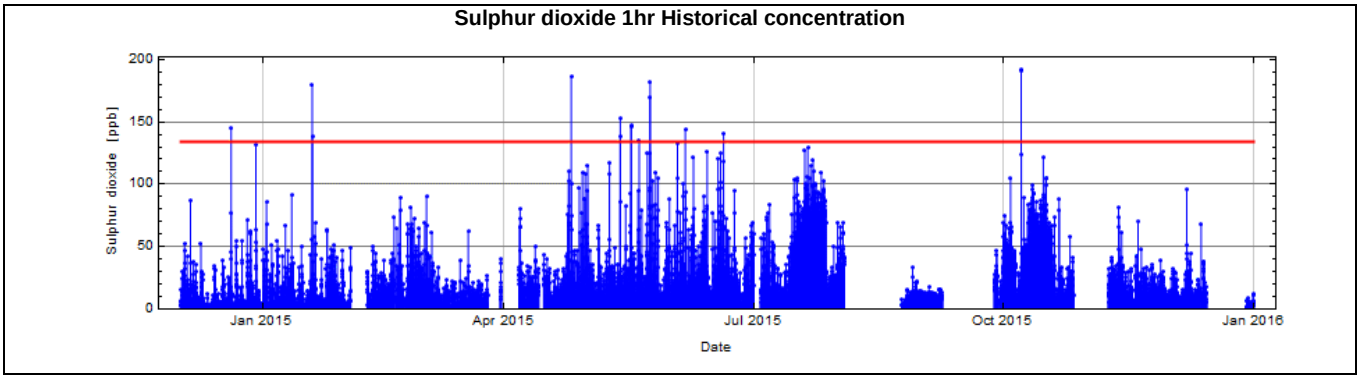

Figure 11: SO_2 1hr mean concentration

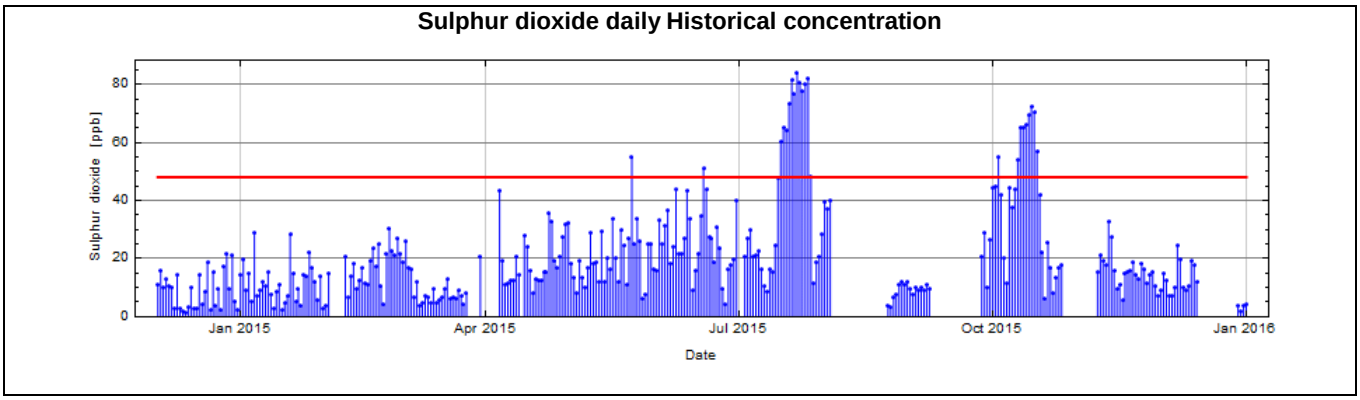

Figure 12: SO_2 daily monthly concentrations

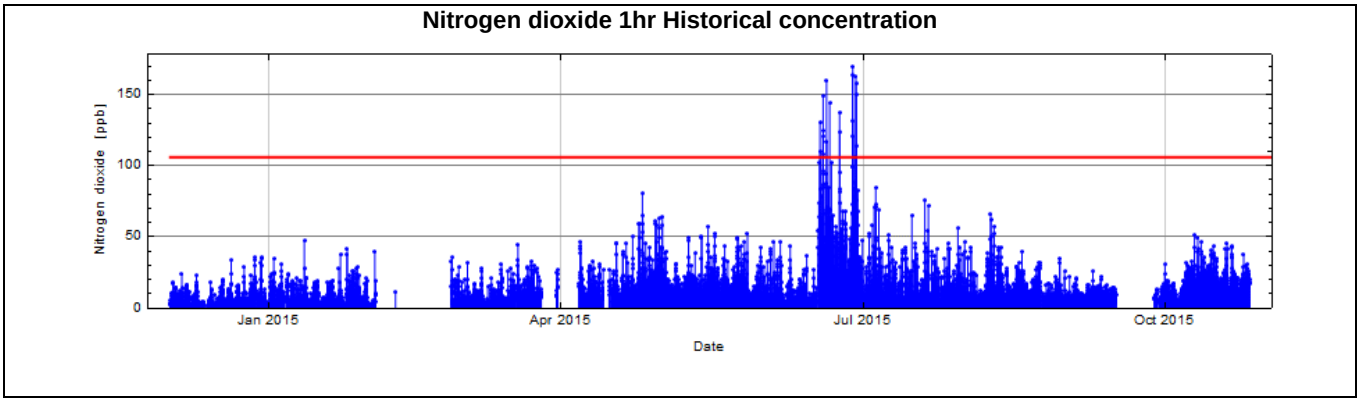

Figure 13: NO_2 1hr monthly concentration

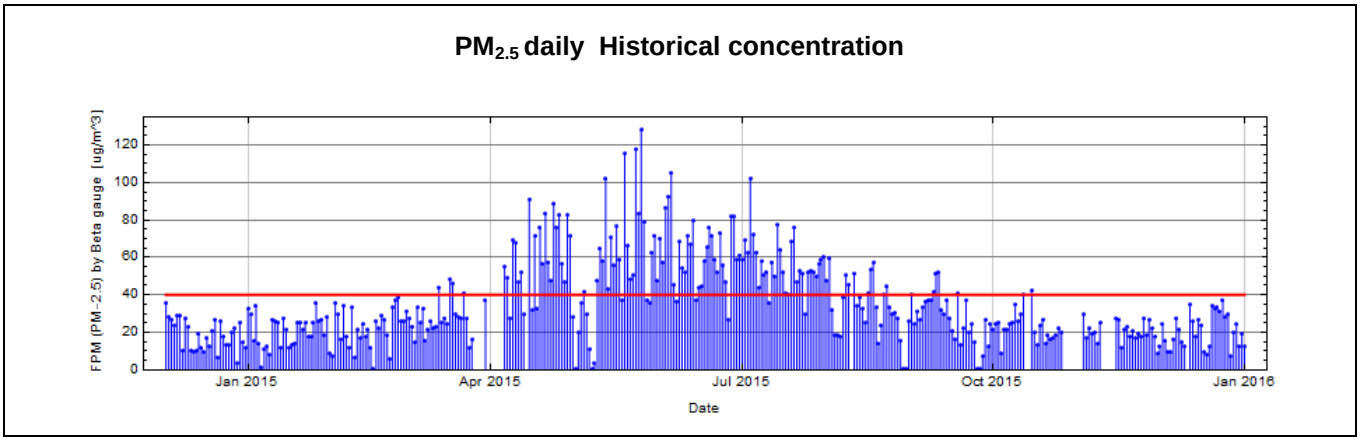

Figure 14: $PM_{2.5}$ daily monthly concentration

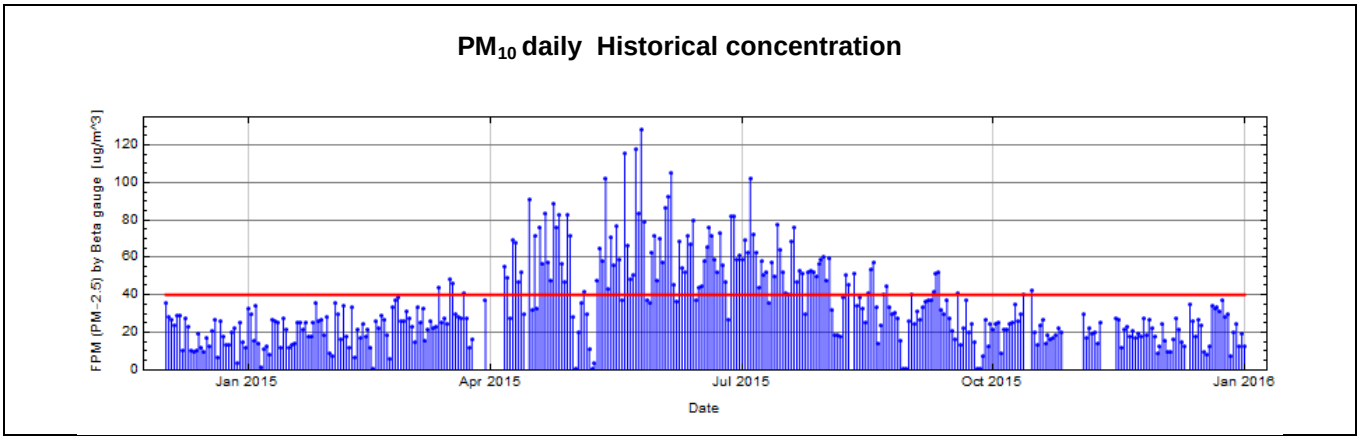

Figure 15: $PM_{2.5}$ daily monthly concentrations

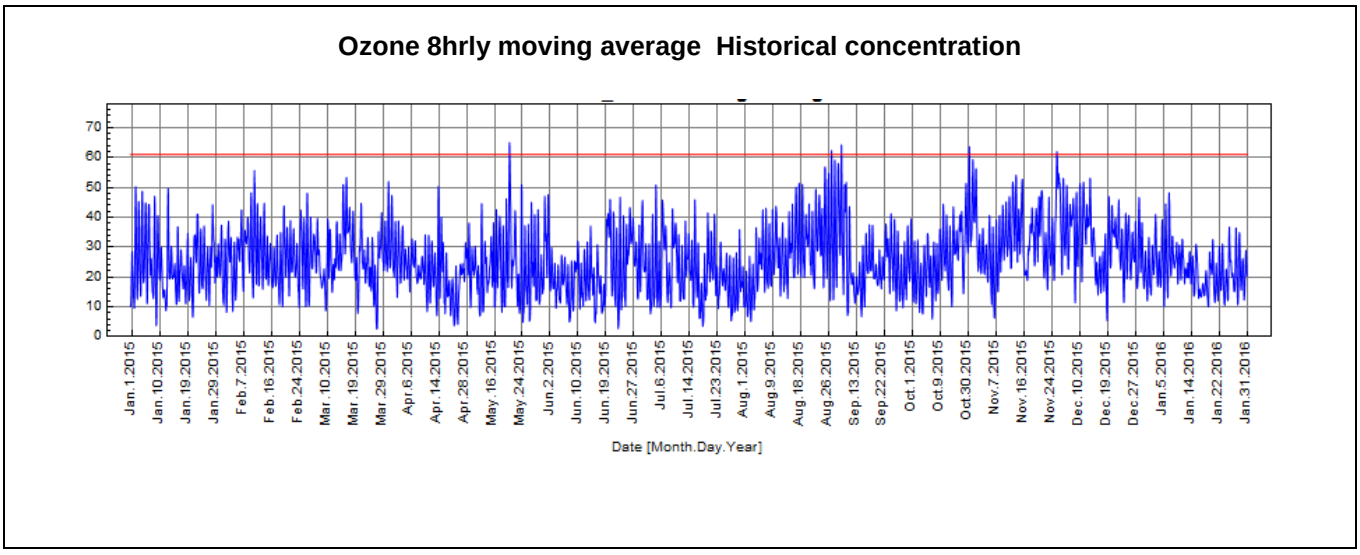

Figure 16: O_3 8hrs moving average

Table 12: Monthly means for the calendar year

Parameter measured	January 2016
$PM_{2.5}$ (µg/m^3)	21
PM_{10} (µg/m^3)	32.5
NO_2 (ppb)	-
O_3 (ppb)	22.4
SO_2 (ppb)	10.9

8. CONCLUSION

There were no exceedances of the national ambient air quality limits for all the parameters monitored at the site during the monitoring period under review**.**

SO_2 ambient air concentrations are impacted by tall stack emitters. Ambient fine particulate matter concentrations indicate the influence of low-level source emissions at KwaZamokuhle.

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9. DISTRIBUTION LIST

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Attention: Gabi Mkhatshwa

Project Leader
Attention: Trinity Ngomane RT&D

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