

5.2.3.2.1 Time of Wetness

Relative humidity, rain, dew, and temperature are determinants of the so-called *time of wetness* (TOW), defined (ISO 9223) as the fraction of time with relative humidity in excess of 80%, at temperatures above freezing ($>0^{\circ}\text{C}$). The TOW of a corroding surface is a key parameter, directly determining the duration of the electrochemical corrosion processes. This is a complex variable, since all the means of formation and evaporation of the surface electrolyte solution must be considered. The TOW refers to the period of time during which the atmospheric conditions are favourable for the formation of a surface layer of moisture on a metal or alloy. As pointed in the previous section, this moisture film is extremely important from the point of view of the chemical mechanisms of the corrosion process.

Meteorological data from the Secunda Club and Embalenhle AQMS were used to calculate the TOW. The average TOW across both stations was 2 946 hours per year (34%). According to the ISO 9233 classification (Table 5-37), the TOW class represented by these weather conditions is **T4**.

Table 5-37: ISO 9223 Classification of the Time of Wetness

Category	Time of Wetness	Example of Occurrence	Comment
	Hours per Year	Percentage	
T1	$T \leq 10$	$T \leq 0.1$	Indoor
T2	$10 < T \leq 250$	$0.1 < T \leq 3$	Indoor without climate control
T3	$250 < T \leq 2500$	$3 < T \leq 30$	Outdoor atmospheres in dry, cold climates and part of temperate climates
T4	2 500 < T ≤ 5 500	30 < T ≤ 60	Outdoor atmospheres in all climates except for dry and cold climates
T5	$5\,500 < T$	$60 < T$	Tropical outdoor or surf

5.2.3.2.2 Atmospheric pollutants

As indicated by the ISO standard, corrosion due to atmospheric pollution is dominated by sulfur dioxide (urban environments) and chlorides (marine environments). This is also evident from open literature where the focus of atmospheric corrosion of metals has predominantly been described through the impact of these two pollutants.

Sulfur Dioxide

Sulfate ions are formed in the surface moisture layer by the oxidation of sulfur dioxide and their formation is considered to be the main corrosion accelerating effect from sulfur dioxide. Sulfur dioxide may be expressed either in terms of a deposition rate or an airborne concentration. The method of determining the deposition rate in this instance followed the ISO 9223 Method, where the corrosion potential due to SO_2 is classified according to the long-term (annual) deposition rate or air concentration of SO_2 , as summarised in Table 5-38. Any concentration of SO_2 within category P_0 is considered to be the background concentration and is insignificant from the point of view of corrosive attack. Pollution by SO_2 within category P_3 is considered extreme and is typical of operational microclimates beyond the scope of the International Standard. The annual SO_2 concentrations as a result of SSO fall into the P_1 category for all modelled scenarios (Table 5-39).

Table 5-38: ISO 9223 classification of pollution by sulfur-containing substances represented by SO_2

Category	Concentration of SO_2	Deposition Rate of SO_2
	$\mu\text{g}/\text{m}^3$	$\text{mg}/(\text{m}^2 \cdot \text{day})$
P_0	$P_c \leq 12$	$P_d \leq 10$
P_1	$12 < P_c \leq 40$	$10 < P_d \leq 35$

Category	Concentration of SO ₂	Deposition Rate of SO ₂
	µg/m ³	mg/(m ² .day)
P2	40 < P _c ≤ 90	35 < P _d ≤ 80
P3	90 < P _c ≤ 250	80 < P _d ≤ 200

Table 5-39: ISO 9223 classification of pollution by sulfur-containing substances represented by SO₂ associated with SSO

Criterion	Scenario			
	Baseline	Existing Plant Emission Standards	New Plant Emission Standards	Alternative Emissions
Maximum annual SO ₂ concentration (µg/m ³)	12.09	12.06	12.06	12.25
ISO corrosivity category for SO ₂	P1	P1	P1	P1

Airborne Chloride

The ISO 9223 classification of pollution by chloride containing substances is provided in Table 5-40. The predicted chloride deposition rates, based on the simulated concentrations of HCl (as a result of HCl emissions from the incinerators at SSO) are classified as category S0 (Table 5-41). The contribution of marine chloride contribution at the site is also unknown, but likely to be very low.

Table 5-40: ISO 9223 classification of pollution by airborne chloride containing substances

Category	Deposition Rate of Chloride (mg/m ² .day)
S0	S ≤ 3
S1	3 < S ≤ 60
S2	60 < S ≤ 300
S3	300 < S ≤ 1500

Table 5-41: ISO 9223 classification of pollution by airborne chloride containing substances associated with SSO

Criterion	Scenario			
	Baseline	Existing Plant Emission Standards	New Plant Emission Standards	Alternative Emissions
Chloride deposition (mg/m ² .day)	0.28	0.06	0.06	0.21
ISO corrosivity category for Cl	S0	S0	S0	S0

5.2.3.2.3 Corrosivity Potential

Having calculated the TOW, the classification of pollution by sulfate and chloride containing substances, the corrosivity category (C1 to C5) for individual metals can be estimated according to ISO 9223, as shown in Table 5-42, and specific corrosivity categories associated with SSO are summarised for the four scenarios in Table 5-43. Once the corrosivity category has been determined, the corrosion rate for carbon and weathered steel, zinc, copper and aluminium can be estimated using the rates given in Table 5-44. The corrosivity category estimated based on the ISO method (C3) correspond to ISO coil exposure experiments conducted at SSO (Secunda Club and Embaleh AQMS) as reported by Leitch (2009).

Table 5-42: Estimated corrosivity categories of the atmosphere

Unalloyed carbon steel															
	T1			T2			T3			T4			T5		
	S ₀ -S ₁	S ₂	S ₃	S ₀ -S ₁	S ₂	S ₃	S ₀ -S ₁	S ₂	S ₃	S ₀ -S ₁	S ₂	S ₃	S ₀ -S ₁	S ₂	S ₃
P ₀ -P ₁	1	1	1/2	1	2	3/4	2/3	3/4	4	3	4	5	3/4	5	5
P ₂	1	1	1/2	1/2	2/3	3/4	3/4	3/4	4/5	4	4	5	4/5	5	5
P ₃	1/2	1/2	2	2	3	4	4	4/	5	5	5	5	5	5	5
Zinc and copper															
	T1			T2			T3			T4			T5		
	S ₀ -S ₁	S ₂	S ₃	S ₀ -S ₁	S ₂	S ₃	S ₀ -S ₁	S ₂	S ₃	S ₀ -S ₁	S ₂	S ₃	S ₀ -S ₁	S ₂	S ₃
P ₀ -P ₁	1	1	1	1	1/2	3	3	3	3/4	3	4	5	3/4	5	5
P ₂	1	1	1/2	1/2	2	3	3	3/4	4	3/4	4	5	4/5	5	5
P ₃	1	1/2	2	2	3	3/4	3	3/4	4	4/5	5	5	5	5	5
Aluminium															
	T1			T2			T3			T4			T5		
	S ₀ -S ₁	S ₂	S ₃	S ₀ -S ₁	S ₂	S ₃	S ₀ -S ₁	S ₂	S ₃	S ₀ -S ₁	S ₂	S ₃	S ₀ -S ₁	S ₂	S ₃
P ₀ -P ₁	1	2	2	1	2/3	4	3	3/4	4	3	3/4	5	4	5	5
P ₂	1	2	2/3	1/2	3/4	4	3	4	4/5	3/4	4	5	4/5	5	5
P ₃	1	2/3	3	3/4	4	4	3/4	4/5	5	4/5	5	5	5	5	5

Note: Corrosivity is expressed as the numerical part of the corrosivity category code (for example: 1 instead of C1).

Table 5-43: Estimated corrosivity categories of the atmosphere associated with SSO

Metal type	Scenario			
	Baseline	Existing Plant Emission Standards	New Plant Emission Standards	Alternative Emissions
Unalloyed carbon steel	C3	C3	C4	C3
Zinc and copper	C3	C3	C3	C3
Aluminium	C3	C3	C3	C3

Table 5-44: Average and steady state corrosion rates for Different Metals and Corrosivity Categories

Metal	Average corrosion rate (r_{av}) during the first 10 years for the following corrosivity categories ($\mu\text{m/annum}$)				
	C1	C2	C3	C4	C5
Carbon steel	$r_{av} \leq 0.5$	$0.5 < r_{av} \leq 5$	$5 < r_{av} \leq 12$	$12 < r_{av} \leq 30$	$30 < r_{av} \leq 100$
Weathering steel	$r_{av} \leq 0.1$	$0.1 < r_{av} \leq 2$	$2 < r_{av} \leq 8$	$8 < r_{av} \leq 15$	$15 < r_{av} \leq 80$
Zinc	$r_{av} \leq 0.1$	$0.1 < r_{av} \leq 0.5$	$0.5 < r_{av} \leq 2$	$2 < r_{av} \leq 4$	$4 < r_{av} \leq 10$
Copper	$r_{av} \leq 0.01$	$0.01 < r_{av} \leq 0.1$	$0.1 < r_{av} \leq 1.5$	$1.5 < r_{av} \leq 3$	$3 < r_{av} \leq 5$
Aluminium	$r_{av} \approx 0.01$	$r_{av} \leq 0.025$	$0.01 < r_{av} \leq 0.1$	(5)	(5)
Metal	Steady state corrosion rate (r_{lin}) for the following corrosivity categories ($\mu\text{m/annum}$)				
	C1	C2	C3	C4	C5
Carbon steel	$r_{av} \leq 0.1$	$0.1 < r_{av} \leq 1.5$	$1.5 < r_{av} \leq 8$	$8 < r_{av} \leq 20$	$20 < r_{av} \leq 90$
Weathering steel	$r_{av} \leq 0.1$	$0.1 < r_{av} \leq 1$	$1 < r_{av} \leq 5$	$5 < r_{av} \leq 10$	$10 < r_{av} \leq 80$
Zinc	$r_{av} \leq 0.05$	$0.1 < r_{av} \leq 0.5$	$0.5 < r_{av} \leq 2$	$2 < r_{av} \leq 4$	$4 < r_{av} \leq 10$
Copper	$r_{av} \leq 0.01$	$0.01 < r_{av} \leq 0.1$	$0.1 < r_{av} \leq 1$	$1 < r_{av} \leq 3$	$3 < r_{av} \leq 5$
Aluminium	negligible	$0.01 < r_{av} \leq 0.02$	$0.02 < r_{av} \leq 0.2$	(5)	(5)
Notes					
1) The corrosion rate of carbon steel is not constant during the first 10 years.					

Metal	Average corrosion rate (r_{av}) during the first 10 years for the following corrosivity categories ($\mu\text{m/annum}$)				
	C1	C2	C3	C4	C5
2) The corrosion rate of weathering steel is strongly dependent on the combination of various influencing factors (alternation between wet and dry periods). In atmospheres with sulfur dioxide (SO_2) pollution, a more protective rust layer is formed. Rain protected surfaces in marine atmospheres heavily polluted with chlorides may have much higher corrosion rates than freely exposed surfaces. 3) Applies also to the copper-zinc, copper-tin and similar alloys with a copper content of at least 60 %. 4) The rates shown are based on commercially pure aluminium (purity > 99.5%) which, like most aluminium alloys, corrodes in the atmosphere at a rate that decreases with time. However, these rates are based on average mass loss results while the corrosion attack is usually manifested as pitting. Consequently, the rates shown do not represent rates of penetration. Penetration rates for pitting also decrease with exposure time. Commercially pure aluminium, aluminium alloys containing magnesium, manganese and/or silicon as the major alloying elements, and Alclad products generally have better corrosion resistance than aluminium alloys containing significant quantities of copper, zinc and/or iron. Alloys with significant quantities of magnesium, zinc, copper and/or iron may also be subject to other forms of localized corrosion such as stress corrosion cracking, exfoliation and intergranular attack. 5) In atmospheres defined by corrosivity categories C4 and C5, a marked increase in corrosion rate may be expected and local corrosion effects become important. For these two corrosivity categories, the data concerning general corrosion may be misleading.					

5.2.3.3 ISOCORRAG Atmospheric Corrosion Model

The ISOCORRAG equation was developed to predict the annual corrosion rate resulting from atmospheric corrosion for several metals. The equation was created by the multiple linear regressions of corrosion data from several sites around the globe. With ISOCORRAG, the annual corrosion rate is expressed as (Knotkova *et al.*, 1995):

$$K = a + b_1[\text{SO}_2] + b_2[\text{Cl}^-] + b_3[\text{TOW}]$$

Equation 2

Where the constants a , b_1 , b_2 , and b_3 , differ according to the type of metal, shape of the specimen, and exposure conditions. Table 5-45 is a summary of constants for flat metal specimens. The deposition of SO_2 is expressed as an equivalent concentration, i.e. $\mu\text{g}/\text{m}^3$; the deposition of chloride pollutants $[\text{Cl}^-]$ is expressed in $\text{mg}/\text{m}^2\cdot\text{day}$, and time of wetness $[\text{TOW}]$ in hours per year.

Table 5-45: ISOCORRAG regression model constants (Knotkova *et al.*, 1995)

Metal	Regression Constants for ISOCORRAG model			
	a	b_1	b_2	b_3
Steel	1.3269	0.4313	0.1384	0.0057
Zinc	0.2098	0.0232	0.0059	0.00027
Copper	0.9556	0.0065	0.00393	0.0000538
Aluminium	0.0069	0.00638	0.000558	0.0000650

Using simulated concentrations of SO_2 and HCl (as a result of emissions from SSO) (as in Section 5.2.2.2 above) the rate of corrosion (K) was calculated (using Equation 2) across the dispersion modelling domain. Average TOW from the two AQMS was used. A summary of the findings is presented in Table 5-46. The corrosion rates calculated using the ISOCORRAG method are higher than the ranges of corrosion rates presented for the ISO method (Table 5-44). The corrosion rates calculated using the ISOCORRAG method (Table 5-44) correspond to ISO coil exposure experiments conducted at SSO (Secunda Club and Embalenhle AQMS) as reported by Leitch (2009).

Table 5-46: Corrosion rate of metals associated with SSO calculated according to the ISOCORRAG method

Scenario	Criteria	Corrosion rate (K) [µm/annum]			
		Steel	Zinc	Copper	Aluminium
Average time of wetness					
Simulated Baseline Concentrations	Min	18.25	68.55	1.12	0.20
	Max	23.33	68.83	1.19	0.28
Simulated Concentrations for Existing Plant Emission Standards	Min	18.25	68.55	1.12	0.20
	Max	23.32	68.83	1.19	0.28
Simulated Concentrations for New Plant Emission Standards	Min	18.25	68.55	1.12	0.20
	Max	23.32	68.83	1.19	0.28
Simulated Concentrations for Alternative Emissions	Min	18.25	68.55	1.12	0.20
	Max	23.40	68.83	1.19	0.28

5.2.4 Sulfur and Nitrogen Deposition Impacts

Understanding the impact of deposition of atmospheric sulfur (S) and nitrogen (N) on South African ecosystems has been on-going since the late 1980's (Tyson *et al.* 1988), with much of the earlier work focussing on the circulation over the sub-continent (Tyson *et al.* 1996). More recent research has focussed on quantifying S and N deposition (Galpin and Turner 1999, Zunckel *et al.* 1996, Scorgie and Kornelius 2009, Josipovic *et al.* 2010) and the subsequent impacts on ecosystems (Fey and Guy 1993, Van Tienhoven *et al.* 1995, Reid 2007, Bird 2011, Josipovic *et al.* 2011).

These studies estimating deposition of S and or N compounds to ecosystems present ranges of deposition rates where the differences are related to the distance from major industrial sources; the method of estimation (field work and/or calculation based on deposition velocities or dispersion modelling). As an indication, total S deposition over the industrialised Highveld of South Africa was modelled to range between 8 and 35 kg/ha/year with background levels of approximately 1 kg/ha/year (Scorgie and Kornelius 2009). In contrast, using ambient SO₂ concentrations and an inferential deposition model to calculate S deposition, Zunckel *et al.* (1996) estimated total S deposition of 13.9 kg/ha/year as maximum deposition rate on the Highveld. Estimates of nitrogen deposition range between 6.7 kg/ha/year (Collett *et al.* 2010) and 15 kg/ha/year (Scorgie and Kornelius 2009). Considering total acidic input from atmospheric sources, Josipovic and colleagues (2011) calculated a range of deposition rates between 15.8 and 23.2 kg/ha/year. All estimates are within the range of deposition rates for S and N as for some of the industrialised regions of Europe and North America (compared in Scorgie and Kornelius 2009, and Bird 2011) raising concern that the acidic loading of sulfur and nitrogen on the ecosystems of the Highveld – South Africa's most heavily industrialised region – could have implications for ecosystem functioning.

Establishing clear cause-effect relationships in complex ecosystem studies can be difficult, especially where the extent of visible damage is large and local emissions are low (Matzner and Murach 1995). Reasons include: time lags between stressor (high concentration of atmospheric pollutants) and visible symptomatic response of biota; interaction of natural factors (e.g. climate, soil and pests) and human activities (such as management, site history and air pollution); local ecosystem uniqueness and difficulty of extrapolating to larger scales; or, symptomatic responses that are not unique to the cause (e.g. defoliation) (Matzner and Murach 1995). The synergistic effect of pollutant cocktails can also add complexity to identifying causative pollutants (Emberson 2003).

Mobilisation of active forms of S and N into the atmosphere, and later as deposition onto ecosystems, can result in acidification of soils and freshwater systems, soil nutrient depletion, fertilization of naturally (usually nitrogen) limited systems and increased availability of metal ions (e.g. Al) disrupting ecosystem functioning (Rodhe *et al.* 1995) and changing plant

and/or freshwater species diversity (Stevens *et al.* 2004). Many of these impacts occur over a decade or longer where attributing source contributions can be complex within a regional setting. Sasol have, however, supported the long-term deposition quantification studies in South Africa under the DEBITS (Deposition of Biogeochemically Important Trace Species) programme, as part of the International Global Atmospheric Chemistry Project. Three DEBITS sites are maintained within South Africa, one located near Amersfoort, on the Mpumalanga Highveld, downwind from major industrial sources, including SSO. Investigating deposition and its impacts on the Highveld grasslands as a result of SO operations was beyond the time-frame of the accompanying postponement application especially since long-term impact studies are not yet available for South Africa.

5.2.5 Potential Environmental Impact of Benzene

Benzene (together with other VOCs) is a precursor pollutant involved in the formation of secondary atmospheric pollutants, such as smog (generally) and ozone (specifically).

As a secondary pollutant, O₃ is formed in the lower part of the atmosphere, from complex photochemical reactions following emissions of precursor gases such as NO_x and VOCs (Seinfeld and Pandis, 1998). O₃ is produced during the oxidation of CO and hydrocarbons by hydroxyls (OH) in the presence of NO_x and sunlight (Seinfeld and Pandis, 1998). The rate of ozone production can therefore be limited by CO, VOCs or NO_x. In densely populated regions with high emissions of NO_x and hydrocarbons, rapid O₃ production can take place and result in a surface air pollution problem. In these urban areas O₃ formation is often VOC-limited. O₃ is generally NO_x-limited in rural areas and downwind suburban areas.

O₃ concentration levels have the potential to become particularly high in areas where considerable O₃ precursor emissions combine with stagnant wind conditions during the summer, when high insolation and temperatures occur (Seinfeld and Pandis, 1998). The effects of sunlight on O₃ formation depend on its intensity and its spectral distribution.

The main sectors that emit ozone precursors are road transport, power and heat generation plants, household (heating), industry, and petrol storage and distribution. In many urban areas, O₃ nonattainment is not caused by emissions from the local area alone. Due to atmospheric transport, contributions of precursors from the surrounding region can also be important. The transport of O₃ is determined by meteorological and chemical processes which typically extend over spatial scales of several hundred kilometres. Thus, in an attempt to study O₃ concentrations in a local area, it is necessary to include regional emissions and transport. This requires a significantly larger study domain with the inclusion of a significantly more comprehensive emissions inventory of NO_x and VOCs sources (e.g. vehicle emissions in Gauteng). Such a collaborative study was not within the scope of this report.

Ozone is a strong oxidant known to cause injury and thereby reduce crop plant yield, especially above a threshold of 40 ppb. Recent assessments of ozone concentrations on the Highveld, to which the SSO benzene emissions would contribute, show ambient concentrations below the AOT40 (WHO Ambient Ozone Threshold of 40 ppb):

- Ambient monthly ozone concentrations measured at Amersfoort during the 3-year period 2000 to 2002 ranged between 15 and 45 ppb (Zunckel 2004) where the highest concentrations were measured between July and November 2001.
- Ambient monthly ozone concentrations measured during a campaign between September 2005 and August 2007 showed across the Highveld rarely exceeded 20 ppb. The maximum monthly average (43 ppb) was measured near Thabazimbi (Josipovic *et al.* 2010)

Lourens *et al.* (2011) note that in the South African context, carbon monoxide is probably a more important precursor to ozone formation than benzene (or BTEX more broadly), where ozone concentrations and CO concentrations peak simultaneously during late winter and early spring when biomass burning (veld fires) regularly occur.

Benzene is also a primary pollutant (slightly soluble in water (1.79 g/L at 15°C)) that is toxic to aquatic systems, primarily by altering redox potentials which in turn limits the biological communities which can function under the altered redox potentials (Fahy *et al.* 2005). The toxicity for aquatic organisms is considered to be low to moderate, but this is only likely to be apparent when high concentrations arise from significant spills. Benzene quickly reacts with other chemicals in the air and is thus removed within a few days of release. In soils and water bodies it breaks down more slowly and can pass into groundwater where it can persist for weeks. Benzene does not accumulate in animals or plants and is unlikely to have any environmental effects at a global level (Scottish Environmental Protection Agency (SEPA)).

6 COMPLAINTS

Year	Nature of complaints	Actions taken to investigate complaints	Causes of complaints identified	Measures taken to avoid reoccurrences in instances where the plant's operations were found to be the cause
2016	One external Sasol related complaint was received. The following complaint was received: The complaint related to unpleasant odour from the factory experienced in Secunda town. The last odour related complaint related to a sulphur / H ₂ S smell	Analyses of measured meteorological data at the time of the incident were undertaken and low winds speeds were identified as an exacerbating factor. Analyses of measured ambient data was also undertaken to observe the concentrations at the time of the incident to identify the pollutants causing the smells.	Process conditions on the factory and H ₂ S emissions from sulphur plants during low wind conditions	An investigation form is sent to the relevant BU's environmental manager who launches a full investigation. Measures implemented to prevent a similar incident from reoccurring need to be specified and implemented. This is tracked from the Environmental group
2015	A total of 3 external Sasol related complaints were received during 2015. The following complaints were received: The complaint related to a nuisance smell coming from the water recovery effluent dams, which was being experienced in the Secunda residential area. The second complaint related to unpleasant odour from the factory experienced in Secunda town. The last odour related complaint related to a sulphur / H ₂ S smell.	Regarding the first complaint, feedback was given to the complainant which included an explanation on how the process dams operate and the possible contributing factors that results in odour. A commitment to inform and discuss the matter further with the senior manager of that plant was also undertaken and further feedback requested. For both odour related complaints, analyses of measured meteorological data at the time of the incidents was undertaken and low winds speeds was identified as an exacerbating factor. Analyses of measured ambient data was also undertaken to observe the concentrations at the times of the incidents to identify the pollutants causing the smells.	Process conditions on the factory and Sasol emissions (from process dams and H ₂ S from sulphur plants) during low wind conditions	An investigation form is sent to the relevant BU's environmental manager who launches a full investigation. Measures implemented to prevent a similar incident from reoccurring need to be specified and implemented. This is tracked from the Environmental group
2014	Only 1 external Sasol related complaints was received during 2014. The following complaint was received: The complaint related to a 'chemical smell' within the Secunda residential area.	Sasol operates a complaint line where any environmental complaint can be registered. The environmental standby will investigate the complaint and ensure that the necessary steps are taken to reduce and manage the impact and to reduce the time of the incident. An analyses of ambient data that could have contributed to the problem was undertaken.	Process conditions on the factory. Generally higher than normal ambient concentrations of ambient pollutants (H ₂ S, SO ₂ and NO _x) and low wind conditions at the time. Looking at the plant operations over this time period there were no abnormal conditions	An investigation form is sent to the relevant BU's environmental manager who launches a full investigation. Measures implemented to prevent a similar incident from reoccurring need to be specified and implemented. This is tracked from the Environmental group

7 CURRENT OR PLANNED AIR QUALITY MANAGEMENT INTERVENTIONS

An overview of approved air quality management improvement interventions, currently implemented and scheduled over the next 5 to 10 years, is detailed in the accompanying Motivation Report.

8 COMPLIANCE AND ENFORCEMENT ACTIONS

No directives or compliance notices have been issued to SSO in the last five years.

9 ADDITIONAL INFORMATION

Beyond the requirements stipulated in the AIR Regulations and Dispersion Modelling Regulations, the following additional information is considered useful for better understanding the impacts of Sasol's activities and the implications of the requested postponements on ambient air quality. A brief description of each of these analyses is provided below, and referenced to where in the applications the information may be found.

a) Polar plots

Polar plots have been provided in Section 5.1.6.1 of the AIR to visually demonstrate directional contribution as well as the dependence of concentrations on wind speed, in much the same way as a pollution rose does. The polar plots identify major contributing emissions sources impacting on a monitoring station and the direction of the impact. These polar plots do not replace isopleth plots, but rather provide additional information on the measured air quality in the region of the facility.

b) Delta approach to assessing implications of postponements for ambient air quality

In assessing the impacts of Sasol's postponement applications on ambient air quality, a fit-for-purpose approach, as requested for by the Dispersion modelling Regulations, was taken to assess the results from the dispersion modelling, which is referred to as the "delta approach". The delta approach is premised on recognising that the difference between the current or "before additional compliance is implemented" emission scenario (i.e. the baseline scenario) and "after additional compliance is implemented" scenario (i.e. the 2020 MES compliance scenario) relates to the change in emissions from the point sources in question.

Therefore, the delta approach focuses on demonstrating the change in simulated ambient impacts of the various compliance scenarios, to guide decision makers toward better understanding the implications of the approval of postponements on air quality, and how compliance with the existing and new plant standards would impact on prevailing ambient air quality.

A detailed explanation of the scenarios modelled to highlight the delta changes in ambient air quality arising from retrofit of abatement technology is provided in Section 5.1.1.2 of the AIR. In summary, the four scenarios modelled include:

- Baseline Emissions – modelling conducted based on the current inventory and impacts
- Minimum Emissions Standards – modelling conducted based on plants theoretically complying with:
 - Existing Plant Standards, and
 - New Plant Standards
- Alternative Emission Limits – the proposed maximum emission concentrations, where applicable and different from the other three emission scenarios.

c) Estimating background ambient air pollutant concentrations

A background air concentration is normally defined as that concentration which would result from air emission sources outside the chosen modelling domain. This concentration can, for instance, be estimated by analysing observed air concentrations for those wind directions when it is blowing towards the sources included in the modelling domain. In other words, the observation point would be upwind from the sources being simulated by the dispersion modelling.

However, as used in the current investigation, background concentrations could also incorporate the contributions from air emission sources present in the modelling domain, but which were not included in the dispersion simulations. For example, air emissions from vehicle tailpipes can significantly contribute to the local ambient NO₂ concentrations. Although most of the sources of air emissions within the Sasol operations were included in the simulations, there remains some that were excluded, for instance fugitive emissions, but would add to the background concentration level.

Since these sources are not neatly located for easy analysis of upwind contributions, the procedure normally adopted to estimate background air concentrations could not be followed. Instead, the “background” concentration was established by comparing the simulated air concentrations with the observed air concentrations. The background concentration as used in this application therefore corresponds to the observed concentration value at a monitoring site when the simulated value at this site reached a near zero value. In other words, the observed residual air concentration was assumed to arise from other sources in the modelling domain.

With this method, the assumption is made that the model performs realistically and that the residual concentration determined this way is a good reflection of the emissions not included in the simulations. In an attempt to illustrate the model accuracy, the fractional bias was calculated for each monitoring station as described in Section 5.1.6.2. This methodology has been prescribed by the US EPA (U.S. EPA 1992) as an acceptable manner to illustrate the validity of atmospheric dispersion model. Given the good model performance, as measure by the fractional bias, it is assumed that the background concentration obtained using this methodology is reasonable estimates.

10 ANNEXURE A

DECLARATION OF ACCURACY OF INFORMATION – APPLICANT

Name of Enterprise: Sasol Secunda Synfuels Operations

Declaration of accuracy of information provided:

Atmospheric Impact Report in terms of section 30 of the Act.

I, ESTELLE MARAIS [duly authorised], declare that the information provided in this atmospheric impact report is, to the best of my knowledge, in all respects factually true and correct. I am aware that the supply of false or misleading information to an air quality officer is a criminal offence in terms of section 51(1)(g) of the National Environmental Management : Air Quality Act (Act No. 39 of 2004).

Signed at Secunda on this 18th day of JANUARY 2017



SIGNATURE

Senior Manager Environment: Air & GHG
CAPACITY OF SIGNATORY

11 ANNEXURE B

DECLARATION OF INDEPENDENCE - PRACTITIONER

Name of Practitioner: Reneé von Gruenewaldt

Name of Registration Body: South African Council for Natural Scientific Professions

Professional Registration No.: 400304/07

Declaration of independence and accuracy of information provided:

Atmospheric Impact Report in terms of section 30 of the Act.

I, Reneé von Gruenewaldt, declare that I am independent of the applicant. I have the necessary expertise to conduct the assessments required for the report and will perform the work relating the application in an objective manner, even if this results in views and findings that are not favourable to the applicant. I will disclose to the applicant and the air quality officer all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the air quality officer. The information provided in this atmospheric impact report is, to the best of my knowledge, in all respects factually true and correct. I am aware that the supply of false or misleading information to an air quality officer is a criminal offence in terms of section 51(1)(g) of this Act.

Signed at Midrand on this 19th day of January 2017


SIGNATURE

Principal Air Quality Scientist

CAPACITY OF SIGNATORY

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APPENDIX A: COMPETENCIES FOR PERFORMING AIR DISPERSION MODELLING

All modelling tasks were performed by competent personnel. Table A-1 is a summary of competency requirements. Apart from the necessary technical skills required for the calculations, personnel competency also include the correct attitude, behaviour, motive and other personal characteristic that are essential to perform the assigned job on time and with the required diligence as deemed necessary for the successful completion of the project.

The project team included a principal engineer, with relevant experience of more than 25 years and two principal scientists with 5 years and 15 years relevant experience. One of the principal scientists managed and directed the project.

The principal engineer also conducted verification of modelling results. The latter function requires a thorough knowledge of the

- meteorological parameters that influence the atmospheric dispersion processes and
- atmospheric chemical transformations that some pollutants may undergo during the dispersion process.

Table A-1: Competencies for Performing Air Dispersion Modelling

Competency	Task, Knowledge and Experience
Context	Communication with field workers, technicians, laboratories, engineers and scientists and project managers during the process is important to the success of the model
	Familiar with terminology, principles and interactions
	Record keeping is important to support the accountability of the model - Understanding of data collection methods and technologies
Knowledge	Meteorology: • Obtain, review and interpret meteorological data • Understanding of meteorological impacts on pollutants • Ability to identify and describe soil, water, drainage and terrain conditions ○ Understanding of their interaction ○ Familiarity with surface roughness • Ability to identify good and bad data points/sets • Understanding of how to deal with incomplete/missing meteorological data
	Atmospheric Dispersion models • Select appropriate dispersion model • Prepare and execute dispersion model • Understanding of model input parameters • Interpret results of model
	Chemical and physical interactions of atmospheric pollutants • Familiarity with fate and transport of pollutants in air • Interaction of primary pollutants with other substances (natural or industrial) to form secondary pollutants
	Information relevant to the model • Identify potential pollution (emission) sources and rates • Gather physical information on sources such as location, stack height and diameter • Gather operating information on sources such as mass flow rates, stack top temperature, velocity or volumetric flow rate • Calculate emission rates based on collected information • Identify land use (urban/rural) • Identify land cover/terrain characteristics • Identify the receptor grid/site
	Legislation, regulations and guidelines in regards to National Environment Management: Air Quality Act (Act No 39 of 2004), including • Minimum Emissions Standards (Section 21 of Act) • National Ambient Air Quality Standards • Regulations Regarding Air Dispersion Modelling

Competency	Task, Knowledge and Experience
	Atmospheric Impact Report (AIR)
Abilities	Ability to read and understand map information
	Ability to prepare reports and documents as necessary
	Ability to review reports to ensure accuracy, clarity and completeness
	Communication skills
	Team skills

APPENDIX B: COMPARISON OF STUDY APPROACH WITH THE REGULATIONS PRESCRIBING THE FORMAT OF THE ATMOSPHERIC IMPACT REPORT AND THE REGULATIONS REGARDING AIR DISPERSION MODELLING (GAZETTE NO 37804 PUBLISHED 11 JULY 2014)

The Regulations prescribing the format of the Atmospheric Impact Report (AIR) (Government Gazette No 36094; published 11 October 2013) were referenced for the air dispersion modelling approach used in this study. Table B-1 compares the AIR Regulations with the approach used in Section 5.

The regulations regarding Air Dispersion Modelling (Gazette No 37804 published 11 July 2014) were referenced for the air dispersion modelling approach used in this study. The promulgated Regulations regarding Air Dispersion Modelling (Gazette No. 37804, vol 589; 11 July 2014) were consulted to ensure that the dispersion modelling process used in this assessment was in agreement with the updated regulations. Table B-2 compares the Regulations Regarding Air Dispersion Modelling with the approach used in Section 5.

Table B-1: Comparison of Regulations for the AIR with study approach

Chapter	Name	AIR regulations requirement	Status in AIR
1	Enterprise details	• Enterprise Details • Location and Extent of the Plant • Atmospheric Emission License and other Authorisations	Enterprise details included. Location of plant included. AEL numbers included.
2	Nature of process	• Listed Activities • Process Description • Unit Processes	All sources at the SSO included (Section 2).
3	Technical Information	• Raw Materials Used and Production Rates • Appliances and Abatement Equipment Control Technology	Raw materials information that is not confidential and proprietary information is included. Sensitive information will be made available to the Licensing Authorities upon request (Section 3.1 and 3.2).
4	Atmospheric Emissions	• Point Source Emissions • Point Source Parameters • Point Source Maximum Emission Rates during Normal Operating Conditions • Point Source Maximum Emission Rates during Start-up, Maintenance and/or Shut-down • Fugitive Emissions • Emergency Incidents	Completed as set out by the Regulations.
5	Impact of enterprise on receiving environment		
5.1	Analysis of emissions impact on human health	Must conduct dispersion modelling, must be done in accordance with Regulations; must use NAAQS	Completed as set out by the Regulations for the sources of concern.
5.2	Analysis of emissions impact on environment	Must be undertaken at discretion of Air Quality Officer.	Literature review and analysis, where possible, included in AIR.
6	Complaints	Details on complaints received for last two years	Included
7	Current or planned air quality management interventions	Interventions currently being implemented and scheduled and approved for next 5 years.	Information on air quality interventions are included in detail in the motivation reports.
8	Compliance and enforcement history	Must set out all air quality compliance and enforcement actions undertaken against the enterprise in the last 5 years. Includes directives, compliance notices, interdicts,	Included

Chapter	Name	AIR regulations requirement	Status in AIR
		prosecution, fines	
9	Additional information		Included polar plots as an additional visualisation means of ambient air quality as monitored. Independent peer review of dispersion modelling methodology by international expert consultant.

Table B-2: Comparison of Regulations regarding Air Dispersion Modelling with study approach

AIR Regulations	Compliance with Regulations	Comment
Levels of assessment - Level 1: where worst-case air quality impacts are assessed using simpler screening models - Level 2: for assessment of air quality impacts as part of license application or amendment processes, where impacts are the greatest within a few kilometers downwind (less than 50km) - Level 3: requires more sophisticated dispersion models (and corresponding input data, resources and model operator expertise) in situations: - where a detailed understanding of air quality impacts, in time and space, is required; - where it is important to account for causality effects, calms, non-linear plume trajectories, spatial variations in turbulent mixing, multiple source types, and chemical transformations; - when conducting permitting and/or environmental assessment process for large industrial developments that have considerable social, economic and environmental consequences; - when evaluating air quality management approaches involving multi-source, multi-sector contributions from permitted and non-permitted sources in an airshed; or, - when assessing contaminants resulting from non-linear processes (e.g. deposition, ground-level ozone (O₃), particulate formation, visibility)	Level 3 assessment using CALPUFF	This Lagrangian Gaussian Puff model is well suited to simulate low or calm wind speed conditions. Alternative regulatory models such as the US EPA AERMOD model treats all plumes as straight-line trajectories, which under calm wind conditions grossly over-estimates the plume travel distance. CALPUFF is able to perform chemical transformations. In this study the conversion of NO to NO₂ and the secondary formation of particulate matter were concerns.
Model Input Source characterisation	Yes	Section 4
Emission rates: For new or modified existing sources the maximum allowed amount, volume, emission rates and concentration of pollutants that may be discharged to the atmosphere should be used	Yes	Section 4 and Section 5.1.7.
Meteorological data Full meteorological conditions are recommended for regulatory applications.	Yes	WRF modelled meteorology (including upper air) corrected with on-site observed meteorology (surface meteorology) (Sections 5.1.4.6.1 and 5.1.5).
Data period	Yes	3 years (2013 to 2015)
Geographical Information Topography and land-use		Required for CALMET 3D meteorological file preparation (Section 5.1.4.6.2)

AIR Regulations	Compliance with Regulations	Comment
Domain and co-ordinate system	Yes	- Dispersion modelling domain: 50 x 50 km - UTM co-ordinate system (WGS84) (Section 5.1.4.6.4)
General Modelling Considerations Ambient Background Concentrations, including estimating background concentrations in multi-source areas NAAQS analyses for new or modified sources: impact of source modification in terms of ground-level concentrations should be assessed within the context of the background concentrations and the facility. Land-use classification Surface roughness Albedo Temporal and spatial resolution Receptors and spatial resolutions Building downwash Chemical transformations	Yes Yes Yes Yes Yes Yes Yes Yes	Section 5.1.5.4, Section 5.1.6.1, and Appendix G Model simulated concentrations compared against current observed concentrations (Section 5.1.6.2). Used as an indication of how modifications to the plant will impact ambient concentrations (Section 5.1.8). Section 5.1.4.6.2 Computed from Land-use categories in the CALMET pre-processing step (Section 5.1.4.6.2). Computed from Land-use categories in the CALMET pre-processing step (Section 5.1.4.6.2). Sections 5.1.4.6.4 and Section 5.1.8 Section 5.1.4.6.5 Sections 5.1.4.6.4
General Reporting Requirements Model accuracy and uncertainty Plan of study Air Dispersion Modelling Study Reporting Requirements Plotted dispersion contours	Yes Yes Yes Yes	Section 5.1.6, Section 5.1.9, and Appendix J Section 5.1.1.1 As per the Regulations Prescribing the Format of the Atmospheric Impact Report, Government Gazette No. 36904, Notice Number 747 of 2013 (11 October 2013) and as per the Regulations Regarding Air Dispersion Modelling (Government Gazette No. 37804 published 11 July 2014). Section 5.1.8.

APPENDIX C: RAW MATERIALS, ABATEMENT EQUIPMENT AND ATMOSPHERIC EMISSIONS AT SASOL SECUNDA

C1: Raw Materials

Table C-1: Raw materials used at Sasol Secunda

Raw Material Type	Maximum Permitted Consumption Rate ^(a)	Units (quantity/period)
Utilities		
<u>Boilers</u>		
Coal		tonnes/h per boiler
Boiler feed water		tonnes/h per boiler
Fuel oil		m ³ /cold start up
Tar sludge East		tonnes/h per boiler
Tar sludge West		tonnes/h per boiler
Ammonia		kg/precipitator/h (90%NH ₃ East and 99% NH ₃ West)
Air (total)		kNm ³ /h per boiler
Low pressure (LP) steam (400kPag)		tonnes/h per boiler
<u>Gas Turbines</u>		
Natural Gas or Methane Rich Gas (MRG)		kJ/kWh (per gas turbine)
		kg/h per gas turbine
Boiler feed water (condensate)		tonnes/h per HRSG
Low pressure (LP) steam (400kPag @ 174°C)		tonnes/h per boiler (de-aerator)
Gas Production		
<u>Coal Processing</u>		
Run-of-mine coal		tonnes/day (per unit)
<u>Gasification and Raw Gas Cooling</u>		
Coarse coal		tonnes/day (per unit)
98.6+ vol% pure oxygen		kNm ³ /h
HP superheated steam		tonnes/h
<u>Rectisol</u>		
Raw Gas		kNm ³ /h per unit
Gas Circuit		
<u>Benfield</u>		
Tail Gas into Benfield		kNm ³ /h
Potassium carbonate recirculation rate		m ³ /h
Carbonate system steam consumption		tonnes/h
DEA solution recirculation rate		m ³ /h
DEA system steam consumption		tonnes/h
<u>Catalyst Manufacturing & Catalyst Reduction</u>		
IP sensitivities		
Refining		
<u>Tar Distillation (Unit 14 / 214)</u>		
Crude Tar/ Depitched Tar (all 4 trains combined)		m ³ /h

Raw Material Type	Maximum Permitted Consumption Rate ^(a)	Units (quantity/period)
<u>Unit 27A</u>		
HNO-DTA		m³/h
<u>Unit 74</u>		
Phenolic pitch		m³/h
<u>Coal Tar Naphtha Hydrogenation (Unit 15 / 215)</u>		
Rectisol, Light and Heavy (containing coker naphtha and raffinate from Merisol) naphtha		m³/h
Naphtha (containing coker naphtha and raffinate from Merisol) from Tar Distillation		m³/h
Naphtha from Tar Distillation		m³/h
<u>Creosote Hydrogenation (Unit 228)</u>		
Creosote from Tar Distillation including coker gas oil		m³/h
<u>Naphtha Hydrotreater, Platformer and CCR (Unit 30/230, 31/231)</u>		
NHT hydrotreater		m³/h
Platformer		m³/h
CCR		
<u>Catalytic Distillation Hydrotreater (Unit 78)</u>		
C5/C6 Hydrocarbons (From Co-monomers)		m³/h
C5 Hydrocarbons from U229/29		m³/h
C6/C7 Hydrocarbons		m³/h
<u>CD Tame (Unit 79)</u>		
C5/C6 Hydrocarbons from Co-monomers		m³/h
Methanol		m³/h
<u>C5 Isomerisation (Unit 90)</u>		
C5 Hydrocarbons from Co-monomers		m³/h
<u>Vacuum Distillation (Unit 34 / 234)</u>		
Decanted Oil		m³/h
<u>Distillate Hydrotreater (Unit 35 / 235)</u>		
DHT feed from U29/229/34/234		m³/h
<u>Distillate Selective Cracker (Unit 35DSC)</u>		
DHT distillate feed from U35 / 235		m³/h
<u>Light Oil Fractionation (Unit 29 / 229)</u>		
Synthol light oil		m³/h
<u>Catalytic polymerisation and LPG recovery (Unit 32 / 232)</u>		
Condensates		m³/h

Raw Material Type	Maximum Permitted Consumption Rate ^(a)	Units (quantity/period)
<u>Polymer Hydrotreater (Unit 33 / 233)</u>		
Unhydrogenated petrol / diesel feed from unit 32/232		m ³ /h
<u>Total Refinery West</u>		
Hydrogen		Nm ³ /h
<u>Total Refinery East</u>		
Hydrogen		Nm ³ /h
<u>Sasol Catalytic Converter</u>		
Fresh C6/C7 Feed		tonnes/h
C2 Rich Gas		tonnes/h
U24 Cracked Gas		tonnes/h
FT Feed to VL7001		tonnes/h
Rerun Gasoline		tonnes/h
99% Hydrogen to reactor		tonnes/h
Hydrogen to CD Hydro Columns		Nm ³ /h
PPU3 Vent Gas		tonnes/h
PP2 Carrier Gas		tonnes/h
HVGO		m ³ /h
Caustic		tonnes/h
Tar, Phenosolvan and sulfur		
<u>Gas Liquor Separation</u>		
Dusty Gas Liquor		kg/h per factory
Tarry Gas Liquor		kg/h per factory
Oily Gas Liquor		kg/h per factory
Trim and Final Cooler Return		kg/h per factory
Rectisol Return		kg/h per factory
<u>Phenosolvan</u>		
Gas Liquor		m ³ /h per factory
<u>Sulfur Recovery</u>		
Offgas from Rectisol & Phenosolvan		kNm ³ /h per absorber (8 absorbers)
Caustic soda		m ³ /day per phase
SAV		tonnes/week (only when required)
ADA		tonnes/week (only when required)
NaSCN		tonnes/day (only when required)
<u>Wet Sulfuric Acid</u>		
Off gas from Rectisol & Phenosolvan		kNm ³ /h
Potable water (Rand Water)		m ³ /h supply to Proxa
Ammonia		Nm ³ /h
<u>Carbo Tar and Coal Tar Filtration</u>		
Unit 039 MTP		m ³ /h
Unit 039 Waxy Oil		m ³ /h
Unit 039 FCC Slurry		m ³ /h

Raw Material Type	Maximum Permitted Consumption Rate ^(a)	Units (quantity/period)
Unit 075 Green coke		tonnes/year
Unit 075 Green coke Hybrid		tonnes/year
Unit 076 Green Coke		tonnes/year
Unit 096 Coal Tar		m ³ /day
Unit 096 Oil		m ³ /day
Unit 086 Waxy Oil Train 1 API Oil		m ³ /h per train
Unit 086 Train 1 Waxy Oil API Oil		m ³ /h per train
Unit 086 Tar Train 2 Dam Tar		m ³ /h per train
Unit 086 Tar Train 2 Raw Tar		m ³ /h per train
Unit 086 Tar Train 2 Tank Sludge's		m ³ /h per train
Unit 086 OBF Waxy Oil 12		m ³ /h per train
Unit 086 OBF HFO 150		m ³ /h per train
Water and Ash		
<u>Multi hearth sludge incinerator</u>		
Thickened waste activated sludge	508	m ³ /day
<u>HOW Incinerator</u>		
High organic waste	48	m ³ /day
<u>Sewage Incinerator</u>		
Raw sewage and Domestic waste Screenings	440	kg/day
<u>WRF TO</u>		
Vent gas, Nitrogen and Air	1578	Nm ³ /h
Market and Process Integration		
<u>Central Corridor Flares</u>		
The flares are safety devices that need to flare gasses to protect equipment during process upset conditions		
Solvents		
<u>Solvents West</u>		
Reaction water ex Synthol		tonnes/h
Propanol plus		tonnes/h
Heavy aldehydes (C3 aldehydes)		tonnes/h
Ethanol 95%		tonnes/h
93 % ethanol for HPE (from EA)		tonnes/h
<u>Solvents East</u>		
Reaction water		tonnes/h
Aldehydes ex West		tonnes/h
Ethanol Effluent		tonnes/h
<u>Ethyl acetate</u>		
Ethanol 95 (E/A)		tonnes/h
<u>Hexene</u>		
Feed (C5- C7)		tonnes/h
NMP		tonnes/year
Methanol		tonnes/h
<u>Octene</u>		
Sweetened feed (total)		tonnes/h
Ethanol		m ³ /year

Raw Material Type	Maximum Permitted Consumption Rate ^(a)	Units (quantity/period)
NMP		tonnes/year
Potassium Carbonate		tonnes/year
<u>Regenerator</u>		
Potassium salt		kg/h
Stripper off gases		kg/h
Fuel gas		kg/h
Atomising steam		kg/h
<u>Safol</u>		
29VL106 Overheads		kg/h
229VL104 Sidedraw		kg/h
Acetonitrile		
HP Hydrogen		kg/h
Pure Gas		kg/h
Instrument air		kg/h
<u>Octene Train 3</u>		
1-Heptene feed from Hexene and Octene 1 (acid free)		
1-Heptene feed from Octene 2 (acidic)		
Syngas		
Hydrogen		
Polymers		
<u>Polypropylene</u>		
<u>PP1</u>		
Propylene		tonnes/year
Ethylene		tonnes/year
Hydrogen		tonnes/year
Nitrogen		tonnes/year
Heptane		tonnes/year
Catalyst		tonnes/year
Co- catalyst		tonnes/year
Silane		tonnes/year
Iso propanol		tonnes/year
1-Pentene		tonnes/year
<u>PP2</u>		
Propylene		tonnes/year
Ethylene		tonnes/year
Hydrogen		tonnes/year
Gas bleed from reactors and propylene recovery unit		kg/h
20 Caustic solution		kg – once per year
<u>Monomers</u>		
<u>Monomers West</u>		
C ₂ Rich Gas (from Synfuels)		tonnes/h
60% C ₂ H ₄		tonnes/h
40% C ₂ H ₆		tonnes/h
Propane		kNm ³ /h

Raw Material Type	Maximum Permitted Consumption Rate ^(a)	Units (quantity/period)
Low Pressure Gas		m³/h
C ₃ Condensate		m³/h
Carrier gas		kNm³/h
Ethane from SCC		tonnes/h
Ethane from U280		tonnes/h
<u>Monomers East</u>		
Condensate 2 to U288		tonnes/year
Condensate 3 to U288		tonnes/year
Condensate 3 to U285		tonnes/year
C2's to U280		tonnes/year
Oil		
<u>Main flares</u>		
Feed gas (off-gases, off specification gases and emergency venting)		tonnes/h
<u>Ground level flares</u>		
<u>First flare burner</u>		
Alcohols or off spec products		m³/h
<u>Ammonia flares</u>		
Ammonia		kg/h
Propane		kg/h
Ethane		kg/h
<u>Storage of hydrocarbons</u>		
Various intermediate liquid material		
LOC		
Various products in road loading (Central road loading facility)	VOC containing products loaded in quantities exceeding 50 000 m³/a	m³/year
Various products in rail loading (Central rail loading facility)	VOC containing products loaded in quantities less than 50 000 m³/a	m³/year
Nitro		
<u>Fertilisers</u>		
<u>Granulation Plant</u>		
Ammonia		tonnes/year
Ammonium nitrate		tonnes/year
Ammonium sulfate		tonnes/year
Limestone		tonnes/year
<u>Nitric Acid Plant</u>		
Ammonia		tonnes/day
Air		Nm³/day

Raw Material Type	Maximum Permitted Consumption Rate ^(a)	Units (quantity/period)
Water		m ³ /day
<u>Ammonium Nitrate Plant</u>		
Ammonia		tonnes/year
Nitric Acid		tonnes/year
<u>Liquid Fertilizer Plant</u>		
Water		tonnes/year
Ammonia		tonnes/year
Potassium Chloride		tonnes/year
Urea		tonnes/year
Phosphoric Acid		tonnes/year
Ammonium Nitrate		tonnes/year
Zinc		tonnes/year
<u>Ammonium Sulfate Plant</u>		
Ammonia		kg/h
Sulfuric Acid		tonnes/year
<u>Explosives (open burning grounds)</u>		
Waste		kg/day
Note: Raw material and/or consumption rates were excluded for proprietary or competition law sensitivities.		

Table C-2: All appliances and abatement equipment used on unit processes at the SSO

Appliance name	Appliance type/description	Appliance function/purpose
Not available	Electrostatic Precipitators	Reduce particulate emissions
Not available	Stainless Steel Filters	Reduce particulate emissions
Venturi Scrubber	Venturi Scrubber	Reduce particulate and gaseous emissions
Electrostatic precipitator	Wet Electrostatic precipitator	Reduce particulate and gaseous emissions
Reactor	DeNOx converter	Reduce NOx emissions
Flares	Flares	Combust organic gasses to CO ₂ and H ₂ O
Bag house	Bag filters	Reduce particulate emissions
Cyclones	Cyclones	Reduce particulate emissions

C2: Point Source Emissions

Table C-3: Point source parameters

Point Source code	Source name	Latitude (decimal degrees)	Longitude (decimal degrees)	Height of Release Above Ground (m)	Height Above Nearby Building (m)	Diameter at Stack Tip / Vent Exit (m)	Actual Gas Exit Temperature (°C)	Actual Gas Volumetric Flow (m³/hr)	Actual Gas Exit Velocity (m/s)	Emission Hours	Type of Emission (Continuous / Batch / Intermittent)
Utilities											
B1	West stack	26.5575	29.14993	250	230	13.6	185	10 025 400	23-27	24	Continuous
B2	East stack	26.56014	29.16841	301	281	14.4	185	11 278 580	23-27	24	Continuous
GT1	Gas Turbine stack	26.564167	29.165	40	37	5.3	548	3 176 904	40	24	Continuous
GT2	Gas Turbine stack	26.564167	29.164444	40	37	5.3	548	3 176 904	40	24	Continuous
Gas Production											
Rectisol East	Off gas to main stack	26.56014	29.16841	301	281	13.6	20 - 25	830 370	20-30	24	Continuous
Rectisol West	Off gas to main stack	26.5575	29.14993	250	230	14.4	20 – 25	830 370	20-30	24	Continuous
Gas Circuit											
<i>Catalyst Manufacturing</i>											
CM1	West Kiln Stack	26.55496	29.15655	25	-5	0.91	170	81 163	28.7	24	Batch
CM2	West Arc Furnace Stack	26.55509	29.15655	25	-5	1.6	35	190 211	34.3	24	Batch
CM3	East A Kiln Stack	26.55735	29.17548	25	-5	0.76	205	33 917	12	24	Batch
CM4	East Arc Furnace Stack	26.55773	29.17531	25	-5	1.6	73	43 720	5.35	24	Batch
CM5	East B Kiln Stack	26.55692	29.17537	25	-5	0.77	192	19 970	11.9	24	Batch
Refining											
<i>Tar Distillation</i>											
R1 (14HT101)	Tar Distillation Reboiler Stack Outlet	-26.54917	29.18306	51.876	46.876	0.894	440	7 390	3.27	24	Continuous
R2	Tar Distillation Reboiler Stack	-26.54917	29.15083	51.876	46.876	0.894	440	7 390	3.27	24	Continuous

Point Source code	Source name	Latitude (decimal degrees)	Longitude (decimal degrees)	Height of Release Above Ground (m)	Height Above Nearby Building (m)	Diameter at Stack Tip / Vent Exit (m)	Actual Gas Exit Temperature (°C)	Actual Gas Volumetric Flow (m³/hr)	Actual Gas Exit Velocity (m/s)	Emission Hours	Type of Emission (Continuous / Batch / Intermittent)
(14HT201)	Outlet										
R3 (214HT101)	Tar Distillation Reboiler Stack Outlet	-26.54917	29.13417	51.876	46.876	0.894	440	7 390	3.27	24	Continuous
R4 (214HT201)	Tar Distillation Reboiler Stack Outlet	-26.54917	29.11750	51.876	46.876	0.894	440	7 390	3.27	24	Continuous
<u>Creosote Hydrogenation</u>											
R5 (228HT101)	Heater stack outlet	-26.91972	29.28278	41.274	36.274	0.914	318	9 220	3.9	24	Continuous
<u>Naphtha Hydrotreater, Platformer and CCR</u>											
R6 (30HT101)	NHT charge heater stack outlet	-26.55028	29.14972	51.876	46.876	1.22	298	6216	1.48	24	Continuous
R7 (30HT102)	Stripper Reboiler heater stack outlet	-26.55028	29.14972	38.4	33.4	0.99	304	11527	4.16	24	Continuous
R8 (30HT103)	Platformer charge heater stack outlet	-26.55028	29.14972	51.7	46.7	2.362	177	37722	2.39	24	Continuous
R9 (30HT104)	Debutanizer Reboiler heater stack outlet	-26.55028	29.14972	43	38	1.28	360	8313	1.79	24	Continuous
R10 (30HT105)	Splitter Reboiler heater stack outlet	-26.55028	29.14972	38.4	33.4	0.99	313	6856	2.47	24	Continuous
R11 (230HT101)	NHT charge heater stack outlet	-26.92417	29.28278	51.9	46.9	1.22	298	9696	2.3	24	Continuous
R12 (230HT102)	Stripper reboiler stack outlet	-26.92361	29.28278	38.4	33.4	0.99	304	8576	3.09	24	Continuous
R13 (230HT103)	Platformer Charge Heater stack outlet	-26.92222	29.28306	51.7	46.7	2.362	177	40816	2.59	24	Continuous
R14 (230HT104)	Debutanizer reboiler stack outlet	-26.92306	29.28306	43	38	1.28	360	3312	0.79	24	Continuous
R15 (230HT105)	Splitter reboiler stack outlet	-26.92361	29.28306	38.4	33.4	0.99	313	7115	2.57	24	Continuous
<u>Vacuum Distillation</u>											
R17 (34HT101)	Vacuum heater stack outlet	-26.55056	29.15028	32	27	1.27	321	10727	2.35	24	Continuous

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Point Source code	Source name	Latitude (decimal degrees)	Longitude (decimal degrees)	Height of Release Above Ground (m)	Height Above Nearby Building (m)	Diameter at Stack Tip / Vent Exit (m)	Actual Gas Exit Temperature (°C)	Actual Gas Volumetric Flow (m³/hr)	Actual Gas Exit Velocity (m/s)	Emission Hours	Type of Emission (Continuous / Batch / Intermittent)
R18 (234HT101)	Vacuum heater stack outlet	-26.92472	29.28306	32	27	1.27	321	10727	2.35	24	Continuous
<u>Distillate Hydrotreater</u>											
R19 (35HT101)	Reactor Charge Heater stack outlet	-26.38250	29.14306	41.3	36.3	0.99	299	7865	1.916	24	Continuous
R20 (35HT102)	Fractionator Charge Heater stack outlet	-26.38250	29.14306	44.2	39.2	1.35	345	11112	1.76	24	Continuous
R22 (235HT101)	Reactor Charge Heater stack outlet	-26.92111	29.28278	41.3	36.3	1.308	299	6806	1.31	24	Continuous
R23 (235HT102)	Fractionator Charge Heater stack outlet	-26.92111	29.28278	44.2	39.2	1.35	310	12641	2.45	24	Continuous
<u>Distillate Selective Cracker</u>											
R24 (35HT103)	Reactor Charge Heater stack outlet	-26.38250	29.14306	31.4	26.4	0.87	388	3495	1.63	24	Continuous
R25 (35HT104)	Fractionator Charge Heater stack outlet	-26.38250	29.14306	35	30	0.99	221	3135	1.13	24	Continuous
R26 (35HT105)	Vacuum Charge Heater stack outlet	-26.38250	29.14306	31	26	0.684	340	3728	2.82	24	Continuous
<u>Light Oil Fractionation</u>											
R27 (29HT101)	Light Oil Splitter Reboiler stack outlet	-26.55083	29.15056	48	43	1.808	280	21349	2.31	24	Continuous
R28 (29HT102)	Diesel Splitter Reboiler stack outlet	-26.55139	29.15111	42.6	37.6	1.2	267	13708	3.37	24	Continuous
R29 (229HT101)	Light Oil Splitter Reboiler stack outlet	-26.92472	29.28306	47.7	42.7	1.727	367	36129	4.28	24	Continuous
<u>Polymer Hydrotreating</u>											
R30 (33HT101)	Stripper Reboiler stack outlet	-26.55111	29.14972	34.9	29.9	1.53	300	15260	8300	24	Continuous
R31 (33HT102)	Charge Heater stack outlet	-26.55083	29.14972	38.68	33.68	1.4	274	16055	10429	24	Continuous
R32 (33HT105)	Splitter Reboiler stack outlet	-26.55083	29.14972	46	41	1.37	320	26830	18200	24	Continuous

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Point Source code	Source name	Latitude (decimal degrees)	Longitude (decimal degrees)	Height of Release Above Ground (m)	Height Above Nearby Building (m)	Diameter at Stack Tip / Vent Exit (m)	Actual Gas Exit Temperature (°C)	Actual Gas Volumetric Flow (m³/hr)	Actual Gas Exit Velocity (m/s)	Emission Hours	Type of Emission (Continuous / Batch / Intermittent)
R33 (233HT101)	Stripper Reboiler stack outlet	-26.92556	29.28250	34.9	29.9	1.53	300	15260	8300	24	Continuous
R34 (233HT102)	Charge Heater stack outlet	-26.92556	29.28250	38.68	33.68	1.4	274	16055	10429	24	Continuous
R35 (233HT105)	Splitter Reboiler stack outlet	-26.92556	29.28250	46	41	1.37	320	26830	18200	24	Continuous
<i>Catalytic Polymerisation and LPG recovery</i>											
R36 (32HT101)	Poly Debutanizer Reboiler stack outlet.	-26.92556	29.15028	37.2	32.2	1.24	267	16520	13679	24	Continuous
R37 (32HT201)	Poly Debutanizer Reboiler stack outlet.	-26.55167	29.15028	37.2	32.2	1.24	226	15266	12641	24	Continuous
R38 (32HT102)	Recycle Column Reboiler stack outlet.	-26.55167	29.15028	51.5	46.5	2.13	309	86588	24300	24	Continuous
R39 (232HT101)	Poly Debutanizer Reboiler stack outlet.	-26.92806	29.28167	37.2	32.2	1.24	267	17530	14516	24	Continuous
R40 (232HT201)	Poly Debutanizer Reboiler stack outlet.	-26.92806	29.28167	37.2	32.2	1.24	226	18754	15529	24	Continuous
R41 (232HT102)	Recycle Column Reboiler stack outlet.	-26.92806	29.28167	51.5	46.5	2.13	309	84654	23757	24	Continuous
<i>Sasol Catalytic Converter</i>											
SCC1 Stack	Main stack	26.55599	29.1639	80	76	1.067	232	410 000	12.5	24	Continuous
SCC2 (TK 1001)	Slurry Storage Tank – N ₂ blanketing	26.55599	29.1639	11	N/A	N/A	N/A	N/A	N/A	24	Intermittent
SCC3 (TK 1002)	Fuel Oil Storage Tank – N ₂ blanketing	26.55599	29.1639	11	N/A	N/A	N/A	N/A	N/A	24	Intermittent
SCC4 (TK 1003)	Fuel Oil Make-up Tank – N ₂ blanketing	26.55599	29.1639	7	N/A	N/A	N/A	N/A	N/A	24	Intermittent
SCC5 (TK 3201)	DEA – Storage Tank – N ₂ blanketing	26.55599	29.1639	9	N/A	N/A	N/A	N/A	N/A	24	Intermittent
SCC6 (TK 3202)	Slop Oil tank – N ₂ blanketing	26.55599	29.1639	5.7	N/A	N/A	N/A	N/A	N/A	24	Intermittent

Point Source code	Source name	Latitude (decimal degrees)	Longitude (decimal degrees)	Height of Release Above Ground (m)	Height Above Nearby Building (m)	Diameter at Stack Tip / Vent Exit (m)	Actual Gas Exit Temperature (°C)	Actual Gas Volumetric Flow (m³/hr)	Actual Gas Exit Velocity (m/s)	Emission Hours	Type of Emission (Continuous / Batch / Intermittent)
SCC7 (TK 3401)	Caustic Storage Tank – N ₂ blanketing	26.55599	29.1639	5.5	N/A	N/A	N/A	N/A	N/A	24	Intermittent
SCC8 (TK 3402)	Spent Caustic Tank – N ₂ blanketing	26.55599	29.1639	5.5	N/A	N/A	N/A	N/A	N/A	24	Intermittent
Tar, Phenosolvan and Sulfur:											
<i>Phenosolvan</i>											
P1	Ammonia vent line at west stack	26.5575	29.14993	250	230	0.6	33	30	0.114		Intermittent
P2	Ammonia vent line at east stack	26.56014	29.16841	301	281	0.6	31	30	0.114		Intermittent
<i>Wet Sulfuric Acid</i>											
WSA1 (518ME-1003)	Wet Sulfuric Acid stack	26.559278	29.167642	75	65	2.75	41	206 600	9.73	24	Continuous
<i>Carbo Tar and Coal Tar Filtration</i>											
FPP1 (U86 TK201)	Storage and mixing Tank	26.54895	29.14649	18	12	N/A	N/A	N/A	N/A	24	Batch
FPP2 (U86 TK202)	Storage and mixing Tank	26.54887	29.14697	18	12	N/A	N/A	N/A	N/A	24	Batch
FPP3 (U86 TK203)	Storage and mixing Tank	26.54882	29.14697	18	12	N/A	N/A	N/A	N/A	24	Batch
FPP4 (U86 TK204)	Storage and mixing Tank	26.54876	29.14697	18	12	N/A	N/A	N/A	N/A	24	Batch
FPP5 (U86 ME514)	Stack	26.5487	29.14879	18	14	0.609	17.86	20 000	24	24	Batch
CT1 (39 TK101)	Waxy Oil 30 tank	26.54887	29.1483	10	6	N/A	N/A	N/A	N/A	24	Continuous
CT 2 (39 TK102)	Waxy Oil 30 tank	26.54896	29.14816	10	6	N/A	N/A	N/A	N/A	24	Continuous
CT3 (39 TK103)	Pitch tank	26.54899	29.14762	10	6	N/A	N/A	N/A	N/A	24	Continuous

Point Source code	Source name	Latitude (decimal degrees)	Longitude (decimal degrees)	Height of Release Above Ground (m)	Height Above Nearby Building (m)	Diameter at Stack Tip / Vent Exit (m)	Actual Gas Exit Temperature (°C)	Actual Gas Volumetric Flow (m³/hr)	Actual Gas Exit Velocity (m/s)	Emission Hours	Type of Emission (Continuous / Batch / Intermittent)
CT4 (39 TK104)	Pitch tank	26.54887	29.14746	10	6	N/A	N/A	N/A	N/A	24	Continuous
CT5 (39 TK105)	Pitch tank	26.54875	29.14714	10	6	N/A	N/A	N/A	N/A	24	Continuous
CT6 (39 TK112)	FCC Slurry tank	26.54887	29.14746	10	6	N/A	N/A	N/A	N/A	24	Continuous
CT7 (39 TK 113)	FCC Slurry tank	26.54875	29.14714	10	6	N/A	N/A	N/A	N/A	24	Continuous
CT8 (39 TK 114)	FCC Slurry tank	26.54904	29.1472	10	6	N/A	N/A	N/A	N/A	24	Continuous
CT9 (39 TK 115)	FCC Slurry tank	26.54907	29.14731	10	6	N/A	N/A	N/A	N/A	24	Continuous
CT10 (39TK 201)	Fuel Oil 10	26.5487	29.14711	8	N/A	N/A	N/A	N/A	N/A	24	Continuous
CT11 (39TK 202)	Low Sulfur Heavy Fuel Oil	26.54877	29.14711	8	N/A	N/A	N/A	N/A	N/A	24	Continuous
CT12 (39TK 203)	Low Sulfur Heavy Fuel Oil	26.54884	29.14709	8	N/A	N/A	N/A	N/A	N/A	24	Continuous
CT13 (39TK 204)	Heavy Tar Oil	26.54891	29.14709	8	N/A	N/A	N/A	N/A	N/A	24	Continuous
CT14 (39 H101)	Stack	26.55026	29.14843	60	56	1.53	320	5.74	3.1	24	Continuous
Water and Ash:											
<i>Multi Hearth Sludge Incinerators</i>											
WA1 (52WK-2102)	Stack	26.54617	29.1422	30	10	1.2	80	41 063	10.08	24	Continuous
WA2 (52WK-2202)	Stack	26.54598	29.14155	30	10	1.2	80	41 063	10.08	24	Continuous
WA3 (252WK-2102)	Stack	26.54096	29.14283	30	10	1.2	80	40 298	9.89	24	Continuous

Point Source code	Source name	Latitude (decimal degrees)	Longitude (decimal degrees)	Height of Release Above Ground (m)	Height Above Nearby Building (m)	Diameter at Stack Tip / Vent Exit (m)	Actual Gas Exit Temperature (°C)	Actual Gas Volumetric Flow (m³/hr)	Actual Gas Exit Velocity (m/s)	Emission Hours	Type of Emission (Continuous / Batch / Intermittent)
WA4 (252WK-2202)	Stack	26.54111	29.14226	30	10	1.2	80	40 298	9.89	24	Continuous
<u>HOW Incinerators</u>											
HOW1 (052CI-101)	Chimney	26.5481	29.14257	15	7	1.8	600 (max)	74 731	8.15	24	Continuous
HOW2 (252CI-101)	Chimney	26.5432	29.14331	15	7	1.8	600 (max)	60 055	6.55	24	Continuous
<u>Sewage Incinerator</u>											
SW1 (353IN101)	Chimney	26.53883	29.14611	10	5	0.8	231	4485	4.4	24	Batch
<u>WRF RTO</u>											
WRF	Thermal oxidiser	26.55089	29.1434	20	15	1.25	815	1940	0.44	24	Continuous
Solvents											
1	Regenerator Stack (Octene)	26.5534028	29.1788083	66	63	Approx 1.2m	88.04	66654	16.93	24	Continuous
2	Stack for heater and	26.554425	29.180619	58	52	1	350	27000	9.6	24	Continuous
Polymers											
<u>Monomers West</u>											
1	Furnace A stack	26.54283	29.154	34	30	0.7	300	43000	31	24	Continuous
2	Furnace B stack	26.54283	29.154	34	30	0.7	300	43000	31	24	Continuous
3	Furnace C stack	26.54283	29.154	34	30	0.7	300	43000	31	24	Continuous
4	Furnace D stack	26.54283	29.154	34	30	0.7	300	43000	31	24	Continuous
5	Furnace E stack	26.54283	29.154	34	30	0.7	300	43000	31	24	Continuous
LOC											
1	Central road loading	-29.1648	26.5487	2 -3 m	Not Available	Not Available	Fugitive emissions				
2	Central road loading	29.1608	26.5488	2 -3 m	Not Available	Not Available	Fugitive emissions				

Point Source code	Source name	Latitude (decimal degrees)	Longitude (decimal degrees)	Height of Release Above Ground (m)	Height Above Nearby Building (m)	Diameter at Stack Tip / Vent Exit (m)	Actual Gas Exit Temperature (°C)	Actual Gas Volumetric Flow (m³/hr)	Actual Gas Exit Velocity (m/s)	Emission Hours	Type of Emission (Continuous / Batch / Intermittent)
Nitro											
1	Nitric Acid Stack	26.5918	29.18227	61	20.5	1.52	100	120 000	18.36	24	Continuous
2	Ammonium Nitrate Production Plant Stack	26.58996	29.18286	45.3	38.8	0.8	76.5	20413	11.28	24	Continuous
3	Granular Fertilizer Production Plant Stack (LAN)	26.9775	29.4086	64	42	3	40	420000	12.38	24	Continuous
4	Ammonium Sulfate Stack	26.7142	29.4147	21		0.91	22.1	40 401	17.25	24	Continuous

Table C-5: Point source emission rates during normal operating conditions

Point Source Code	Pollutant Name	Maximum Release Rate (mg/Nm ³) ^(a)	Average Period	Duration of Emissions
Utilities				
B1 (U43)	Particulate matter	120	Daily	Continuous
	SO ₂	2 000	Daily	Continuous
	NO _x	1 100	Daily	Continuous
B2 (2U43)	Particulate matter	120	Daily	Continuous
	SO ₂	2 000	Daily	Continuous
	NO _x	1 100	Daily	Continuous
GT1	Particulate matter	10	Daily	Continuous
	SO ₂	500	Daily	Continuous
	NO _x	300	Daily	Continuous
GT2	Particulate matter	10	Daily	Continuous
	SO ₂	500	Daily	Continuous
	NO _x	300	Daily	Continuous
Gas Production				
Rectisol East (Off gas to main stack)	H ₂ S (measured as S)	13.5 t/hr (combined with West)	Daily	Continuous
	Total VOC's	300	Hourly	Continuous
	H ₂ S	8 400	Daily	Continuous
Rectisol West (Off gas to main stack)	H ₂ S (measured as S)	13.5 t/hr (combined with East)	Daily	Continuous
	Total VOC's	300	Hourly	Continuous
	H ₂ S	8 400	Daily	Continuous
Gas Circuit				
CM1 (West Kiln Stack)	Particulate matter	100	Hourly	Continuous
	SO ₂	500	Hourly	Continuous
	NO _x expressed as NO ₂	2000	Hourly	Continuous
CM2 (West Arc Furnace stack)	Particulate matter	100	Hourly	Continuous
	SO ₂	500	Hourly	Continuous
	NO _x expressed as NO ₂	500	Hourly	Continuous
CM3 (East Kiln A Stack)	Particulate matter	100	Hourly	Continuous
	SO ₂	500	Hourly	Continuous
	NO _x expressed as NO ₂	2000	Hourly	Continuous
CM4 (East Arc Furnace stack)	Particulate matter	100	Hourly	Continuous
	SO ₂	500	Hourly	Continuous
	NO _x expressed as NO ₂	500	Hourly	Continuous
CM5 (East Kiln B Stack)	Particulate matter	100	Hourly	Continuous
	SO ₂	500	Hourly	Continuous
	NO _x expressed as NO ₂	2000	Hourly	Continuous
Refining				
R1 (14HT101)	Particulate matter	120	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
R2 (14HT201)	Particulate matter	120	Hourly	Continuous

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Point Source Code	Pollutant Name	Maximum Release Rate (mg/Nm ³) ^(a)	Average Period	Duration of Emissions
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
R3 (214HT101)	Particulate matter	120	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
R4 (214HT201)	Particulate matter	120	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
R5 (228HT101)	Particulate matter	120	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
R6 (30HT101)	Particulate matter	120	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
R7 (30HT102)	Particulate matter	120	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
R8 (30HT103)	Particulate matter	120	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
R9 (30HT104)	Particulate matter	120	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
R10 (30HT105)	Particulate matter	120	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
R11 (230HT101)	Particulate matter	120	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
R12 (230HT102)	Particulate matter	120	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
R13 (230HT103)	Particulate matter	120	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
R14 (230HT104)	Particulate matter	120	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
R15 (230HT105)	Particulate matter	120	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
R17 (34HT101)	Particulate matter	120	Hourly	Continuous

Point Source Code	Pollutant Name	Maximum Release Rate (mg/Nm ³) ^(a)	Average Period	Duration of Emissions
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
R18 (234HT101)	Particulate matter	120	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
R19 (35HT101)	Particulate matter	120	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
R20 (35HT102)	Particulate matter	120	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
R22 (235HT101)	Particulate matter	120	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
R23 (235HT102)	Particulate matter	120	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
R24 (35HT103)	Particulate matter	120	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
R25 (35HT104)	Particulate matter	120	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
R26 (35HT105)	Particulate matter	120	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
R27 (29HT101)	Particulate matter	120	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
R28 (29HT102)	Particulate matter	120	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
R29 (229HT101)	Particulate matter	120	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
R30 (33HT101)	Particulate matter	120	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
R31 (33HT102)	Particulate matter	120	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
R32 (33HT105)	Particulate matter	120	Hourly	Continuous

Point Source Code	Pollutant Name	Maximum Release Rate (mg/Nm ³) ^(a)	Average Period	Duration of Emissions
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
	Particulate matter	120	Hourly	Continuous
R33 (233HT101)	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
	Particulate matter	120	Hourly	Continuous
R34 (233HT102)	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
	Particulate matter	120	Hourly	Continuous
R35 (233HT105)	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
	Particulate matter	120	Hourly	Continuous
R36 (32HT101)	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
	Particulate matter	120	Hourly	Continuous
R37 (32HT201)	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
	Particulate matter	120	Hourly	Continuous
R38 (32HT102)	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
	Particulate matter	120	Hourly	Continuous
R39 (232HT101)	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
	Particulate matter	120	Hourly	Continuous
R40 (232HT201)	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
	Particulate matter	120	Hourly	Continuous
R41 (232HT102)	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
	Particulate matter	120	Hourly	Continuous
SCC5 Stack	SO ₂	3000	Hourly	Continuous
	NO _x expressed as NO ₂	550	Hourly	Continuous
	Particulate matter	330	Hourly	Continuous
Tar, Phenosolvan and Sulfur (TPS)				
WSA1 (518-ME-1003)	SO ₂	2800	Hourly	Continuous
	SO ₃	100	Hourly	Continuous
	NO _x	2000	Hourly	Continuous
Water and Ash				
^(a) emission limits in line with the alternative emission limit applied for				
^(b) Average concentrations measured quarterly for preceeding 2 years. Incinerator will be decommissioned in first quarter of 2017.				
WA1 (052WK-2102) ^(a)	Particulate matter	600	Hourly	Continuous
	CO	4 422	Hourly	Continuous
	SO ₂	205	Hourly	Continuous
	NO _x expressed as NO ₂	714	Hourly	Continuous

Point Source Code	Pollutant Name	Maximum Release Rate (mg/Nm ³) ^(a)	Average Period	Duration of Emissions
	HCl	29	Hourly	Continuous
	HF	20	Hourly	Continuous
	Pb+As+Sb+Cr+Co+Cu+Mn+Ni+V	2.6	Hourly	Continuous
	Hg	0.95	Hourly	Continuous
	Cd+Tl	0.12	Hourly	Continuous
	TOC	4 216	Hourly	Continuous
	NH ₃	52	Hourly	Continuous
	Dioxins and furans	0.31 (ng I-TEQ/Nm ³)	Hourly	Continuous
WA2 (052WK-2202) ^(a)	Particulate matter	600	Hourly	Continuous
	CO	4 422	Hourly	Continuous
	SO ₂	205	Hourly	Continuous
	NO _x expressed as NO ₂	714	Hourly	Continuous
	HCl	29	Hourly	Continuous
	HF	20	Hourly	Continuous
	Pb+As+Sb+Cr+Co+Cu+Mn+Ni+V	2.6	Hourly	Continuous
	Hg	0.95	Hourly	Continuous
	Cd+Tl	0.12	Hourly	Continuous
	TOC	4 216	Hourly	Continuous
	NH ₃	52	Hourly	Continuous
	Dioxins and furans	0.31 (ng I-TEQ/Nm ³)	Hourly	Continuous
WA3 (252WK-2102) ^(a)	Particulate matter	600	Hourly	Continuous
	CO	4 422	Hourly	Continuous
	SO ₂	205	Hourly	Continuous
	NO _x expressed as NO ₂	714	Hourly	Continuous
	HCl	29	Hourly	Continuous
	HF	20	Hourly	Continuous
	Pb+As+Sb+Cr+Co+Cu+Mn+Ni+V	2.6	Hourly	Continuous
	Hg	0.95	Hourly	Continuous
	Cd+Tl	0.12	Hourly	Continuous
	TOC	4 216	Hourly	Continuous
	NH ₃	52	Hourly	Continuous
	Dioxins and furans	0.31 (ng I-TEQ/Nm ³)	Hourly	Continuous
WA4 (252WK-2202) ^(a)	Particulate matter	600	Hourly	Continuous
	CO	4 422	Hourly	Continuous
	SO ₂	205	Hourly	Continuous
	NO _x expressed as NO ₂	714	Hourly	Continuous
	HCl	29	Hourly	Continuous
	HF	20	Hourly	Continuous
	Pb+As+Sb+Cr+Co+Cu+Mn+Ni+V	2.6	Hourly	Continuous
	Hg	0.95	Hourly	Continuous
	Cd+Tl	0.12	Hourly	Continuous
	TOC	4 216	Hourly	Continuous

Point Source Code	Pollutant Name	Maximum Release Rate (mg/Nm ³) ^(a)	Average Period	Duration of Emissions
	NH ₃	52	Hourly	Continuous
	Dioxins and furans	0.31 (ng I-TEQ/Nm ³)	Hourly	Continuous
SW1 (353IN101) ^(b)	Particulate matter	26	Hourly	Continuous
	CO	193	Hourly	Continuous
	SO ₂	20	Hourly	Continuous
	NO _x expressed as NO ₂	200	Hourly	Continuous
	HCl	10	Hourly	Continuous
	HF	1.6	Hourly	Continuous
	Pb+As+Sb+Cr+Co+Cu+Mn+Ni+V	1.3	Hourly	Continuous
	Hg	0.7	Hourly	Continuous
	Cd+Tl	0.05	Hourly	Continuous
	TOC	92	Hourly	Continuous
	NH ₃	10	Hourly	Continuous
	Dioxins and furans	0.19 (ng I-TEQ/Nm ³)	Hourly	Continuous
HOW1 (052CI-101) ^(a)	Particulate matter	1 354	Hourly	Continuous
	CO	1 400	Hourly	Continuous
	SO ₂	546	Hourly	Continuous
	NO _x expressed as NO ₂	3 800	Hourly	Continuous
	HCl	55	Hourly	Continuous
	HF	10	Hourly	Continuous
	Pb+As+Sb+Cr+Co+Cu+Mn+Ni+V	21	Hourly	Continuous
	Hg	0.27	Hourly	Continuous
	Cd+Tl	0.12	Hourly	Continuous
	TOC	38	Hourly	Continuous
	NH ₃	12	Hourly	Continuous
	Dioxins and furans	4.2 (ng I-TEQ/Nm ³)	Hourly	Continuous
HOW2 (252CI-101) ^(a)	Particulate matter	1 354	Hourly	Continuous
	CO	1 400	Hourly	Continuous
	SO ₂	546	Hourly	Continuous
	NO _x expressed as NO ₂	3 800	Hourly	Continuous
	HCl	55	Hourly	Continuous
	HF	10	Hourly	Continuous
	Pb+As+Sb+Cr+Co+Cu+Mn+Ni+V	21	Hourly	Continuous
	Hg	0.27	Hourly	Continuous
	Cd+Tl	0.12	Hourly	Continuous
	TOC	38	Hourly	Continuous
	NH ₃	12	Hourly	Continuous
	Dioxins and furans	4.2 (ng I-TEQ/Nm ³)	Hourly	Continuous
Solvents				
1 (Regenerator Stack, Octene)	Particulate matter	120	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	200	Hourly	Continuous

Point Source Code	Pollutant Name	Maximum Release Rate (mg/Nm ³) ^(a)	Average Period	Duration of Emissions
2 (HT 1901/HT1902)	Particulate matter	120	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	200	Hourly	Continuous
Polymers				
1 (Furnace A stack)	Particulate matter	120	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
2 (Furnace B stack)	Particulate matter	120	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
3 (Furnace C stack)	Particulate matter	120	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
4 (Furnace D stack)	Particulate matter	120	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
5 (Furnace E stack)	Particulate matter	120	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
Oil				
All sources	VOCs (non-thermal)	40000	24 hours	Continuous
Nitro				
1 Nitric Acid Stack	NO _x expressed as NO ₂	2000	Hourly	Continuous
	NH ₃	100	Hourly	Continuous
2 Ammonium Nitrate Stack	NH ₃	180 mg/Nm ³ on a wet basis	Hourly	Continuous
	Particulate matter	50 mg/Nm ³ on a wet basis	Hourly	Continuous
3 Granular Fertilizer (LAN) stack	NH ₃	300	Hourly	Continuous
	Particulate matter	100	Hourly	Continuous
4 (Ammonium Sulfate Stack	NH ₃	100	Hourly	Continuous
	Particulate matter	100	Hourly	Continuous

(a) units are mg/Nm³ unless otherwise specified

APPENDIX D: CALMET MODEL CONTROL OPTIONS

The CALMET run type selected for this assessment has been highlighted in blue in Table D-1 below.

Table D-1: CALMET model control options

Run Type	Description of Run Type	Ease of Use and Representativeness	Data availability	Advantages	Disadvantages
No Observations	•Prognostic model data, such as WRF to drive CALMET. •No surface or upper air observations input at all.	•Relatively simple to implement in model •Representative of regional meteorological conditions	WRF data (Lakes Environmental) for 2013, 2014 and 2015 at 4km resolution for 200km by 200km study area (Secunda + Sasolburg)	•Simple to implement •Full spatial and temporal variability •No overwater data required •Cloud cover has spatial distribution •Eliminates need for complicated 7 user-input site-specific variables •Ideal as screening run as gives very good estimate	Resolution of prognostic data may potentially be too coarse to be representative of local conditions
Partial Observations	•Prognostic model data, such as WRF to drive CALMET PLUS •One or more surface stations	•More difficult to implement than only prognostic (WRF) data. •Require 7 site-specific model parameters to be specified. •Difficulty in dealing with missing data. •Potential disagreement between prognostic and surface observations. •Very representative and considered 'refined modelling'	• WRF data (Lakes Environmental) for 2013, 2014 and 2015 at 4km resolution for 200km by 200km study area (Secunda + Sasolburg) •Sasol operated surface meteorological weather stations (4 Sasolburg³ and 3 Secunda⁴)	•Full spatial and temporal variability •No overwater data required •Refined model run as using combined approach of numerical model and observations. •Ability to incorporate surface representative observation data when WRF data is too coarse to fully pick up local effects.	•Surface data, especially winds may be different to that in the WRF data file •User must include 7 site-specific variables •Data preparation and missing data
Observations Only	CALMET driven solely by surface, upper air and optional overwater and precipitation stations	•Require 7 site-specific model parameters to be specified. Difficulty in dealing with missing data.	•Sasol operated surface meteorological weather stations (4 Sasolburg and 3 Secunda) •Closest upper air monitoring	Very good if upper air and surface stations are located close to the facility and if upper air data are recorded at sunrise and sunset.	•Upper air data typically 12 hourly, poor spatial and temporal resolution •Model has to interpolate

³ Sasol 1 Fence Line (WS, WD, TEMP, RH,AMB PRESS, SOL RAD, RAIN); AJ Jacobs (WS, WD,SO₂, NO₂, PM₁₀, PM_{2.5}); Leitrim (WS, WD, TEMP, AMB PRESS, SO₂, O₃, NO₂, PM₁₀, PM_{2.5}) and Eco Park (WS, WD, TEMP, RH,AMB PRESS, SOL RAD, RAIN, SO₂, O₃, NO₂, PM₁₀, PM_{2.5})

⁴ Sasol Club (WS, WD, TEMP, NO₂, SO₂, H₂S, O₃, PM₁₀, PM_{2.5}, CO, VOC); Bosjesspruit (WS, WD, TEMP, NO₂, SO₂, H₂S) and Embalenhle (WS, WD, TEMP, NO₂, SO₂, H₂S, O₃, PM₁₀, PM_{2.5}, CO)

Run Type	Description of Run Type	Ease of Use and Representativeness	Data availability	Advantages	Disadvantages
		•Considered representative if sufficient observation stations and site specific choice of parameters by the modeller.	station is at OR Tambo International Airport (twice-daily soundings only)		between 12 hour soundings •Soundings at incorrect time of the day. •User has to deal with missing surface and upper air data

APPENDIX E: CALPUFF MODEL CONTROL OPTIONS

The CALPUFF run type selected for this assessment has been highlighted in blue in Table E-1 below.

Table E-1: CALPUFF model control options

Run Type	Description of Run Type	Ease of Use and Representativeness	Data availability	Advantages	Disadvantages
Sampling Function Puff	This sampling scheme employs radically symmetric Gaussian puffs and is suitable for far field.				
Sampling Function Slug	This sampling scheme uses a non-circular puff (a "slug"), elongated in the direction of the wind during release, to eliminate the need for frequent releases of puffs. Used for near field during rapidly-varying meteorological conditions.				Takes a very long time to run.
Dispersion coefficients MDISP = 1	Dispersion coefficients are computed from measured values of turbulence, sigma-v and sigma-w.	The user must provide an external PROFILE.DAT file containing these parameters, and select a backup method out of options 2, 3 and 4 below in case of missing data.	This measured data is not available in South Africa	Very good if data is available.	These measured parameters are not readily available in South Africa.
Dispersion coefficients MDISP = 2	Dispersion coefficients are computed from internally-calculated sigma-v, sigma-w using micrometeorological variables (u^*, w^*, L, etc.).	This option can simulate AERMOD-type dispersion when the user also selects the use of PDF method for dispersion in the convective boundary layer (MPDF = 1). Note that when simulating AERMOD-type dispersion, the input meteorological data must be	The data is obtained from WRF input information.	Based on improved theoretical work and is an improvement over Pasquill-Gifford.	The coefficients are derived from other parameters.

Run Type	Description of Run Type	Ease of Use and Representativeness	Data availability	Advantages	Disadvantages
		from CALMET and cannot be ISC-type ASCII format data. The user should also be aware that under this option the CALPUFF model will be more sensitive to the appropriateness of the land use characterization.			
Dispersion coefficients MDISP = 3	Pasquill-Gifford (PG) dispersion coefficients for rural areas (computed using the ISCST3 multi-segment approximation) and McElroy-Pooler (MP) coefficients in urban areas.	The current default selection is MDISP = 3, which is ISC-type dispersion. Given the demonstrated improved characterization of dispersion provided by AERMOD, and EPA's intention to replace ISC with AERMOD, use of AERMOD-like dispersion (MDISP = 2, and MPDF = 1) is also acceptable, but likely will be of most benefit for short-range complex flow applications.		Simple to use if you don't have detailed meteorological information. This option can be run using fairly basic meteorological data.	Based on discreet classification scheme (not continuous function). Based on field experiments done elsewhere, may or may not be representative of Highveld area. Previous projects done using this scheme however have provided good correlation over this area.
Dispersion coefficients MDISP = 4	Same as MDISP = 3, except PG coefficients are computed using the MESOPUFF II equations				
Dispersion coefficients MDISP = 5	CTDM sigmas are used for stable and neutral conditions. For unstable conditions, sigmas are computed as in MDISP=3 described above.	When selecting this option, the user must provide an external PROFILE.DAT file, and select a backup method out of options 2, 3 and 4 above in case of missing data.			
Chemical transformation RIVAD	Pseudo-first-order chemical mechanism for SO₂, SO₄²⁻, NO, NO₂, HNO₃, and NO₃ - (RIVAD/ARM3 method)	- RIVAD is a 6-species scheme wherein NO and NO₂ are treated separately. - In the RIVAD scheme the conversion	In order to use the RIVAD scheme, the user must divide the NO_x emissions into NO and NO₂ for each source.	In several tests conducted to date, the results have shown no significant differences between the RIVAD and MESOPUFF II options.	User has to input the NO and NO₂ emissions which are not always known for all sources.

Run Type	Description of Run Type	Ease of Use and Representativeness	Data availability	Advantages	Disadvantages
		- of SO₂ to sulfates is not RH-dependent. - The conversion of NO_x to nitrates is RH-dependent.	- Two options are specified for the ozone concentrations: (1) hourly ozone concentrations from a network of stations, or (2) a single user defined ozone value. - The background ammonia concentrations required for the HNO₃/NH₄NO₃ equilibrium calculation can be user-specified or a default value will be used.		- User has to input the ozone concentrations which are not always known. - The model is restricted to rural conditions.
Chemical transformation MESOPUFF II	Pseudo-first-order chemical mechanism for SO₂, SO₄²⁻, NO_x, HNO₃, and NO₃- (MESOPUFF II method)	- MESOPUFF II is a 5-species scheme in which all emissions of nitrogen oxides are simply input as NO_x. - In the MESOPUFF II scheme, the conversion of SO₂ to sulfates is dependent on relative humidity (RH), with an enhanced conversion rate at high RH. - The conversion of NO_x to nitrates is RH-dependent.	- The MESOPUFF II scheme assumes an immediate conversion of all NO to NO₂. - Two options are specified for the ozone concentrations: (1) hourly ozone concentrations from a network of stations, or (2) a single user defined ozone value. - The background ammonia concentrations required for the HNO₃/NH₄NO₃ equilibrium calculation can be user-specified or a default value will be used.	- In several tests conducted to date, the results have shown no significant differences between the RIVAD and MESOPUFF II options for sulfate and nitrate formation. - The model is applicable to both urban and rural conditions.	- User has to input the ozone concentrations which are not always known. - NO to NO₂ conversion is not included. In model.
User-specified diurnal cycles of transformation					

Run Type	Description of Run Type	Ease of Use and Representativeness	Data availability	Advantages	Disadvantages
rates					
No chemical conversion					

APPENDIX F: THE NO₂/NO_x CONVERSION RATIOS FOR NO₂ FORMATION

Scire and Borissova (2011) analysed hourly monitored NO₂ and NO_x data for 2006 at 325 monitoring sites throughout USA (approximately 2.8 million data points for each species). These observations were grouped into a number of concentration bins and were used to compute bin maximums and bin average curves. Short-term (1-hr) NO₂/NO_x ratios were developed on bin-maximum data, whereas the long-term (annual average) NO₂/NO_x ratios were based on bin-averaged data. The method was subsequently tested using the NO₂/NO_x ratios applied to the observed NO_x at selected stations to predict NO₂, and then compared to observed NO₂ concentrations at that station. As illustrated in the examples, Figure F-1 and Figure F-2, using these empirical curves provide a reasonable estimate of the observed NO₂ can be obtained, albeit mostly more conservative. In Figure F-3, the method is compared to the assumption of 100% conversion over the short-term, which clearly illustrates the extreme conservatism, especially at elevated concentrations.

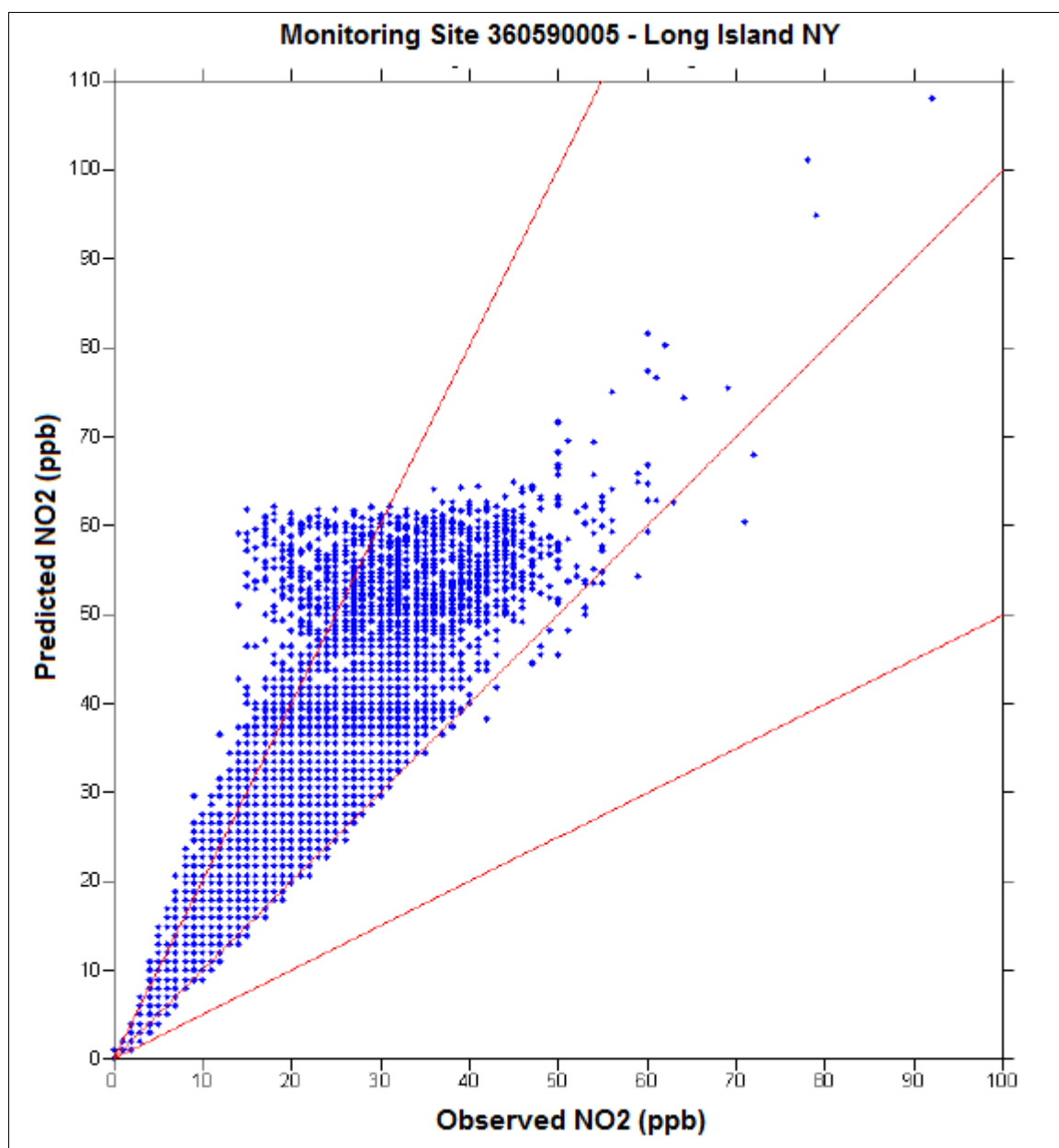


Figure F-1: Comparison of observed with predicted NO₂ concentrations (Long Island, NY) using the derived short-term NO₂/NO_x ratios (Scire and Borissova, 2011)

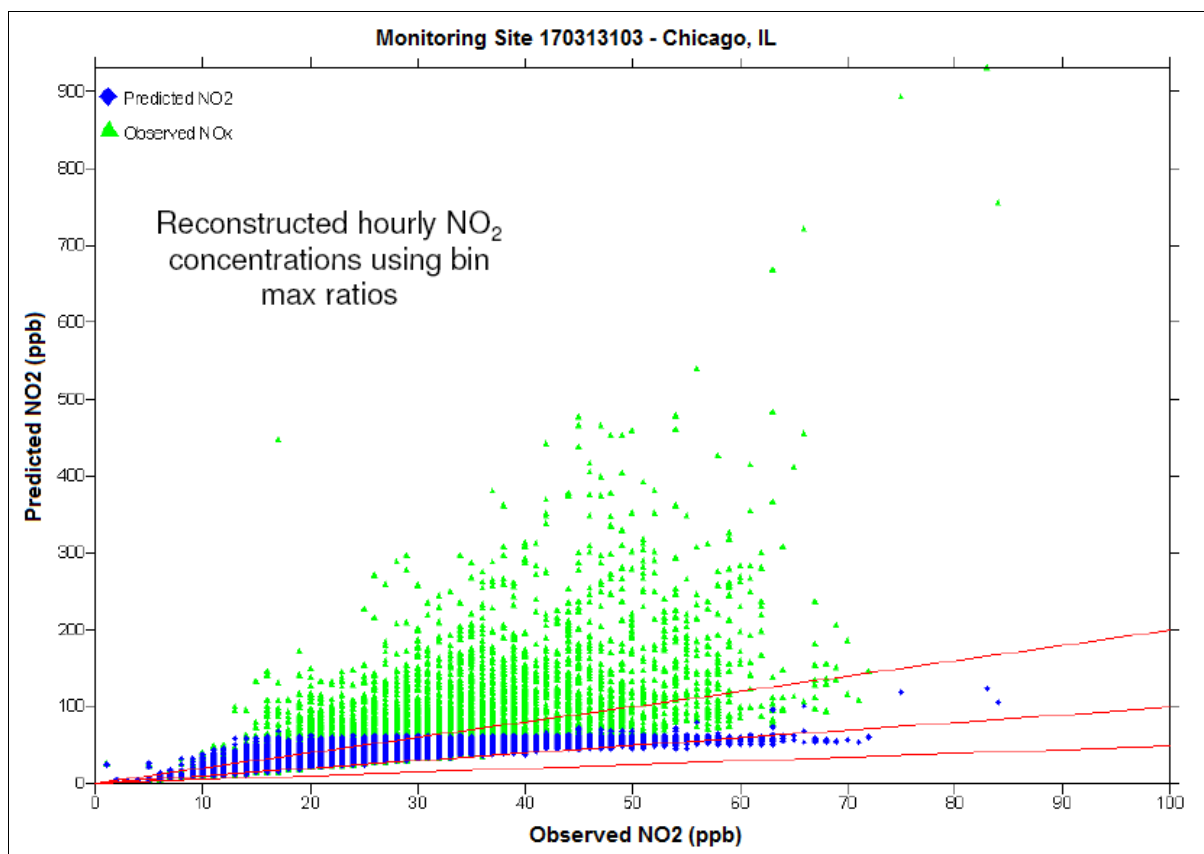


Figure F-2: Comparison of observed with predicted NO₂ concentrations (Chicago, IL) using the derived short-term NO₂/NO_x ratios (Scire and Borissova, 2011)

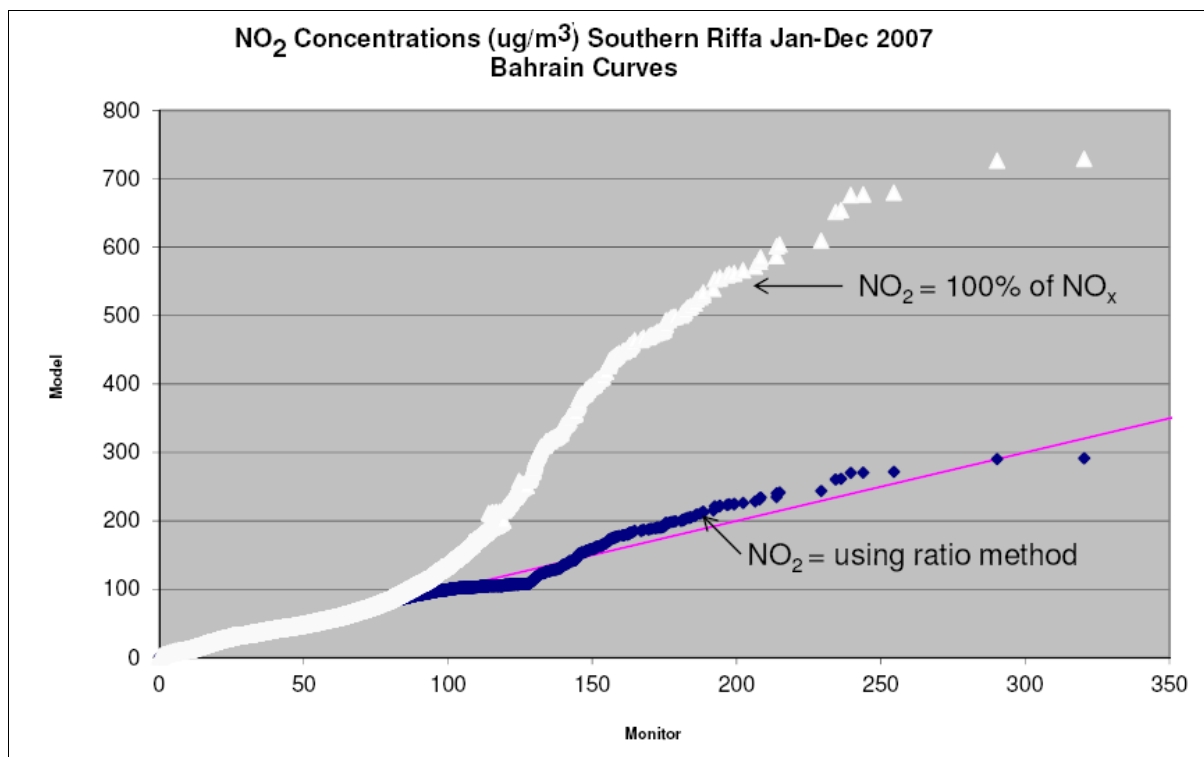


Figure F-3: Observed versus predicted NO₂ concentrations (Bahrain) using the derived short-term NO₂/NO_x ratios (Scire and Borissova, 2011)

It was decided that the NO₂/NO_x conversion factors described by Scire and Borissova (2011) and as given in Table F-1, will be employed in this study. Observed NO₂/NO_x ratios at the Sasolburg monitoring stations were also analysed and compared to the factors in the table (Figure F-1). It is shown in the table and Figure F-4, that the Scire and Borissova ratios would also be applicable in the current study since it would produce estimates similar or more conservative than if the actual NO₂/NO_x ratios at the site would have been used instead.

Table F-1: NO₂/NO_x conversion ratios for NO₂ formation

Bin	Concentration (µg/m ³)			NO ₂ /NO _x Ratios			
				Sasolburg		Scire and Borissova 2011	
	Min	Max	Centre	AJ Jacobs 2010-2012	Ecopark 2012	Bin Average	1-Hour Max
1	0	19	9	0.658	0.521	0.7980	0.9938
2	19	38	28	0.714	0.605	0.8130	0.9922
3	38	75	56	0.657	0.501	0.7306	0.9844
4	75	113	94	0.506	0.428	0.5544	0.9094
5	113	150	132	0.380	0.305	0.4370	0.7477
6	150	188	169	0.309	0.117	0.3553	0.6085
7	188	235	212	0.265	0.311	0.3013	0.4976
8	235	282	259	0.222	0.019	0.2559	0.4173
9	282	329	306	0.208	0.114	0.2276	0.3543
10	329	376	353	0.184	0.105	0.2081	0.3056
11	376	423	400	0.216	0.164	0.1852	0.2684
12	423	470	447	0.161	0.114	0.1809	0.2404
13	470	517	494	0.135	0.101	0.1767	0.2194
14	517	564	541		0.153	0.1546	0.2035
15	564	611	588		0.119	0.1524	0.1912
16	611	658	635		0.071	0.1476	0.1813
17	658	705	682		0.169	0.1402	0.1726
18	705	752	729		0.157	0.1363	0.1645
19	752	846	799		0.133	0.1422	0.1527
20	846	940	893		0.164	0.1223	0.1506
21	940	1128	1034		0.164	0.1087	0.1474
22	1128	1316	1222			0.1110	0.1432
23	1316	1504	1410			0.1112	0.139
24	1504	1786	1645			0.1165	0.1337

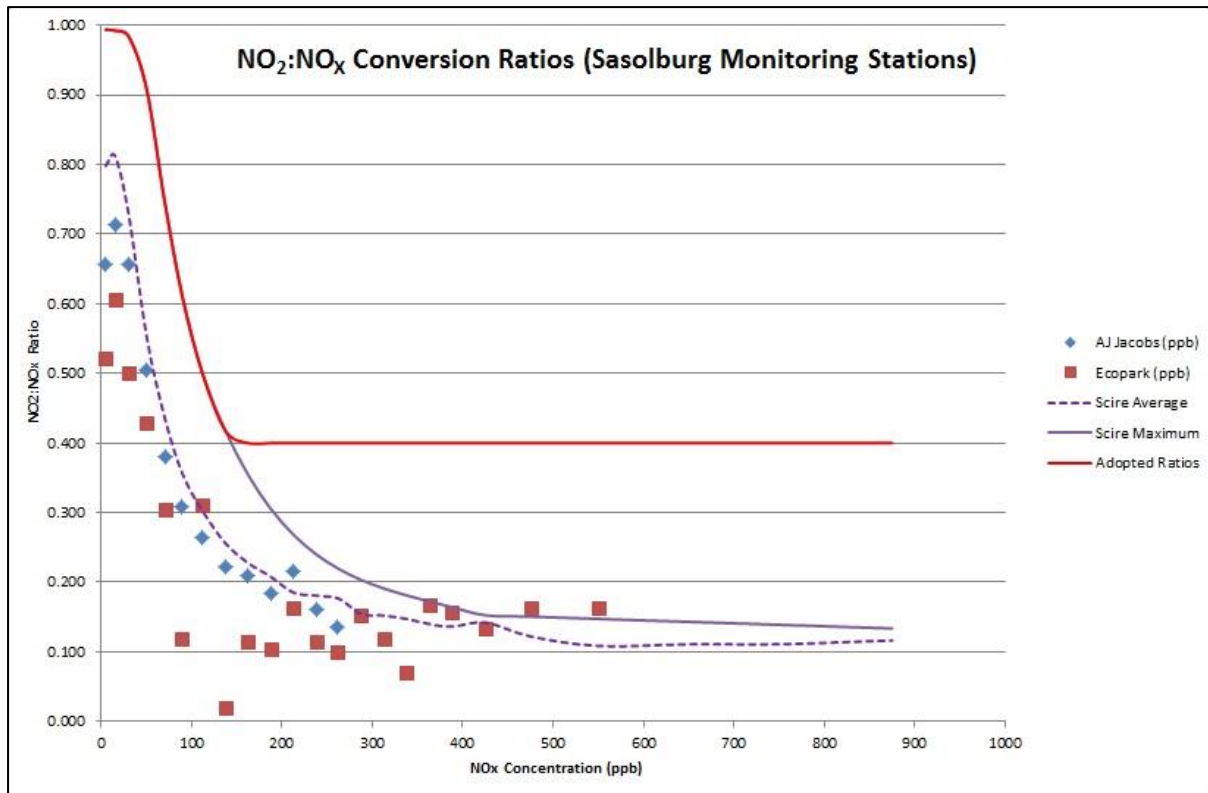


Figure F-4: NO_2/NO_x conversation ratios for Sasol's Sasolburg monitoring stations

APPENDIX G: TIME SERIES PLOTS FOR THE MEASURED AMBIENT AIR QUALITY IN THE STUDY AREA

A summary of the time series plots for the measured data as provided by Sasol is given in the following section.

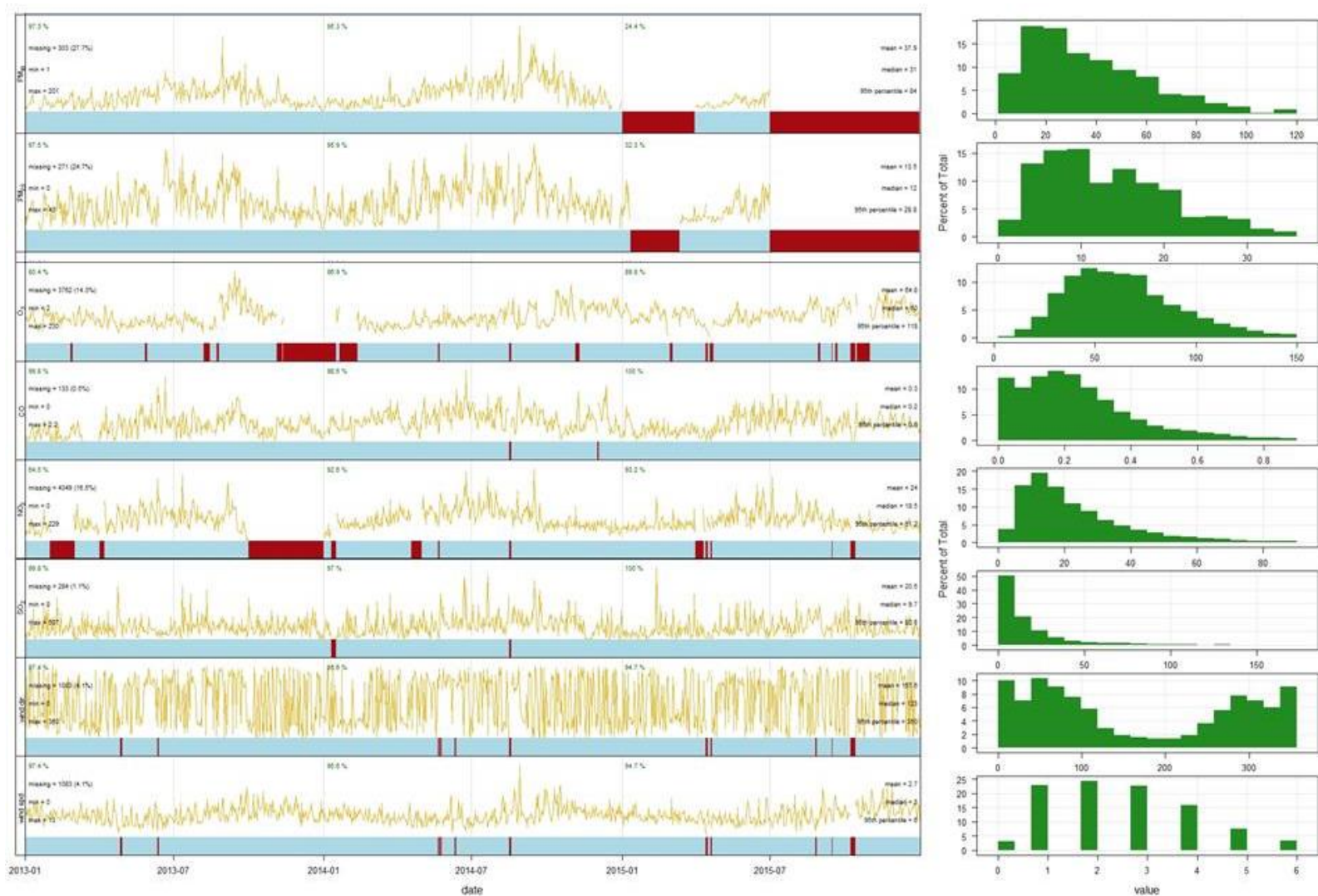


Figure G-1: Data available from the Secunda Club ambient air quality monitoring station

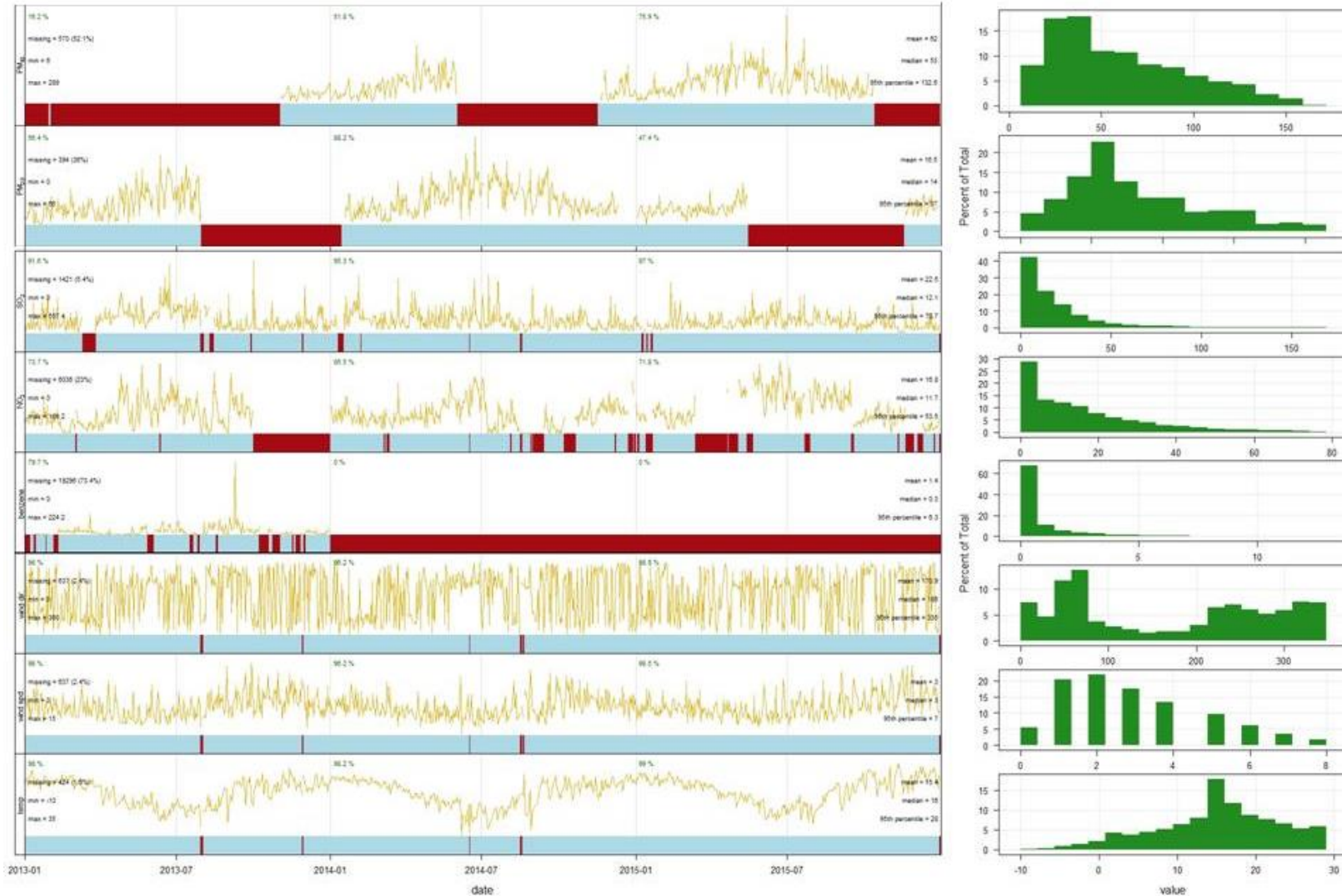


Figure G-2: Data available from the Sasol Embalenhle ambient air quality monitoring station

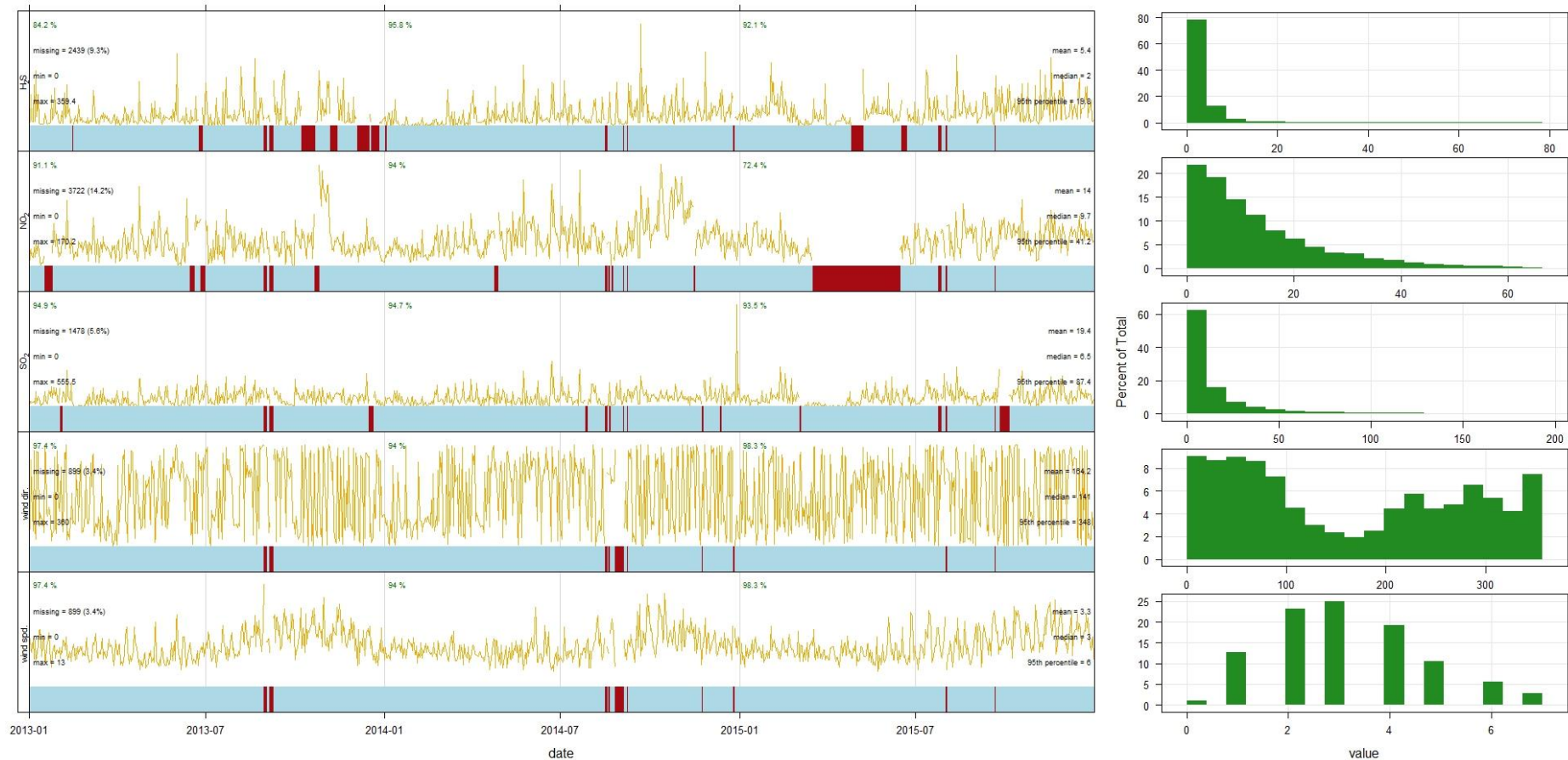


Figure G-3: Data available from the Bosjesspruit ambient air quality monitoring station

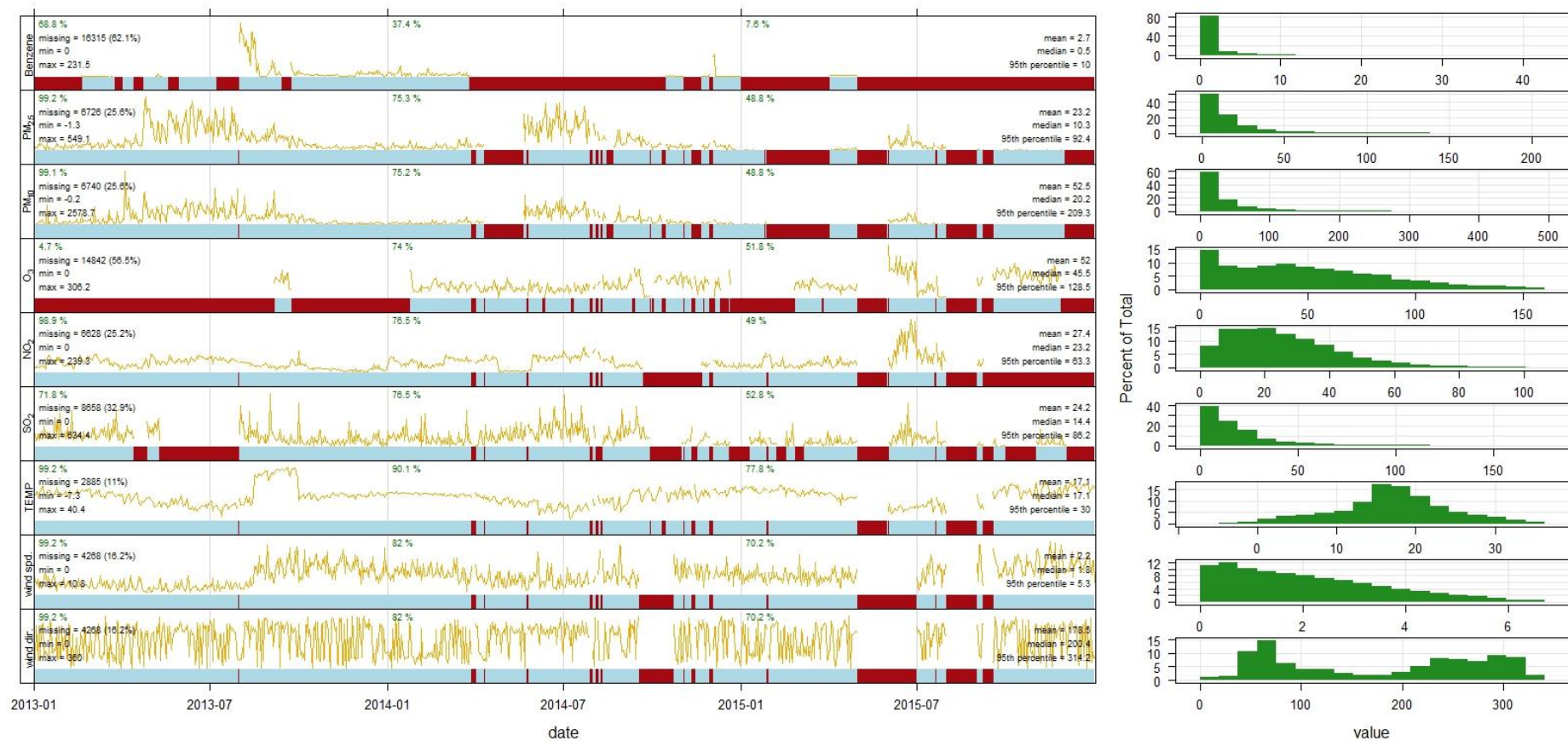


Figure G-4: Data available from the DEA Secunda ambient air quality monitoring station

APPENDIX H: SIMULATED BASELINE AND OBSERVED AIR CONCENTRATIONS

The following tables summarise the predicted baseline SO₂ and NO₂ concentrations at the Sasol and DEA monitoring site locations, respectively. The peak (maximum), 99th, 90th, 50th and annual average values are given for each of the simulated (SSO) years, 2013, 2014 and 2015. The corresponding observed concentration values are also summarised in the tables for comparison. Estimates of background concentrations were obtained from the observed values at the ranked position when no contributions from the simulated sources were predicted.

Table H-1: Simulated SO₂ concentration from routine emissions and observed SO₂ concentration statistics

Description	Year	SO ₂ Concentration (µg/m ³)							
		Bosjesspruit		Secunda Club		Embalenhle		Secunda	
		Simulated	Observed	Simulated	Observed	Simulated	Observed	Simulated	Observed
Maximum	2013	465.5	459.6	838.9	426.3	653.6	557.4	294.4	634.4
	2014	398.3	555.5	437.7	474.4	929.9	433.5	408.5	484.7
	2015	445.6	442.7	779.9	507.0	669.9	397.5	399.7	322.9
	Average	436.5	485.9	685.5	469.2	751.1	462.8	367.5	480.6
99 th Percentile	2013	131.8	184.7	122.5	160.6	61.8	180.1	61.5	161.8
	2014	135.9	194.0	121.6	190.9	116.7	188.1	118.5	195.6
	2015	145.6	203.2	166.0	166.1	89.3	142.9	81.8	126.0
	Average	137.8	194.0	136.7	172.5	89.3	170.4	87.2	161.1
90 th Percentile	2013	6.9	52.0	3.8	47.7	2.6	56.2	1.4	52.1
	2014	7.0	50.6	4.3	54.5	3.5	49.8	1.9	61.2
	2015	8.4	48.5	5.9	46.0	2.8	43.8	1.5	36.9
	Average	7.4	50.4	4.6	49.4	3.0	49.9	1.6	50.0
50 th Percentile	2013	0.0	5.3	0.0	8.9	0.0	15.1	0.0	15.3
	2014	0.0	6.7	0.0	12.9	0.0	12.3	0.0	17.4
	2015	0.0	7.4	0.0	7.4	0.0	10.4	0.0	6.8
	Average	0.0	6.5	0.0	9.7	0.0	12.6	0.0	13.2
Annual Average	2013	5.6	18.6	5.0	19.6	2.9	25.3	2.3	23.6
	2014	5.7	19.8	4.8	23.7	4.4	22.9	3.8	28.5
	2015	6.7	19.9	6.7	18.4	3.5	19.5	2.9	15.2
	Average	6.0	19.4	5.5	20.6	3.6	22.6	3.0	22.4
Background (observed value when)	2013		13.9		22.6		31.3		32.7
	2014		15.6		26.3		25.0		36.6

Description	Year	SO ₂ Concentration (µg/m ³)							
		Bosjesspruit		Secunda Club		Embalenhle		Secunda	
		Simulated	Observed	Simulated	Observed	Simulated	Observed	Simulated	Observed
prediction indicated no contribution at 0.1 µg/m ³)	2015		15.9		19.2		22.6		22.0
	Average		15.2		22.9		26.1		32.2

Table H-2: Simulated NO₂ concentration from routine emissions and observed NO₂ concentration statistics

Description	Year	NO ₂ Concentration (µg/m ³)							
		Bosjesspruit		Secunda Club		Embalenhle		Secunda	
		Simulated	Observed	Simulated	Observed	Simulated	Observed	Simulated	Observed
Maximum	2013	135.4	142.0	248.6	160.2	188.5	169.2	87.0	169.0
	2014	118.4	170.2	128.1	229.0	268.0	162.6	120.3	119.7
	2015	127.1	129.7	231.6	185.8	197.4	118.9	114.4	239.3
	Average	127.0	147.3	202.8	191.7	218.0	150.2	107.3	176.0
99 th Percentile	2013	55.4	64.4	54.2	90.8	40.1	85.5	38.5	69.4
	2014	55.8	71.7	54.1	97.1	54.2	68.2	54.1	77.1
	2015	56.7		58.4	83.4	50.4	80.5	46.7	154.0
	Average	55.9	68.1	55.6	90.4	48.2	78.1	46.4	100.2
90 th Percentile	2013	8.3	31.0	4.4	52.2	7.4	40.7	2.5	44.2
	2014	8.1	34.9	4.5	49.6	8.6	34.4	2.8	50.3
	2015	9.5		5.6	41.7	6.9	47.4	2.3	74.5
	Average	8.6	33.0	4.8	47.8	7.6	40.8	2.5	56.3
50 th Percentile	2013	0.0	7.0	0.0	18.4	0.0	9.2	0.0	21.2
	2014	0.0	11.4	0.0	20.3	0.0	10.9	0.0	26.0
	2015	0.0		0.0	17.1	0.0	14.5	0.0	23.8
	Average	0.0	9.2	0.0	18.6	0.0	11.6	0.0	23.7

Description	Year	NO ₂ Concentration (µg/m ³)							
		Bosjesspruit		Secunda Club		Embalenhle		Secunda	
		Simulated	Observed	Simulated	Observed	Simulated	Observed	Simulated	Observed
Annual Average	2013	3.5	12.1	2.7	24.3	2.4	15.5	1.5	23.5
	2014	3.5	15.9	2.6	25.7	3.0	14.8	2.1	27.9
	2015	3.9	13.9	3.3	22.0	2.4	20.3	1.7	34.2
	<i>Average</i>	3.6	14.0	2.9	24.0	2.6	16.9	1.8	28.5
Background (observed value when prediction indicated no contribution at 0.1 µg/m ³))	2013		12.0		30.7		18.3		33.8
	2014		17.0		29.8		18.7		38.9
	2015		14.5		24.6		27.7		49.0
	<i>Average</i>		14.4		28.1		21.3		38.2

APPENDIX I: MANAGEMENT OF UNCERTAINTIES

Dispersion Model Uncertainties

In the US EPA Guideline on Air Quality Models (U.S. EPA, 2005), the need to address the uncertainties associated with dispersion modelling is acknowledged as an important issue that should be considered. The US Guideline divides the uncertainty associated with dispersion model predictions into two main types (U.S. EPA, 2005), as follows:

- Reducible uncertainty, which results from uncertainties associated with the input values and with the limitations of the model physics and formulations. Reducible uncertainty can be minimized by improved (i.e., more accurate and representative) measurements and improved model physics.
- Inherent uncertainty is associated with the stochastic (turbulent) nature of the atmosphere and its representation (approximation) by numerical models. Models predict concentrations that represent an ensemble average of numerous repetitions for the same nominal event. An individual observed value can deviate significantly from the ensemble value. This uncertainty may be responsible for a $\pm 50\%$ deviation from the measured value.

Atmospheric dispersion models are often criticised for being inadequate since “...it is only a model approximating reality”, and therefore include inherent uncertainty. Both reducible and inherent uncertainties mean that dispersion modelling results may over- or under-estimate measured ground-level concentrations at any specific time or place. However, the US EPA Guideline on Air Quality Models (U.S. EPA, 2005) also states that:

“Models are reasonably reliable in estimating the magnitude of highest concentrations occurring sometime, somewhere within an area. For example, errors in highest estimated concentrations of +/- 10 to 40 per cent are found to be typical, i.e., certainly well within the often-quoted factor of two accuracy that has long been recognized for these models. However, estimates of concentrations that occur at a specific time and site are poorly correlated with actually observed concentrations and are much less reliable.”

To minimise the overall uncertainty, but specifically the “reducible uncertainty”, the following simple principles were followed in the investigation:

- Understanding the objectives of the investigation;
- Demonstrating that the model inputs are as correct as possible;
- Understanding and stating the model performance limitations;
- Demonstrating that the modelling process has been conducted appropriately and in line with both local DEA requirements and international practice;
- Including any validating information from monitoring that might be available; and
- To be conservative in cases where there is greater uncertainty (e.g. conversion of NO to NO₂).

Although the existence of model uncertainty is well-accepted, it does not exclude the use of dispersion modelling results in making important air quality impact decisions. The uncertainties should simply be acknowledged and understood that, given their inherent uncertainty, current dispersion models are a “best-case” approximation of what are otherwise very complex physical processes in the atmosphere. An accepted dispersion model (i.e., CALPUFF) was selected for the analysis to minimize some of these uncertainties. The US EPA states that when dispersion models such as CALPUFF are used to assess ground-level concentration and when a sufficiently large number of meteorological conditions are considered, the

modelling results should ideally fall well within the often quoted "factor of two" accuracy for these modelled (U.S. EPA, 2005).

Validation of Predictions

Model verification and validation (V&V) are the primary processes for quantifying and building credibility in numerical models. There are distinct differences between the two processes, as described below:

- Verification is the process of determining that a model implementation accurately represents the developer's conceptual description of the model and its solution.
- Validation is the process of determining the degree to which a model is an accurate representation of the real world from the perspective of the intended uses of the model.

Whilst V&V cannot prove that a model is correct and accurate for all possible scenarios, it can provide evidence that the model is sufficiently accurate for its intended use.

A rigorous V&V programme was not completed as part of the study; however, regular sanity checks on model results and comparisons with observations were done, as discussed in Section 5.1.6. An attempt was also made to quantify the level of agreement between observed data and model prediction, as well as the predictive accuracy of the model once the necessary adjustments have been made (such as including the estimated background concentrations). In this regard, the CALPUFF model's performance was evaluated by comparing the modelling results for the years 2013, 2014 and 2015 to the Sasol monitoring data collected over the same time period. In particular, the simulated SO₂ and NO₂ concentrations arising from the Secunda operations were included in the comparison.

The performance evaluation was completed using the fractional bias method, since this statistical technique is one of the evaluation methods recommended by the U.S. EPA for determining dispersion model performance (U.S. EPA 1992). Fractional biases were computed for SO₂ and NO₂ as simulated and observed at the four monitoring stations; Bosjesspruit, Secunda Club, Embalenhle and Secunda. The fractional biases of the means were shown to be well within a factor of two, which the U.S. EPA consider to be a reasonable performance target for a dispersion model before it is used for refined regulatory analysis (U.S. EPA 1992).

Scenario Simulations

Since the focus of the study has been to illustrate the relative changes with the introduction of different emission conditions (i.e. emission rates, exit gas temperatures and velocities), whilst maintaining the same stack heights and diameters, it is expected that the model errors would mostly be similar in magnitude between the different modelling scenarios. Therefore, expressing the changes as incremental and relative to the baseline scenario, it is expected that these errors would mostly cancel each other out.

Ambient Monitoring Uncertainty

Sasol operates a total of three ambient air quality monitoring stations in and around Secunda, namely at Bosjesspruit, Secunda Club and Embalenhle. Data for 2013 to 2015 from the monitoring stations were included in this investigation.

All of the abovementioned monitoring stations are ISO/IEC17025 accredited, to ensure data integrity and data quality as well as to ensure that the data obtained from the monitoring stations are representative of the ambient air when measured. Data availability and credibility is maximised through:

- Regular (at least on a weekly basis) visits of the monitoring stations to ensure the stations are functioning properly.
- Dynamic calibrations are conducted on at a quarterly basis, however where possible more frequent calibrations have been done.
- Certified calibration gas is used and obtained from reputable vendors
- Inter-laboratory comparisons are done between Sasol's Sasolburg and Secunda monitoring stations as well as between Sasolburg, Secunda and a third party calibration laboratory.
- Participation in the National Metrological Laboratory's national inter-laboratory comparisons to ensure that the system is in line with the rest of the accredited laboratories in South Africa.

Although the ISO/IEC 17025 System requires a quarterly data availability of 80%, Sasol's internal data availability, tracked on a monthly Scorecard, is a monthly data availability of 90%.

Based on the uncertainty calculations completed as per the ISO/IEC17025 requirements, Sasol's uncertainty in measurements on its ambient air quality monitoring stations is between 3% and 5% with a level of confidence of 95%. This has been confirmed through inter-laboratory comparisons and is confirmed on a regular basis.

Upper Air Meteorological Data

Although meteorological data from the monitoring stations described in the previous section are available for input into the CALPUFF dispersion model, there is a lack of upper air meteorology. Furthermore, it is anticipated that the wind observations at AJ Jacobs may be compromised due to nearby trees and building structures (see Section 5.1.5.1). The lack of appropriate meteorological information is often the single most important limiting factor in modelling accuracy. It is also the most subjective in deciding just how many data are needed, from which location and how accurate they must be.

The CALMET wind field model requires, as a minimum, meteorological data from at least one surface and an upper air station. This information is then used to "seed" the three-dimensional wind field with an initial solution of a relatively simple mass conservation model. CALMET does not include momentum, energy, or moisture conservation equations, and is therefore classified as a diagnostic model.

It is expected, that a wind field developed using all the parameters that could influence the flow, thermal and turbulence mechanisms should improve the accuracy of the dispersion predictions. For simulated data, the Weather Research and Forecasting mesoscale model (known as WRF) was used. The WRF Model is a next-generation mesoscale numerical weather prediction system designed for both atmospheric research and operational forecasting needs. It features two dynamical cores, a data assimilation system, and a software architecture facilitating parallel computation and system extensibility. The model serves a wide range of meteorological applications across scales from tens of meters to thousands of kilometres. WRF can generate atmospheric simulations using real data (observations, analyses) or idealized conditions. WRF offers operational forecasting a flexible and computationally-efficient platform, while providing recent advances in physics, numeric, and data assimilation contributed by developers across the very broad research community.

WRF data for the study domain was purchased from Lake Environmental that has proven record of generating WRF data ready for use in the CALMET modelling suite. The dataset included the years 2013, 2014 and 2015 at 4 km resolution for a 200 km by 200 km study area.

The WRF model together with the meteorological observations provide a 'first-guess field', which is then modified by the CALMET diagnostic model to take account of terrain and land-use features that are at a smaller spatial scale than the terrain used by the prognostic model. The main purpose of this approach is to increase the horizontal resolution of the meteorological fields.

Emission Inventory Uncertainty

In addition to meteorological input data, the uncertainty associated with the emissions inventory needs to be accommodated in the results. All emissions used in the simulations of the baseline scenario were based on either iso-kinetic measurement campaigns or continuous emissions monitoring (CEM).

Sasol makes use of reputable sampling companies for its third party measurement campaign and also operates CEM devices in certain of its plants. Although there is currently no quality accredited system for online monitoring devices within a stack, Sasol is using the same principles as for its ambient air quality monitoring stations, i.e. the ISO/IEC17025 principles to manage the quality of the data received from its online monitoring network.

All third party (and *ad hoc*) sampling requests (or requirements) within the Sasol Group have to comply with AQA Section 21, Schedule 2 of the Listed Activities and Minimum Emission Standard. Furthermore, Sasol has, as far as possible, standardised on US EPA sampling methodologies. Analyses of the samples are also done by an ISO/IEC17025 accredited laboratory to further control the quality of the results.

Where *ad hoc* sampling is done, Sasol's philosophy is aligned with the requirements of the AQA Section 21, namely that all point sources must be sampled at least once a year.

Continuous Emission Monitoring

Due to the lack of a National Accreditation system for CEM, uncertainty in measurements cannot be confirmed at this stage, however based on the uncertainty associated with sampling, Sasol has

- a 10% uncertainty factor associated with its online particulate measurements; and
- an uncertainty below 10% for gases, the based on the accuracy of the completed calibrations, as well as the accuracy of the calibration gases (this uncertainty ranges between 5% and 10%).

These uncertainties are with a level of confidence of 95%.

Third-Party Emission Monitoring

The uncertainty associated with third-party emission's measurements is considered to be up to 10% with a level of confidence of 95%. This uncertainty is based on the isokineticity of the isokinetic sampling, as well as the uncertainty associated with the sample taking and chemical analysis of gaseous components.

According to the Sasol quality control system, all third-party contractors for isokinetic sampling need to comply with the following control criteria:

- Their entire sampling staffs undergo the training associated with the UK-based Monitoring Certification Scheme (MCERTS): Manual Stack emissions monitoring program (MCERTS 2011);
- An electronic automated sampler is used for all isokinetic sampling;
- The pitot tubes used for sampling is calibrated at least on a quarterly basis;
- The pneumatic pressure sensors on the sampler is also calibrated on at least a quarterly basis; and
- The dry gas meters are checked on a regular basis and replaced every 6 months.

The CEM data is logged per second, and then averaged. In this way, all process upsets are captured within the database. The CEM data used in this investigation were based on an hourly average mass flow and concentration.

Ad-Hoc Emissions Sampling

SANAS is compiling an accreditation system for *ad hoc* sampling and as soon as this system is in place, the uncertainty of the measurements will be confirmed; however it is not expected to be higher than 10%.

Sasol is also in the process of conducting an international peer review on its third party contractors to determine whether there is a potential higher uncertainty in its measurements.

The Minimum Emissions Standards requires that sampling be conducted at normal operating conditions; therefore the emissions information included in the dispersion model is aligned with normal operating conditions on site. The sampling schedule is communicated to the plant managers with the aim of having process conditions as representative as possible to normal operations. Sampling upset conditions often poses a challenge from both a logistical and safety point of view, since safety requirements require as few people as possible on the plant during severe upset conditions and therefore sampling cannot be done during such conditions.

PM_{2.5} and PM₁₀ Air Emissions

All particulate matter was assumed to be PM_{2.5} since it was not possible to establish the PM_{2.5}/PM₁₀ split.

Non-Sasol Air Emissions

No attempt was made to estimate the emissions from non-industrial activities within regional communities. Instead, the community contribution (and other sources) of a particular compound was discussed in Section 5.1.6.1.

APPENDIX J: GUIDANCE NOTE ON TREATMENT OF UNCERTAINTIES

The Intergovernmental Panel on Climate Change (IPCC) produced a Guidance Note for lead authors of the IPCC Fifth Assessment Report on consistent treatment of uncertainties. These notes define a common approach and calibrated language that can be used broadly for developing expert judgments and for evaluating and communicating the degree of certainty in findings of the assessment process. Communicating the degree of certainty in key findings relies on expressing the:

- Confidence in the validity of a finding, based on the type, amount, quality, and consistency of evidence (e.g., mechanistic understanding, theory, data, models, expert judgment) and the degree of agreement. Confidence is expressed qualitatively.
- Quantified measures of uncertainty in a finding expressed probabilistically (based on statistical analysis of observations or model results, or expert judgment).

The Guidance Note proposes the use of the following dimensions to evaluate the validity of a finding: the type, amount, quality, and consistency of evidence (summary terms: “limited,” “medium,” or “robust”), and the degree of agreement (summary terms: “low,” “medium,” or “high”), as summarised in the figure below.

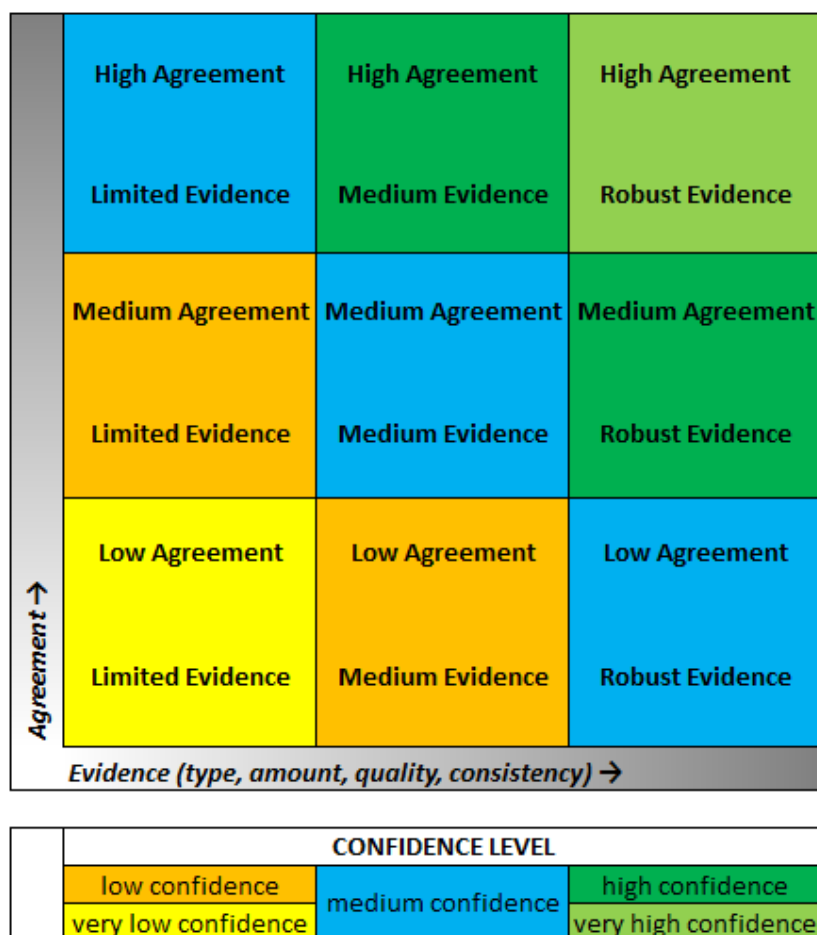


Figure J-1: A depiction of evidence and agreement statements and their relationship to confidence. Confidence increases towards the top-right corner as suggested by the increasing strength of shading. Generally, evidence is most robust when there are multiple, consistent independent lines of high-quality evidence.

Generally, evidence is most robust when there are multiple, consistent independent lines of high-quality evidence. The guide further provides advice for a traceable account describing the evaluation of evidence and agreement, as follows:

- For findings with high agreement and robust evidence, present a level of confidence or a quantified measure of uncertainty.
- For findings with high agreement or robust evidence, but not both, assign confidence or quantify uncertainty when possible. Otherwise, assign the appropriate combination of summary terms for your evaluation of evidence and agreement (e.g., robust evidence, medium agreement).
- For findings with low agreement and limited evidence, assign summary terms for your evaluation of evidence and agreement.
- In any of these cases, the degree of certainty in findings that are conditional on other findings should be evaluated and reported separately.

A level of confidence is expressed using five qualifiers: “very low,” “low,” “medium,” “high,” and “very high.” It synthesizes the author teams’ judgments about the validity of findings as determined through evaluation of evidence and agreement. Figure J-1 depicts summary statements for evidence and agreement and their relationship to confidence. There is flexibility in this relationship; for a given evidence and agreement statement, different confidence levels could be assigned, but increasing levels of evidence and degrees of agreement are correlated with increasing confidence. Confidence cannot necessarily be assigned for all combinations of evidence and agreement in Figure J-1. Presentation of findings with “low” and “very low” confidence should be reserved for areas of major concern, and the reasons for their presentation should be carefully explained. Confidence should not be interpreted probabilistically, and it is distinct from “statistical confidence.” Additionally, a finding that includes a probabilistic measure of uncertainty does not require explicit mention of the level of confidence associated with that finding if the level of confidence is “high” or “very high.”

Likelihood, as defined in Table , provides calibrated language for describing quantified uncertainty. It can be used to express a probabilistic estimate of the occurrence of a single event or of an outcome (e.g., a climate parameter, observed trend, or projected change lying in a given range). Likelihood may be based on statistical or modelling analyses, elicitation of expert views, or other quantitative analyses.

Table J-1: Likelihood scale

Term	Likelihood of the Outcome
Virtually certain	99-100% probability
Very likely	90-100% probability
Likely	66-100% probability
About as likely as not	33 to 66% probability
Unlikely	0-33% probability
Very unlikely	0-10% probability
Exceptionally unlikely	0-1% probability

The categories defined in this table can be considered to have “fuzzy” boundaries. A statement that an outcome is “likely” means that the probability of this outcome can range from ≥66% (fuzzy boundaries implied) to 100% probability. This implies that all alternative outcomes are “unlikely” (0-33% probability). When there is sufficient information, it is preferable to specify the full probability distribution or a probability range (e.g., 90-95%) without using the terms in Table . “About as likely as not” should not be used to express a lack of knowledge.

APPENDIX K: SENSITIVE RECEPTORS INCLUDED IN THE DISPERSION MODEL SIMULATIONS

Table K-1: Discrete sensitive receptors included in the dispersion model simulations

Receptor code name	Receptor details	Distance from centre of operations (km)
Embalenhle	Sasol Embalenhle Monitoring Station (previously Langverwacht)	3.3
Secunda Club	Sasol Secunda Club Monitoring Station	6.3
Secunda	HPA Secunda/ Embalenhle Monitoring Station	6.0
Bosjesspruit	Sasol Bosjesspruit Monitoring Station	8.3
42	Roodebank Combined School	4.5
60	Zamokuthle Primary School	5.8
46	Osizweni Secondary School	6.1
55	Isibanisesizwe Primary School	6.3
41	Maphala-Gulube Primary School	6.3
56	Kiriyatswane Secondary School	6.3
48	Osizweni Primary School	6.4
57	Kusasaletu Secondary School	6.5
58	Laerskool Oranjegloed	6.7
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53	Tholukwazi Primary School	7.3
30	TP Stratten Primary School	7.3
59	School	7.5
33	Laerskool Goedehoop	7.5
38	Laerskool Kruinpark	7.5
52	Lifaletu Primary School	7.6
61	Secunda Mediclinic	7.7
50	Embalenhle Primary School	7.8
51	Buyani Primary School	8.0
54	Allan Makhunga Primary School	8.1
36	Highveld Park Secondary School	8.3
37	Hoërskool Secunda	8.7
45	Muzimuhle Primary School	9.1
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ANNEXURE C: 2014 / 2015 DUSTFALL SAMPLING CAMPAIGN REPORTS



Test Report: Annual Dust Deposition Monitoring

Annual Report

Prepared for
Sasol Secunda
AS892 34.877_A S-SEC

Sampling period: January – December 2014



Facility Accreditation Date: 25 November 2009

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EXECUTIVE SUMMARY

A network of dust fallout monitors has been operational at Sasol Secunda since May 2012. This annual report presents dust fall data collected during the monitoring period of January to December 2014. The dust deposition monitoring was based on the ASTM International standard method for collection and analysis of dust fall (ASTM D1739-98 (Reapproved 2010)), with certain modifications.

The results presented in this report are compared to the South African National Dust Control Regulations, 2013.

This monitoring network comprised thirty single buckets for the monitoring period in review. Sites 1 to 13 and Sites 22 to 25 were commissioned in April 2012; Sites 17 to 21 were commissioned in May 2012; Sites 14 to 16 and Sites 26 to 30 were commissioned in October 2012. Data availability for the Sasol Secunda monitoring network during the monitoring period in review was 99%. The exposure period complied with the standard sampling exposure period of 30 ± 3 days throughout the monitoring period.

There was No Data recorded at the following sites:

- Syferfontein Farm in November 2014 as the sample was contaminated by a dead bird.

There were no exceedances noted during the monitoring period of January to December 2014. All the monitoring sites recorded annual averages below the RESIDENTIAL threshold limit. All the monitoring months recorded temporal averages below the RESIDENTIAL threshold.

Majority of dust falls for the period in review were characterised by the RESIDENTIAL range category with much less occurrence of the NON-RESIDENTIAL dust falls and missing data.

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ABBREVIATIONS

l	Litres
m	Metres
mg/m ² /day	Milligrams per metre squared per day
ml	Millilitres
mm	Millimetres

1 INTRODUCTION

Dust emissions can be separated into two broad categories: process sources and fugitive dust sources. Process source emissions are those associated with industrial operations that alter the chemical or physical characteristics of the feed material and are generally emitted from a stack. Fugitive dust sources are emissions of solid particles by the forces of wind or machinery acting on exposed material. Typical examples include materials handling activities, vehicle entrainment of road dust and wind erosion off stockpiles and tailings impoundments. Particulates may contribute to visibility reduction, pose a threat to human health, or be a nuisance due to their soiling potential.

Dust monitoring networks generally fulfil four main functions:

- Quantification of the companies operation's contribution to dust deposition in the area;
- Identification of possible problem areas;
- Tracking of progress of control measures being implemented; and
- Demonstration of compliance with accepted air quality standards.

Results from the dust deposition monitoring network for the period January to December 2014 are presented in this report. Tabular and graphic summaries of the data are included. In the analysis of the dust fallout samples the total gravimetric mass is recorded. Fluctuations in dust fall rates are a function of variations in the meteorological conditions of the site and/or changes in source characteristics. The meteorological characteristics of the site impact on the rate of emissions from fugitive sources and govern the dispersion and eventual removal of pollutants from the atmosphere.

Fugitive dust emission rates are predominantly a function of the wind speed and the intensity and duration of the activity generating the dust (e.g. traffic volumes, extent of batch drop operations). Evaporation rates and precipitation levels also influence fugitive emission rates due to their impact on the moisture content of materials being handled or stored. The review of meteorological data, including wind speed and precipitation data is undertaken in the current study in order to assist in the analysis of dust fall rates recorded during the period under review.

2 METHODOLOGY

Dust fall monitoring at Sasol Secunda began in May 2012. Windblown settle able dust fall-out is monitored based on the American Society of Testing and Materials standard method for collection and analysis of dust fall (ASTM D1739), with certain modifications. This method employs a simple device consisting of a cylindrical 5 l container half-filled with de-ionised water exposed for one calendar month (30 ± 3 days). The water is treated with an inorganic biocide to prevent algal growth in the buckets. The most common reagent used for this is a 5 % copper sulphate solution.



Figure 1: Single bucket monitoring unit showing a sampling bucket with bird ring and security clamps

The bucket stand comprises a ring that is raised above the rim of the bucket to prevent contamination from perching birds (Figure 2.1). The bucket holder is connected to a 2.1 m galvanised steel pole, which is either directly attached to a fence post or can be attached to a galvanised steel base plate, which is buried to a depth of 500 mm. This allows for a variety of placement options for the fallout samplers. Exposed buckets, when returned to the SGS Environmental laboratories, are rinsed with deionised water to remove residue from the sides of the bucket, and the bucket contents filtered through a 1 mm sieve to remove insects and other coarse organic detritus. The sample is then filtered through a pre-weighed paper filter to remove the insoluble fraction, or dust fallout. This residue and filter are dried, and gravimetrically analysed to determine the insoluble fraction (dust fallout).

3 STANDARDS FOR DUST DEPOSITION

3.1 *National Environmental Management: Air Quality Act, 2004; (Act No. 39 of 2004) National Dust Control Regulations*

Table 1: Extract from the National Dust Control Regulations, No. 36974 Government Gazette, 1 November 2013

Restriction Areas	Dust fall rate (D) (mg/m ² /day, 30- days average)	Permitted frequency of exceeding dust fall rate
Residential area	D < 600	Two within a year, not sequential months
Non-residential area	600 < D < 1200	Two within a year, not sequential months

The method to be used for measuring dustfall rate and the guideline for locating sampling points shall be ASTM D1739: 1970, or equivalent method approved by any internationally recognized body.

3.2 *Residential and non-residential areas*

A residential area means any area classified for residential use in terms of local town planning scheme;

A non-residential area means any area not classified for residential use as per local town planning scheme.

4 SAMPLING NETWORK

This monitoring network comprised thirty single buckets for the monitoring period in review. Site names, site numbers and dates when each site was commissioned are given in Table 2. Sampling dates and comments regarding the Sasol Secunda monitoring network for the period January to December 2014 are summarized in Table 3. Please note that compliance with respect to the National Dust Control Regulations is provisional as the site classifications in terms of these regulations will need to be confirmed by the client by considering the town planning of the area of operation.

5 OPERATIONAL ASPECTS

Data availability for the Sasol Secunda monitoring network during the monitoring period in review was 99%. There was No Data recorded at Syferfontein Farm in November as the sample was contaminated by a dead bird. Shondoni North also recorded no data in July as the sample was contaminated by a dead bird.

The exposure period complied with the standard sampling exposure period of 30 ± 3 days.

Table 3: Sampling dates and comments for Sasol Secunda monitoring network for the period January to December 2014.

Sample month	Start and end date	No of days	Sample Recovery
Jan 2014	6/7 Jan – 4/5 Feb 2014	29/30	100%
Feb 2014	4/5 Feb – 6/7 Mar 2014	29/30	100%
March 2014	6/7 Mar – 2/3 April 2014	27	100%
April 2014	2/3 April – 5/6 May 2014	33	100%
May 2014	5/6 May – 3/4 June 2014	29	100%
June 2014	3/4 June 2013 – 3/4 July 2014	30	100%
July 2014	3/4 July – 4/5 Aug 2014	32	100%
Aug 2014	4/5 Aug – 4/5 Sep 2014	31	100%
Sep 2014	4/5 Sep – 2/3 Oct 2014	28	100%
Oct 2014	2/3 Oct – 4/5 Nov 2014	33	100%
Nov 2014	4/5 Nov – 3/4 Dec 2014	29	96%
Dec 2014	3/4 Dec – 5/6 Jan 2014	33	100%

Comment: Syferfontein Farm was contaminated by a dead bird in Nov 2014

6 DUSTFALL RESULTS

Dust fall rates observed at each of the 30 single buckets for the period January to December 2014, are presented in Tables 4. Temporal variations in dust fall rates are illustrated and described in Section 6.2. Dust fall rates are presented and discussed graphically on a site-by-site basis in Section 6.3.

SGS requires a data recovery of 75% or higher in order to assess compliance to the National Dust Control Regulations, 2013. Results exceeding the RESIDENTIAL target of 600 mg/m²/day are indicated in **bold black** font and the NON-RESIDENTIAL target of 1200 mg/m²/day are indicated in **bold red** font. Please note that compliance with respect to the National Dust Control Regulations is provisional as the site classifications in terms of these regulations will need to be confirmed by the client by considering the town planning of the area of operation.

Time-plots represent a useful means of comparing trends in monthly dustfall levels. Each figure presents the monthly averaged dustfall levels per monitoring site over period January to December 2014, compared with the average results of data for the previous annual period. An increase or decrease of > 200 mg/m²/day is considered to be significant.

Temporal and spatial variations in dustfall rates are illustrated and described at the end of this section, as is the classification of the overall dustfall rates for the period under review. Dustfall rates recorded since the initiation of monitoring in are given in the Appendix.

Table 4A: Dust fall rates for Sasol Secunda single-bucket sites from January to December 2014 (mg/d/m² over a 30-day averaging period).

Sample Month	Thubelisha North	Thubelisha South	Thubelisha West	Thubelisha East	Game Park	Hawe Pan Dam	Resm 3	Langverwacht	Resm 9	Pump Station
Jan 2014	37	16	28	16	14	25	10	167	101	13
Feb 2014	32	15	115	25	22	13	17	31	101	24
Mar 2014	33	60	35	42	49	74	53	35	40	46
April 2014	6	24	34	10	4	14	80	18	28	36
May 2014	25	6	17	20	37	79	44	16	81	27
June 2014	14	51	27	65	15	145	58	66	108	170
July 2014	58	42	29	62	46	95	42	74	53	39
Aug 2014	143	99	40	76	47	200	71	111	52	91
Sep 2014	25	38	42	85	32	167	53	93	60	30
Oct 2014	113	49	60	102	30	96	64	170	81	143
Nov 2014	51	88	31	46	94	34	57	121	54	63
Dec 2014	41	24	29	8	17	13	3	33	38	11
Annual Average	48	43	41	46	34	80	46	78	66	58

Table 4B: Dust fall rates for Sasol Secunda Single bucket sites from January to December 2014 (mg/m²/day over a 30 day averaging period)

Sample Month	SCS	Twistdraai Mine	Twistdraai Export	Twistdraai Export 2	Twistdraai Export 3	Twistdraai Export 4	Syferfontein Veld	Syferfontein Workshop	Syferfontein Farm	Syferfontein main road
Jan 2014	41	24	57	22	24	39	26	80	12	24
Feb 2014	215	13	71	33	17	102	51	199	19	20
Mar 2014	78	35	126	74	78	55	24	186	53	41
April 2014	26	20	31	28	2	8	7	114	28	7
May 2014	8	74	226	46	29	10	63	54	156	14
June 2014	43	106	142	291	39	244	109	126	311	235
July 2014	68	37	219	67	61	15	104	234	176	127
Aug 2014	210	153	334	298	310	269	210	331	141	85
Sep 2014	99	74	120	134	91	47	79	456	105	56
Oct 2014	139	66	187	173	180	35	73	568	96	543
Nov 2014	238	65	93	49	79	58	92	286	ND	51
Dec 2014	46	38	95	12	43	57	22	110	59	28
Annual average	101	59	142	102	80	78	72	229	96	103

Comment: ND: No data.

Table 4C: Dust fall rates for Sasol Secunda Single bucket sites from January to December 2014 (mg/m²/day over a thirty day averaging period)

Sample Month	Syferfontein Dam	Impumulelo West	Impumulelo South	Impumulelo East	Impumulelo North	Impumulelo Conveyor	Shondoni North	Shondoni East	Shondoni South	Shondoni West
Jan 2014	45	60	326	19	86	27	69	66	18	17
Feb 2014	27	46	370	32	46	32	17	76	28	17
Mar 2014	52	64	130	27	69	71	21	294	55	46
April 2014	52	14	92	18	28	13	13	84	52	18
May 2014	25	36	49	31	13	15	33	117	25	12
June 2014	13	28	171	55	20	34	29	74	419	39
July 2014	51	64	175	93	87	50	ND	77	118	74
Aug 201	40	220	121	61	204	83	90	196	371	69
Sep 2014	43	58	110	51	81	45	63	59	252	134
Oct 2014	63	95	184	63	111	52	45	90	57	67
Nov 2014	99	34	200	51	52	75	51	193	340	91
Dec 2014	14	21	78	30	36	27	79	129	33	111
Annual average	44	62	167	44	69	44	43	121	147	58

Comments: ND: No data

6 DISCUSSION OF DUSTFALL RESULTS

6.1 Review of Dustfall Rates on a Site-by-Site Basis

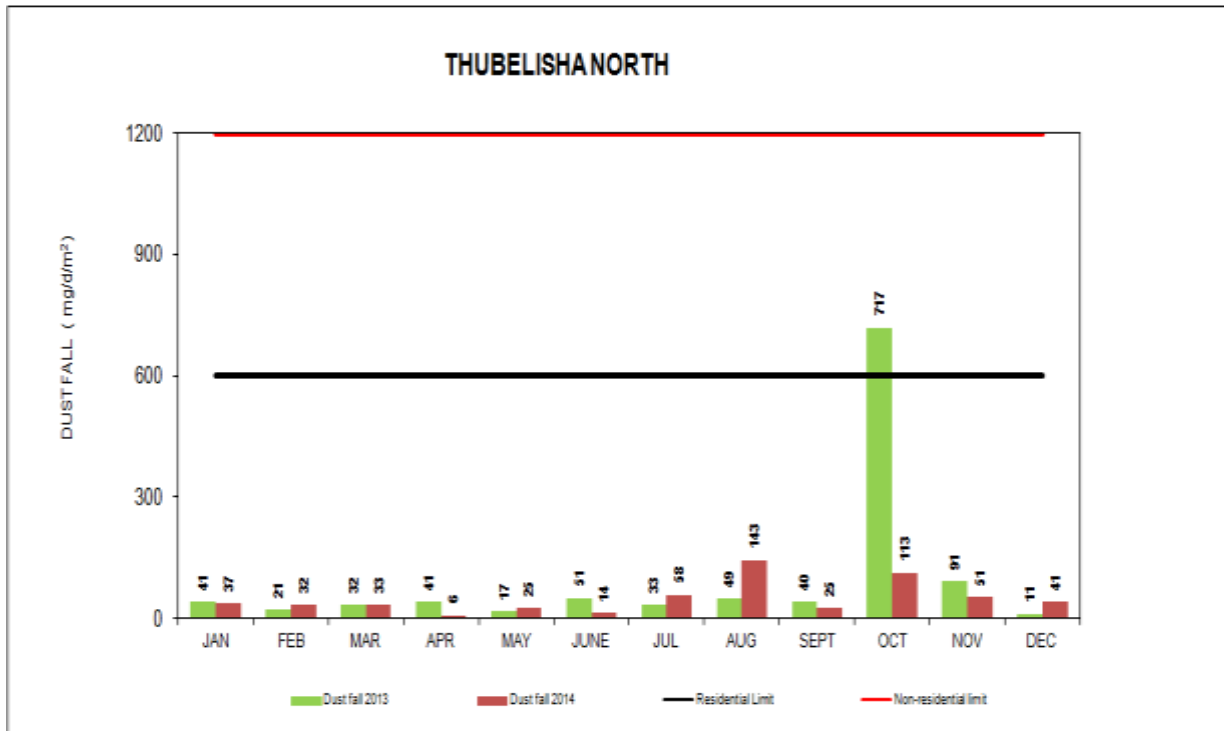
6.1.1 Site 01 – Thubelisha North

This site was commissioned in April 2012 and is classified as a Non-residential site.

During the monitoring period of January to December 2014, all the months recorded dust fall rates below the RESIDENTIAL threshold limit. The month of August 2014 recorded the highest dust fall rate at 143 mg/m²/day while the month of April 2014 recorded the lowest dust fall rate at 6 mg/m²/day.

The results for 2013 are included to show the trend in dust fallout from the previous year. With the exception of October 2014 where the results were lower, all the months experienced dust fallout equivalent to the 2013 results.

Figure 2: Dustfall rates recorded for Site 01 (Thubelisha North) from January - December 2014.



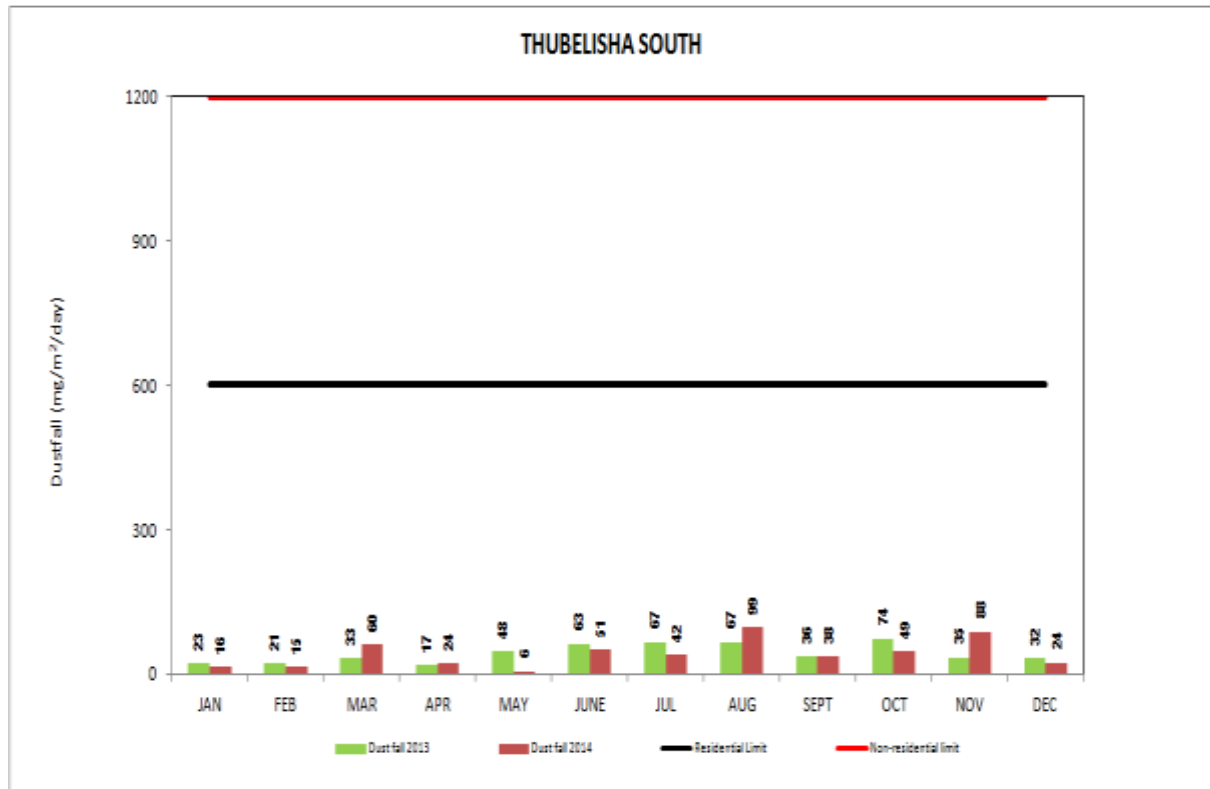
6.1.2 Site 02 – Thubelisha South

This site was commissioned in April 2012 and is classified as a Non-residential site.

RESIDENTIAL range dust falls were recorded during the monitoring period of January to December 2014. The month of August 2014 recorded the highest dust fallout at 99 mg/m²/day and May 2014 recorded the lowest dust fallout at 6 mg/m²/day.

The results for 2013 are included to show the trend in dust fallout from the previous year. All the monitoring months from January to December 2014 recorded dust fallout levels equivalent to the 2013 results

Figure 3: Dustfall rates recorded for Site 02 (Thubelisha South) during January - December 2014.



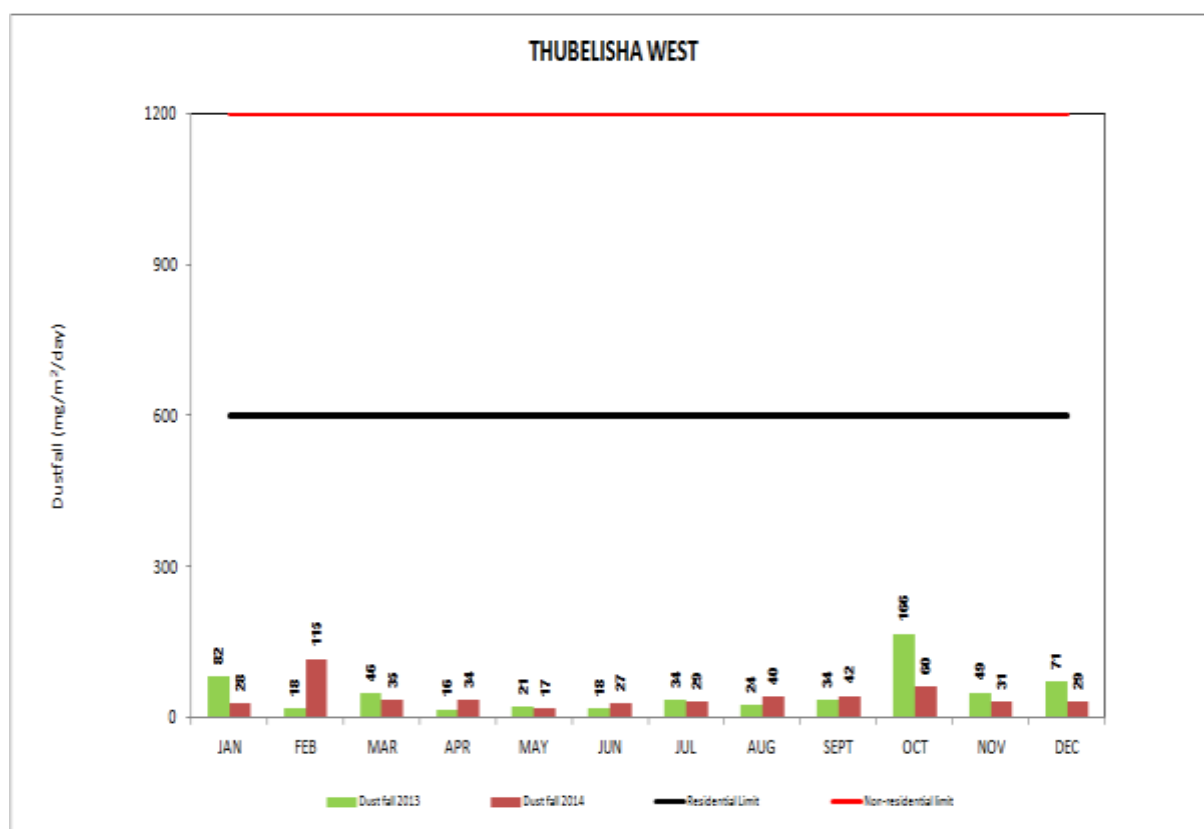
6.1.3 Site 03 – Thubelisha West

This site was commissioned in April 2012 and is classified as a Non-residential site.

During the monitoring period of January to December 2014, all the monitoring months recorded dust fallout below the RESIDENTIAL threshold limit. The month of February 2014 recorded the highest dust fall rate at 115 mg/m²/day while May 2014 recorded the lowest dust fall rate at 17 mg/m²/day.

All the months from January to December 2014 recorded dust fallout levels equivalent to the 2013 dust fallout levels.

Figure 4: Dustfall rates recorded for Site 3 (Thubelisha West) during January to December 2014.



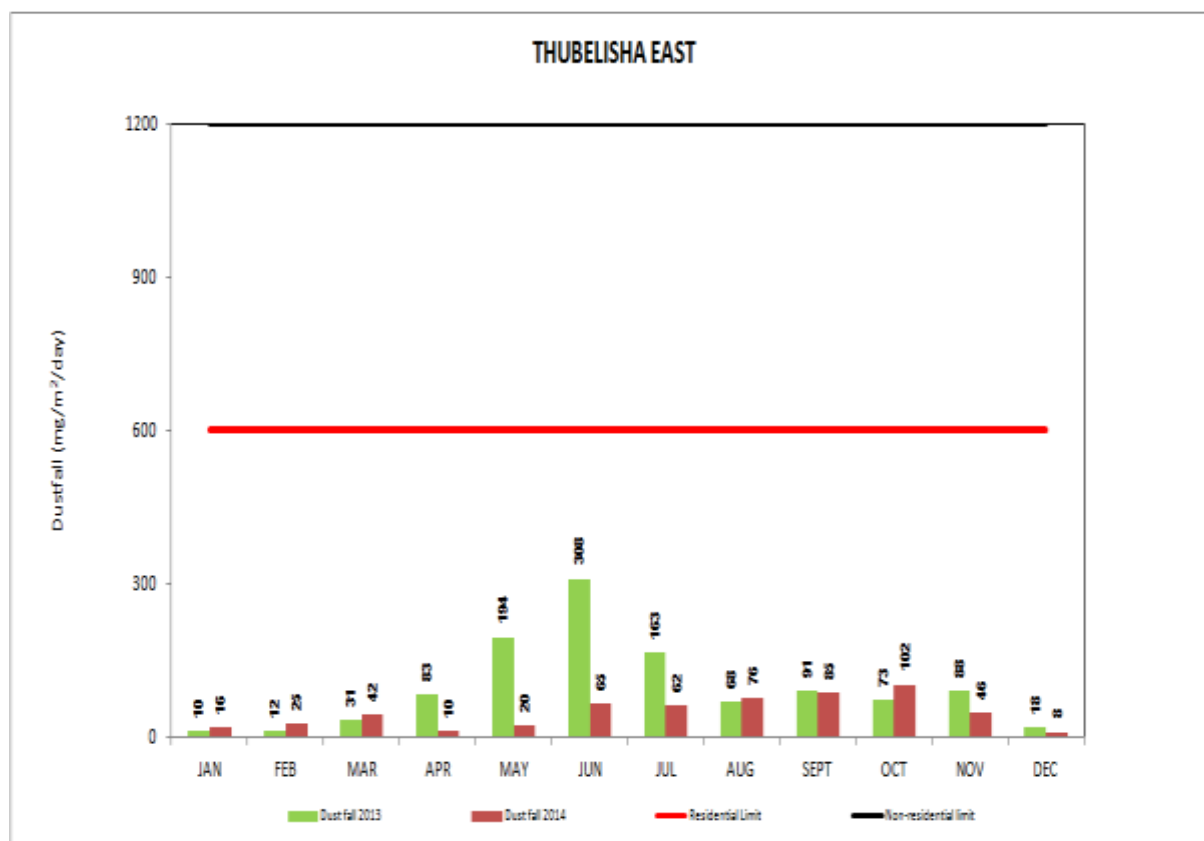
6.1.4 Site 04 – Thubelisha East

This site was commissioned in April 2012 and is classified as a Non-residential site.

During the monitoring period of January to December 2014, all the monitoring months recorded dust fallout below the RESIDENTIAL threshold limit. The month of October 2014 recorded the highest dust fall rate at 102 mg/m²/day. The lowest dust fallout was recorded during December 2014 at 8 mg/m²/day.

With the exception of June 2014 where the results were lower, all the months recorded dust fallout equivalent to the 2013 dust fallout results.

Figure 5: Dust fall rates recorded for Site 4 (Thubelisha East) during January to December 2014.



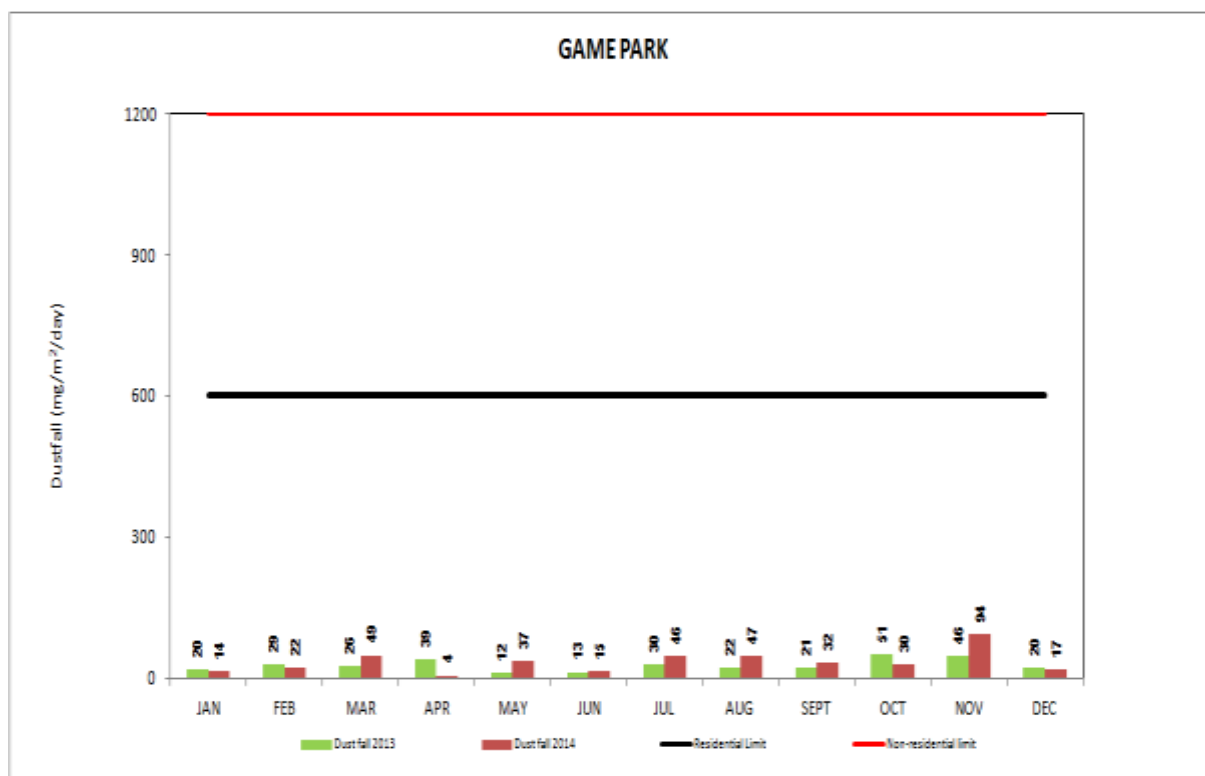
6.1.5 Site 05 – Game Park

This site was commissioned in April 2012 and is classified as a Non-residential site.

During the monitoring period of January to December 2014, all the monitoring months recorded dust fallout below the RESIDENTIAL threshold limit. The month of November 2014 recorded the highest dust fall rate at 94 mg/m²/day while April 2014 recorded the lowest dust fall rate at 4 mg/m²/day.

All the months from January to December 2014 recorded dust fallout levels equivalent to the 2013 dust fallout levels.

Figure 6: Dustfall rates recorded for Site 5 (Game Park) for January to December 2014.



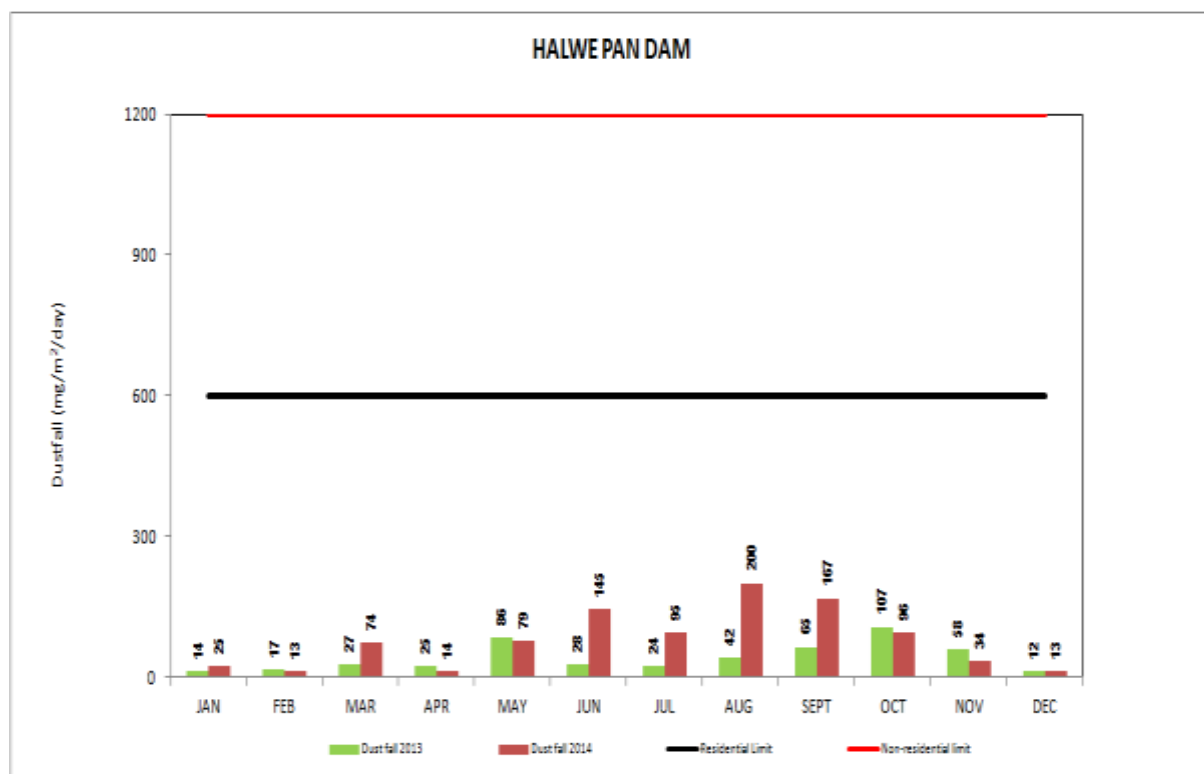
6.1.6 Site 06 – Halwepan Dam

This site was commissioned in April 2012 and is classified as a Non-residential site.

During the monitoring period of January to December 2014, all the monitoring months recorded dust fallout below the RESIDENTIAL threshold limit. The month of August 2014 recorded the highest dust fall rate at 200 mg/m²/day while February and December 2014 recorded the lowest dust fall rates both at 13 mg/m²/day.

All the months from January to December 2014 recorded dust fallout levels equivalent to the 2013 dust fallout levels.

Figure 7: Dust fall rates recorded for Site 6 (Halwe pan Dam) for January to December 2014.



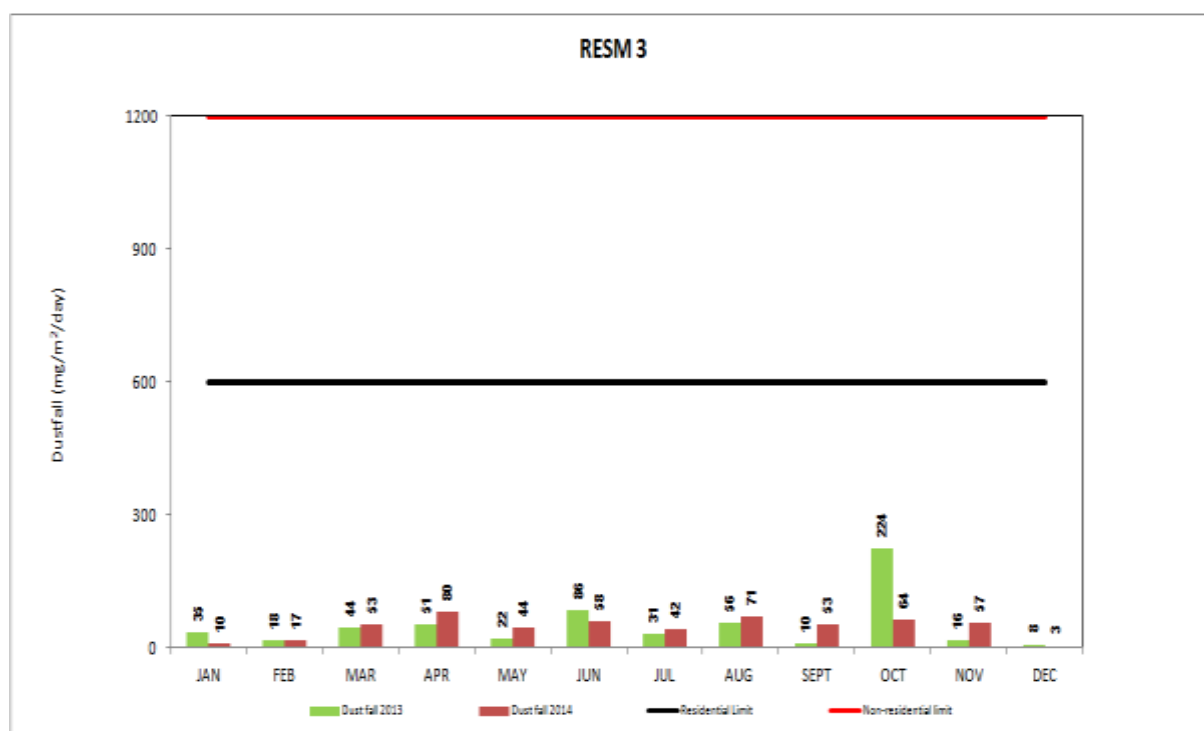
6.1.7 Site 07 – Resm 3

This site was commissioned in April 2012 and is classified as a Non-residential site.

During the monitoring period of January to December 2014, all the monitoring months recorded dust fallout below the RESIDENTIAL threshold limit. The highest dust fallout of 80 mg/m²/day was recorded during the month of April 2014. December 2014 recorded the lowest dust fall rate at 3 mg/m²/day.

All the months from January to December 2014 recorded dust fallout levels equivalent to the 2013 dust fallout levels.

Figure 8: Dust fall rates recorded for Site 7 (Resm 3) for January to December 2014.



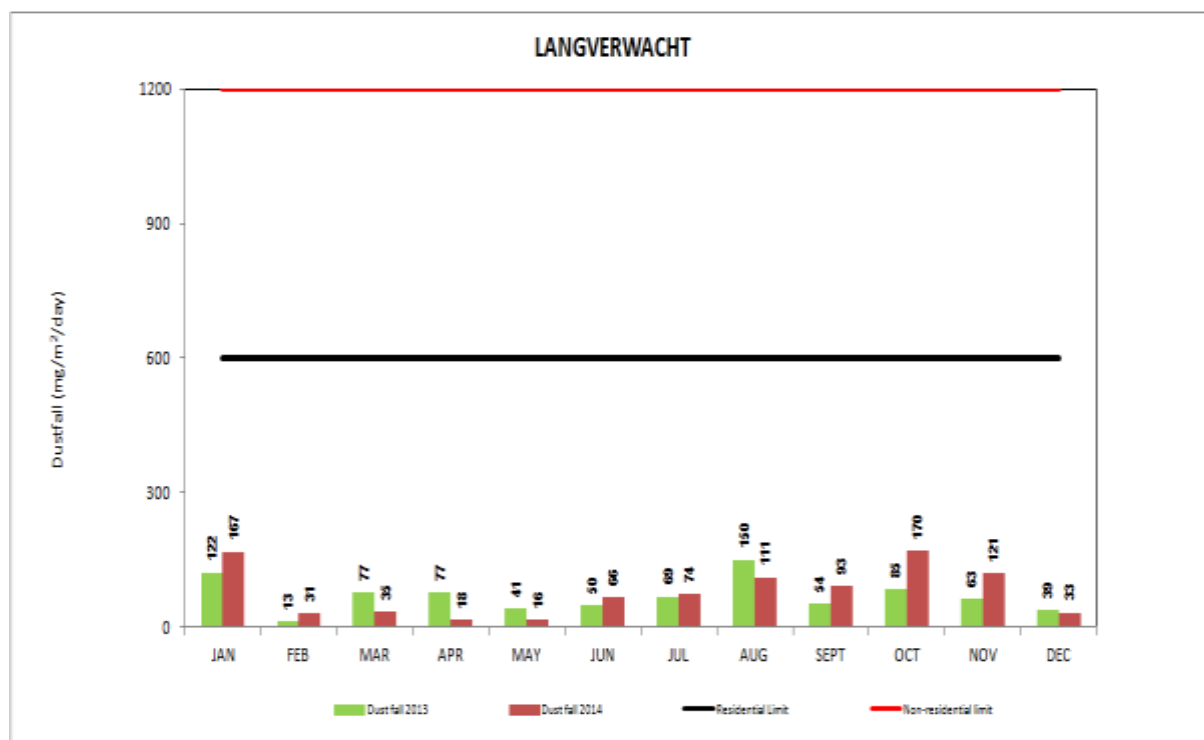
6.1.8 Site 08 - Langverwacht

This site was commissioned in April 2012 and is classified as a Non-residential site.

During the monitoring period of January to December 2014, all the monitoring months recorded dust fallout below the RESIDENTIAL threshold limit. The month of October recorded the highest dust fall rate at 170 mg/m²/day while May recorded the lowest dust fall rate at 16 mg/m²/day.

All the months from January to December 2014 recorded dust fallout levels equivalent to the 2013 dust fallout levels.

Figure 9: Dust fall rates recorded for Site 8 (Langverwacht) for January to December 2014.



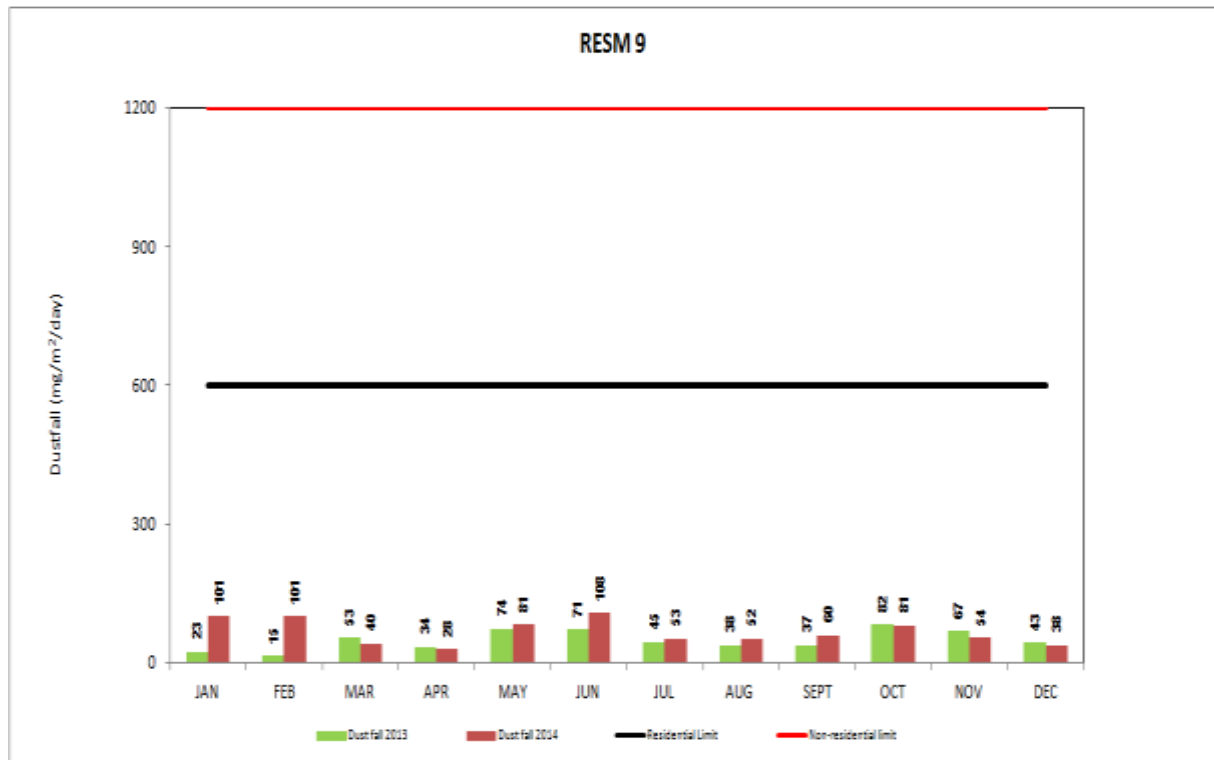
6.1.9 Site 9 – Resm 9

This site was commissioned in April 2012 and is classified as a Non-residential site.

During the monitoring period of January to December 2014, all the monitoring months recorded dust fallout below the RESIDENTIAL threshold limit. The month of June 2014 recorded the highest dust fall rate at 108 mg/m²/day while April 2014 recorded the lowest dust fall rate at 28 mg/m²/day.

All the months from January to December 2014 recorded dust fallout levels equivalent to the 2013 dust fallout levels.

Figure 10: Dust fall rates recorded for Site 9 (Resm 9) for January to December 2014.



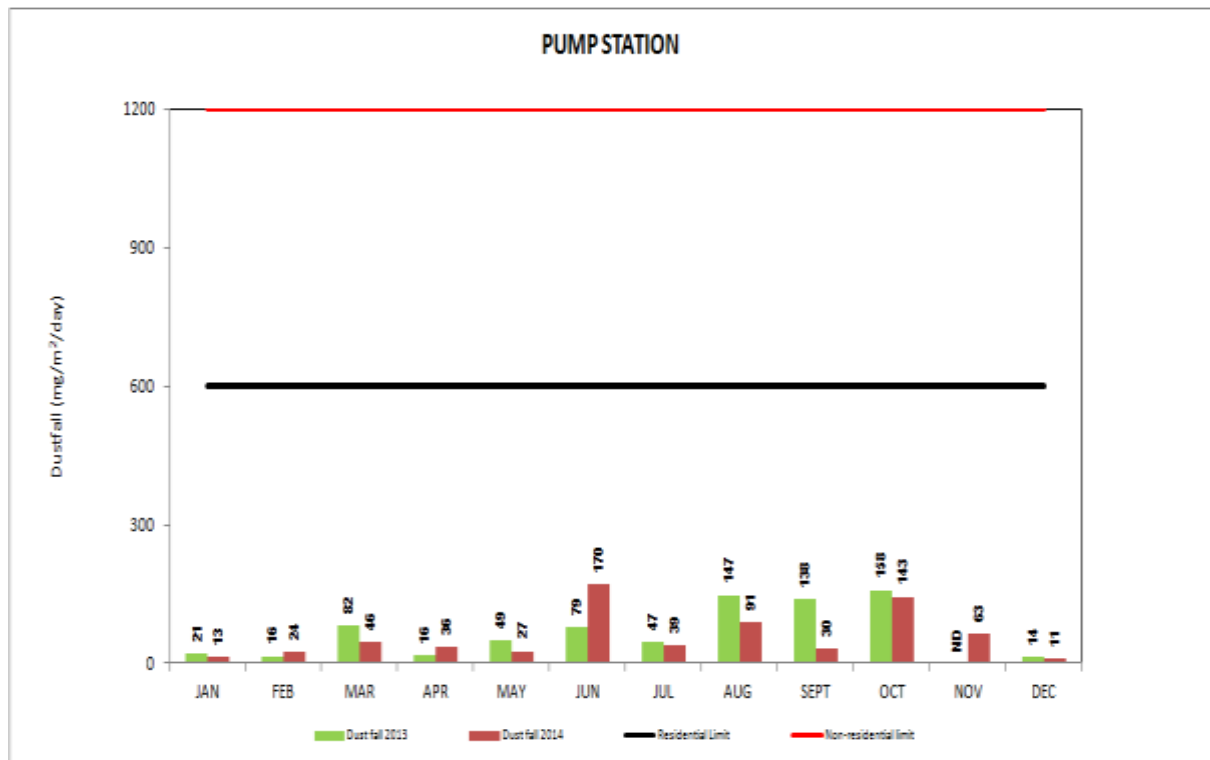
6.1.10 Site 10 – Pump Station

This site was commissioned in April 2012 and is classified as a Non-residential site.

During the monitoring period of January to December 2014, all the monitoring months recorded dust fallout below the RESIDENTIAL threshold limit. The month of June 2014 recorded the highest dust fall rate at 170 mg/m²/day while December recorded the lowest dust fall rate at 11 mg/m²/day.

All the months from January to December 2014 recorded dust fallout levels equivalent to the 2013 results.

Figure 11: Dust fall rates recorded for Site 10 (Pump Station) for January to December 2014.



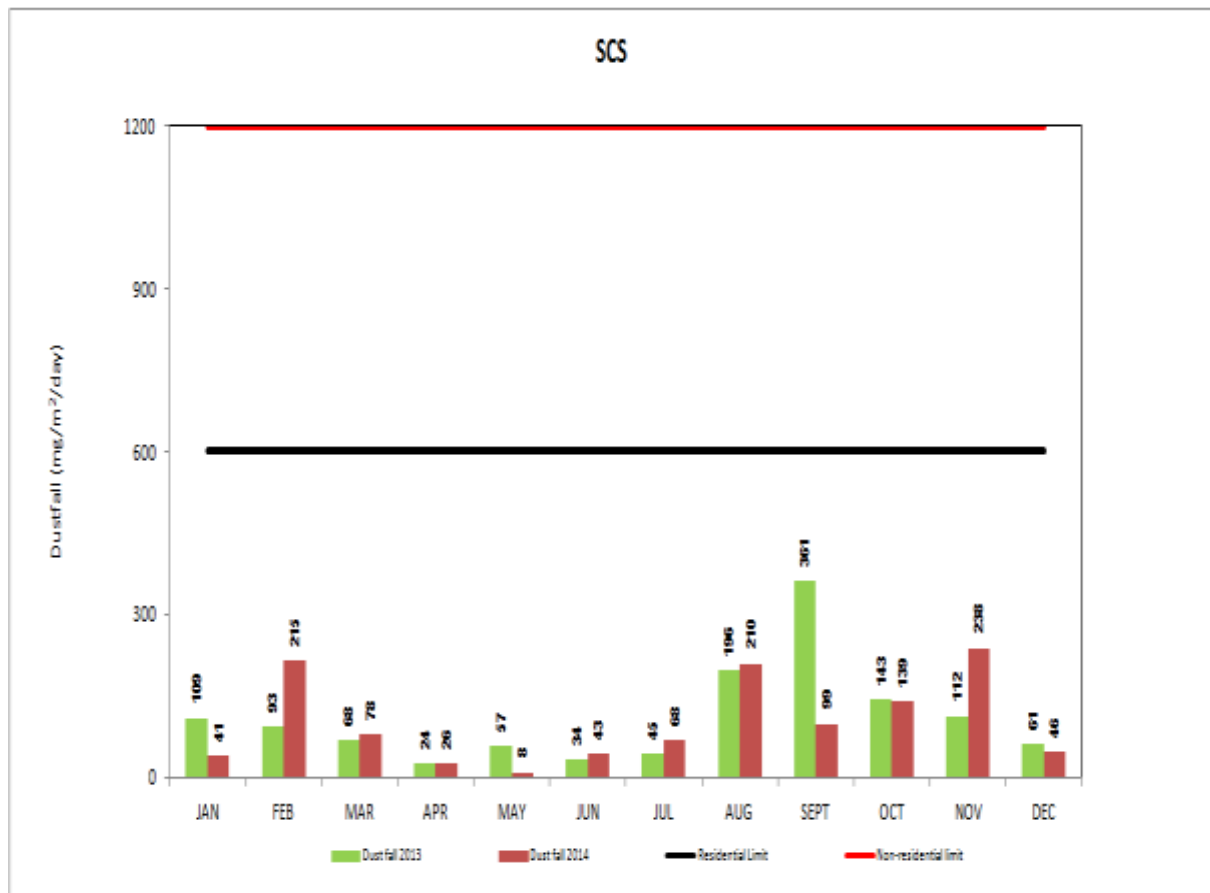
6.1.11 Site 11 - SCS

This site was commissioned in April 2012 and is classified as a Non-residential site.

During the monitoring period of January to December 2014 all the monitoring months recorded dust fallout below the RESIDENTIAL threshold limit. The month of November 2014 recorded the highest dust fall rate at 238 mg/m²/day while May 2014 recorded the lowest dust fall rate at 8 mg/m²/day.

With the exception of September 2014 where the results were lower, all the months recorded dust fallout levels equivalent to the 2013 dust fallout results.

Figure 12: Dust fall rates recorded for Site 11 (SCS) for January to December 2014.



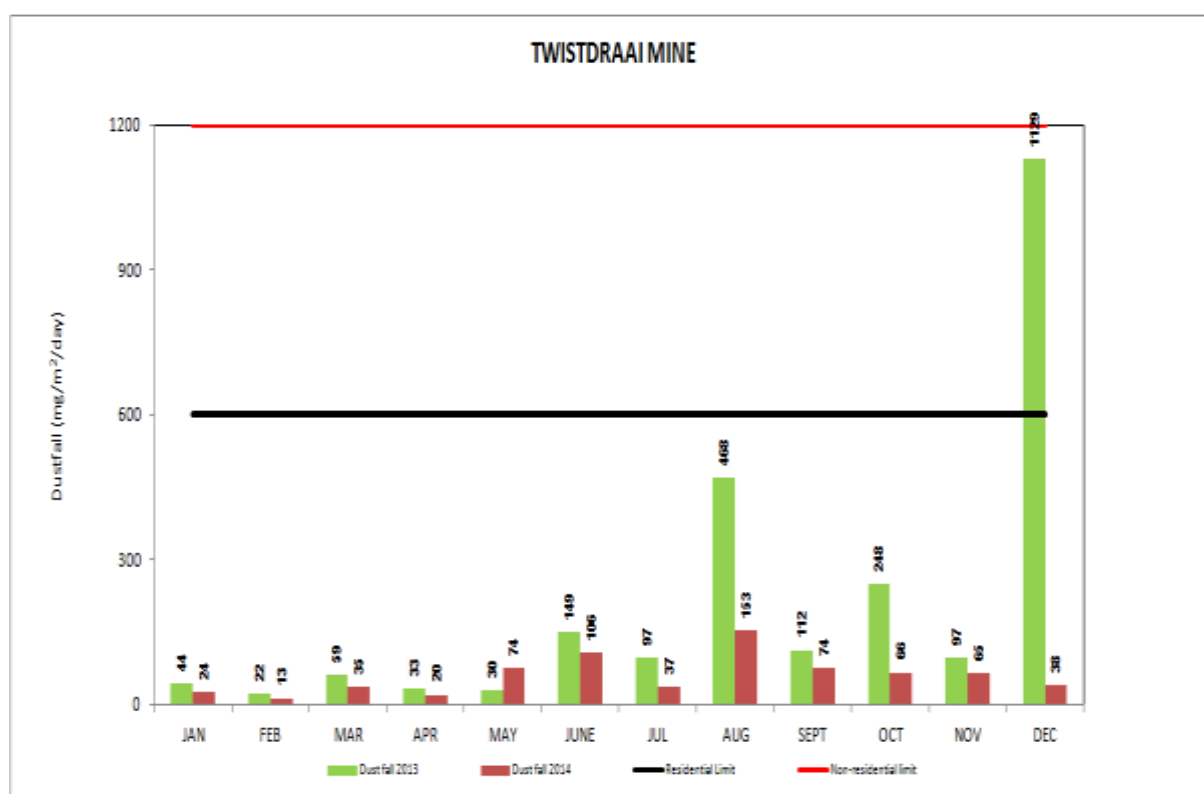
6.1.12 Site 12 – Twistdraai Mine

This site was commissioned in April 2012 and is classified as a Non-residential site.

During the monitoring period of January to December 2014, all the monitoring months recorded dust fallout below the RESIDENTIAL threshold limit. August 2014 recorded the highest dust fallout at 153 mg/m²/day. February 2014 recorded the lowest dust fall rate at 13 mg/m²/day.

August and December 2014 recorded significant decreases in dust fallout compared to the 2013 results. All the other months recorded dust fallout levels equivalent to the 2013 dust fallout levels.

Figure 13: Dust fall rates recorded for Site 12 (Twistdraai Mine) for January to December 2014.



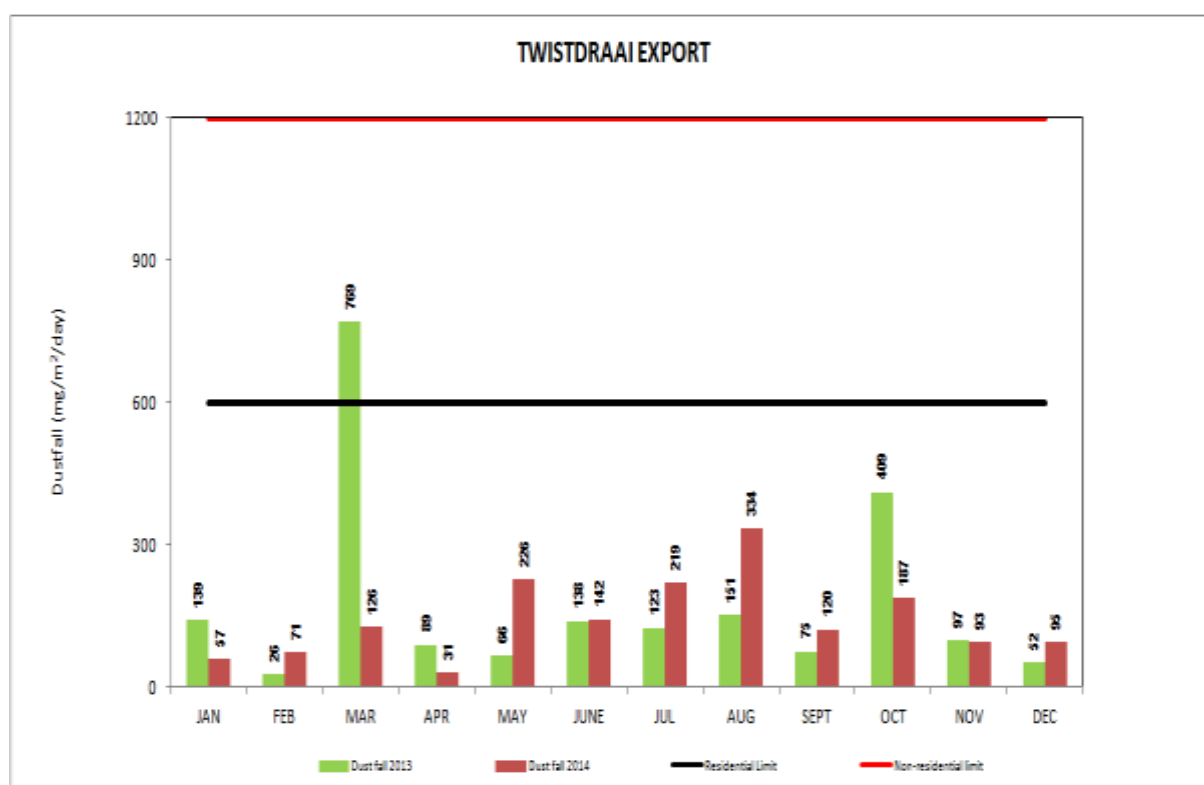
6.1.13 Site 13 – Twistdraai Export

This site was commissioned in April 2012 and is classified as a Non-residential site.

During the monitoring period of January to December 2014, all the monitoring months recorded dust fallout below the RESIDENTIAL threshold limit. August 2014 recorded the highest dust fallout at 334 mg/m²/day. April 2014 recorded the lowest dust fall rate at 31 mg/m²/day.

A decrease in dust fallout levels was recorded in both March and October 2014 when compared to the 2013 results. The remaining months recorded dust fallout levels equivalent to the 2013 dust fallout levels.

Figure 14: Dust fall rates recorded for Site 13 (Twistdraai Export) for January to December 2014.



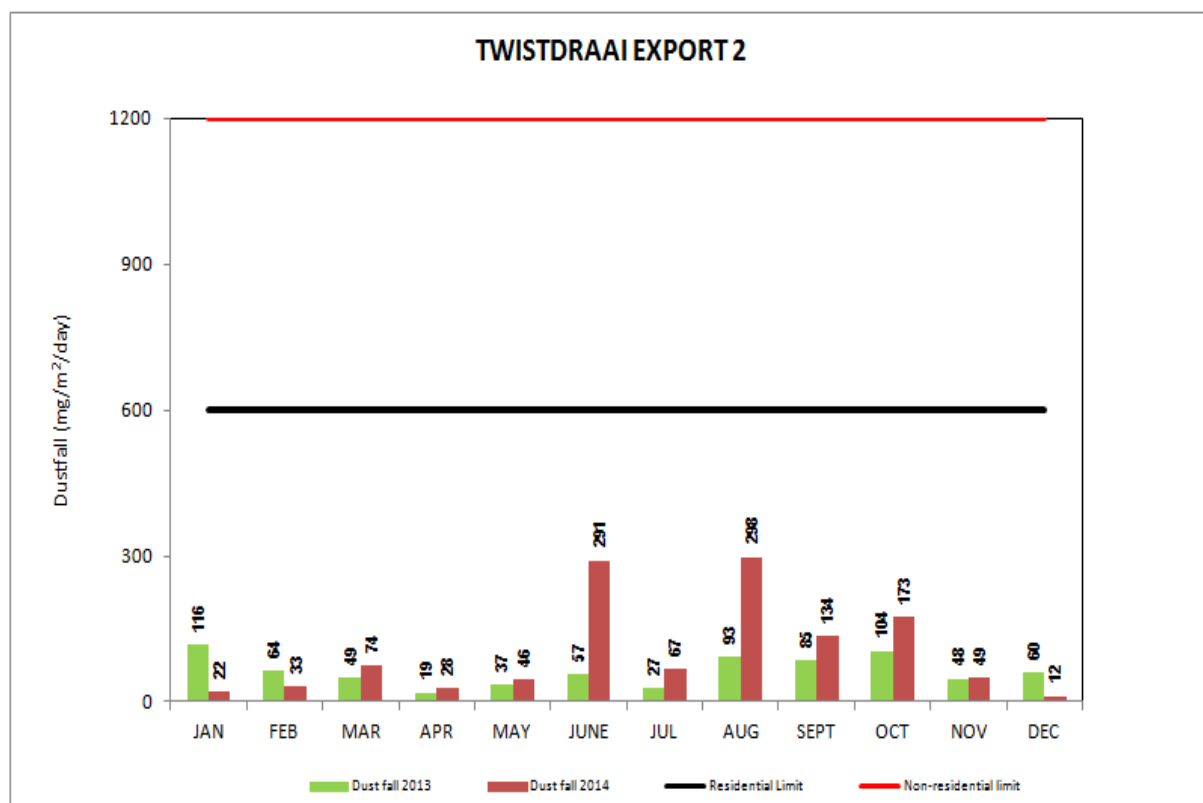
6.1.14 Site 14 – Twistdraai Export 2

This site was commissioned in October 2012 and is classified as a Non-residential site.

During the monitoring period of January to December 2014, all the monitoring months recorded dust fallout below the RESIDENTIAL threshold limit. August 2014 recorded the highest dust fallout at 298 mg/m²/day. December 2014 recorded the lowest dust fall rate at 12 mg/m²/day.

With the exception of June and August where the results were higher, all the months experienced dust fallout equivalent to the 2013 results.

Figure 15: Dust fall rates recorded for Site 14 (Twistdraai Export 2) for January to December 2014.



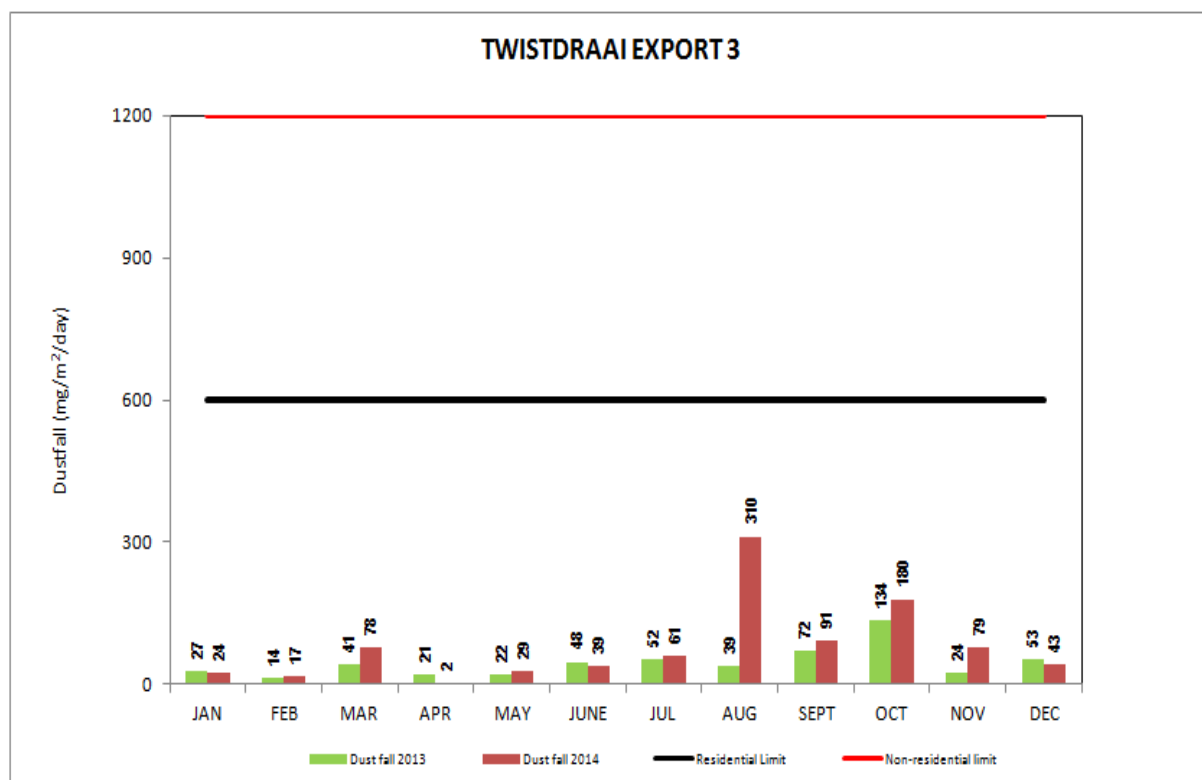
6.1.15 Site 15 – Twistdraai Export 3

This site was commissioned in October 2012 and is classified as a Non-residential site.

During the monitoring period of January to December 2014, all the monitoring months recorded dust fallout below the RESIDENTIAL threshold limit. The highest dust fall rate was recorded in August 2014 at 310 mg/m²/day. April 2014 recorded the lowest dust fallout at 2 mg/m²/day.

With the exception of August 2014 which experienced a decrease in dust fallout, all the months recorded dust fallout equivalent to the 2013 results.

Figure 16: Dust fall rates recorded for Site 15 (Twistdraai Export 3) for January to December 2014.



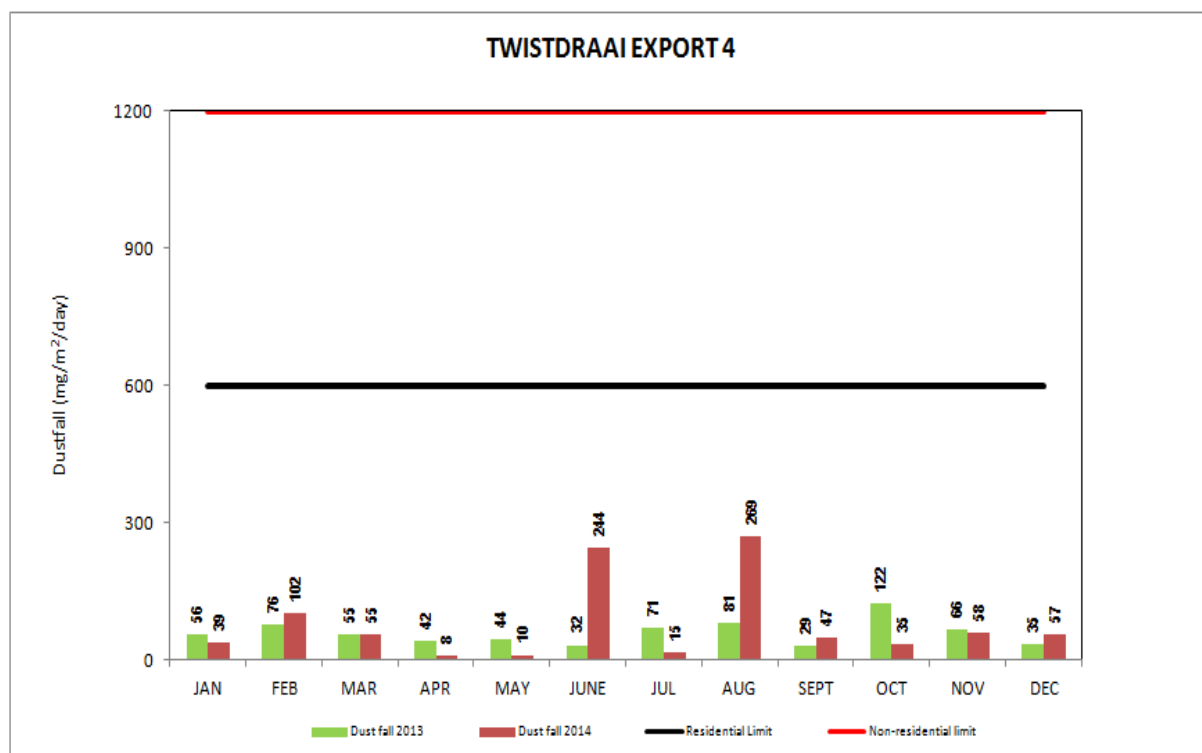
6.1.16 Site 16 – Twistdraai Export 4

This site was commissioned in October 2012 and is classified as a Non-residential site.

During the monitoring period of January to December 2014, all the monitoring months recorded dust fallout below the RESIDENTIAL threshold limit. The highest dust fall rate was recorded in August 2014 at 269 mg/m²/day. April 2014 recorded the lowest dust fallout at 8 mg/m²/day.

With the exception of June 2014 which recorded an increase in dust fallout, all the months recorded dust fallout equivalent to the 2013 results.

Figure 17: Dust fall rates recorded for Site 16 (Twistdraai Export 4) for January to December 2014.



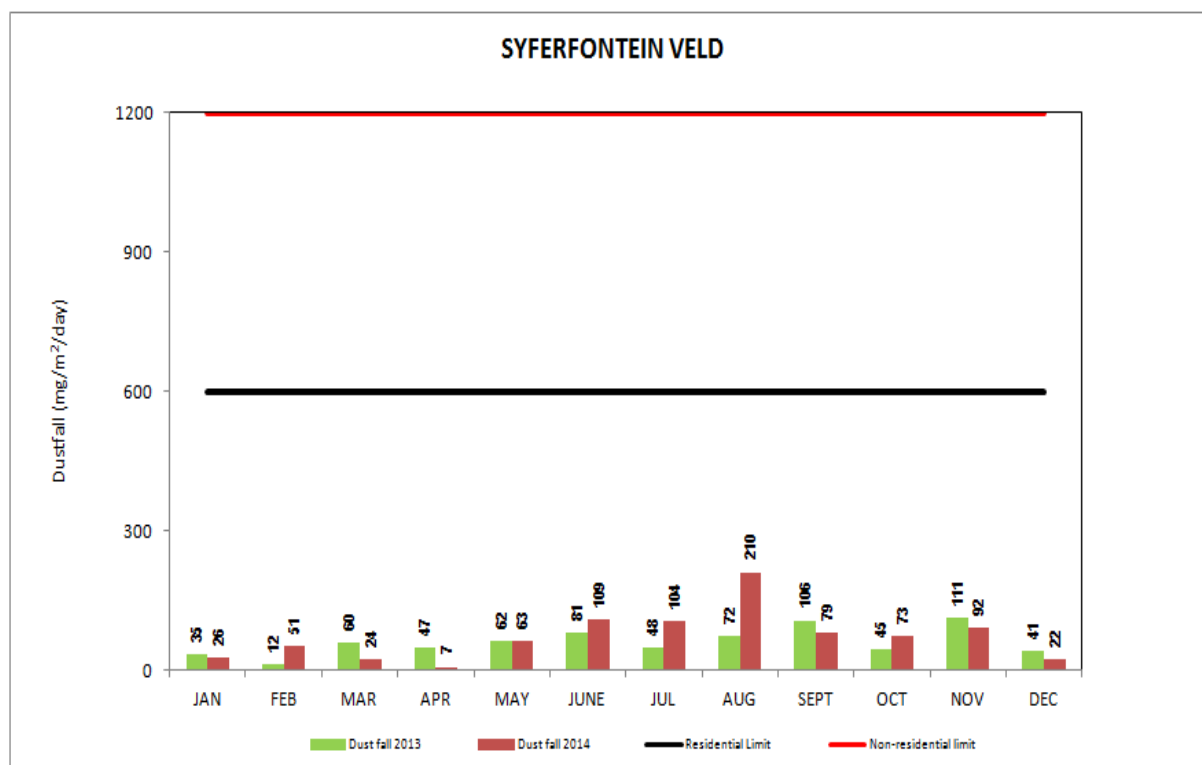
6.1.17 Site 17 – Syferfontein Veld

This site was commissioned in May 2012 and is classified as a Non-residential site.

During the monitoring period of January to December 2014, all the monitoring months recorded dust fallout below the RESIDENTIAL threshold limit. August 2014 recorded the highest dust fallout at 210 mg/m²/day. The month of April 2014 recorded the lowest dust fallout at 7 mg/m²/day.

All the months from January to December 2014 recorded dust fallout levels equivalent to the 2013 dust fallout.

Figure 18: Dust fall rates recorded for Site 17 (Syferfontein Veld) for January to December 2014.



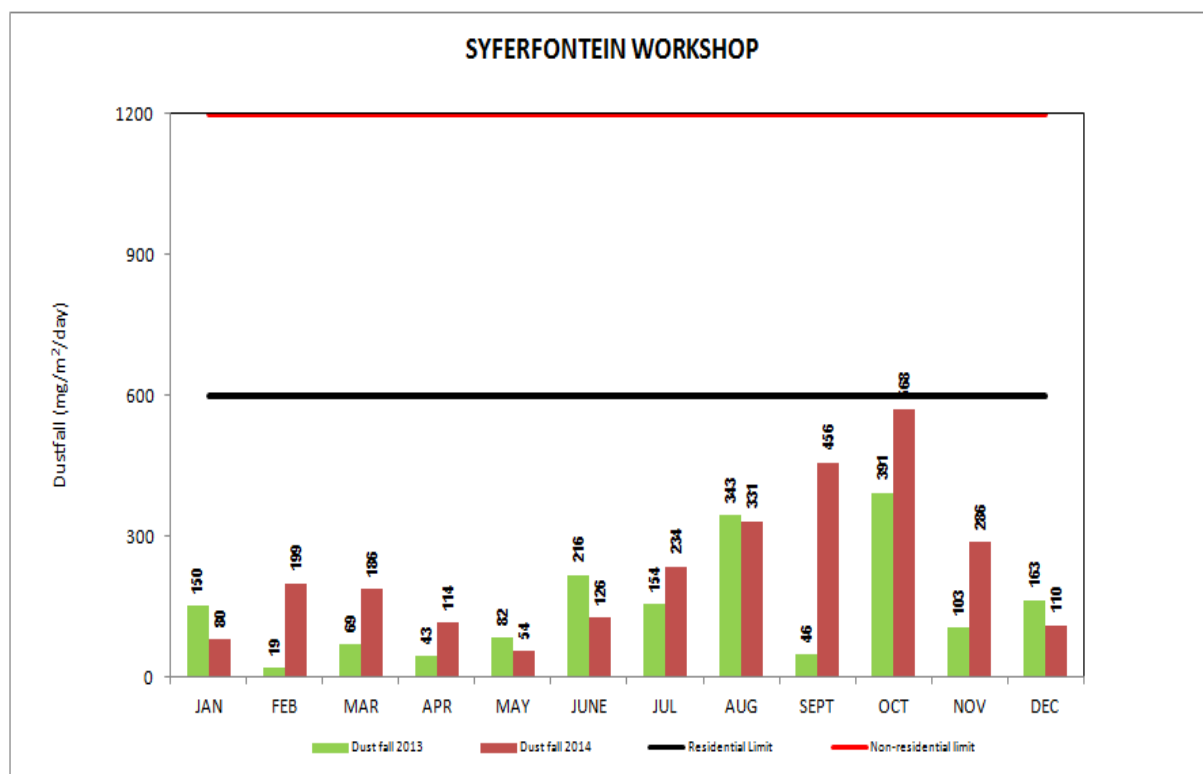
6.1.18 Site 18 – Syferfontein Workshop

This site was commissioned in May 2012 and is classified as a Non-residential site.

During the monitoring period of January to December 2014, all the monitoring months recorded dust fallout below the RESIDENTIAL threshold limit. The month of October 2014 recorded the highest dust fall rate at 568 mg/m²/day, while May 2014 recorded the lowest dust fallout at 54 mg/m²/day.

With the exception of September where the results were significantly higher, all the months recorded dust fallout levels equivalent to the 2013 dust fallout.

Figure 19: Dust fall rates recorded for Site 18 (Syferfontein Workshop) for January to December 2014.



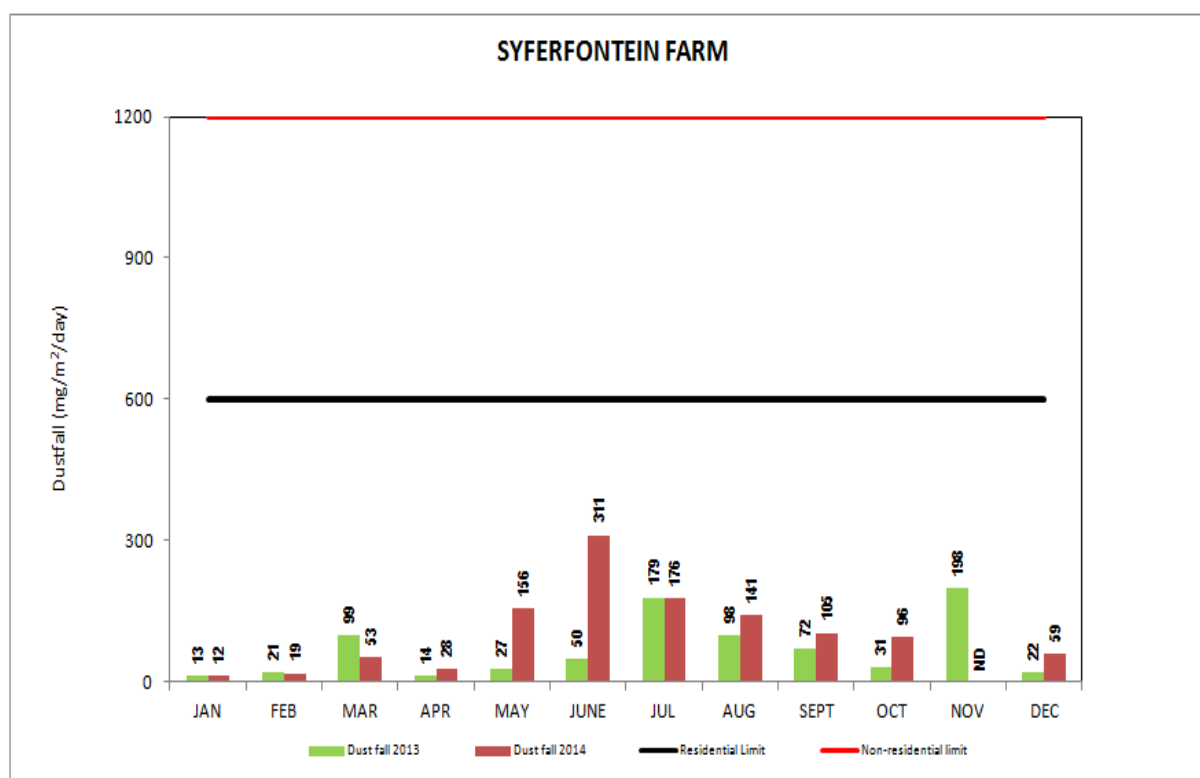
6.1.19 Site 19 – Syferfontein Farm

This site was commissioned in May 2012 and is classified as a Non-residential site.

During the monitoring period of January to December 2014, there was no data recorded during November 2014 as the sample was contaminated by a dead bird. All the remaining monitoring months recorded dust fallout below the RESIDENTIAL threshold limit. The Month of June 2014 recorded the highest dust fall rate at 311 mg/m²/day, while January 2014 recorded the lowest dust fallout at 12 mg/m²/day.

In comparison to the months in which data was recorded in 2014, with the exception of June 2014 where the results were significantly higher, all the months recorded dust fallout levels equivalent to the 2013 dust fallout.

Figure 20: Dust fall rates recorded for Site 19 (Syferfontein Farm) for January to December 2014.



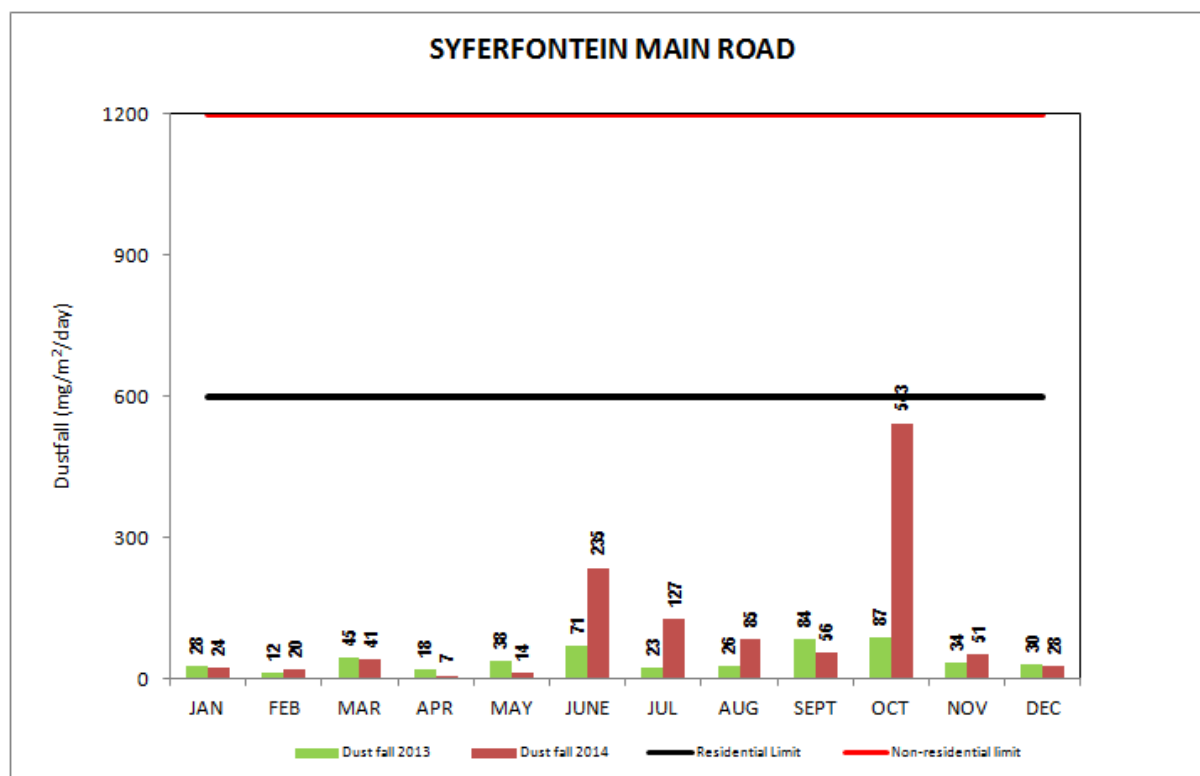
6.1.20 Site 20 – Syferfontein Main Road

This site was commissioned in May 2012 and is classified as a Non-residential site.

During the monitoring period of January to December 2014, all the monitoring months recorded dust fallout below the RESIDENTIAL threshold limit. The month of October 2014 recorded the highest dust fall rate at 543 mg/m²/day, while April 2014 recorded the lowest dust fallout at 7 mg/m²/day.

With the exception of October 2014 where the results were significantly higher, all the months recorded dust fallout levels equivalent to the 2013 dust fallout.

Figure 21: Dust fall rates recorded for Site 20 (Syferfontein Main Road) for January to December 2014.



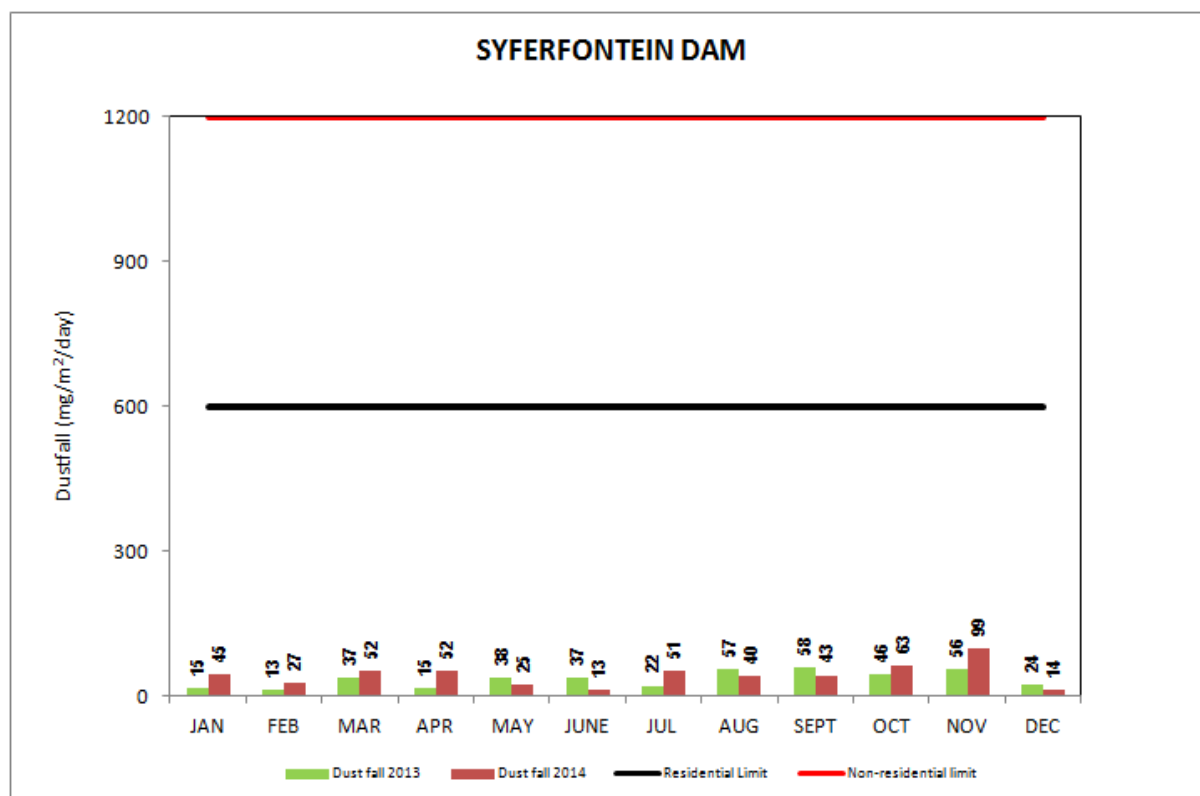
6.1.21 Site 21 – Syferfontein Dam

This site was commissioned in May 2012 and is classified as a Non-residential site.

During the monitoring period of January to December 2014, all the monitoring months recorded dust fallout below the RESIDENTIAL threshold limit. The month of November 2014 recorded the highest dust fall rate at 99 mg/m²/day, while June 2014 recorded the lowest dust fallout at 13 mg/m²/day.

All the months from January to December 2014 recorded dust fallout equivalent to the 2013 dust fallout.

Figure 22: Dust fall rates recorded for Site 21 (Syferfontein Dam) for January to December 2014.



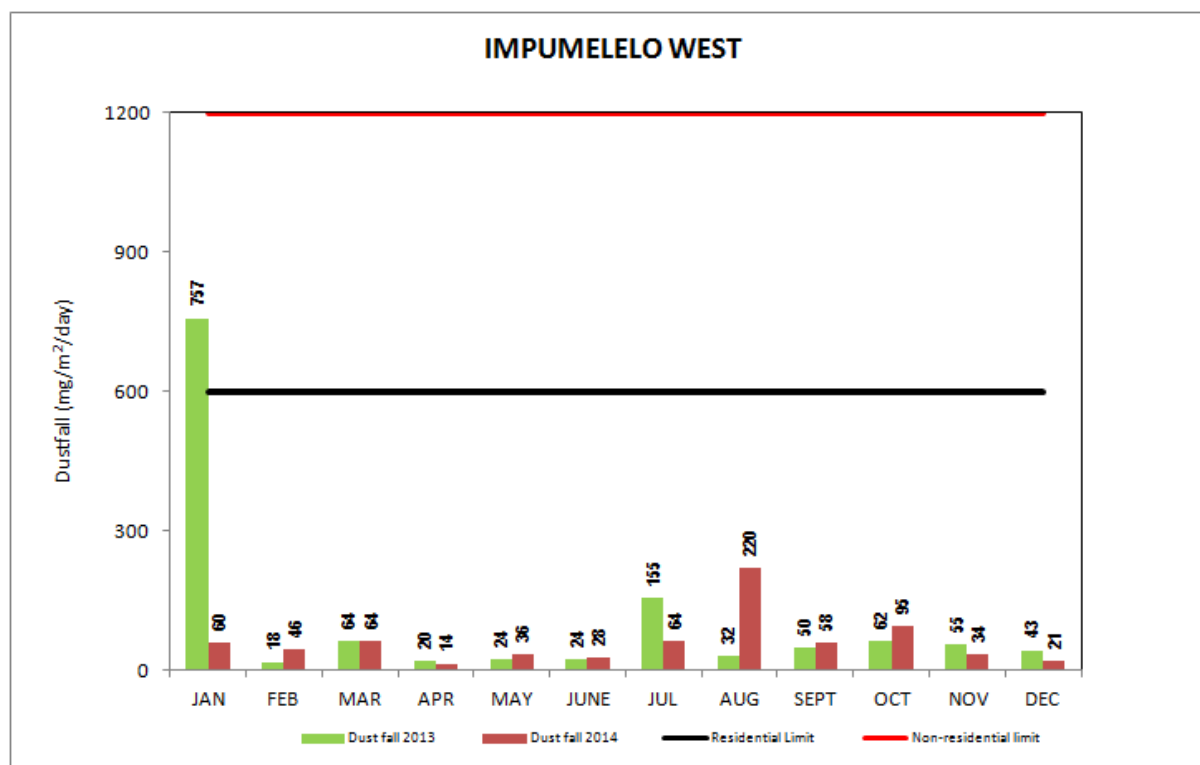
6.1.22 Site 22 – Impumelelo West

This site was commissioned in April 2012 and is classified as a Non-residential site.

During the monitoring period of January to December 2014, all the other monitoring months recorded dust fallout below the RESIDENTIAL threshold limit. The month of August 2014 recorded the highest dust fallout at 220 mg/m²/day. April 2014 recorded the lowest dust fall rate at 14 mg/m²/day.

With the exception of January 2014 where the results were significantly lower, all the months recorded dust fallout levels equivalent to the 2013 dust fallout.

Figure 23: Dust fall rates recorded for Site 22 (Impumelelo West) for January to December 2014.



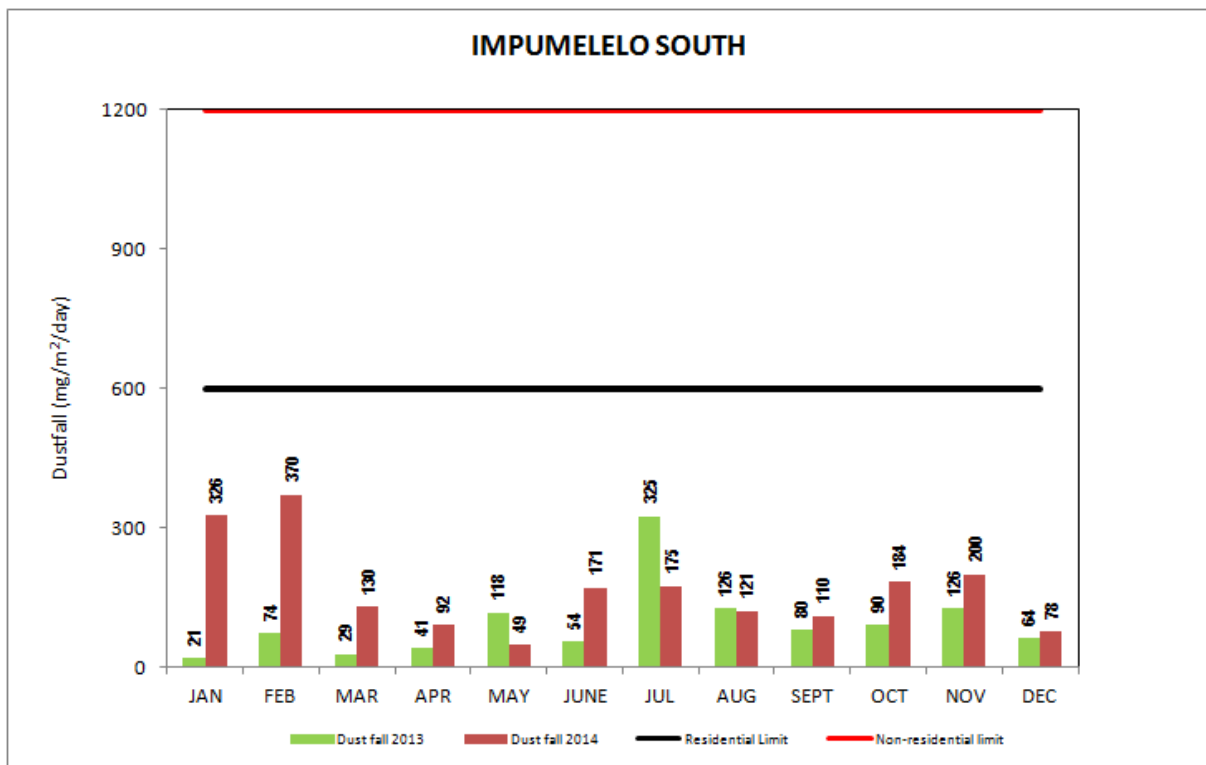
6.1.23 Site 23 – Impumelelo South

This site was commissioned in April 2012 and is classified as a Non-residential site.

During the monitoring period of January to December 2014, all the monitoring months recorded dust fallout below the RESIDENTIAL threshold limit. The month of February 2014 recorded the highest dust fall rate at 370 mg/m²/day, while May 2014 recorded the lowest dust fallout at 49 mg/m²/day.

January and February 2014 both experienced increased dust fallout when compared to the 2013 results. All the remaining months experienced dust fallout equivalent to the 2013 results.

Figure 24: Dust fall rates recorded for Site 23 (Impumelelo South) for January to December 2014.



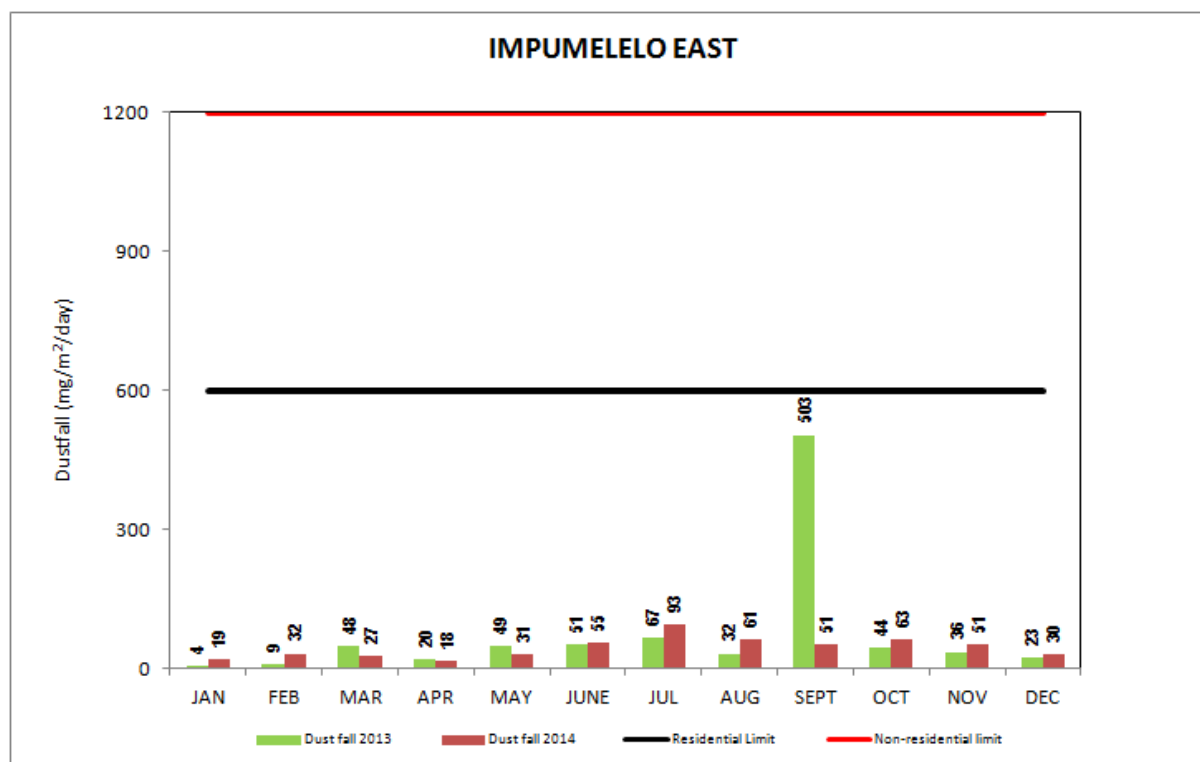
6.1.24 Site 24 – Impumelelo East

This site was commissioned in April 2012 and is classified as a Non-residential site.

During the monitoring period of January to December 2014, all the monitoring months recorded dust fallout below the RESIDENTIAL threshold limit. The month of July 2014 recorded the highest dust fall rate at 93 mg/m²/day, while April 2014 recorded the lowest dust fallout at 18 mg/m²/day.

With the exception of September 2014 where the results were significantly lower, all the months recorded dust fallout equivalent to the 2013 results.

Figure 25: Dust fall rates recorded for Site 24 (Impumelelo East) for January to December 2014.



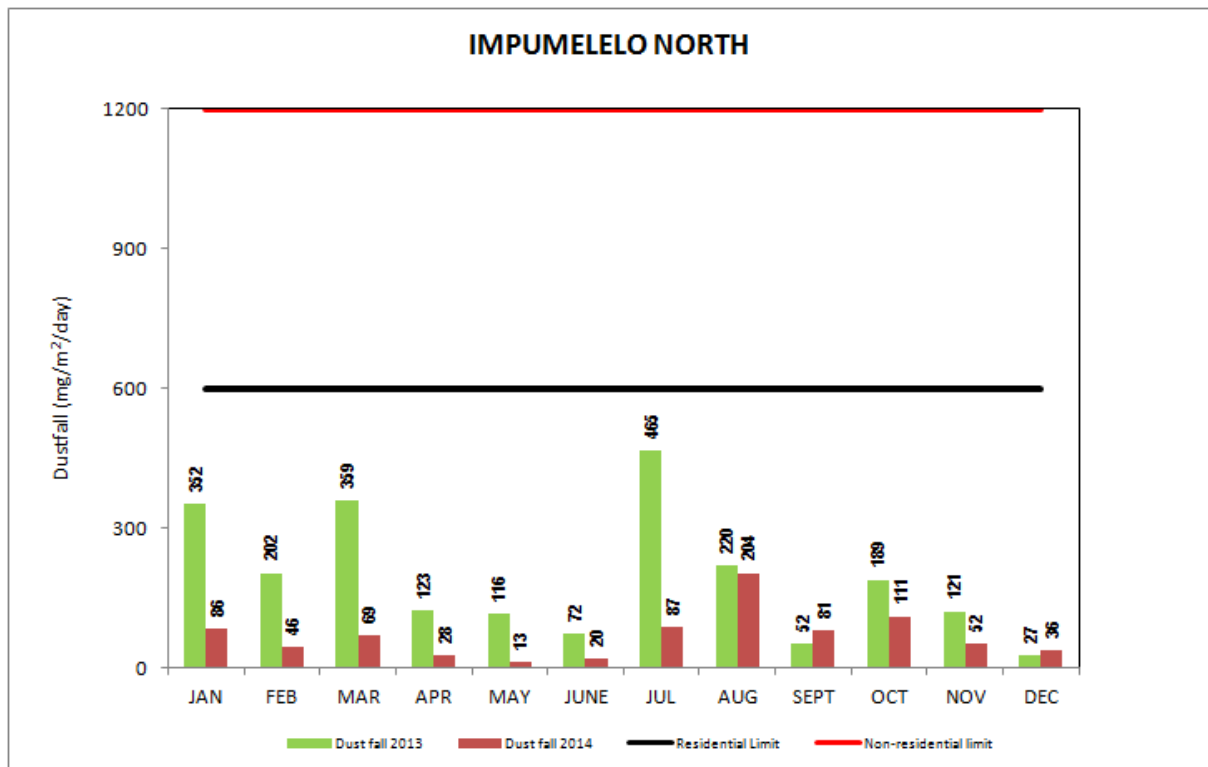
6.1.25 Site 25 – Impumelelo North

This site was commissioned in May 2012 and is classified as a Non-residential site.

During the monitoring period of January to December 2014, all the monitoring months recorded dust fallout below the RESIDENTIAL threshold limit. The month of July 2014 recorded the highest dust fall rate at 204 mg/m²/day, while May 2014 recorded the lowest dust fallout at 13 mg/m²/day.

January, March and July 2014 recorded decreased dust fallout compared to the 2013 results. All the remaining months recorded dust fallout equivalent to the 2013 results.

Figure 26: Dust fall rates recorded for Site 25 (Impumelelo North) for January to December 2014.



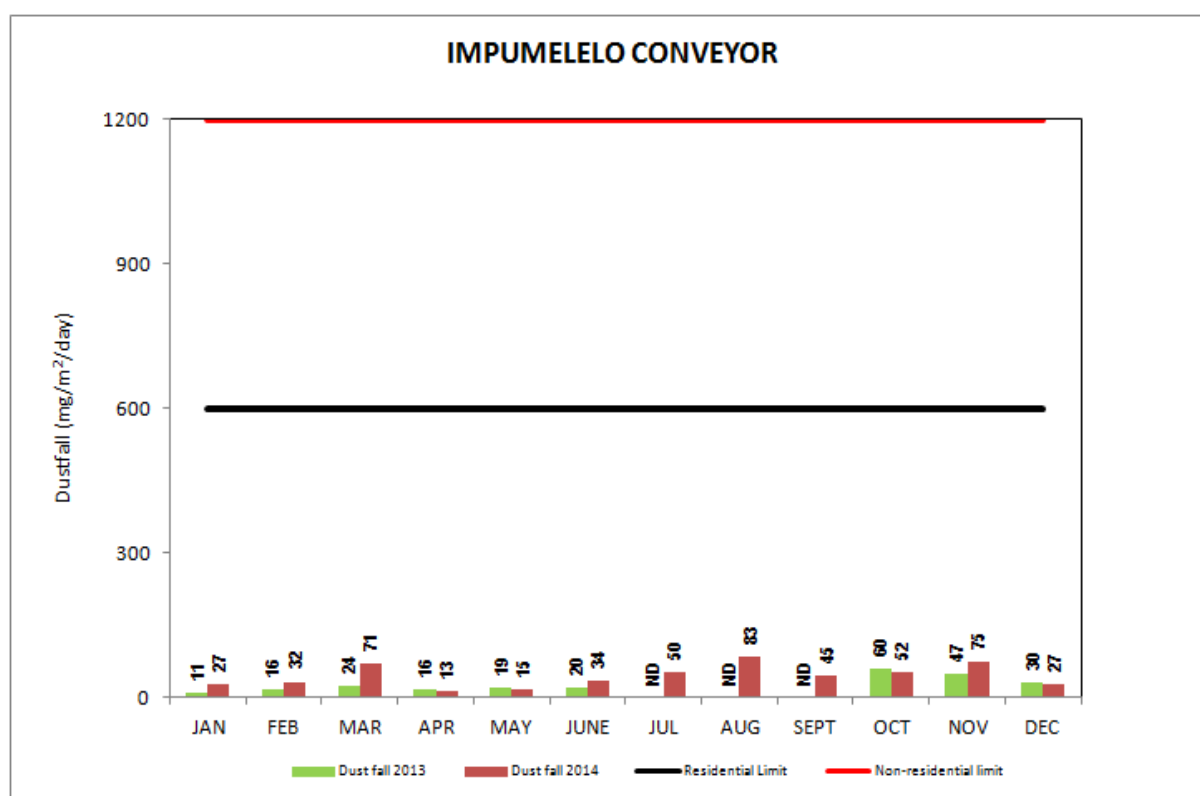
6.1.26 Site 26 – Impumelelo Conveyor

This site was commissioned in October 2012 and is classified as a Non-residential site.

RESIDENTIAL range dust fall levels were recorded during the monitoring period of January to December 2014. The month of August 2014 recorded the highest dust fall rate at 83 mg/m²/day, while April 2014 recorded the lowest dust fallout at 13 mg/m²/day.

In comparison to the months in which data was recorded in 2013 all the months recorded equivalent dust fallout.

Figure 27: Dust fall rates recorded for Site 26 (Impumelelo Conveyor) for January to December 2014.



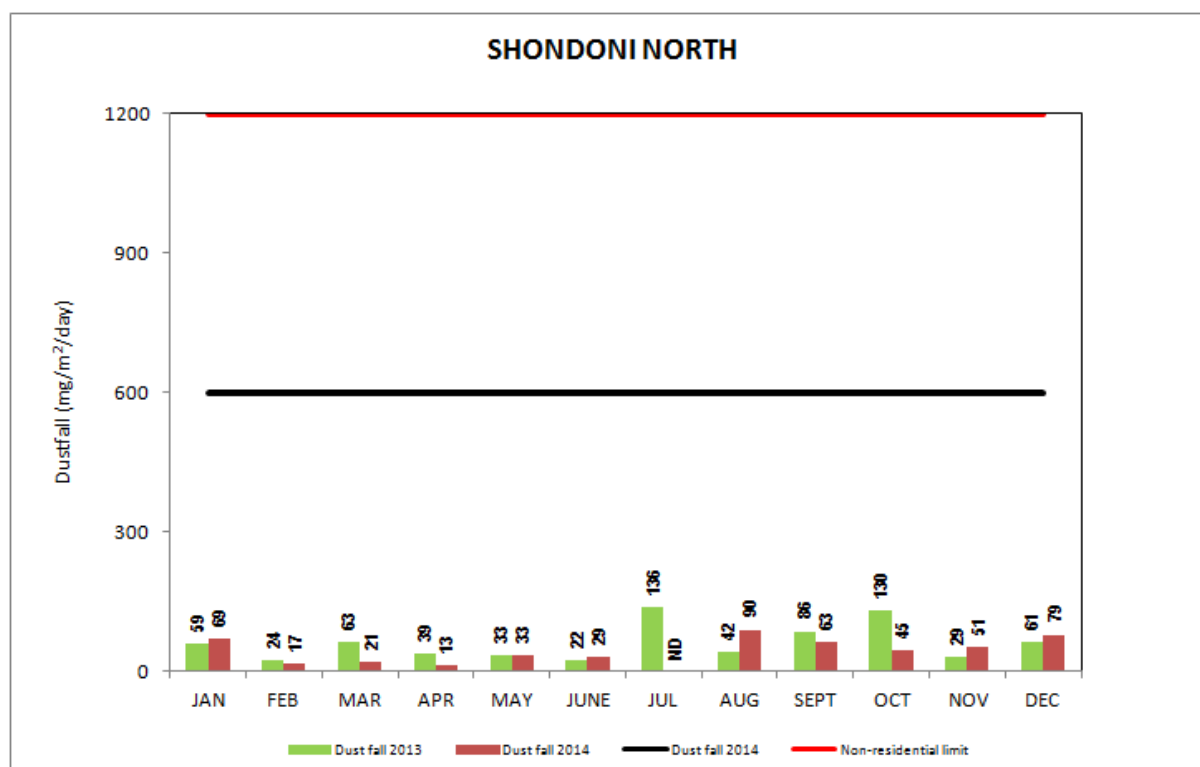
6.1.27 Site 27 – Shondoni North

This site was commissioned in October 2012 and is classified as a Non-residential site.

During the monitoring period of January to December 2014, there was no data recorded during the month of July 2014 as the sample was contaminated by a dead bird. All other monitoring months recorded dust fallout below the RESIDENTIAL threshold limit. The month of August 2014 recorded the highest dust fall rate at 90 mg/m²/day, while April 2014 recorded the lowest dust fallout at 13 mg/m²/day.

In comparison to the months in which data was recorded, all the months recorded equivalent dust fallout.

Figure 28: Dust fall rates recorded for Site 27 (Shondoni North) for January to December 2014.



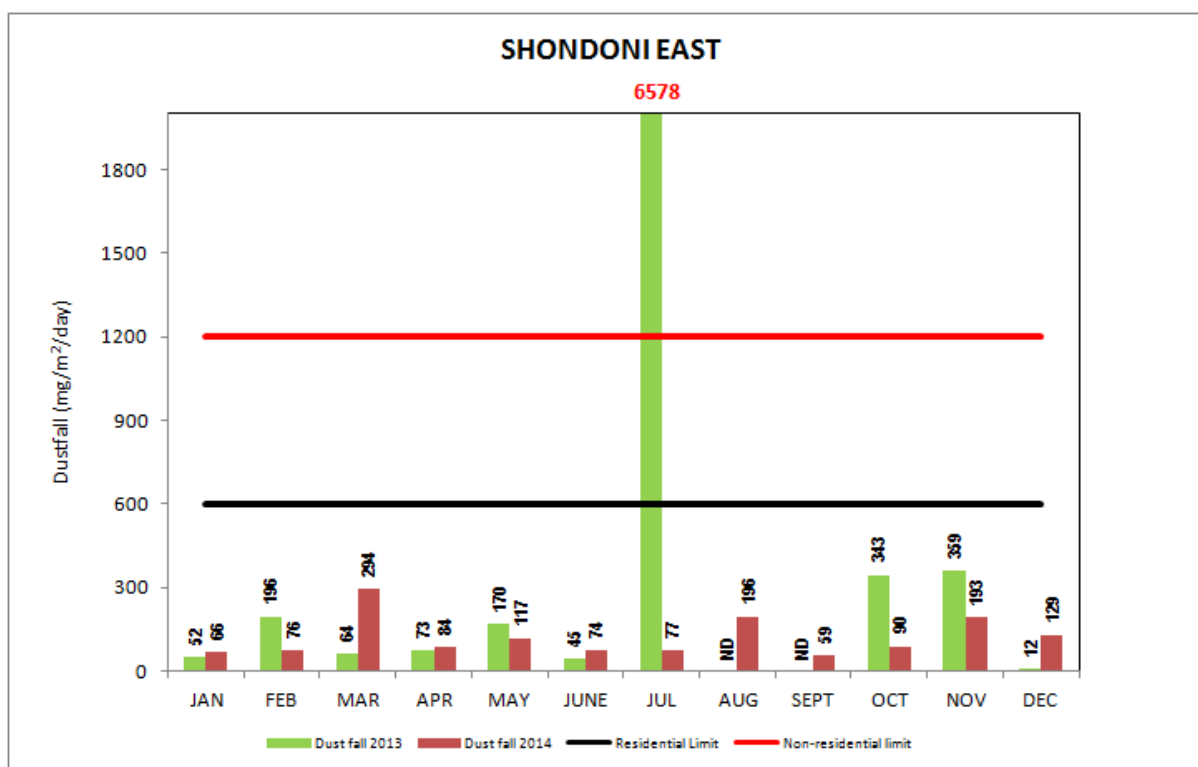
6.1.28 Site 28 – Shondoni East

This site was commissioned in October 2012 and is classified as a Non-residential site.

RESIDENTIAL range dust fallout was recorded during the monitoring period of January to December 2014. The month of March 2014 recorded the highest dust fallout at 294 mg/m²/day. September 2014 recorded the lowest dust fallout at 59 mg/m²/day.

In comparison to the months in which data was recorded in 2013, a significant decrease was recorded during July and October 2014. March 2014 recorded an increase in dust fallout compared to the 2013 results. All the other months recorded dust fallout equivalent to the 2013 results.

Figure 29: Dust fall rates recorded for Site 28 (Shondoni East) for January to December 2014



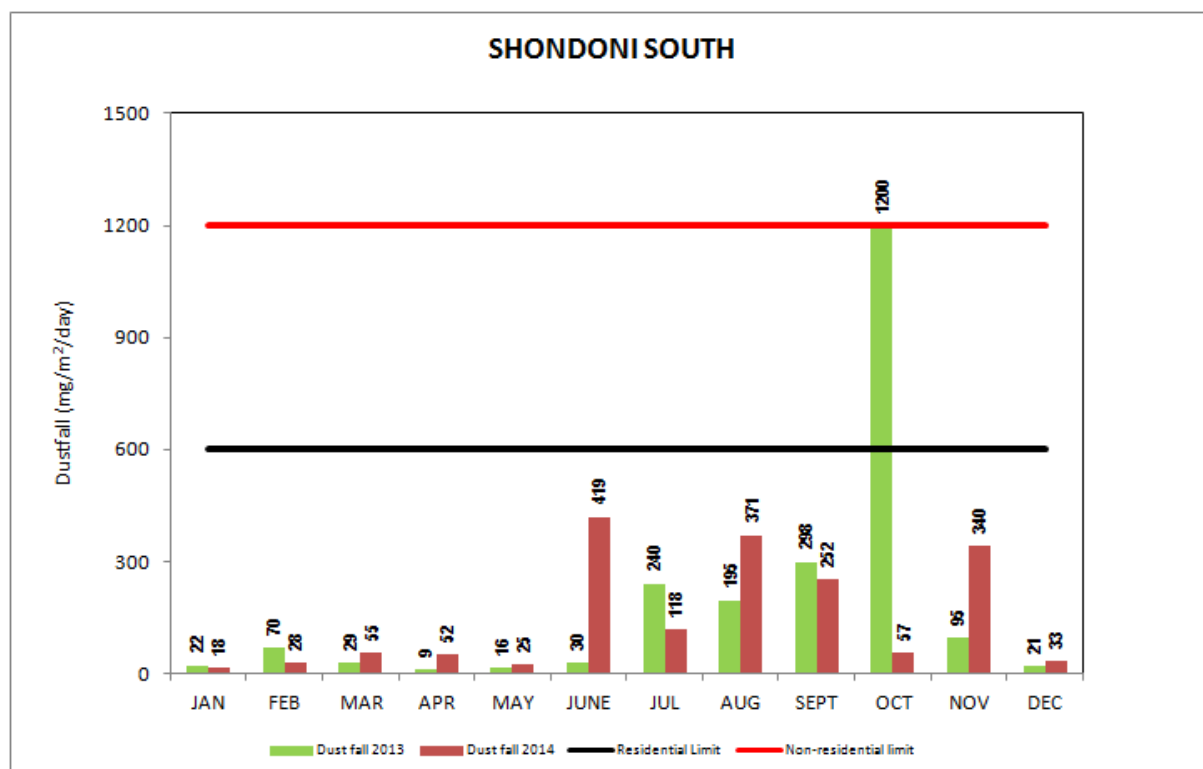
6.1.29 Site 29 – Shondoni South

This site was commissioned in October 2012 and is classified as a Non-residential site.

RESIDENTIAL range dust fallout was recorded during the monitoring period of January to December 2014. June 2014 recorded the highest dust fallout at 419 mg/m²/day. January 2014 recorded the lowest dust fall rate at 18 mg/m²/day.

October 2014 recorded a significant decrease in dust fallout compared to the 2013 results. June and November 2014 recorded increased dust fallout compared to the 2013 results. All other months recorded dust fallout equivalent to the 2013 results.

Figure 30: Dust fall rates recorded for Site 29 (Shondoni South) for January to December 2014.



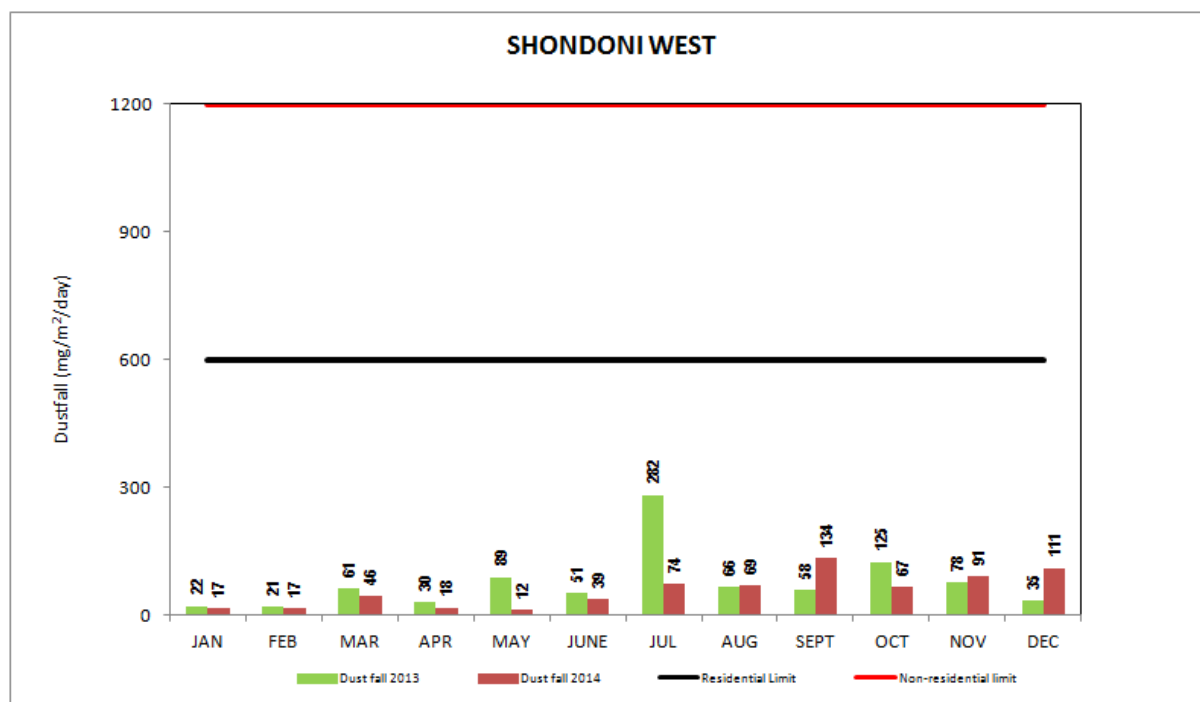
6.1.30 Site 30 – Shondoni West

This site was commissioned in October 2012 and is classified as a Non-residential site.

During the monitoring period of January to December 2014, all the monitoring months recorded dust fallout below the RESIDENTIAL threshold limit. The month of September 2014 recorded the highest dust fall rate at 134 mg/m²/day, while May 2014 recorded the lowest dust fallout at 12 mg/m²/day.

With the exception of July 2014 where the results were lower, all the months recorded dust fallout equivalent to the 2013 results.

Figure 31: Dust fall rates recorded for site 30 (Shondoni West) for January to December 2014.



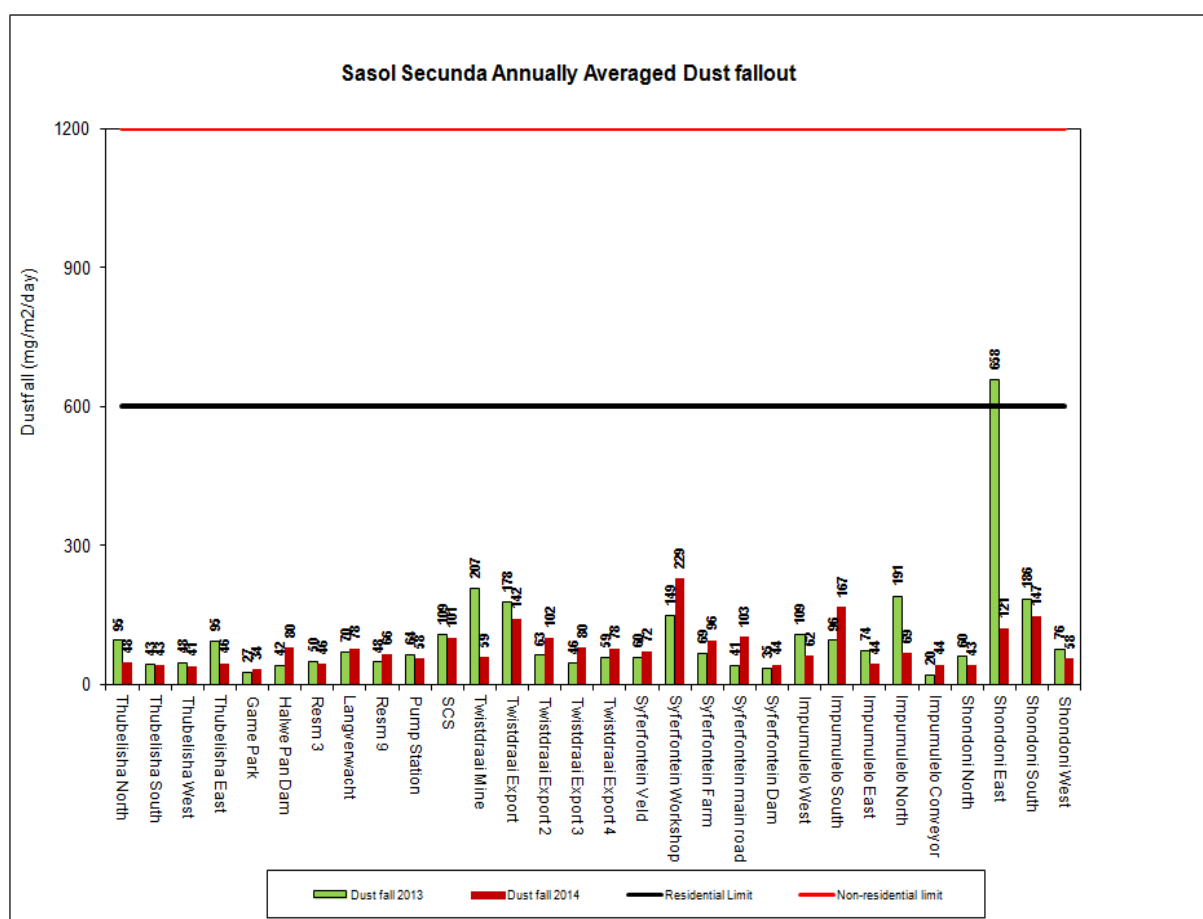
6.2 Annual averages in dust fall rates

Annual average dust fall rates observed at each of the Sasol Secunda single bucket sites during January to December 2014 are given in Figure 32.

All the monitoring sites recorded annual averages below the RESIDENTIAL threshold limit. Syferfontein Workshop recorded the highest annual average at 229 mg/m²/day. Game Park recorded the lowest annual average at 34 mg/m²/day.

With the exception of Shondoni East where the results were lower, all the sites recorded annual averages equivalent to the 2013 results.

Figure 32: Annual average dust fall rates recorded at each site during the January to December 2014 period



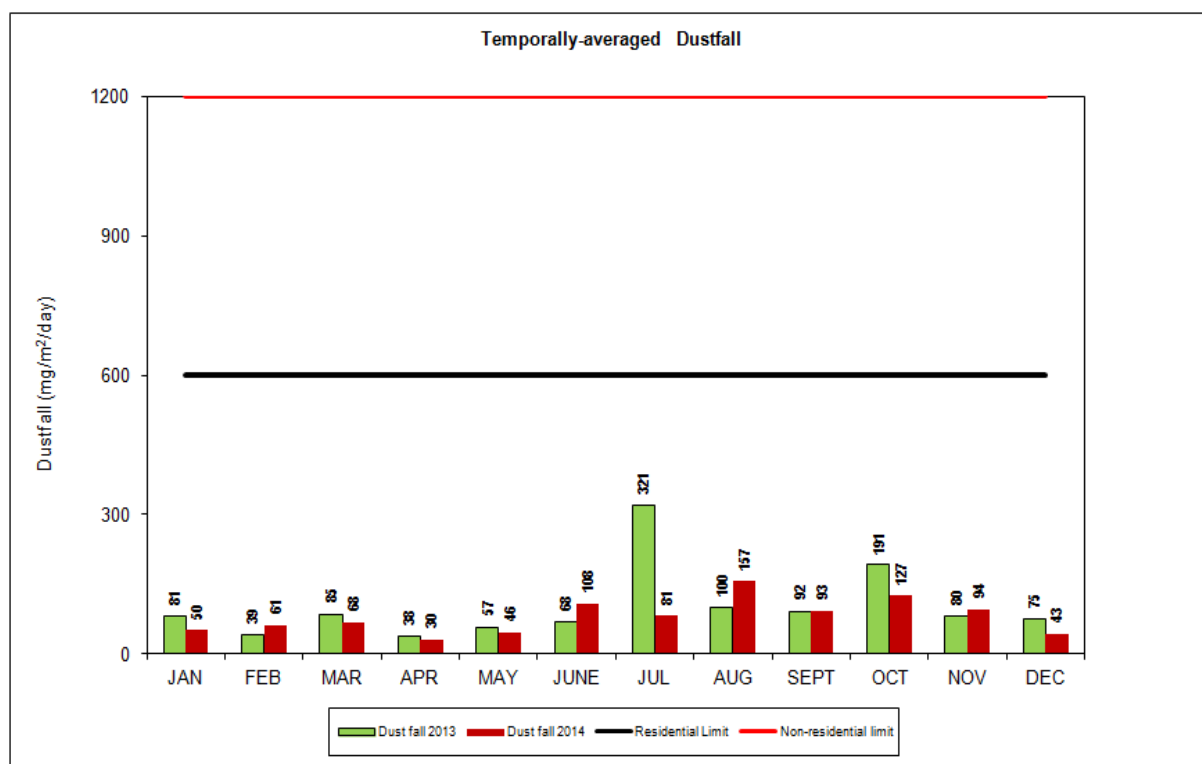
6.3 Temporal averages in dust fall rates

Temporal-averages dust fall rates for all stations for the January to December 2014 period are presented in Figure 33. The averaging of dust fall levels across all the Sasol Secunda sampling sites facilitates an easier analysis of the overall seasonal trends in dust fall levels.

All the monitoring months recorded temporal averages below the RESIDENTIAL threshold. The highest temporal average was recorded in August 2014 at 157 mg/m²/day while April 2014 recorded the lowest temporal average at 30 mg/m²/day.

All the months recorded temporal averages equivalent to the 2013 dust fallout.

Figure 33: Temporal Average Variations in dust fall rates.

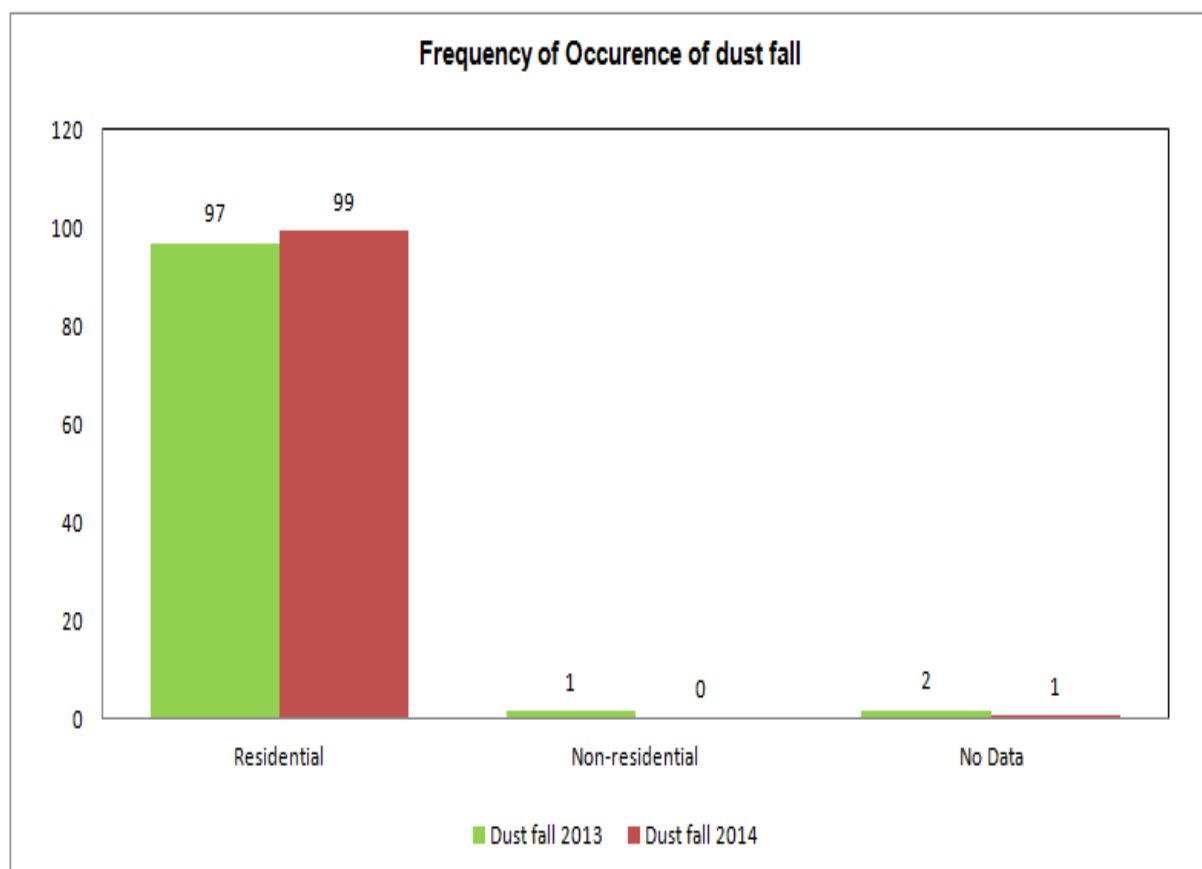


7 CLASSIFICATION OF RESULTS

Results obtained from the thirty single-bucket dust-monitors situated at Sasol Secunda for the period January to December 2014 were presented in the report. A synopsis of the frequency of occurrence of various categories of dust fall rates, based on samples collected for the single-bucket monitoring sites for the monitoring period in review is given in Figure 34.

Majority of dust falls for the period in review occurred within the RESIDENTIAL category at 99%. There was no occurrence of the NON-RESIDENTIAL category. The samples which recorded NO DATA accounted for 1% of the total during the monitoring period in review.

Figure 34: Synopsis of frequency of occurrence of RESIDENTIAL, NON-RESIDENTIAL dustfall and No Data, recorded during the 2014 period.



8 METEOROLOGICAL DATA*

8.1 *Analysis of Meso-Scale Meteorological Data*

The wind field and the intensity and frequency of occurrence of precipitation represent the most important meteorological parameters influencing emissions, dispersion and deposition of fugitive dust. Hourly average wind data and rain fall was obtained from the Sasol Secunda Weather station for the period under review.

SGS is not accredited for the acquisition and reporting meteorological data. The data has been provided by Sasol Secunda personnel and is reported as such. SGS will not take responsibility for any errors that may occur in the acquisition and transmission of data.

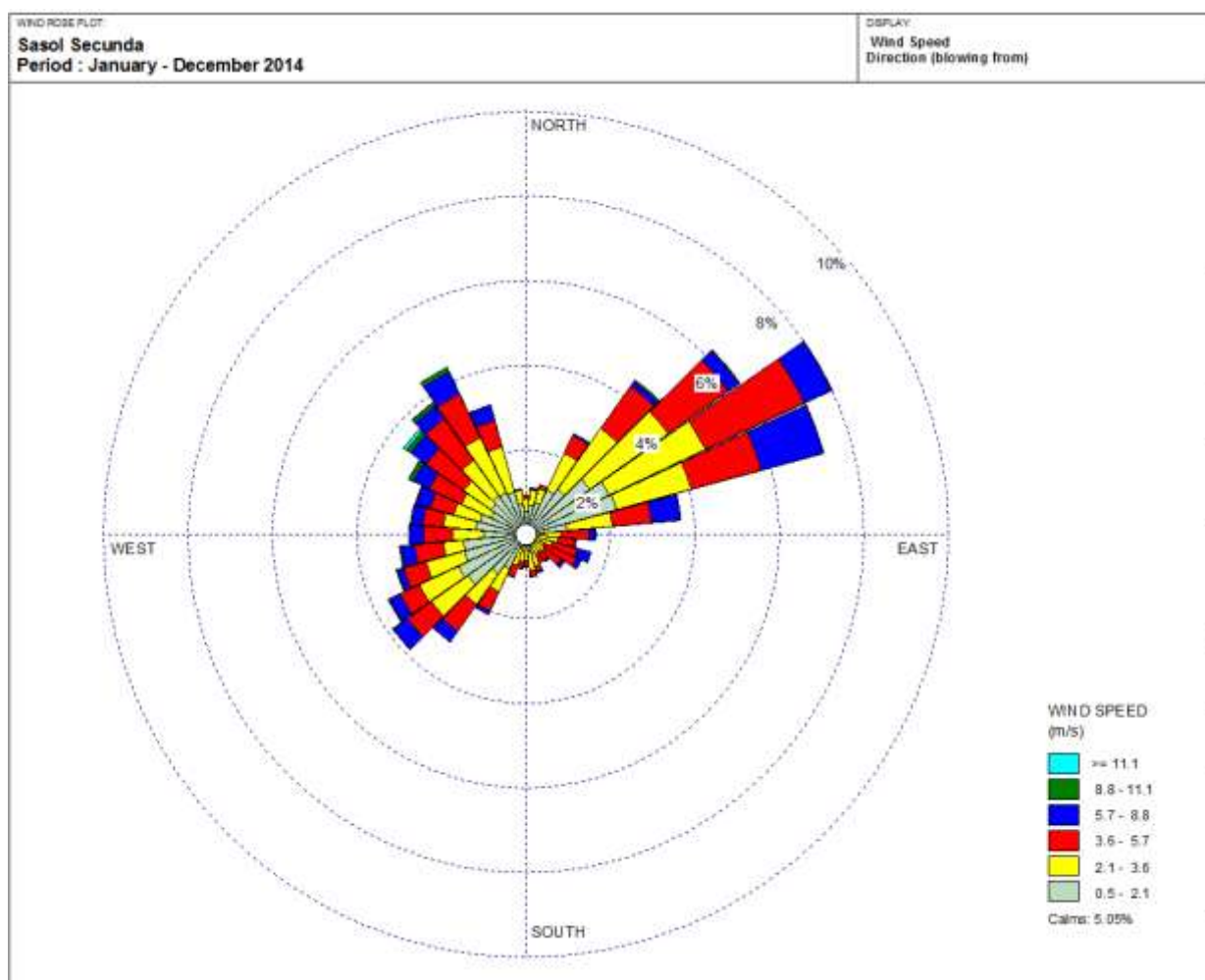
8.1.1 Surface Wind Field Analysis

The erosion and vertical dispersion of dust is a function of the wind field. The wind speed determines the dust generation potential, the distance of downwind transport, and the rate of dilution of pollutants. The generation of mechanical turbulence is similarly a function of the wind speed, in combination with the surface roughness.

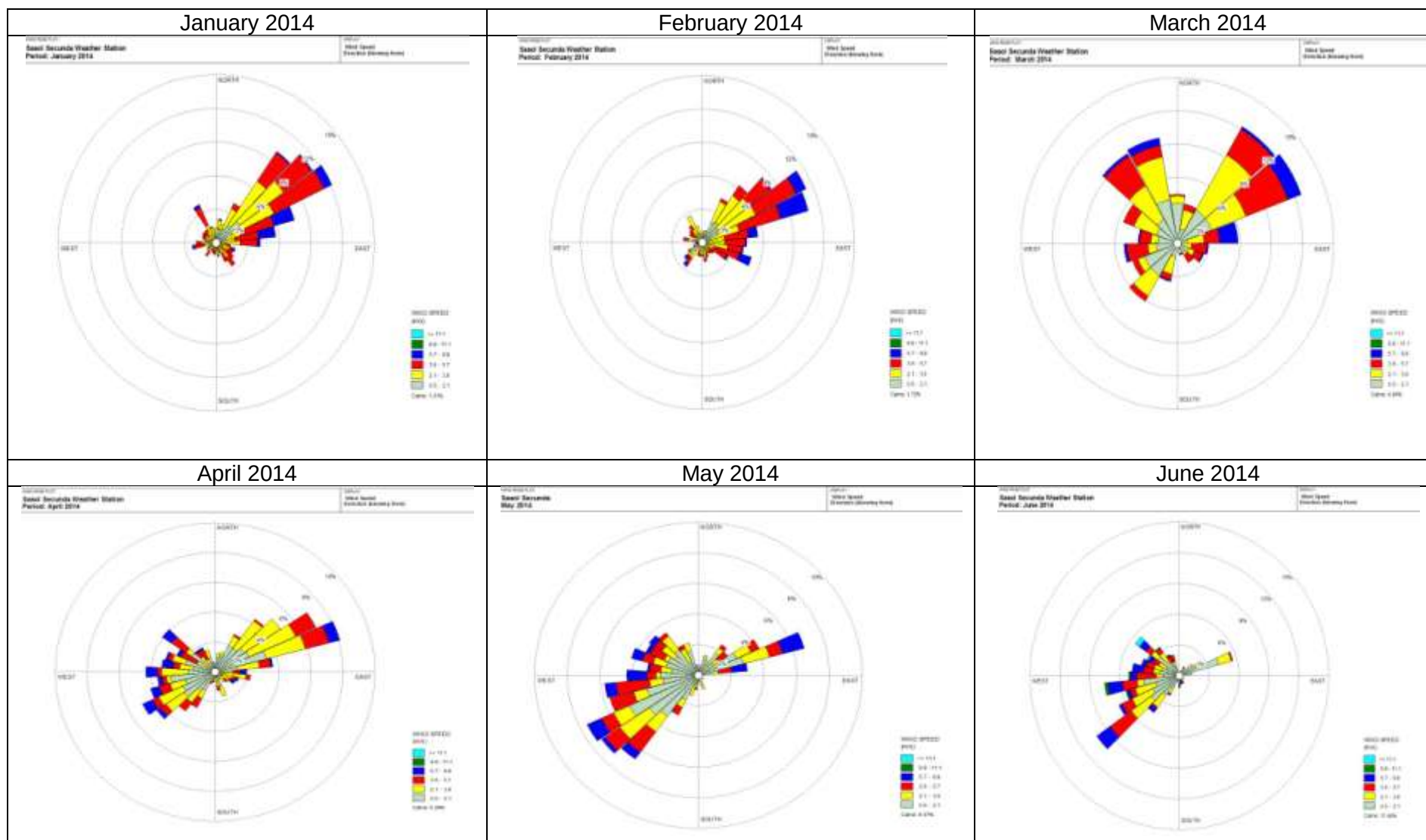
Period average and monthly average wind roses for the January to December 2014 interval are given in Figure 35. The colours reflect the different categories of wind speeds; thus light green represents wind speeds lower than 0.5 to 2.1 m/s, yellow represents winds of 2.1 to 3.6 m/s, red represents 3.6 to 5.7 m/s, blue represents 5.7 to 8.8 m/s, green represents 8.8 to 11.1 m/s and light blue represents winds greater than 11.1 m/s. The dashed circles represent the frequency of occurrence of wind speed and direction categories. Wind speeds higher than 4 m/s will have an influence on dust mobility and are thus the winds of concern with respect to dust concentrations. The threshold wind speed (minimum speed required to transport dust particles) depends on the dust particle size.

Note: *Results marked “Not SANAS Accredited” in this report are not included in the SANAS Schedule of Accreditation for this laboratory.

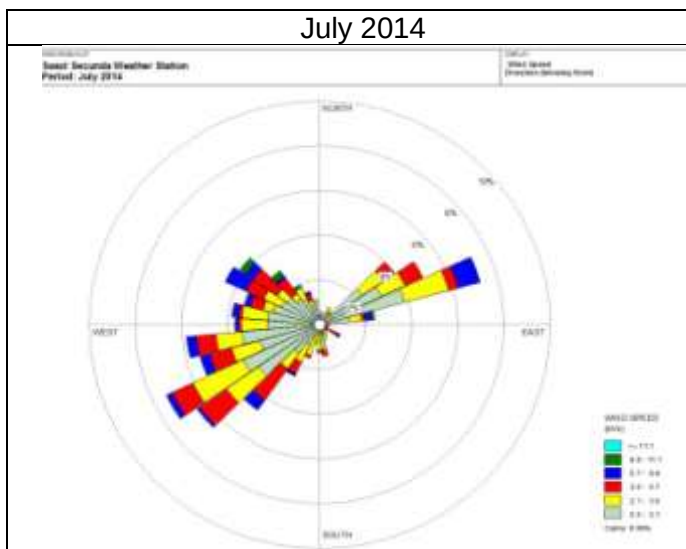
Figure 35: Period average wind rose for the January to December 2014 monitoring period, based on wind field data from the Sasol Secunda Weather Station



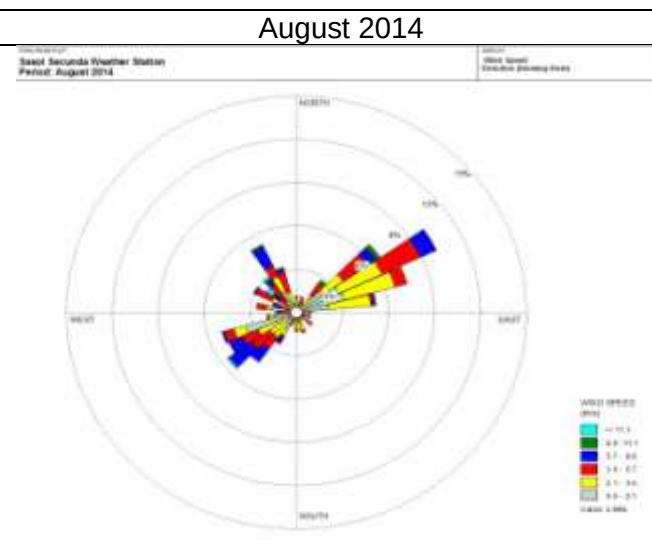
Wind speeds generally decrease during the autumn to winter months and increase again during spring and summer. Over the annual period, winds in the Sasol Secunda region blew predominantly from the North East, with winds from the North West and South West quadrant representing a less frequent secondary flow component.



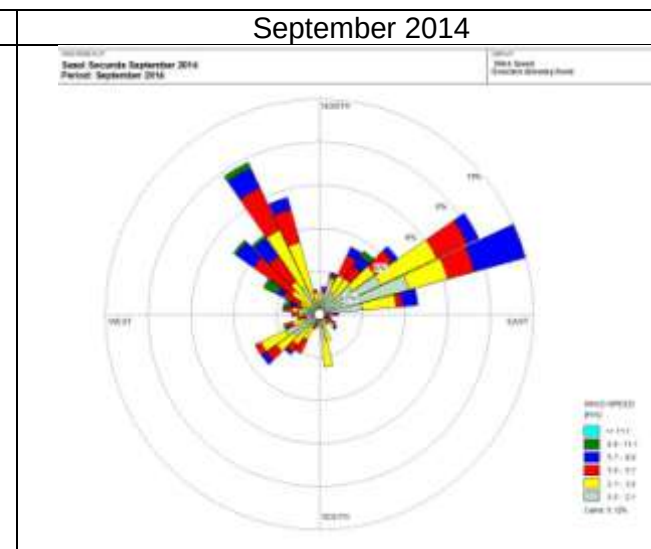
July 2014



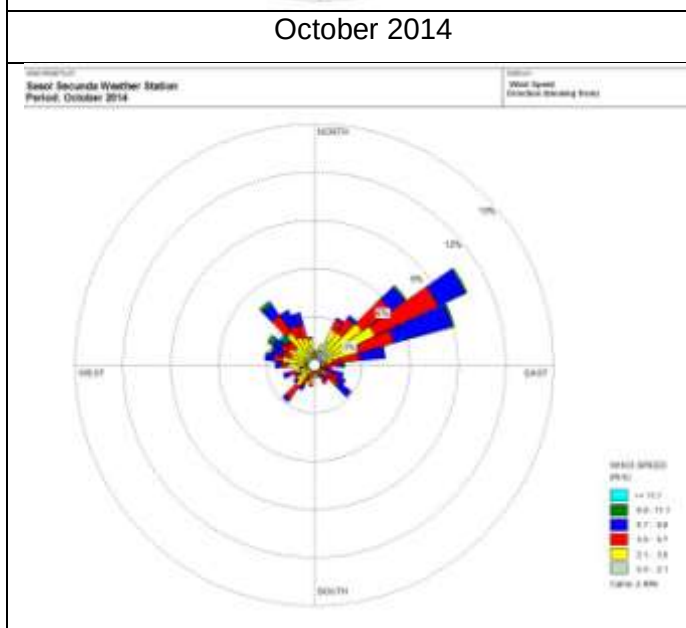
August 2014



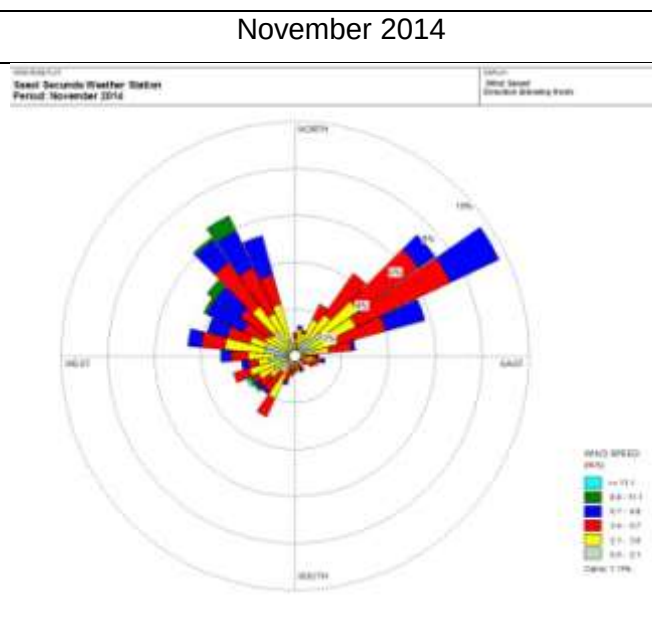
September 2014



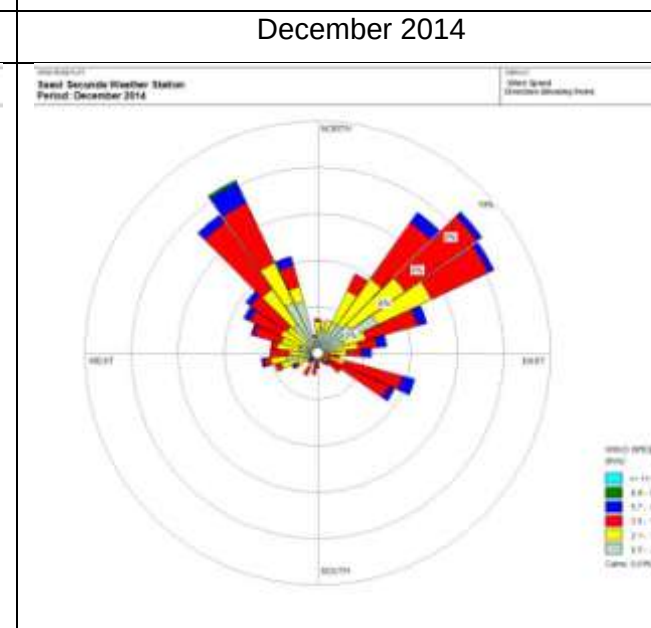
October 2014



November 2014



December 2014

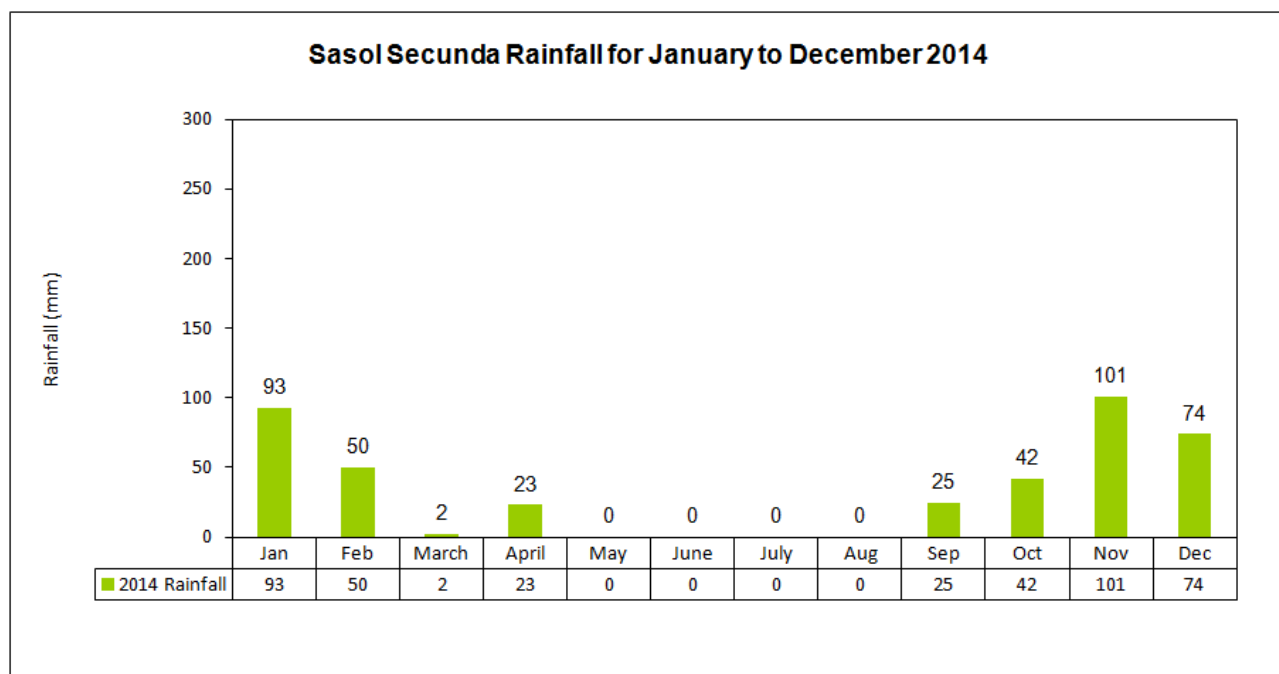


8.1.2 Precipitation*

Precipitation is important to air pollution studies since it represents an effective removal mechanism of atmospheric pollutants and inhibits dust generation potentials. Rainfall data was obtained from the Sasol Secunda weather station for the period under review. The cumulative rainfall is represented in Figure 36.

An annual rainfall of 410 mm was calculated for the January to December 2014 monitoring period. No rainfall was recorded from May to August 2014. The highest rainfall experienced was during the month of November 2014 at 101 mm.

Figure 36: Total Monthly rainfall for January to December 2014



Note: *Results marked "Not SANAS Accredited" in this report are not included in the SANAS Schedule of Accreditation for this laboratory.

9 CONCLUSIONS AND RECOMMENDATIONS

The results obtained from the thirty dust-monitoring sites situated at Sasol Secunda were presented and discussed for the period January to December 2014. Sample contamination by dead birds was encountered on two occasions which resulted in data availability amounting to 99%.

The recommended sampling period of 30 ± 3 days was adhered to throughout the monitoring period of January to December 2014.

Dust fallout during the monitoring period was always below the RESIDENTIAL threshold limit. All the monitoring months recorded temporal average dust fall rates within the RESIDENTIAL range. Annually averaged dust fallout was also below the RESIDENTIAL threshold limit.

Majority of dust falls for the period in review were characterised by the RESIDENTIAL dust fall category.

9.1 SAMPLING NETWORK

It is recommended that the current sampling sites be retained for a further year. If there are additional sensitive locations (new operations or complaints), these should be indicated to SGS so that additional monitoring sites may be recommended, if appropriate.

APPENDIX 1

Sampling locations of all sites

Figure A1.1: Map illustrating the monitoring Sites around Sasol Secunda.



Figure A1.2: Map illustrating the monitoring sites at Twistdraai Export.



Figure A1.3: Map illustrating the monitoring site at Twistdraai East.



Figure A1.4: Map illustrating the monitoring sites at Impumelelo.



Figure A1.5: Map illustrating the monitoring sites at Thubelisha Mine.



Figure A1.6: Map illustrating the monitoring sites at Shondoni.



Figure A1.7: Map illustrating the monitoring sites at Syferfontein.



APPENDIX 2

Results from May 2012 to December 2014

2012	Thubelisha North	Thubelisha South	Thubelisha West	Thubelisha East	Game Park	Halve pan Dam	Resm 3	Langverwa cht	Resm 9	Pump Station
May	ND	ND	ND	ND	230	304	38	89	346	146
June	188	139	204	58	29	83	31	65	118	132
July	244	154	303	341	183	299	35	149	355	39
Aug	272	361	363	450	227	445	156	238	326	338
Sep	ND	37	ND	242	140	229	113	64	503	45
Oct	ND	136	ND	406	171	315	261	219	314	435
Nov	123	139	91	113	66	92	122	101	97	163
Dec	26	11	34	ND	25	85	21	152	20	27

2012	SCS	Twistdraai Mine	Twistdraai Export	Twistdraai Export 2	Twistdraai Export 3	Twistdraai Export 4	Syferfontein Veld	Syferfontein Workshop	Syferfontein Farm	Syferfontein main road
May	44	26	486							
June	ND	65	214				164	30	45	109
July	65	72	414				57	202	282	277
Aug	255	418	319				210	379	424	ND
Sep	64	97	85				164	316	179	130
Oct	702	176	284				97	310	170	102
Nov	251	220	75	175	80	140	278	226	48	47
Dec	112	78	31	22	22	41	9	76	39	15

2012	Syferfontein Dam	Impumulelo West	Impumulelo South	Impumulelo East	Impumulelo North	Impumulelo Conveyor	Shondoni North	Shondoni East	Shondoni South	Shondoni West
May		242	386	458	298					
June	75	72	192	320	231					
July	36	212	289	314	545					
Aug	209	285	192	137	203					
Sep	136	209	225	207	165					
Oct	60	285	352	378	225					
Nov	146	246	248	225	264	340	242	99	151	52
Dec	22	16	24	10	21	ND	10	42	17	53

2013	Thubelisha North	Thubelisha South	Thubelisha West	Thubelisha East	Game Park	Halvepan Dam	Resm 3	Langverwa cht	Resm 9	Pump Station
Jan	41	23	82	10	20	14	35	122	23	21
Feb	21	21	18	12	29	17	18	13	15	16
Mar	32	33	46	31	26	27	44	77	53	82
April	41	17	16	83	39	25	51	77	34	16
May	17	48	21	194	12	86	22	41	74	49
June	51	63	18	308	13	28	86	50	71	79
July	33	67	34	163	30	24	31	69	45	47
Aug	49	67	24	68	22	42	56	150	38	147
Sep	40	36	34	91	21	65	10	54	37	138
Oct	717	74	166	73	51	107	224	85	82	158
Nov	91	35	49	88	46	58	16	63	67	ND
Dec	11	32	71	18	20	12	8	39	43	14*

2013	SCS	Twistdraai Mine	Twistdraai Export	Twistdraai Export 2	Twistdraai Export 3	Twistdraai Export 4	Syferfontein Veld	Syferfontein Workshop	Syferfonte in Farm	Syferfontein main road
Jan	109	44	139	116	27	56	35	150	13	28
Feb	93	22	26	64	14	76	12	19	21	12
Mar	68	59	769	49	41	55	60	69	99	45
April	24	33	89	19	21	42	47	43	14	18
May	57	30	66	37	22	44	62	82	27	38
June	34	149	138	57	48	32	81	216	50	71
July	45	97	123	27	52	71	48	154	179	23
Aug	196	468	151	93	39	81	72	343	98	26
Sep	361	112	75	85	72	29	106	46	72	84
Oct	143	248	409	104	134	122	45	391	31	87
Nov	112	97	97	48	24	66	111	103	198	34
Dec	61	1129	52	60	53	35	41	163	22	30

2013	Syferfontein Dam	Impumulelo West	Impumulelo South	Impumulelo East	Impumulelo North	Impumulelo Conveyor	Shondoni North	Shondoni East	Shondoni South	Shondoni West
Jan	15	757	21	4	352	11	59	52	22	22
Feb	13	18	74	9	202	16	24	196	70	21
Mar	37	64	29	48	359	24	63	64	29	61
April	15	20	41	20	123	16	39	73	9	30
May	38	24	118	49	116	19	33	170	16	89
June	37	24	54	51	72	20	22	45	30	51
July	22	155	325	67	465	ND	136	6578	240	282
Aug	57	32	126	32	220	ND	42	ND	195	66
Sep	58	50	80	503	52	ND	86	ND	298	58
Oct	46	62	90	44	189	60	130	343	1200	125
Nov	56	55	126	36	121	47	29	359	95	78
Dec	24	43	64	23	27	30	61	12	21	35

2014	Thubelisha North	Thubelisha South	Thubelisha West	Thubelisha East	Game Park	Halvepan Dam	Resm 3	Langverwa cht	Resm 9	Pump Station
Jan	37	16	28	16	14	25	10	167	101	13
Feb	32	15	115	25	22	13	17	31	101	24
Mar	33	60	35	42	49	74	53	35	40	46
April	6	24	34	10	4	14	80	18	28	36
May	25	6	17	20	37	79	44	16	81	27
June	14	51	27	65	15	145	58	66	108	170
July	58	42	29	62	46	95	42	74	53	39
Aug	143	99	40	76	47	200	71	111	52	91
Sep	25	38	42	85	32	167	53	93	60	30
Oct	113	49	60	102	30	96	64	170	81	143
Nov	51	88	31	46	94	34	57	121	54	63
Dec	41	24	29	8	17	13	3	33	38	11

2014	SCS	Twistdraai Mine	Twistdraai Export	Twistdraai Export 2	Twistdraai Export 3	Twistdraai Export 4	Syferfontein Veld	Syferfontein Workshop	Syferfonte in Farm	Syferfontein main road
Jan	41	24	57	22	24	39	26	80	12	24
Feb	215	13	71	33	17	102	51	199	19	20
Mar	78	35	126	74	78	55	24	186	53	41
April	26	20	31	28	2	8	7	114	28	7
May	8	74	226	46	29	10	63	54	156	14
June	43	106	142	291	39	244	109	126	311	235
July	68	37	219	67	61	15	104	234	176	127
Aug	210	153	334	298	310	269	210	331	141	85
Sep	99	74	120	134	91	47	79	456	105	56
Oct	139	66	187	173	180	35	73	568	96	543
Nov	238	65	93	49	79	58	92	286	ND	51
Dec	46	38	95	12	43	57	22	110	59	28

2014	Syferfontein Dam	Impumulelo West	Impumulelo South	Impumulelo East	Impumulelo North	Impumulelo Conveyor	Shondoni North	Shondoni East	Shondoni South	Shondoni West
Jan	45	60	326	19	86	27	69	66	18	17
Feb	27	46	370	32	46	32	17	76	28	17
Mar	52	64	130	27	69	71	21	294	55	46
April	52	14	92	18	28	13	13	84	52	18
May	25	36	49	31	13	15	33	117	25	12
June	13	28	171	55	20	34	29	74	419	39
July	51	64	175	93	87	50	0	77	118	74
Aug	40	220	121	61	204	83	90	196	371	69
Sep	43	58	110	51	81	45	63	59	252	134
Oct	63	95	184	63	111	52	45	90	57	67
Nov	99	34	200	51	52	75	51	193	340	91
Dec	14	21	78	30	36	27	79	129	33	111