

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 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 regulations. Table B-2 compares the Air Dispersion Modelling Regulations with the approach used in Section 5. The only updates applied, following stakeholder comment, was to the receptors to include schools and clinics, as indicated on the isopleth plots in Section 5.1.8.

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

Chapter	Name	AIR regulations requirement	Status in AIR
1	Enterprise details	<ul style="list-style-type: none"> • Enterprise Details • Location and Extent of the Plant • Atmospheric Emission Licence and other Authorisations 	Enterprise details included. Location of plant included. APPA permit numbers included.
2	Nature of process	<ul style="list-style-type: none"> • Listed Activities • Process Description • Unit Processes 	All detail included in the regulated format
3	Technical Information	<ul style="list-style-type: none"> • Raw Materials Used and Production Rates • Appliances and Abatement Equipment Control Technology 	All raw materials information that is not confidential and proprietary information. Sensitive information will be made available to the Licensing Authorities upon request (Section 3.1 and 3.2).
4	Atmospheric Emissions	<ul style="list-style-type: none"> • Point Source Emissions <ul style="list-style-type: none"> • 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 	There is no information available regarding the maximum rates, because these are not measured, and are impractical to measure; therefore only emissions rates during normal operating conditions are available. Information regarding fugitive sources has not been included, as the modelling only considers the sources included in the AEL. Information regarding emergency incidents was not included as the applications deal with normal operating conditions.
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.
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, prosecution, fines	Included

Chapter	Name	AIR regulations requirement	Status in AIR
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 the Air Dispersion Modelling with study approach

AIR Regulations	Compliance with Regulations	Comment
<p>Levels of assessment</p> <ul style="list-style-type: none"> 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 kilometres downwind (less than 50km) Level 3: requires more sophisticated dispersion models (and corresponding input data, resources and model operator expertise) in situations: <ul style="list-style-type: none"> 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	<p>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.</p> <p>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.</p>
<p>Model Input</p> <p>Source characterisation</p> <p>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</p> <p>Meteorological data</p> <p>Full meteorological conditions are recommended for regulatory applications.</p> <p>Data period</p> <p>Geographical Information</p> <p>Topography and land-use</p>	<p>Yes</p> <p>Yes</p> <p>Yes</p> <p>Yes</p>	<p>Source characterisation provided in Section 5.1.7.</p> <p>Emission rates used for each scenario are provided in Section 5.1.7.</p> <p>WRF modelled meteorology (including upper air) corrected with on-site observed meteorology (surface meteorology) (Sections 5.1.4.6 and 5.1.5).</p> <p>3 years (2013 to 2015)</p> <p>Required for CALMET 3D meteorological file preparation (Section 5.1.4.6.2)</p>

AIR Regulations	Compliance with Regulations	Comment
Domain and co-ordinate system	Yes	<ul style="list-style-type: none"> Dispersion modelling domain: 50 x 50 km UTM co-ordinate system (WGS84) (Section 5.1.4.6.4)
<p>General Modelling Considerations</p> <p>Ambient Background Concentrations, including estimating background concentrations in multi-source areas</p> <p>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</p> <p>Land-use classification</p> <p>Surface roughness</p> <p>Albedo</p> <p>Temporal and spatial resolution</p> <p>Receptors and spatial resolutions</p> <p>Building downwash</p> <p>Chemical transformations</p>	<p>Yes</p>	<p>Section 5.1.5.4, Section 5.1.6, and Appendix F</p> <p>Model predicted, 99th percentile ground-level concentrations compared against current observed concentrations and assessed for contribution to ambient concentrations. Used as an indication of how modifications to the plant will impact ambient concentrations. (Section 5.1.8)</p> <p>Section 5.1.4.2 and Section 5.1.4.6.2</p> <p>Computed from Land-use categories in the CALMET pre-processing step (Section 5.1.4.6.2).</p> <p>Computed from Land-use categories in the CALMET pre-processing step (Section 5.1.4.6.2).</p> <p>Sections 5.1.8 and 5.1.4.6.4</p> <p>Section 5.1.4.6.5</p> <p>Sections 5.1.4.3, Section 5.1.4.4 and Appendix E and Appendix F.</p>
<p>General Reporting Requirements</p> <p>Model accuracy and uncertainty</p> <p>Plan of study</p> <p>Air Dispersion Modelling Study Reporting Requirements</p> <p>Plotted dispersion contours</p>	<p>Yes</p> <p>Yes</p> <p>Yes</p> <p>Yes</p>	<p>Section 5.1.6, Section 5.1.9, Appendix I and Appendix J</p> <p>Section 5.1.1.1</p> <p>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 Notice R533, 11 July 2014).</p> <p>Section 5.1.8</p>

APPENDIX C: RAW MATERIALS, ABATEMENT EQUIPMENT, ATMOSPHERIC EMISSIONS AND MEASURED DUSTFALL AT SASOL'S SASOLBURG OPERATIONS

C1: Raw Materials

Table C-1: Raw materials used at SO

Raw Material Type	Maximum Permitted Consumption Rate (Quantity)	Units (quantity/period)
Sasolburg Operations		
<i>ATR</i>		
Natural Gas	147800	Nm ³ /h
<i>Rectisol</i>		
Gas mixture (CO, H ₂ , CO ₂ , CH ₄)	150000	Nm ³ /h
<i>Water and waste – Thermal oxidation</i>		
Spent Caustic	3.5	tonnes/year
Organic Solvents		tonnes/hour
High Sulphur Pitch	2.5	tonnes/hour
Limestone	3	tonnes/hour
Organic waste water	2	tonnes/hour
Off- specification waxes	60	tonnes/month
Sasol spent catalyst	204	tonnes/month
Funda filter cake	220	tonnes/month
Polyethylene wax	80	tonnes/month
Other solid waste	150	tonnes/month
High organic waste	400	tonnes/month
Pitch/ tar waste	150	tonnes/month
Slop oils		
<i>Steam Stations</i>		
Water (Steam station 1)	1304	tonnes/hour
Water (Steam station 2)	1467	tonnes/hour
Water (Steam station 3)	255	tonnes/hour
Coal (Steam station 1)	245.2	tonnes/hour
Coal (Steam station 2)	228.2	tonnes/hour
Coal (Steam Station 3)	35.5	tonnes/hour
<i>Ammonia</i>		
Gas mixture (CO, H ₂ , CO ₂ , CH ₄)		Nm ³ /h
Nitrogen		Nm ³ /h
Steam		tonnes/hour
<i>Prillian</i>		
Ammonia nitrate solution (88%)		tonnes/day
<i>Nitric Acid/Ammonium Nitrate</i>		
Ammonia		tonnes/day
SCCM		
Alumina		tonnes/year
Tetra Ethyl Ortho Silicate		tonnes/year
Wax		tonnes/year
Hydrogen		kNm ³ /year
Ethanol		tonnes/year
Ammonia		tonnes/year
Fuel Gas		tonnes/year
Electrical Power		MVA
Nitrogen		kNm ³ /year
Cobalt Solution		tonnes/year
Platinum		tonnes/year
Merisol		
IP sensitive information		
Solvents		
<i>Solvents – All plants</i>		

Raw Material Type	Maximum Permitted Consumption Rate (Quantity)	Units (quantity/period)
Hydrogen	1046	Nm ³ /h
Acetone	18	m ³ /h
Catalyst	15000	l/a
<i>Solvents – MIBK 1 and 2</i>		
Crude methanol		m ³ /h
Make – up water		l/h
<i>Solvents – Methanol</i>		
Crude methanol		m ³ /h
Make – up water		l/h
<i>Solvents – Methanol TG</i>		
Crude methanol E1102		m ³ /h
<i>Solvents – E1204</i>		
Sabutol feed		m ³ /h
<i>Solvents - Butanol</i>		
Propylene		tonnes/hour
Synthesis gas		Nm ³ /h
99 mol% Hydrogen		Nm ³ /h
<i>Solvents - AAA</i>		
Propylene		tonnes/year
Butanol		tonnes/year
Ethanol		tonnes/year
LOC		
Storage of various raw materials and products on site		
Polymers		
<i>Poly 2</i>		
Ethylene	Information protected. Licensing Authority can view information on site	
Additives		
1-Hexene		
Hydrogen		
<i>Poly 3</i>		
Ethylene		tonnes/year
Propylene		tonnes/year
Isododecain		
Organic peroxide initiators		tonnes/year
Additives (depending on market requirements)		tonnes/year
<i>VCM and PVC</i>		
<i>VCM Plant</i>		
Ethylene		tonnes/day
Chlorine		tonnes/day
Oxygen		tonnes/day
Hydrogen		tonnes/day
<i>PVC Plant</i>		
Vinyl Chloride monomer (VCM)		tonnes/day
Ethyl chloroformate		tonnes/day
<i>Monomers</i>		
C2-feed from Secunda	Information IP sensitive	
Ethane from Secunda		
Depropaniser off gas from Natref (propane + ethane)		
PPU4 bottoms from Natref (mainly propane)		
<i>Cyanide 1</i>		
Ammonia		tonnes/month
		Nm ³ /h (instantaneous)
Natural gas		GJ/month
		Nm ³ /h (instantaneous)
Electricity		MW/month
		kW instantaneous
Caustic		tonnes/month
		kg/h (instantaneous)
Graphite		tonnes/month
Nitrogen		kNm ³ /month

Raw Material Type	Maximum Permitted Consumption Rate (Quantity)	Units (quantity/period)
		Nm ³ /h (instantaneous)
<i>Cyanide 2</i>		
Ammonia		tonnes/month
		Nm ³ /h (instantaneous)
Natural gas		GJ/month
		Nm ³ /h (instantaneous)
Electricity		MW/month
		kW instantaneous
Caustic		tonnes/month
		kg/h (instantaneous)
Graphite		tonnes/month
		kNm ³ /month
Nitrogen		Nm ³ /h (instantaneous)
<i>Chlorine</i>		
Sodium Chloride		tonnes/year
Wax		
Sasol Wax – Production		Information IP sensitive
Sasol Wax – Catalyst preparation		

* Raw materials not provided are due to IP or competition law sensitivities

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

Appliance name	Appliance type/description	Appliance function/purpose
Precipis	Electrostatic precipitators	Reduce particulate emissions
Bag filters	Bag house	Reduce particulate emissions
Venturi Scrubber	Venturi Scrubber	Reduce particulate and SO ₂ emissions
SCR	Selective catalytic reduction unit	Reduce NOx emissions
Flares	Flare	Convert organic gasses into CO ₂ and H ₂ O
Scrubbers	Wet scrubbers	Reduce particulate emissions
Filters	Reverse pulse cartridge filters	Reduce particulate emissions
VCU	Vapour combustion units	Converting fugitive emissions from columns, tanks and loading operations into CO ₂ and H ₂ O
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)	Emissions Hours	Type of Emissions (Continuous / Batch)
Sasolburg Operations											
<u>ATR</u>											
13	Fired Heaters ATR A	-26.82631	27.84055	65	-	3.32	190	794 710	25.5	24 Hours	Continuous
14	Fired Heaters ATR B	-26.82668	27.84077	65	-	3.32	190	769 778	24.7	24 Hours	Continuous
<u>Steam Stations</u>											
123	SS1 Boiler 4	-26.82217	27.84073	75	n/a	2.5	160	235 030	13.3	24 Hours	Continuous
124	SS1 Boiler 5&6	-26.82235	27.84037	75	n/a	2.5	160	458 751	26.0	24 Hours	Continuous
125	SS1 Boiler 7&8	-26.82248	27.84009	75	n/a	25	160	478 543	27.1	24 Hours	Continuous
126	SS2 Boiler 1 to 7	-26.82217	27.84884	145	n/a	7.8	160	1 746 014	10.2	24 Hours	Continuous
<u>Thermal Oxidation</u>											
132	Heavy Ends B incinerator (B6990)	-26.82549	27.84035	40	n/a	1.5	570	63 617	3.9	24 Hours	Continuous
133	High sulfur pitch incinerator (B6930)	-26.82537	27.84022	40	n/a	1.53	171	139 958	26.2	24 Hours	Continuous
134	Spent caustic incinerator (B6993)	-26.82553	27.84043	40	n/a	1.2	83	50 894	12.9	24 Hours	Continuous
<u>PRILLIAN / Ammonium nitrate</u>											
15	J 4062 A Dust scrubber	-26.82900	27.84100	22	n/a	1	29	106 311	37.6	24 Hours	Batch
16	J 4062 B Dust scrubber	-26.82900	27.84100	22	n/a	1	28	92 372	32.67	24 Hours	Batch
17	J4063 A	-26.82900	27.84100	85	n/a	1.5	21	89 700	14.1	24 Hours	Batch
18	J4063 B	-26.82900	27.84100	85	n/a	1.5	23	94 599	14.87	24 Hours	Batch
19	J4063 C	-26.82900	27.84100	85	n/a	1.5	23	66 607	10.47	24 Hours	Batch

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)	Emissions Hours	Type of Emissions (Continuous / Batch)
<u>Nitric Acid Plant</u>											
I53	Effluent stack	-26.82524	27.86023	75	n/a	1.5	215	39 634	6.23	24 Hours	Continuous
Merisol											
I12	Fuel gas furnace	-26.83023	-26.83023	40	None in vicinity	0.11	99	164	4.8	24h/d	Continues
I13	Phenol plant	-26.82387	-26.82387	30	None in vicinity	0.2	29	26	0.23	24h/d	Continues
I14	SOx scrubber on N-base units	-26.83000	-26.83000	12	None in vicinity	0.11	300	1 687	49.3	24h/d	Continues
	Merisol Flare	-26.831706	27.845865	67	None in vicinity	1.2	Not available	2 000 m3/hr	4.8	adhoc	adhoc
Sasol Technology											
	Pilot Plant Flare	-26.8221	27.8447	39	3.5	0.15-0.2	200	2160	~70	24 Hours	Intermittently related to start-up, shut down and upset conditions
Solvents											
<u>AAA</u>											
I1	ST6010	-26.82300	27.86800	20	n/a	0.95	790	16 586	6.4	24 hours	Continuous
I2	ST1040	-26.82328	27.86682	25	n/a	1.5	123	70 615	12.63	24 hours	Continuous
<u>Solvents</u>											
	E 501 Bottoms knockout	-26.776	27.84419	Ties in to B 1102 – 10 m	Ties in to B 1102	Ties in to B 1102	Ties in to B 1102	Ties in to B 1102	Ties in to B 1102	24 hours	Continuous
	F501 + F 502 vent	-26.77617	27.84472	15	None in vicinity	0.16	35	50.7	0.7	24 hours	Continuous
	F 505 vent	-26.77618	27.84471	15	None in vicinity	0.1	176	57.1	2.02	24 hours	Continuous
	E1204	-26.77589	27.84469	15	None in vicinity	0.1	24	12.4	0.44	24 hours	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)	Emissions Hours	Type of Emissions (Continuous / Batch)
	B 1102	-26.7759	27.8447	10	None in vicinity	0.4	59	452.4	1	24 hours	Continuous
	F1133 A+B	-26.77588	27.84468	15	None in vicinity	0.1	27	36.8	1.3	24 hours	Continuous
LOC											
	VCU UNIT	-26.82794	27.84175	12		2.4	152	68401	4.2	24 hours	Intermittently when loading occurs
Polymers											
<i>Poly 2 (LLDPE) and Poly 3 (LDPE) plant</i>											
	Poly 2 Flare	-26.83327	27.87093	±52	None in the vicinity	TBM	Flame	7173	Above flashback velocity	24 hours	Continuous
	Poly 3 Flare	-26.83271	27.87146	52	None in the vicinity	0.6	Flame	Designed for max relief load of 120t/h	Above flashback velocity	24 hours	Continuous
	Poly 3 Emergency Vent Separator (EVS)			8	None in the vicinity	0.8	Used only during emergency situations			24 hours	Continuous
<i>Monomers</i>											
110	Steam cracker furnaces, B002A/B	-26.83199	27.84400	20	None in the vicinity	1.8	417	54 049	5.9	24 hours	Continuous
111	Steam cracker furnaces, B003	-26.83190	27.84395	26	None in the vicinity	1.2 x 2	200	34 608	8.5	24 hours	Continuous
	Elevated Flare (B101)	-26.83351	27.84492	65	None in the vicinity	0.914	176 (op)	Non continuous Flow		24 hours	Continuous
	Tank Flare (B180)	-26.83408	27.84626	30	None in the vicinity			Non continuous Flow		24 hours	Continuous
	Ground Flare (B009)	-26.83342	27.84558	24.39	None in the vicinity	19.278	100 (20 – 200)	12.1	0.0065	24 hours	Continuous
	Mea Regen Off Gas	-26.832	27.84386	35	None in the vicinity	0.1016	40	0.098	0.003	24 hours	Continuous
<i>Vinyl Chloride Monomer (VCM) Plant</i>											

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)	Emissions Hours	Type of Emissions (Continuous / Batch)
	VCM incinerator	-26.82999	27.87300	30	None in the vicinity	0.36	134	9527	22.7	24 hours	Continuous
	VCM Cracker	-26.82999	27.87300	40	None in the vicinity	1.71	390	26457	3.2	24 hours	Continuous
	VCM Safety Scrubber – not continuous flow	-26.82833	27.87253	26.6	None in the vicinity	0.7	96	18500	13.5	24 hours	Continuous
	VCM Cold Flare – not continuous flow	-26.82858	27.87306	50	None in the vicinity	0.81	136	77200	42	24 hours	Continuous

<u>Poly Vinyl Chloride (PVC) Plant</u>	
PVC Autoclave H Vent	The autoclave vents at the PVC plant are vents for the safety bursting discs. Venting only occurs under emergency conditions.
PVC Autoclave J Vent	
PVC Autoclave K Vent	
PVC Autoclave L Vent	
PVC Autoclave M Vent	
PVC Autoclave N Vent	
PVC Autoclave P Vent	
PVC Autoclave Q Vent	
PVC Autoclave R Vent	
PVC Autoclave S Vent	
PVC Autoclave T	

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)	Emissions Hours	Type of Emissions (Continuous / Batch)
	Vent										
	PVC Autoclave U Vent										
	PVC Reaction Stack North	-26.82758	27.87408	24	n/a	0.6	30	7700	7.6	24 hours	Continuous
	PVC Reaction Stack South	-26.82717	27.87353	24	n/a	0.6	30	7700	7.6	24 hours	Continuous
	PVC Slurry Stock Tank Stack	-26.82717	27.87442	35	n/a	1.2	45	60000	15	24 hours	Continuous
	PVC VCM Recovery Stack	-26.828	27.87408	24	n/a	0.05	-40	19	3	24 hours	Continuous
	PVC Multigrade Vent Stack	-26.82758	27.87408	6	n/a	0.05	100	89	12.6	24 hours	Continuous
129	PVC Drier Stack North	-26.82787	27.87330	35	n/a	1.8	63	131 917	14.4	24 hours	Continuous
130	PVC Dryer Stack South	-26.82791	27.87336	35	n/a	1.8	55	141 352	15.4	24 hours	Continuous
<i>Chlorine plant</i>											
131	HCl burner stacks	-26.82546	27.84039	15	n/a	0.16	30	120	2.8	24 hours	Continuous
	Chlorine hypo stacks	-26.82361	27.87406	40	n/a	0.25	23	60	2.2	24 hours	Continuous
<i>Cyanide plant</i>											
	Cyanide stacks	-26.82361	27.86672			0.2	35	Cannot be quantified due to hydrogen and the associated fire risk		24 hours	Continuous
Sasol Wax											
<i>Sasol Wax</i>											
115	Oven B 4701	-26.83078	27.84631	26	None in the vicinity	1	409	18 378	6.5	24 hours	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)	Emissions Hours	Type of Emissions (Continuous / Batch)
I16	Oven B 4702	-26.83079	27.84625	26	None in the vicinity	1	320	18 661	6.6	24 hours	Continuous
I17	Oven B 4801	-26.83081	27.84639	26	None in the vicinity	1.25	165	23 856	5.4	24 hours	Continuous
I18	Oven B 4802	-26.83076	27.84648	26	None in the vicinity	1.25	285	30 925	7	24 hours	Continuous
I19	Oven L 4234 Catalyst washout	-26.83109	27.84242	45	None in the vicinity	0.5	61	9 613	13.6	24 hours	Continuous
	Oven B 2801	-26.82617	27.84292	20	None in the vicinity	0.7	188	3 930	2.8	24 hours	Continuous
	Oven B 1521	-26.82578	27.84256	20	None in the vicinity	0.77	285	4 670	2.8	24 hours	Continuous
<i>Wax catalyst preparation</i>											
I20	Catalyst preparation Salt plant	-26.83108	27.84210	15	None in the vicinity	0.2	36	1312	11.6	24 hours	Continuous
I21	Catalyst preparation SBR	-26.83131	27.84264	15	More or less midway between the ground and the roof	0.5	58	6 030	8.53	24 hours	Continuous
I22	Catalyst preparation FBR	-26.83109	27.84244	15	On top of the roof	0.61	61	15 879	15.6	24 hours	Continuous
	Nitric acid plant / Calcliner stack	-26.831254	27.842644	40m	± 3 m	1	40	4 000	5.7	24 hours	Continuous
Sasol Gas Engine Power Plant											
I35	Bay 1 (stack 1 - 6) - Engine 1	-26.81964	27.84770	27	n/a	1.2	301	114 613	28.2	24 hours	Continuous
I36	Bay 1 (stack 1 - 6) - Engine 2	-26.81964	27.84770	27	n/a	1.2	346	107284	26.4	24 hours	Continuous
I37	Bay 1 (stack 1 - 6) - Engine 3	-26.81964	27.84770	27	n/a	1.2	341	144 946	35.6	24 hours	Continuous
I38	Bay 1 (stack 1 - 6) - Engine 4	-26.81964	27.84770	27	n/a	1.2	345	134 970	33.2	24 hours	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)	Emissions Hours	Type of Emissions (Continuous / Batch)
I39	Bay 1 (stack 1 - 6) - Engine 5	-26.81964	27.84770	27	n/a	1.2	325	116 445	28.6	24 hours	Continuous
I40	Bay 1 (stack 1 - 6) - Engine 6	-26.81964	27.84770	27	n/a	1.2	338	135 581	33.3	24 hours	Continuous
I41	Bay 2 (stack 7-12) - Engine 7	-26.81936	27.84820	27	n/a	1.2	339	125 606	30.9	24 hours	Continuous
I42	Bay 2 (stack 7-12) - Engine 8	-26.81936	27.84820	27	n/a	1.2	356	135 581	33.3	24 hours	Continuous
I43	Bay 2 (stack 7-12) - Engine 9	-26.81936	27.84820	27	n/a	1.2	339	122 145	30.0	24 hours	Continuous
I44	Bay 2 (stack 7-12) - Engine 10	-26.81936	27.84820	27	n/a	1.2	342	131 713	32.4	24 hours	Continuous
I45	Bay 2 (stack 7-12) - Engine 11	-26.81936	27.84820	27	n/a	1.2	345	140 060	34.4	24 hours	Continuous
I46	Bay 2 (stack 7-12) - Engine 12	-26.81936	27.84820	27	n/a	1.2	331	118 277	29.1	24 hours	Continuous
I47	Bay 3 (stack 13-18) - Engine 13	-26.81918	27.84860	27	n/a	1.2	335	114 409	28.1	24 hours	Continuous
I48	Bay 3 (stack 13-18) - Engine 14	-26.81918	27.84860	27	n/a	1.2	351	137 820	33.9	24 hours	Continuous
I49	Bay 3 (stack 13-18) - Engine 15	-26.81918	27.84860	27	n/a	1.2	343	127 642	31.4	24 hours	Continuous
I50	Bay 3 (stack 13-18) - Engine 16	-26.81918	27.84860	27	n/a	1.2	342	134 156	33.0	24 hours	Continuous
I51	Bay 3 (stack 13-18) - Engine 17	-26.81918	27.84860	27	n/a	1.2	353	132 935	32.7	24 hours	Continuous
I52	Bay 3 (stack 13-18) - Engine 18	-26.81918	27.84860	27	n/a	1.2	346	100 810	24.8	24 hours	Continuous

Table C-4: 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
SO				
ATR A	Particulates	120	Hourly	Continuous
	NO _x	1700	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
ATR B	Particulates	120	Hourly	Continuous
	NO _x	1700	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
Boiler 4	Particulates	165	Daily	Continuous
	SO ₂	2000	Hourly	Continuous
	NO _x	1450	Hourly	Continuous
Boiler 5&6	Particulates	165	Daily	Continuous
	SO ₂	2000	Hourly	Continuous
	NO _x	1450	Hourly	Continuous
Boiler 7&8	Particulates	165	Daily	Continuous
	SO ₂	2000	Hourly	Continuous
	NO _x	1450	Hourly	Continuous
SS2 Boiler 1-7	Particulates	100	Daily	Continuous
	SO ₂	2000	Hourly	Continuous
	NO _x	1250	Hourly	Continuous
Thermal Oxidation (90 Furnace)	Particulates	Cannot be measured due to high temperature		
	CO	50	Hourly	Continuous
	NO _x expressed as NO ₂	360	Hourly	Continuous
	SO ₂	50	Hourly	Continuous
	HCl	10	Hourly	Continuous
	HF	1.5	Hourly	Continuous
	Pb+As+Sb+Cr+Co+Cu+Mn+Ni+V	Cannot be measured due to high temperature		
	Hg			
	Cd+Tl			
	TOC	25	Hourly	Continuous
	NH ₃	10	Hourly	Continuous
	Dioxins and furans	Cannot be measured due to high temperature		
Thermal Oxidation (30 Furnace)	Particulates	50	Hourly	Continuous
	CO	75	Hourly	Continuous
	NO _x expressed as NO ₂	750	Hourly	Continuous
	SO ₂	1800	Hourly	Continuous
	HCl	10	Hourly	Continuous
	HF	1	Hourly	Continuous
	Pb+As+Sb+Cr+Co+Cu+Mn+Ni+V	1	Hourly	Continuous
	Hg	0.05	Hourly	Continuous
	Cd+Tl	0.05	Hourly	Continuous
	TOC	50	Hourly	Continuous
	NH ₃	10	Hourly	Continuous
	Dioxins and furans	0.1 ng TEQ/Nm ³	Hourly	Continuous
Thermal Oxidation	Particulates	180	Hourly	Continuous

Point Source Code	Pollutant Name	Maximum Release Rate (mg/Nm ³) ^(a)	Average Period	Duration of Emissions
(93 Furnace)	CO	1050	Hourly	Continuous
	NO _x expressed as NO ₂	420	Hourly	Continuous
	SO ₂	50	Hourly	Continuous
	HCl	15	Hourly	Continuous
	HF	1.2	Hourly	Continuous
	Pb+As+Sb+Cr+Co+Cu+Mn+Ni+V	22	Hourly	Continuous
	Hg	0.05	Hourly	Continuous
	Cd+Tl	0.05	Hourly	Continuous
	TOC	10	Hourly	Continuous
	NH ₃	10	Hourly	Continuous
	Dioxins and furans	0.1 ng TEQ/Nm ³	Hourly	Continuous
10	Particulates	50	Hourly	Batch
	NH ₃	100	Hourly	Batch
11	Particulates	50	Hourly	Batch
	NH ₃	100	Hourly	Batch
12	Particulates	50	Hourly	Batch
	NH ₃	100	Hourly	Batch
13	NO _x	500	Hourly	Continuous
Cobalt Catalyst plant				
1	VOCs	40	Hourly	Continuous
2	NO _x	700	Hourly	Continuous
3	NO _x	700	Hourly	Continuous
4	VOCs	40	Hourly	Batch
5	VOCs	40	Hourly	Batch
6	Particulates	50	Hourly	Continuous
7	NO _x	700	Hourly	Continuous
	VOCs	40	Hourly	Continuous
8	NO _x	700	Hourly	Continuous
9	NO _x	700	Hourly	Continuous
	VOCs	40	Hourly	Continuous
10	NO _x	700	Hourly	Continuous
	VOCs	40	Hourly	Continuous
11	NO _x	700	Hourly	Continuous
	VOCs	40	Hourly	Continuous
Merisol				
1	Particulates	120	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
2	SO ₃	100	Hourly	Continuous
	VOCs	40000	Hourly	Continuous
3	SO ₃	100	Hourly	Continuous
	VOCs	40000	Hourly	Continuous
4	VOCs	40000	Hourly	Continuous
Sastech				
1	Not applicable as the point source is associated with emergency flaring.			

Point Source Code	Pollutant Name	Maximum Release Rate (mg/Nm ³) ^(a)	Average Period	Duration of Emissions
Solvents				
1	VOCs	150	Hourly	Continuous
2	VOCs	150	Hourly	Continuous
3	VOCs	150	Hourly	Continuous
4	VOCs	150	Hourly	Continuous
5	VOCs	150	Hourly	Continuous
6	VOCs	150	Hourly	Continuous
7	VOCs	150	Hourly	Continuous
8	VOCs	150	Hourly	Continuous
LOC				
98	VOCs	150	Hourly	Intermittent
Polymers				
1	Particulates	120	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
1b	Particulates	120	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
	NO _x expressed as NO ₂	1700	Hourly	Continuous
1c	Methyl amine	10	Hourly	Continuous
2	Particulates	25	Hourly	Continuous
	SO ₂	50	Hourly	Continuous
	NO expressed as NO ₂	200	Hourly	Continuous
	HF	1	Hourly	Continuous
	CO	75	Hourly	Continuous
	HCl	30	Hourly	Continuous
	Pb+As+Sb+Cr+Co+Cu+Mn+Ni+V	0.5	Hourly	Continuous
	Hg	0.05	Hourly	Continuous
	Cd+Tl	0.5	Hourly	Continuous
	TOC	10	Hourly	Continuous
	NH ₃	10	Hourly	Continuous
	Dioxins	0.2ngTEQ/Nm ³	Hourly	Continuous
3	Particulates	120	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
	NO _x	200 ppm	Hourly	Continuous
3a	VOCs	40000	Hourly	Continuous
3b	Bursting discs – emissions will only occur during over pressure incidents			Only during emergencies
3c				Only during emergencies
3d				Only during emergencies
3e				Only during emergencies
3f				Only during emergencies
3g				Only during emergencies
3h				Only during emergencies
3i				Only during emergencies
3j				Only during emergencies
3k				Only during emergencies
3l		VCM	150 ppm (m/m)	Daily

Point Source Code	Pollutant Name	Maximum Release Rate (mg/Nm ³) ^(a)	Average Period	Duration of Emissions
3m	VCM	150 ppm (m/m)	Daily	Continuous
3n	VCM	25 ppm (m/m)	Daily	Continuous
3o	VOCs	40000	Hourly	Continuous
3p	VOCs	40000	Hourly	Continuous
4	Particulates	21 mg/Am ³	Hourly	Continuous
5	Particulates	21 mg/Am ³	Hourly	Continuous
6	Cl ₂	5	Hourly	Continuous
	HCl	10	Hourly	Continuous
7	Cl ₂	50	Hourly	Continuous
8	HCN	50 ppm	Hourly	Continuous
Wax				
1, 2, 3, 4, 5, 6, 7, 12, 13	Particulates	120	Hourly	Continuous
	NO _x	1700	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
8, 9, 10	Particulate Matter	50	Hourly	Continuous
	NO _x	2000	Hourly	Continuous
	SO ₂	1700	Hourly	Continuous
11	NO _x	3.5 t/month	Daily	Continuous

(a) units mg/Nm³ unless otherwise stated

C3: Fugitive emissions – dustfall monitoring

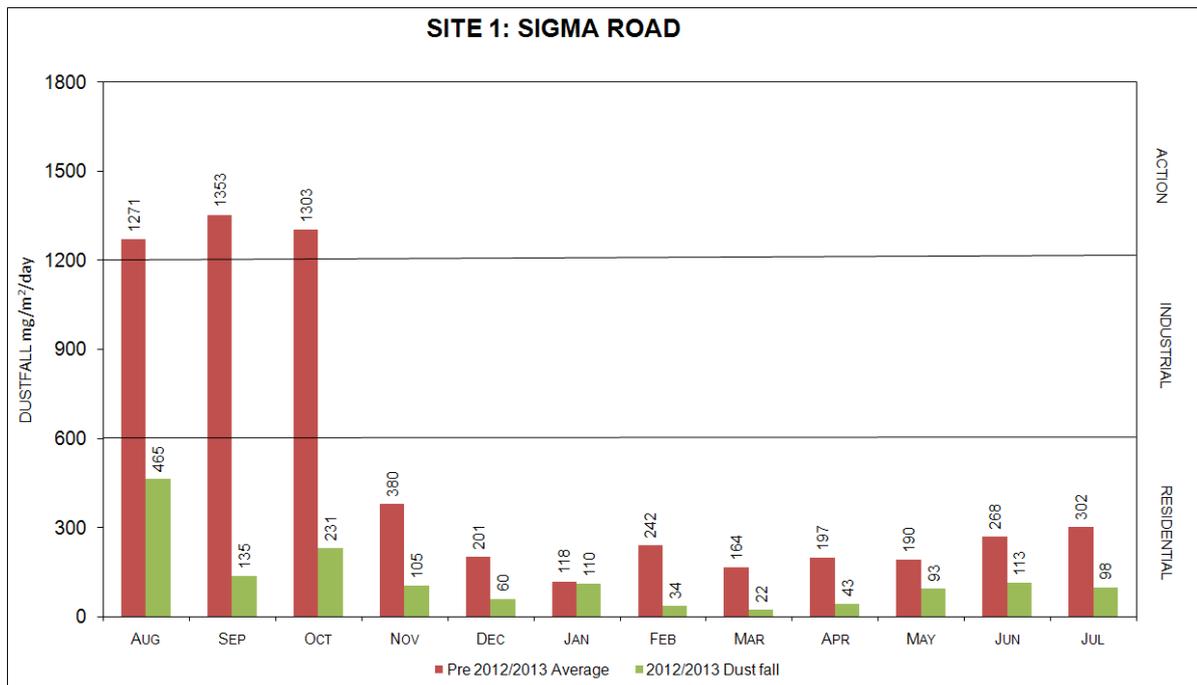


Figure C-1: Dustfall rates at Site 1 (Sigma road) between August 2012 and July 2013

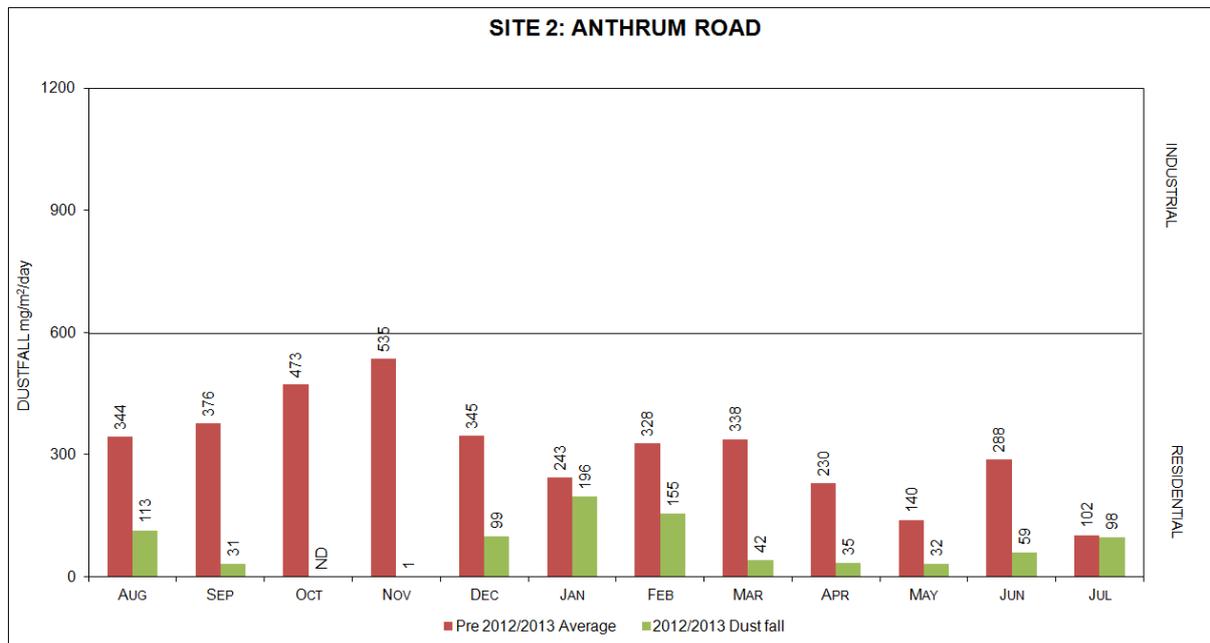


Figure C-2: Dustfall rates at Site 2 (Anthrum road) between August 2012 and July 2013

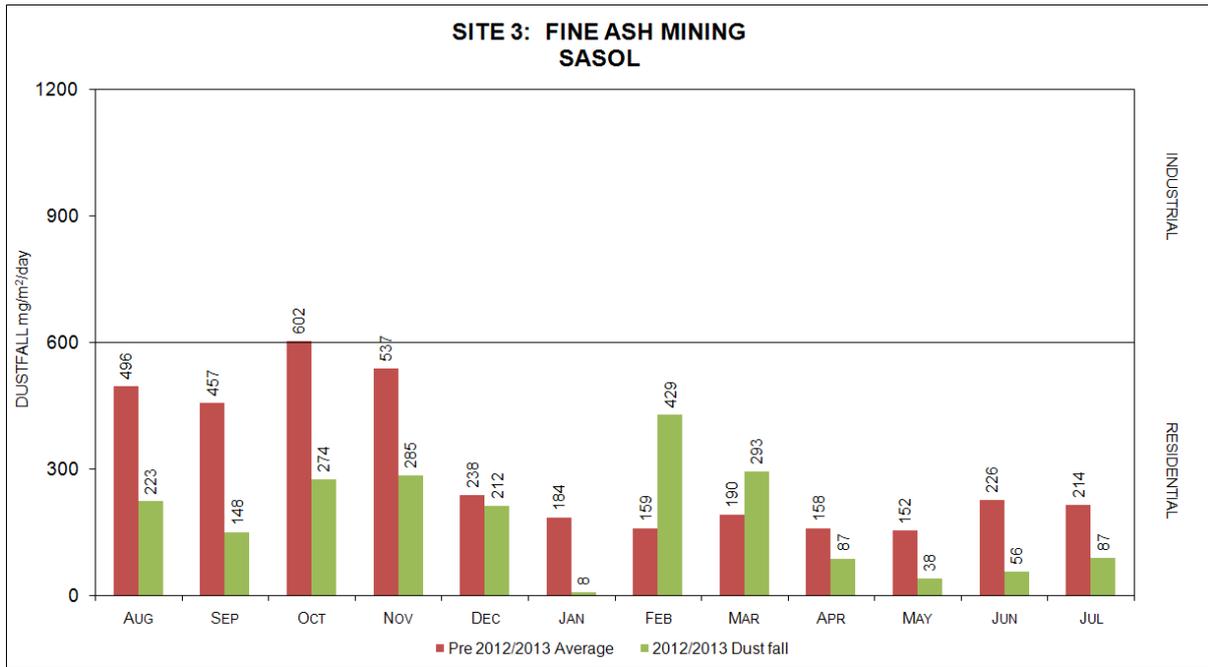


Figure C-3: Dustfall rates at Site 3 (Fine Ash Mining) between August 2012 and July 2013

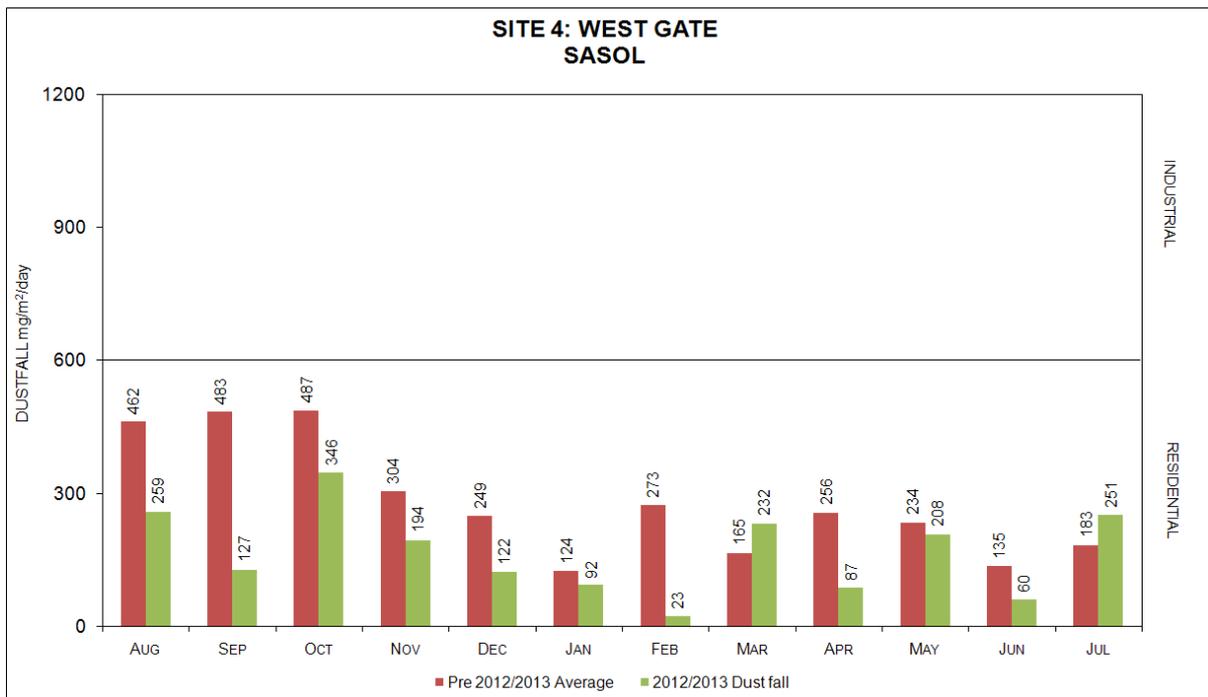


Figure C-4: Dustfall rates at Site 4 (West Gate) between August 2012 and July 2013

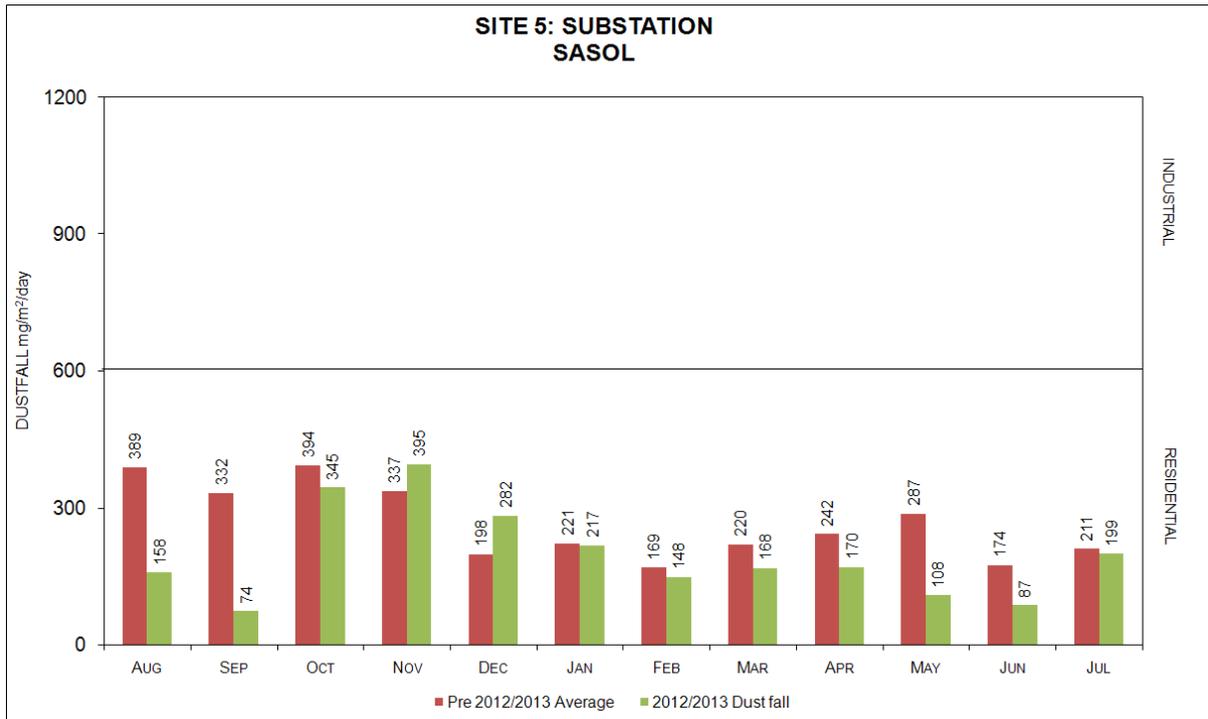


Figure C-5: Dustfall rates at Site 5 (Substation) between August 2012 and July 2013

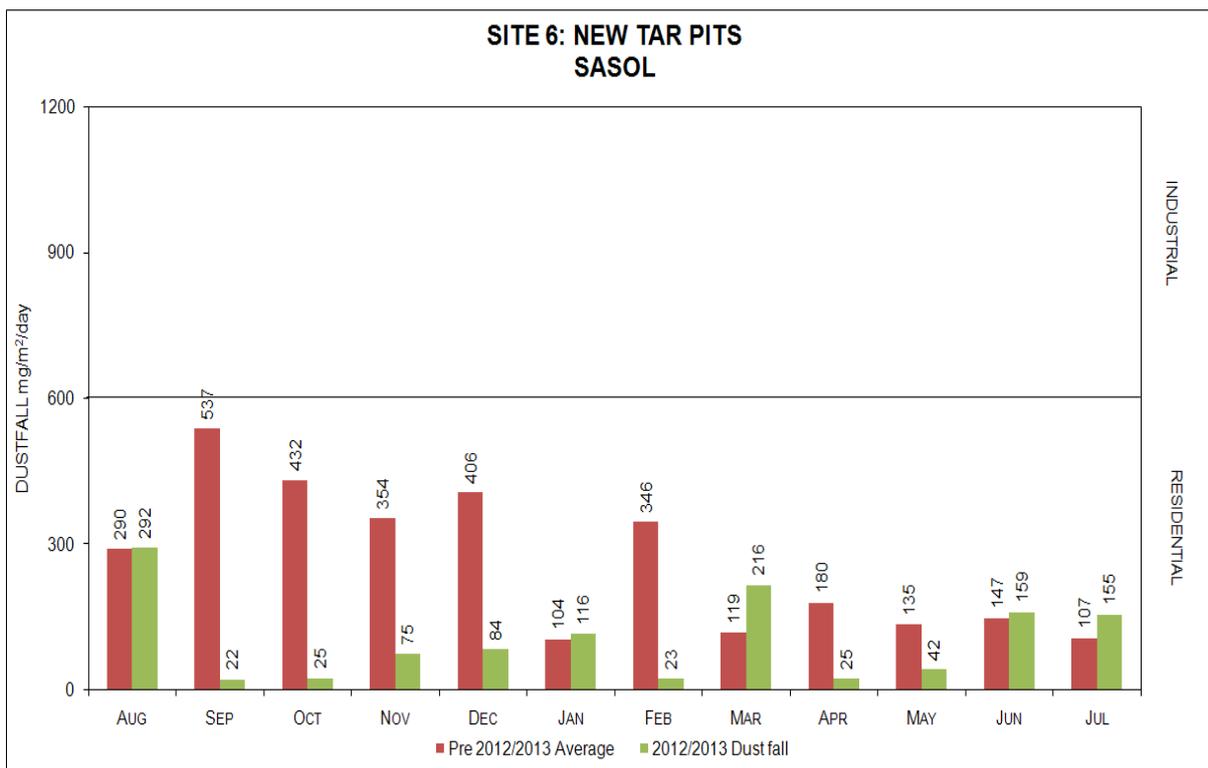


Figure C-6: Dustfall rates at Site 6 (New Tar Pits) between August 2012 and July 2013

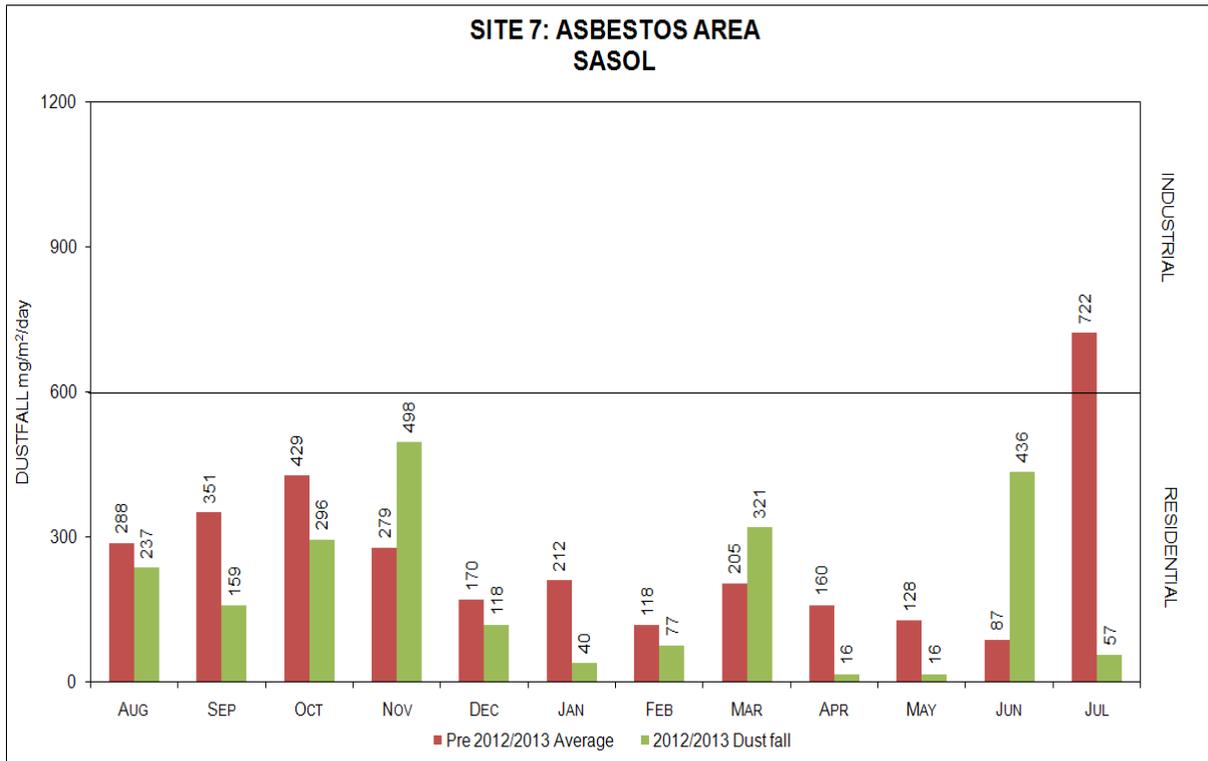


Figure C-7: Dustfall rates at Site 7 (Asbestos area) between August 2012 and July 2013

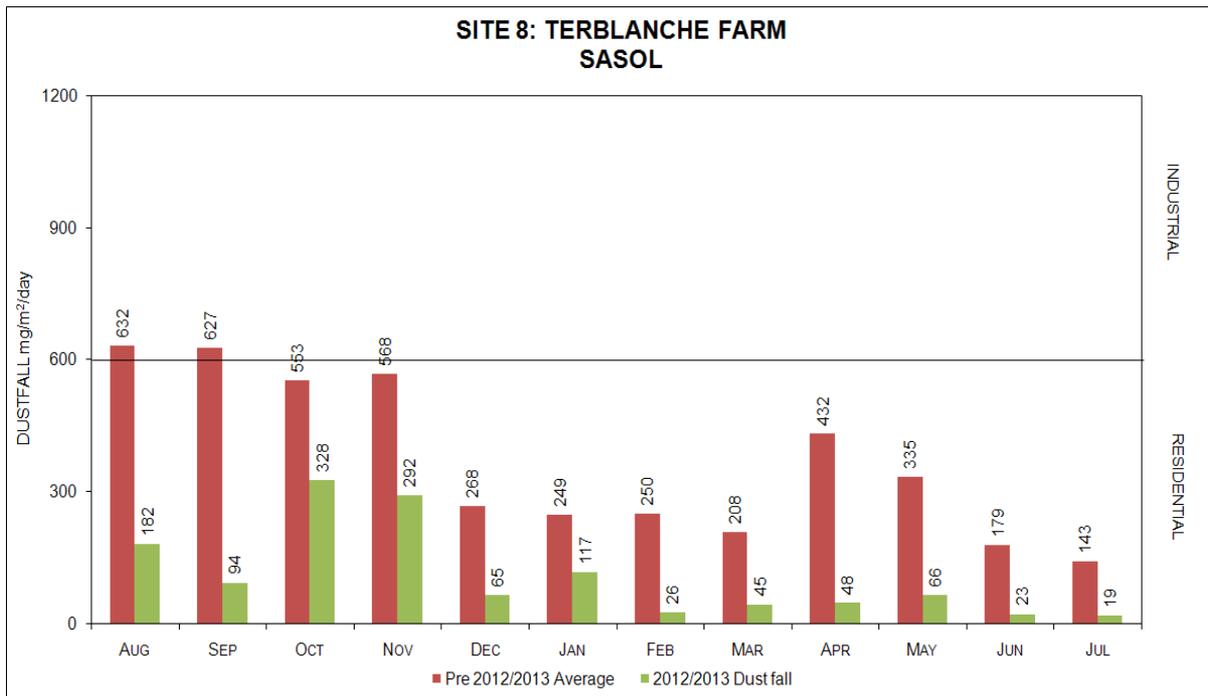


Figure C-8: Dustfall rates at Site 8 (Terblanche farm) between August 2012 and July 2013

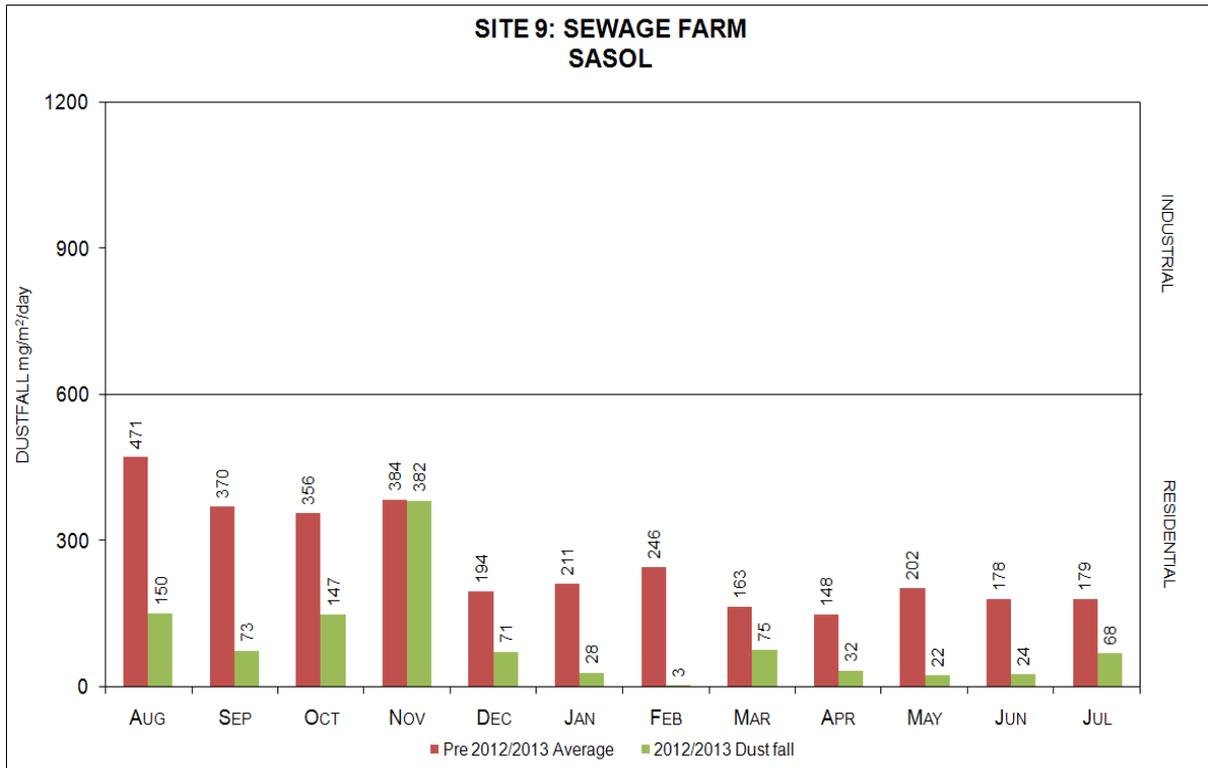


Figure C-9: Dustfall rates at Site 9 (Sewage farm) between August 2012 and July 2013

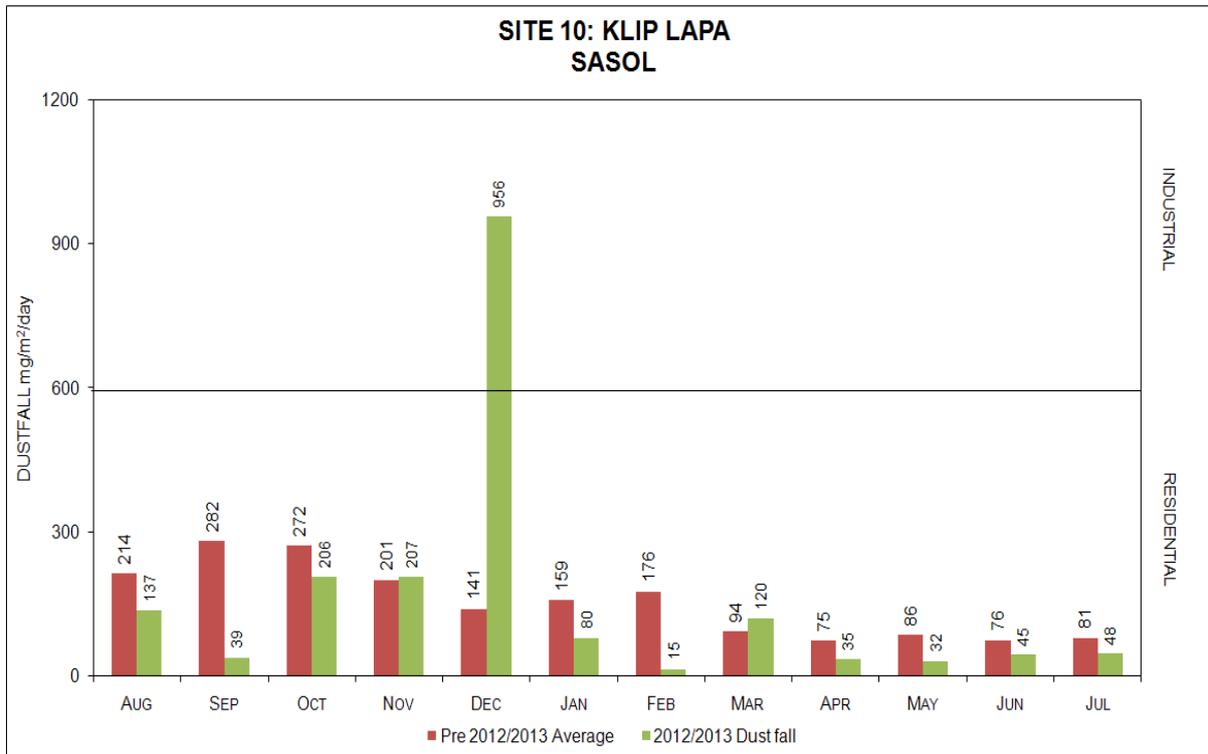


Figure C-10: Dustfall rates at Site 10 (Klip Lapa) between August 2012 and July 2013

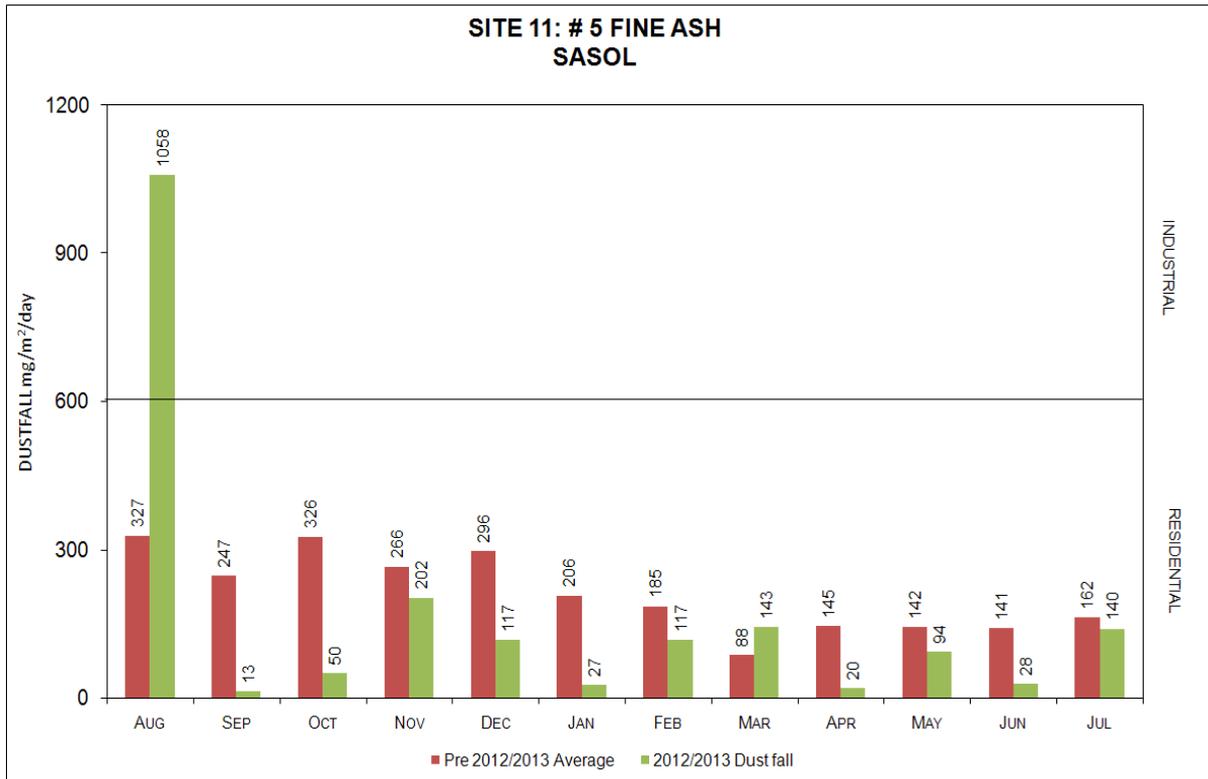


Figure C-11: Dustfall rates at Site 11 (#5 Fine Ash) between August 2012 and July 2013

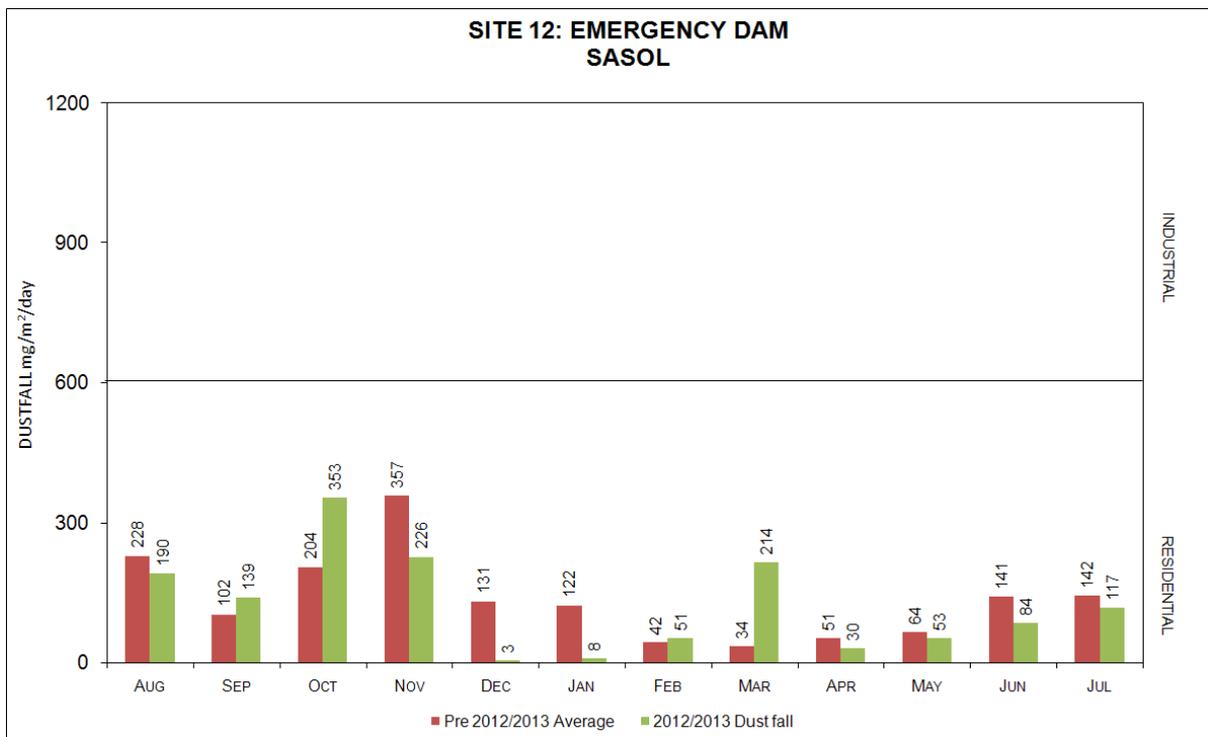


Figure C-12: Dustfall rates at Site 12 (Emergency dam) between August 2012 and July 2013

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	<ul style="list-style-type: none"> •Prognostic model data, such as WRF to drive CALMET. •No surface or upper air observations input at all. 	<ul style="list-style-type: none"> •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)	<ul style="list-style-type: none"> •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	<ul style="list-style-type: none"> •Prognostic model data, such as WRF to drive CALMET <p>PLUS</p> <ul style="list-style-type: none"> •One or more surface stations 	<ul style="list-style-type: none"> •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' 	<ul style="list-style-type: none"> • 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) 	<ul style="list-style-type: none"> •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. 	<ul style="list-style-type: none"> •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	<ul style="list-style-type: none"> •Require 7 site-specific model parameters to be specified. <p>Difficulty in dealing with missing data.</p> <ul style="list-style-type: none"> •Considered representative if sufficient 	<ul style="list-style-type: none"> •Sasol operated surface meteorological weather stations (4 Sasolburg and 3 Secunda) •Closest upper air monitoring station is at OR Tambo 	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.	<ul style="list-style-type: none"> •Upper air data typically 12 hourly, poor spatial and temporal resolution •Model has to interpolate between 12 hour soundings

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
		observation stations and site specific choice of parameters by the modeller.	International Airport (twice-daily soundings only)		<ul style="list-style-type: none"> •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	<ul style="list-style-type: none"> Dispersion coefficients are computed from measured values of turbulence, sigma-v and sigma-w. 	<ul style="list-style-type: none"> 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. 	<ul style="list-style-type: none"> This measured data is not available in South Africa 	<ul style="list-style-type: none"> Very good if data is available. 	<ul style="list-style-type: none"> These measured parameters are not readily available in South Africa.
Dispersion coefficients MDISP = 2	<ul style="list-style-type: none"> Dispersion coefficients are computed from internally-calculated sigma-v, sigma-w using micrometeorological variables (u^*, w^*, L, etc.). 	<ul style="list-style-type: none"> 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 from CALMET and cannot be ISC-type 	<ul style="list-style-type: none"> The data is obtained from WRF input information. 	<ul style="list-style-type: none"> Based on improved theoretical work and is an improvement over Pasquill-Gifford. 	<ul style="list-style-type: none"> The coefficients are derived from other parameters.

Run Type	Description of Run Type	Ease of Use and Representativeness	Data availability	Advantages	Disadvantages
		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	<ul style="list-style-type: none"> Pasquill-Gifford (PG) dispersion coefficients for rural areas (computed using the ISCST3 multi-segment approximation) and McElroy-Pooler (MP) coefficients in urban areas. 	<ul style="list-style-type: none"> 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. 		<ul style="list-style-type: none"> Simple to use if you don't have detailed meteorological information. This option can be run using fairly basic meteorological data. 	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Same as MDISP = 3, except PG coefficients are computed using the MESOPUFF II equations 				
Dispersion coefficients MDISP = 5	<ul style="list-style-type: none"> CTDM sigmas are used for stable and neutral conditions. For unstable conditions, sigmas are computed as in MDISP=3 described above. 	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Pseudo-first-order chemical mechanism for SO₂, SO₄²⁻, NO, NO₂, HNO₃, and NO₃- (RIVAD/ARM3 method) 	<ul style="list-style-type: none"> RIVAD is a 6-species scheme wherein NO and NO₂ are treated separately. In the RIVAD scheme the conversion of SO₂ to sulfates is not RH-dependent. 	<ul style="list-style-type: none"> In order to use the RIVAD scheme, the user must divide the NO_x emissions into NO and NO₂ for each source. Two options are specified for the ozone concentrations: (1) 	<ul style="list-style-type: none"> In several tests conducted to date, the results have shown no significant differences between the RIVAD and MESOPUFF II options. 	<ul style="list-style-type: none"> User has to input the NO and NO₂ emissions which are not always known for all sources. User has to input the ozone concentrations which are not

Run Type	Description of Run Type	Ease of Use and Representativeness	Data availability	Advantages	Disadvantages
		<ul style="list-style-type: none"> The conversion of NO_x to nitrates is RH-dependent. 	<ul style="list-style-type: none"> 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. 		<ul style="list-style-type: none"> always known. The model is restricted to rural conditions.
Chemical transformation MESOPUFF II	<ul style="list-style-type: none"> Pseudo-first-order chemical mechanism for SO₂, SO₄²⁻, NO_x, HNO₃, and NO₃- (MESOPUFF II method) 	<ul style="list-style-type: none"> 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. 	<ul style="list-style-type: none"> 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. 	<ul style="list-style-type: none"> 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. 	<ul style="list-style-type: none"> 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 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.

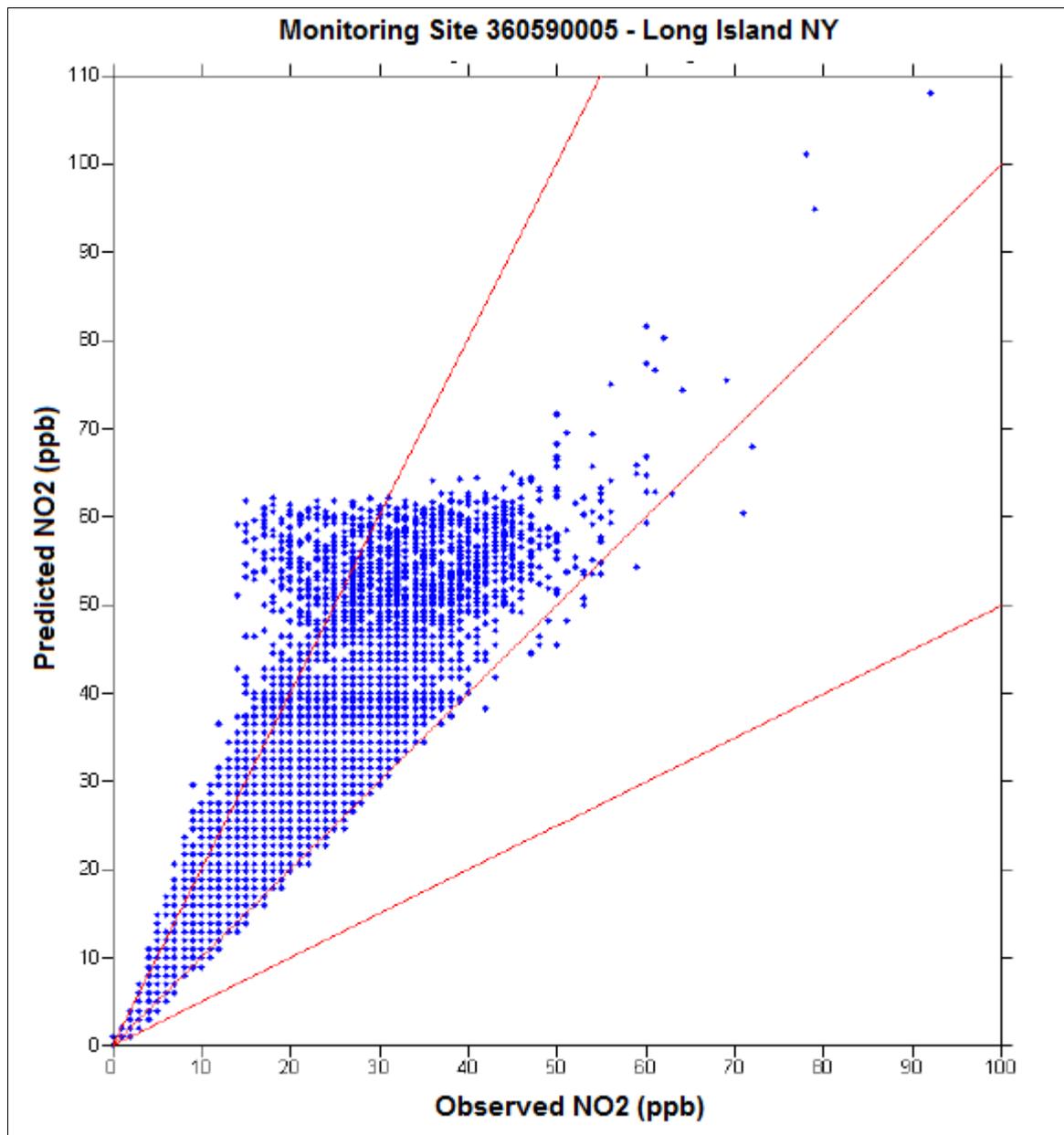


Figure F-1: Comparison of observed with predicted NO₂ concentrations (Long Island, NY) using the derived short-term NO₂/NO_x ratios (Scire and Borissova, 2011)

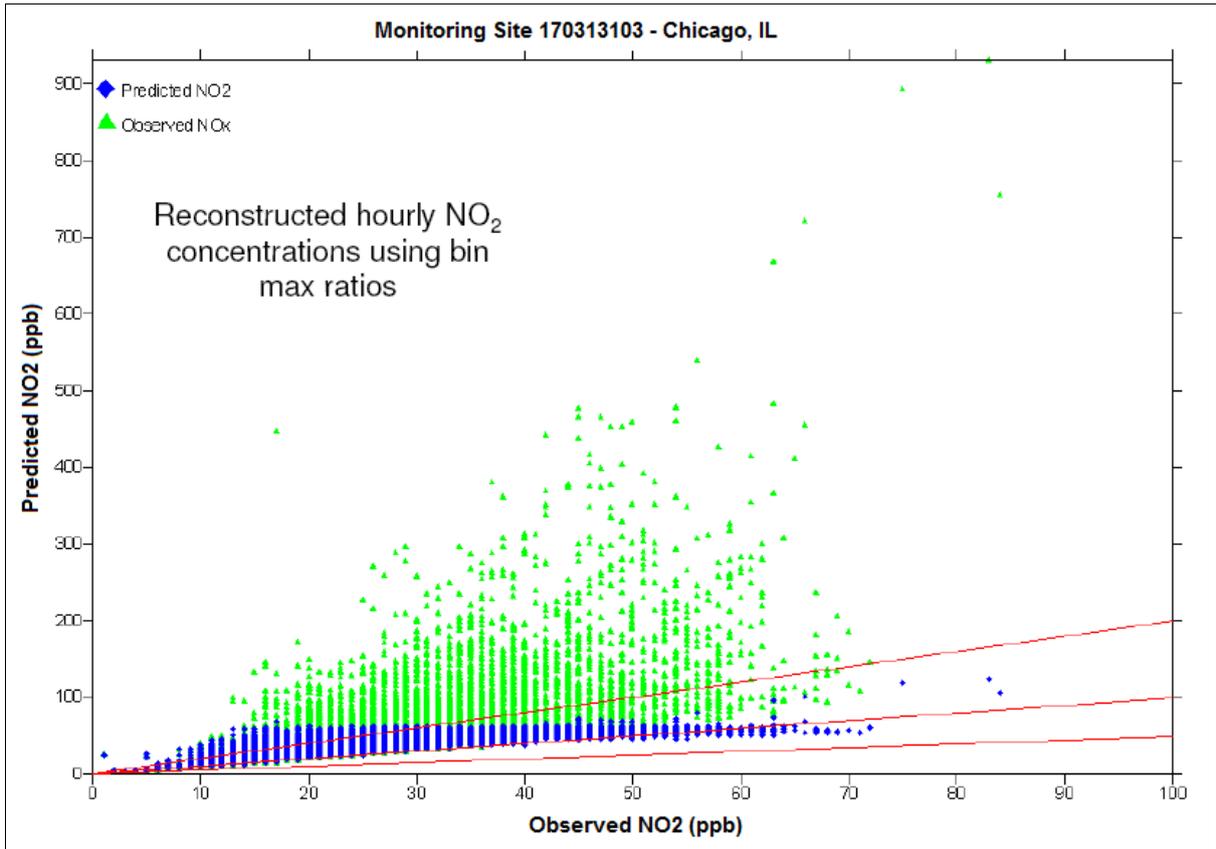


Figure F-2: Comparison of observed with predicted NO₂ concentrations (Chicago, IL) using the derived short-term NO₂/NO_x ratios (Scire and Borissova, 2011)

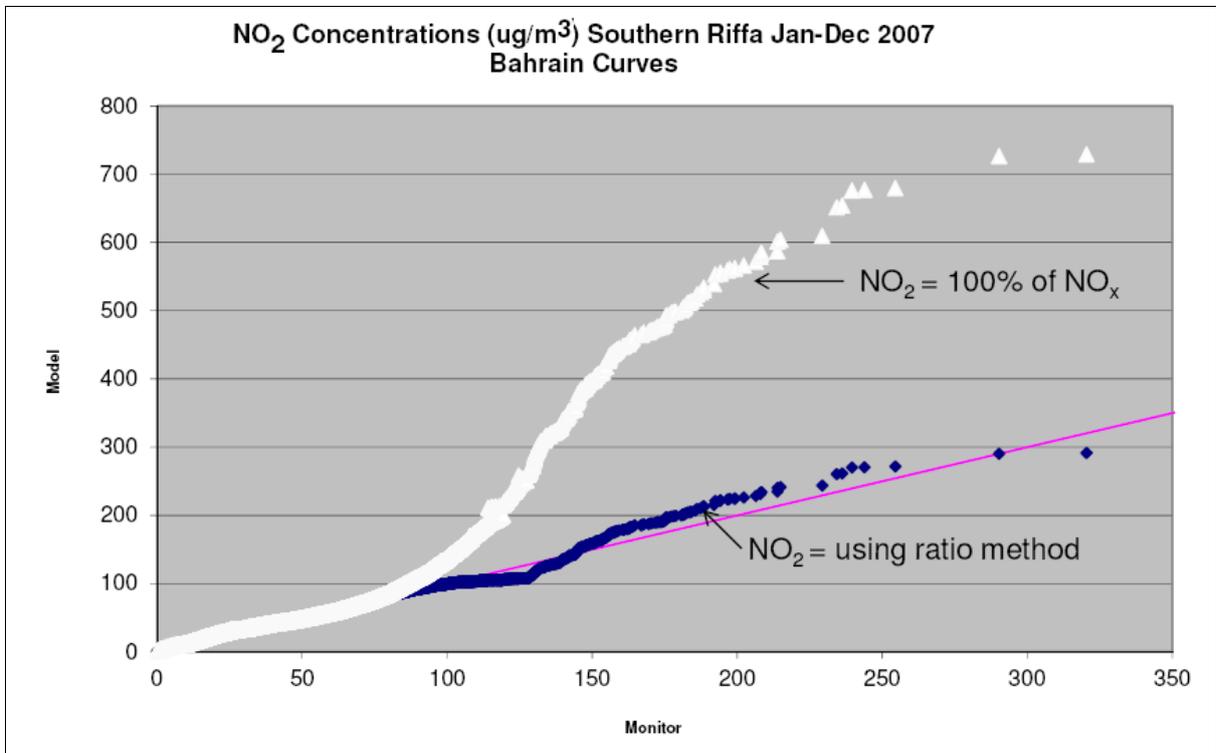


Figure F-3: Observed versus predicted NO₂ concentrations (Bahrain) using the derived short-term NO₂/NO_x ratios (Scire and Borissova, 2011)

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

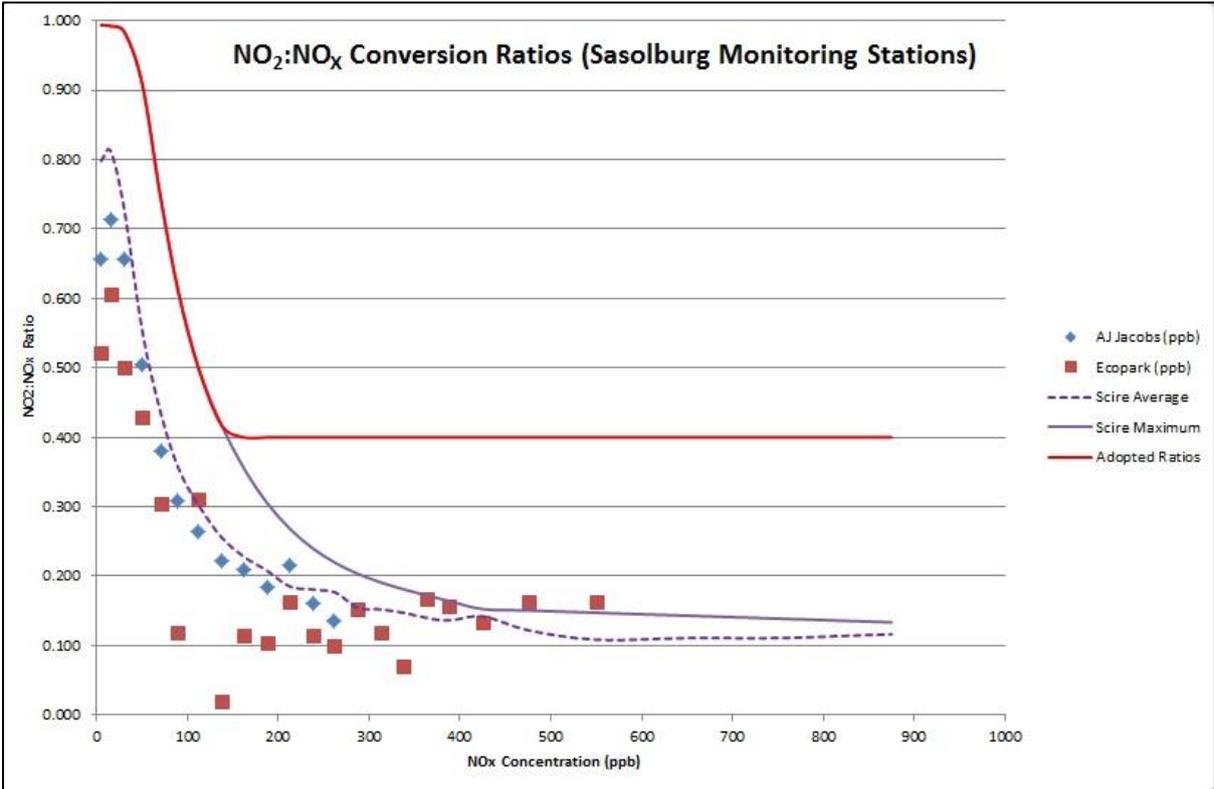


Figure F-4: NO₂/NO_x conversion ratios for Sasol's Sasolburg monitoring stations

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.

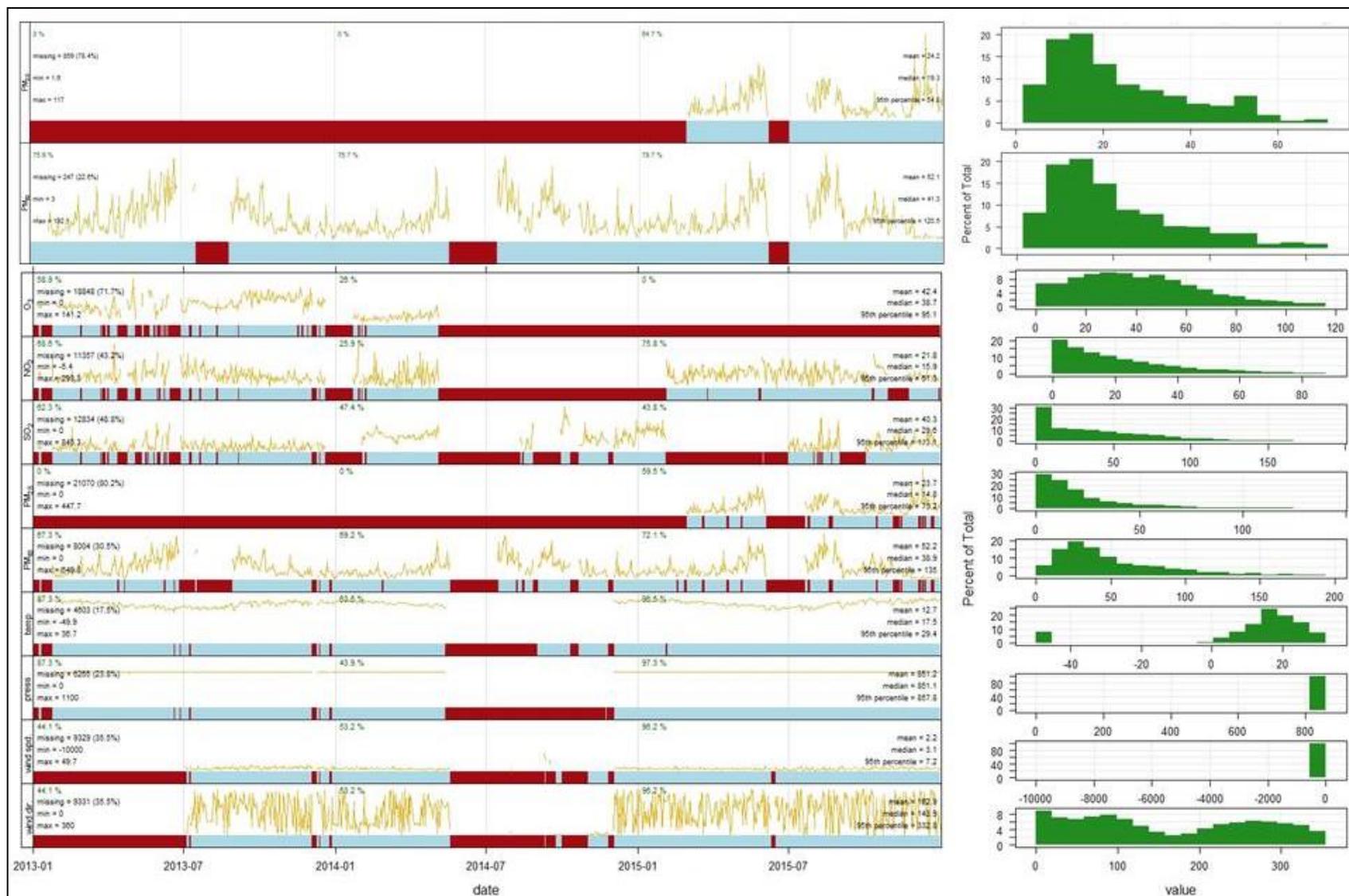


Figure G-1: Summary of meteorological and ambient air quality data received for Leitrim (2013-2015)

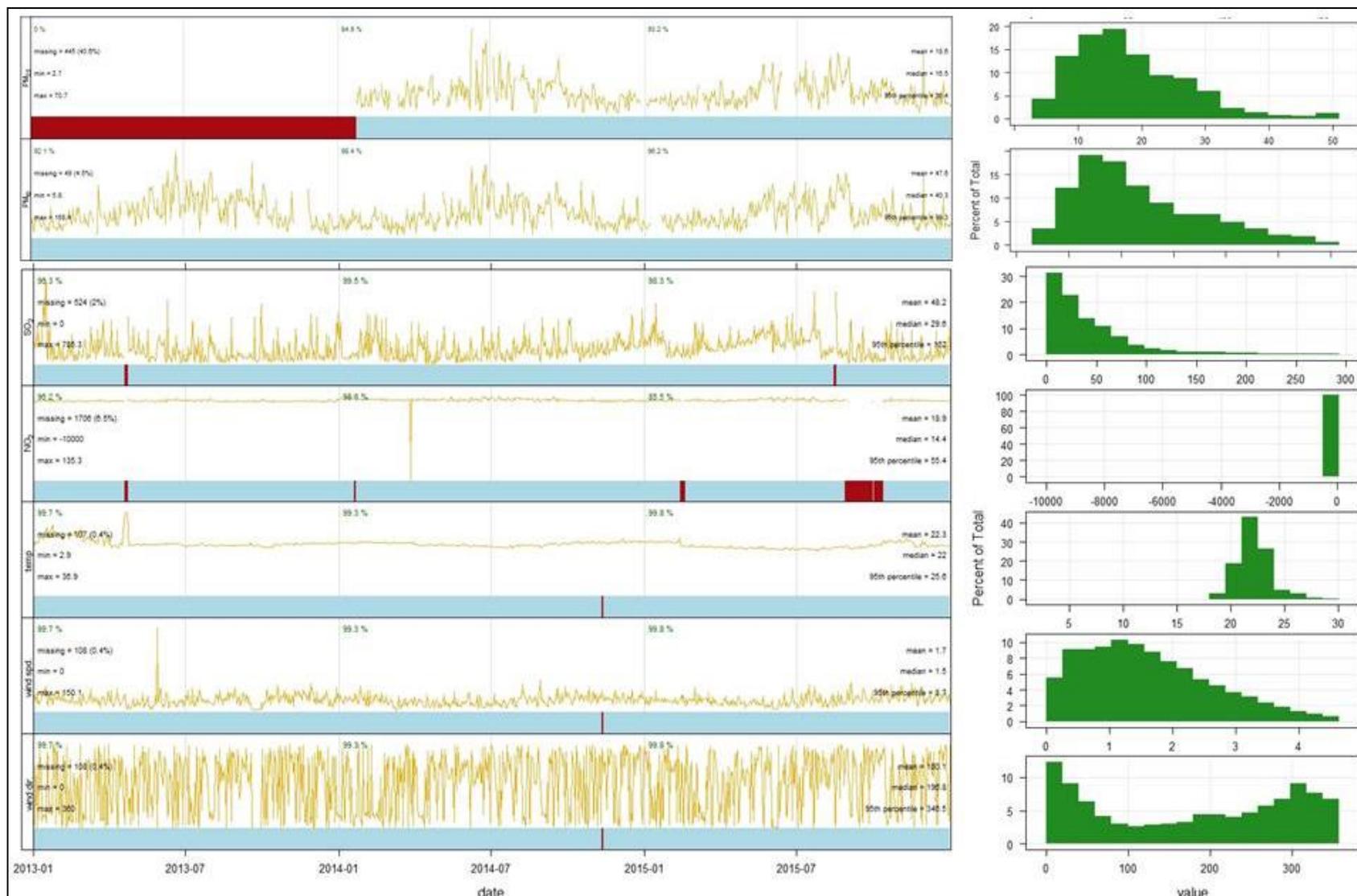


Figure G-2: Summary of meteorological and ambient air quality data received for AJ Jacobs (2013-2015)

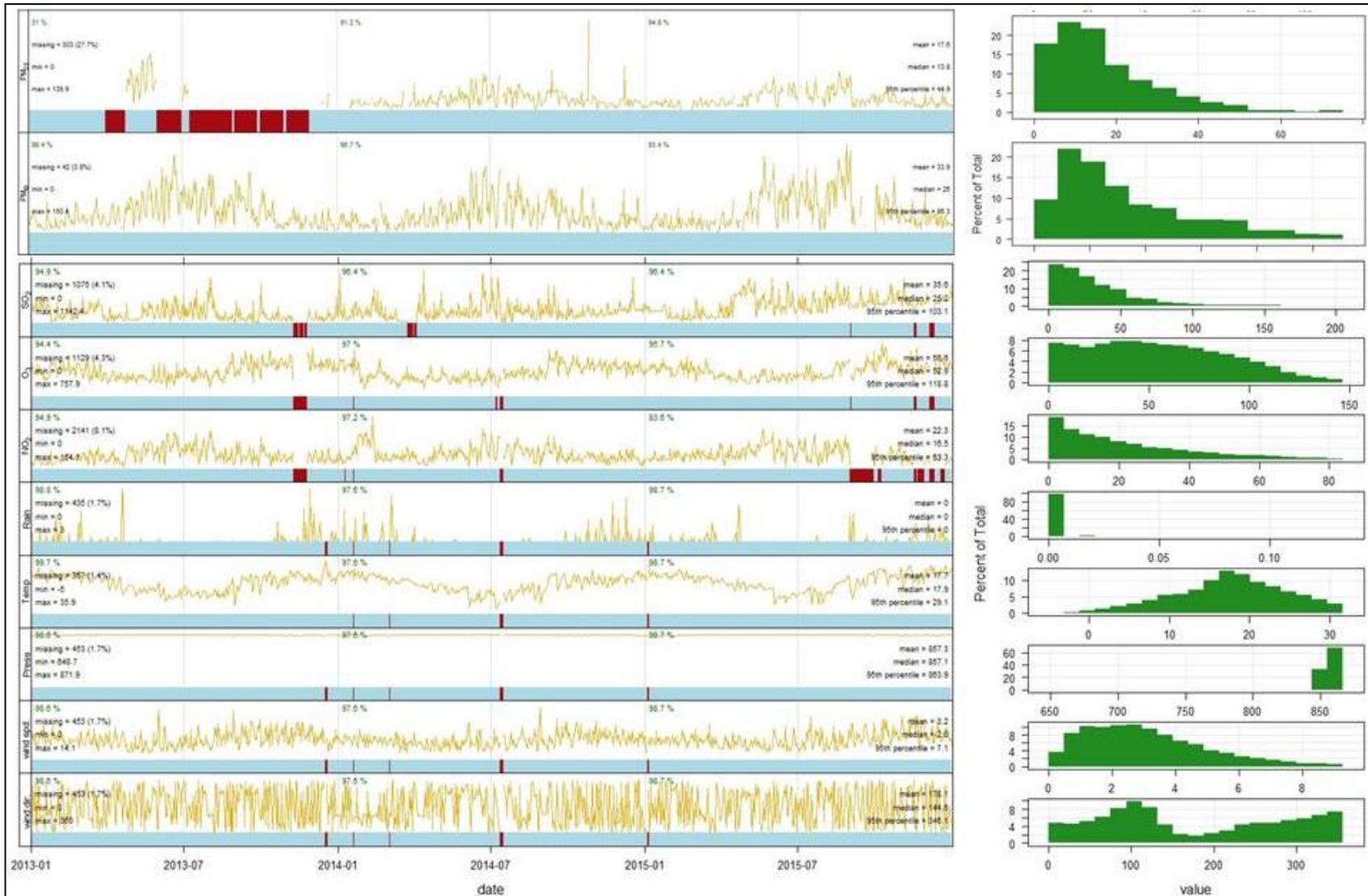


Figure G-3: Summary of meteorological and ambient air quality data received for Eco Park (2013-2015)

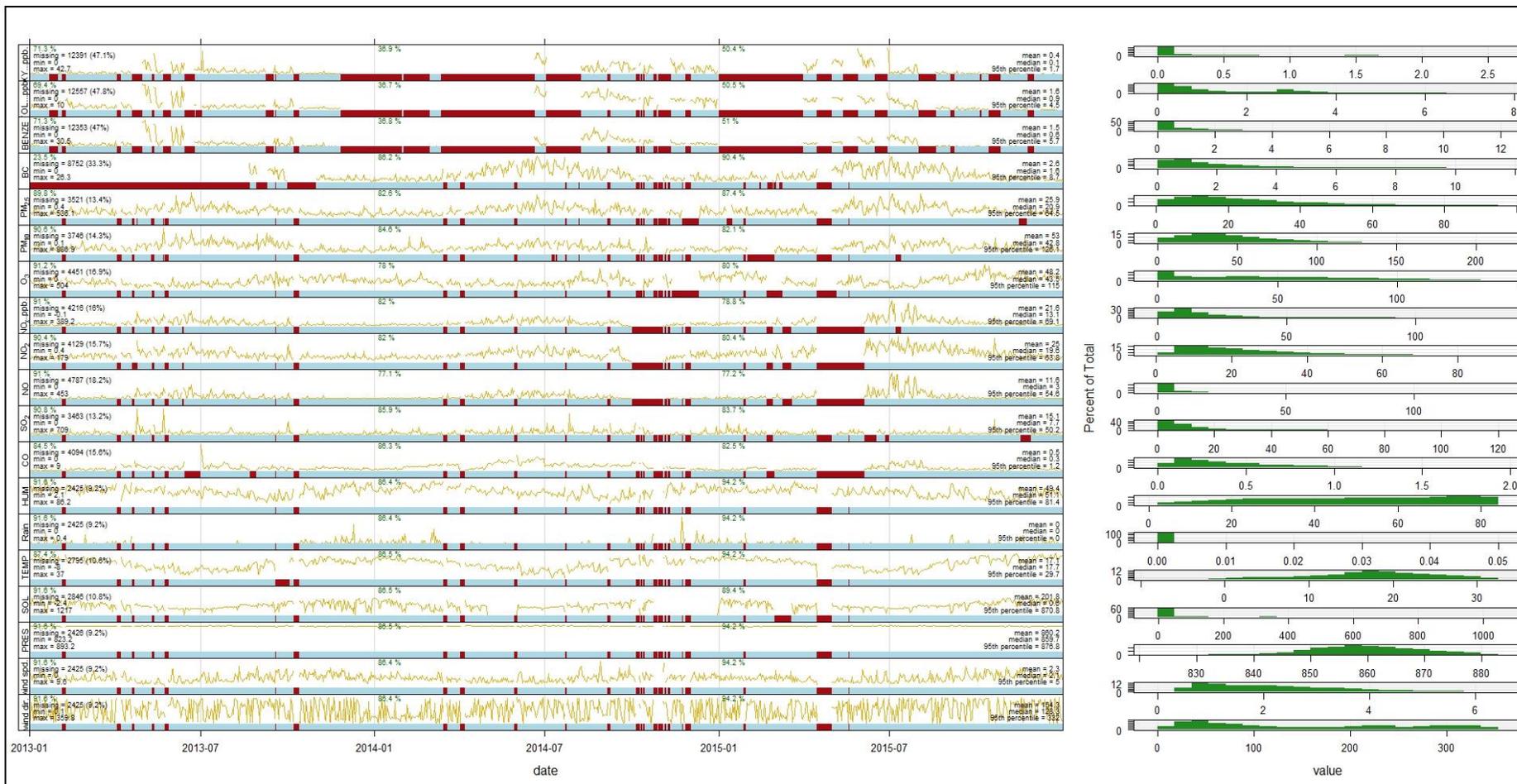


Figure G-4: Summary of meteorological and ambient air quality data received for Three Rivers (2013-2015)

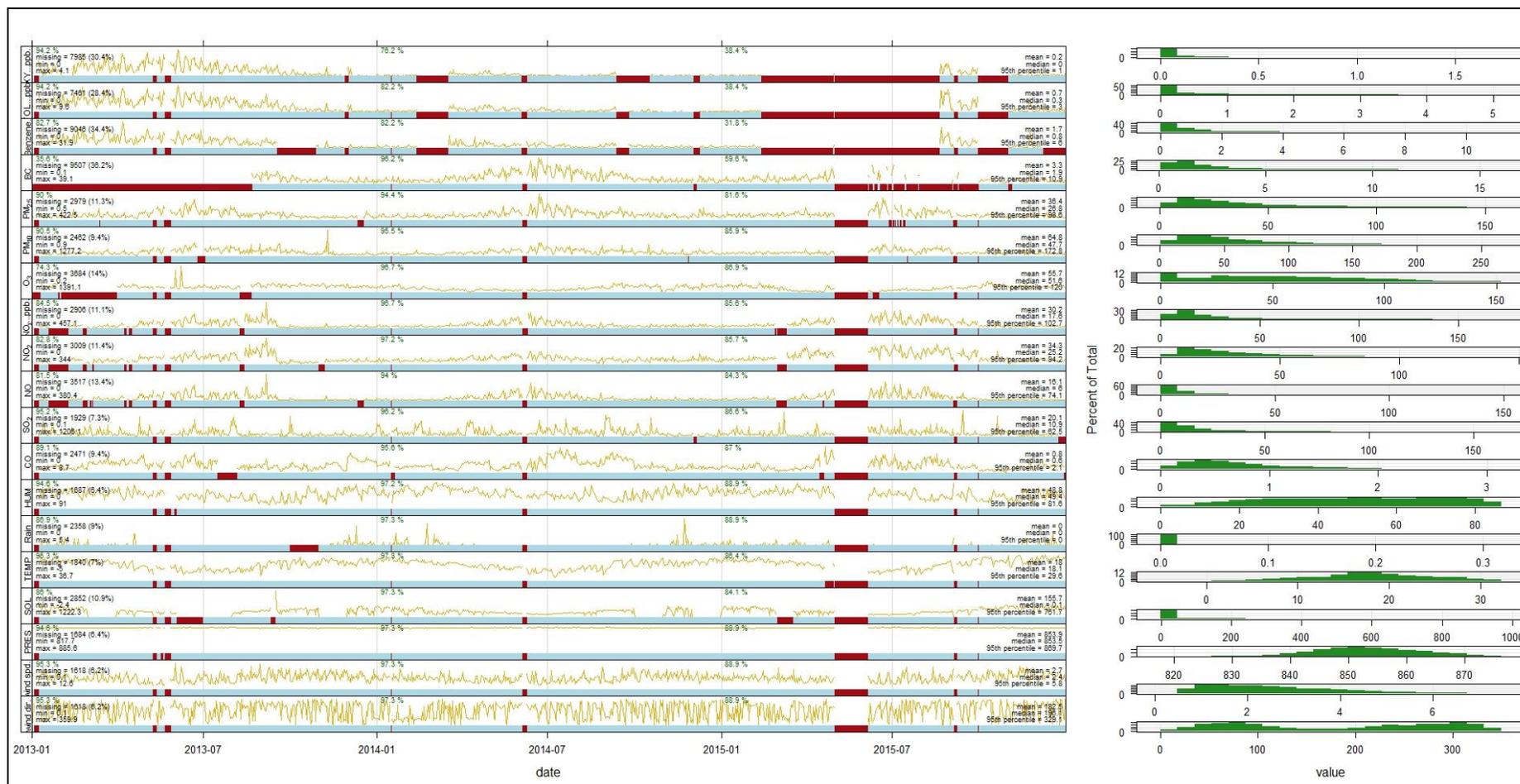


Figure G-5: Summary of meteorological and ambient air quality data received for Sharpeville (2013-2015)

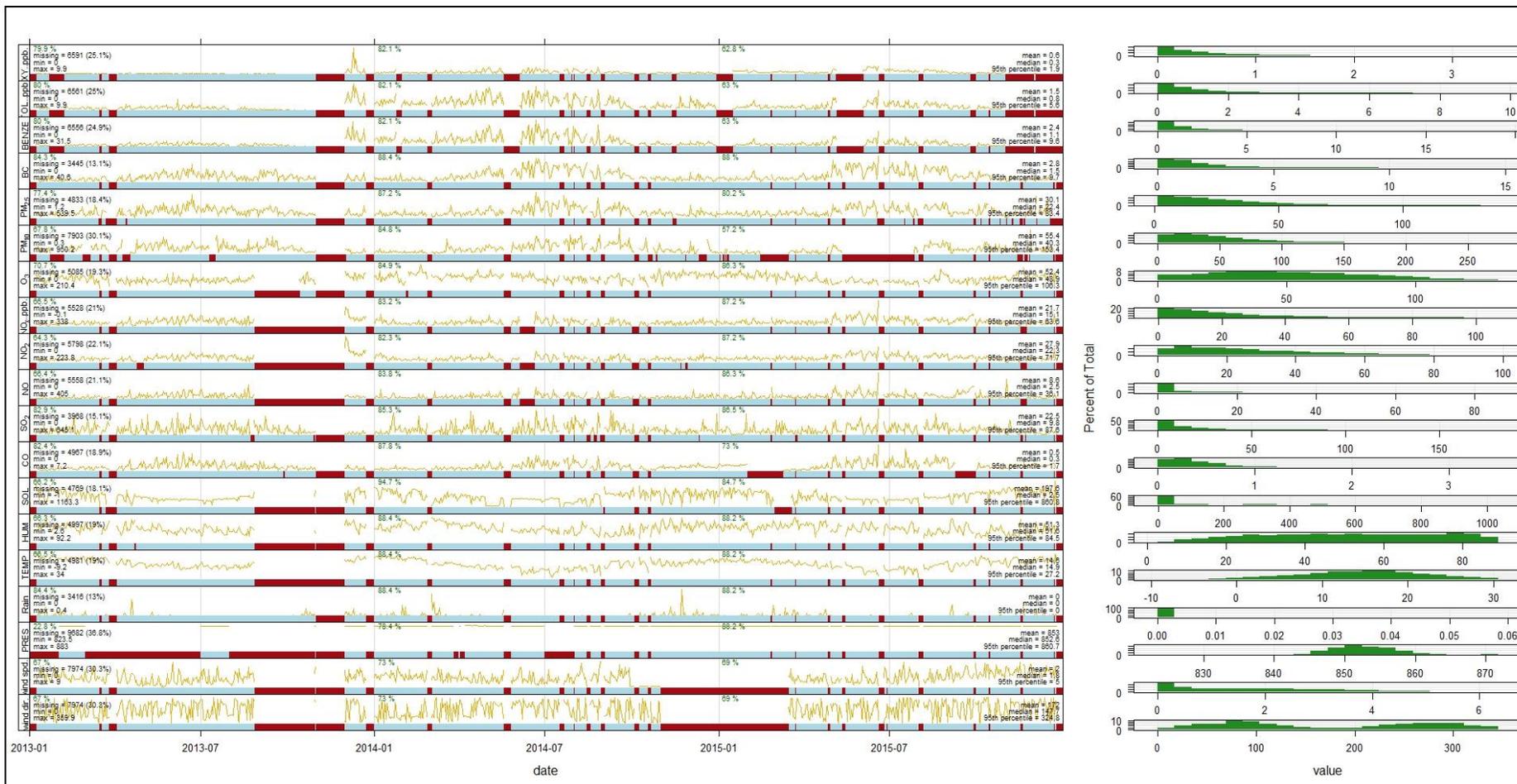


Figure G-6: Summary of meteorological and ambient air quality data received for Zamdela (2013-2015)

APPENDIX H: PREDICTED 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 (SO and Natref combined) 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)											
		Leitrim		AJ Jacobs		Eco Park		Three Rivers		Sharpeville		Zamdela	
		Simulated	Observed	Simulated	Observed	Simulated	Observed	Simulated	Observed	Simulated	Observed	Simulated	Observed
Maximum	2013	363.9	445.4	677.3	785.3	177.4	388.8	55.6	709.0	119.3	866.3	153.9	645.1
	2014	270.2	758.5	631.3	534.0	224.7	782.6	48.3	550.0	107.9	1206.1	186.8	573.2
	2015	206.2	845.3	379.5	603.6	316.6	1142.4	42.3	592.0	70.5	950.4	246.8	414.5
	<i>Average</i>	<i>280.1</i>	<i>683.1</i>	<i>562.7</i>	<i>641.0</i>	<i>239.6</i>	<i>771.3</i>	<i>48.8</i>	<i>617.0</i>	<i>99.2</i>	<i>1007.6</i>	<i>195.8</i>	<i>544.3</i>
99 th Percentile	2013	64.5	165.6	289.8	303.0	39.7	167.9	12.6	116.4	14.7	141.3	66.1	178.2
	2014	73.3	187.3	277.9	292.5	43.8	211.4	12.5	135.0	16.2	192.5	73.2	202.5
	2015	69.4	206.6	157.7	284.1	29.0	221.1	10.5	110.0	9.9	135.8	91.5	172.7
	<i>Average</i>	<i>69.1</i>	<i>186.5</i>	<i>241.8</i>	<i>293.2</i>	<i>37.5</i>	<i>200.1</i>	<i>11.8</i>	<i>120.5</i>	<i>13.6</i>	<i>156.5</i>	<i>76.9</i>	<i>184.5</i>
90 th Percentile	2013	12.5	57.9	21.4	95.9	1.0	58.1	0.6	27.2	0.5	39.2	16.6	54.3
	2014	13.2	106.8	25.7	103.2	1.4	64.2	0.6	38.5	0.6	48.8	15.3	56.9
	2015	17.6	91.2	4.6	111.1	0.7	88.8	0.4	30.3	0.4	38.2	21.3	52.4
	<i>Average</i>	<i>14.4</i>	<i>85.3</i>	<i>17.2</i>	<i>103.4</i>	<i>1.0</i>	<i>70.4</i>	<i>0.5</i>	<i>32.0</i>	<i>0.5</i>	<i>42.1</i>	<i>17.8</i>	<i>54.5</i>
50 th Percentile	2013	0.0	10.1	0.0	20.1	0.0	14.0	0.0	6.4	0.0	9.5	0.0	9.3
	2014	0.0	54.2	0.0	28.4	0.0	19.7	0.0	9.0	0.0	12.2	0.0	10.9
	2015	0.0	32.3	0.0	46.3	0.0	41.7	0.0	8.0	0.0	10.9	0.0	9.2
	<i>Average</i>	<i>0.0</i>	<i>32.2</i>	<i>0.0</i>	<i>31.6</i>	<i>0.0</i>	<i>25.2</i>	<i>0.0</i>	<i>7.8</i>	<i>0.0</i>	<i>10.9</i>	<i>0.0</i>	<i>9.8</i>
Annual Average	2013	4.5	22.8	13.1	42.1	1.5	26.0	0.5	13.2	0.6	17.9	5.1	22.0
	2014	4.9	60.8	14.3	46.0	1.7	31.4	0.5	17.6	0.7	23.2	5.3	24.2
	2015	5.3	43.0	5.9	56.2	1.1	49.3	0.4	14.5	0.4	19.1	7.0	21.4
	<i>Average</i>	<i>4.9</i>	<i>42.2</i>	<i>11.1</i>	<i>48.1</i>	<i>1.5</i>	<i>35.5</i>	<i>0.5</i>	<i>15.1</i>	<i>0.6</i>	<i>20.1</i>	<i>5.8</i>	<i>22.5</i>
Background (observed value when simulation indicated little contribution)	2013		16.3		25.0		38.4		19.0		30.1		13.2
	2014		64.6		31.4		42.3		27.0		37.1		15.3
	2015		44.0		61.6		71.2		23.4		31.6		11.3

Description	Year	SO ₂ Concentration (µg/m ³)											
		Leitrim		AJ Jacobs		Eco Park		Three Rivers		Sharpeville		Zamdela	
		Simulated	Observed	Simulated	Observed	Simulated	Observed	Simulated	Observed	Simulated	Observed	Simulated	Observed
(0.1 µg/m ³)	Average		42.4		38.4		54.0		23.6		32.4		13.4

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

Description	Year	NO ₂ Concentration (µg/m ³)											
		Leitrim		AJ Jacobs		Eco Park		Three Rivers		Sharpeville		Zamdela	
		Simulated	Observed	Simulated	Observed	Simulated	Observed	Simulated	Observed	Simulated	Observed	Simulated	Observed
Maximum	2013	280.2	150.8	431.0	95.4	132.2	141.3	59.5	129.0	56.7	239.5	91.7	203.7
	2014	169.9	293.3	403.5	135.3	128.1	164.1	47.2	136.0	59.7	212.1	102.8	223.8
	2015	98.4	283.2	233.9	127.4	184.6	150.5	33.7	179.0	53.4	344.0	140.3	168.1
	Average	182.8	242.4	356.1	119.4	148.3	152.0	46.8	148.0	56.6	265.2	111.6	198.5
99 th Percentile	2013	56.0	74.7	177.4	54.4	35.4	82.2	10.9	72.7	13.7	149.9	57.1	115.8
	2014	57.8	165.4	162.0	86.8	33.8	84.6	11.5	75.9	16.0	95.1	58.0	83.2
	2015	56.2		84.3	79.1	24.9	85.2	7.9	104.6	10.0	156.7	59.8	100.4
	Average	56.7	120.0	141.2	73.5	31.4	84.0	10.1	84.4	13.2	133.9	58.3	99.8
90 th Percentile	2013	11.7	46.0	32.9	30.8	0.8	49.6	0.3	42.8	0.3	66.4	19.1	63.6
	2014	12.4	46.5	36.2	52.8	0.9	50.4	0.3	43.8	0.4	55.1	18.0	50.4
	2015	17.8		5.2	46.0	0.5	54.1	0.2	64.5	0.2	96.3	25.6	62.4
	Average	14.0	46.3	24.7	43.2	0.7	51.3	0.3	50.4	0.3	72.6	20.9	58.8
50 th Percentile	2013	0.0	16.5	0.0	9.0	0.0	15.4	0.0	17.4	0.0	22.3	0.1	22.9
	2014	0.0	7.9	0.0	20.8	0.0	16.9	0.0	18.3	0.0	23.2	0.1	20.0
	2015	0.0		0.0	14.9	0.0	17.0	0.0	24.8	0.0	31.3	0.1	24.6
	Average	0.0	12.2	0.0	14.9	0.0	16.5	0.0	20.2	0.0	25.6	0.1	22.5
Annual Average	2013	4.3	21.0	10.2	13.1	1.2	21.2	0.4	21.4	0.5	31.4	5.4	29.7
	2014	4.5	18.7	10.7	25.2	1.3	22.6	0.5	22.5	0.6	28.4	5.3	24.0

Description	Year	NO ₂ Concentration (µg/m ³)											
		Leitrim		AJ Jacobs		Eco Park		Three Rivers		Sharpeville		Zamdela	
		Simulated	Observed	Simulated	Observed	Simulated	Observed	Simulated	Observed	Simulated	Observed	Simulated	Observed
	2015	4.9	23.7	4.2	20.6	0.9	23.2	0.3	31.5	0.4	43.9	6.3	30.1
	<i>Average</i>	4.6	21.1	8.4	19.7	1.1	22.3	0.4	25.1	0.5	34.5	5.7	27.9
Background (observed value when simulation indicated little contribution (0.1 µg/m ³))	2013		21.0		11.2		38.1		37.5		57.0		0.0
	2014		11.4		22.9		39.3		38.9		48.7		20.0
	2015		23.6		23.6		45.4		60.0		87.7		24.6
	<i>Average</i>		20.9		18.6		41.3		45.7		64.4		22.3

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 monitoring data collected over the same time period. In particular, the predicted SO₂ and NO₂ concentrations arising from both the SO and Natref plant 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). The fractional bias was computed for SO₂ and NO₂ as predicted and observed at monitoring stations within the study area. 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 carried between the different modelling scenarios. Therefore, expressing the changes as incremental and relative to the baseline scenario, it is expected that these errors would be mostly cancel each other out.

Ambient Monitoring Uncertainty

Sasol operates a total of four ambient air quality monitoring stations in and around Sasolburg, namely at Sasol 1 Fence Line, AJ Jacobs, Leitrim and Eco Park. No ambient data was provided for the Sasol 1 Fence Line monitoring station. The DEA operate three monitoring stations in the study area, namely Zamdela, Three Rivers and Sharpeville. Data from the Sasol and DEA monitoring stations for 2013, 2014 and 2015 were included in this investigation.

All of the abovementioned Sasol 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).

Natref 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 has 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.

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 SO 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 Emission 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 5.1.5.4. and Section 5.1.6.

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.

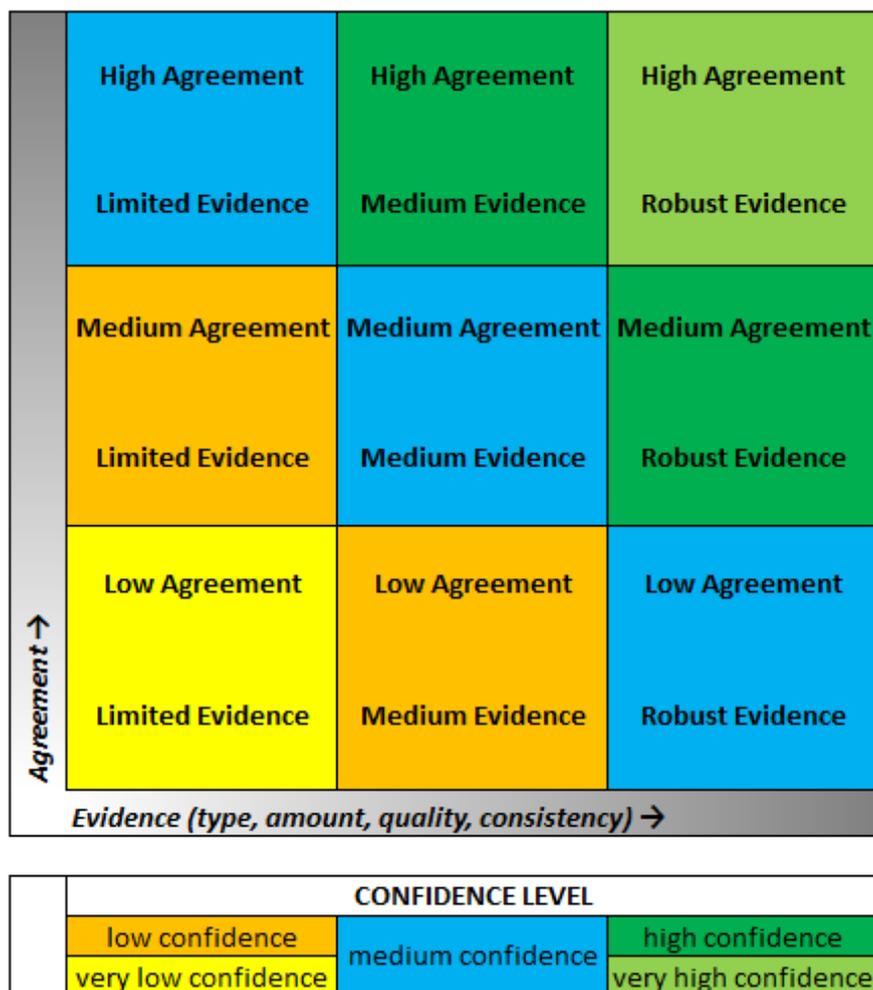


Figure J-1: A depiction of evidence and agreement statements and their relationship to confidence. Confidence increases towards the top-right corner as suggested by the increasing strength of shading. Generally, evidence is most robust when there are multiple, consistent independent lines of high-quality 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 J-1, 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 $\geq 66\%$ (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 J-1. “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)
Zamdela	VTAPA Zamdela monitoring station	2.1
Leitrim	Sasol Leitrim monitoring station	3.1
AJ Jacobs	Sasol AJ Jacobs monitoring station	3.2
EcoPark	Sasol EcoPark monitoring station	5.7
Sharpeville	VTAPA Sharpeville monitoring station	15.1
Three Rivers	VTAPA Three Rivers monitoring station	23.4
25	Malakabeng Primary School	1.7
32	Cedar Secondary School	1.9
15	Bofula- Tshepe Primary School	2.0
49	Clinic A Zamdela	2.1
51	Zamdela Hospital Zumayear	2.2
35	Iketsetseng Secondary School	2.2
48	Clinic B Zamdela	2.2
29	Tsatsi Primary School	2.3
20	Isaac Mhlambi Primary School	2.3
37	Nkopoleng Secondary School	2.4
34	HTS Secondary School	2.4
44	Zamdela Community Clinic	2.8
14	AJ Jacobs Primary School	2.9
28	Theha Setjhaba Primary School	3.0
52	Sasolburg Clinic	3.2
18	Credo Primary School	3.3
23	Lehutso Primary School	3.6
50	Harry Gwala Clinic Creche	3.7
36	Kahobotjha-sakubusha Secondary School	4.1
43	Sasolburg Provincial Hospital	4.2
19	Fonteine Primary School	4.3
33	Fakkel Secondary School	4.6
38	Sasolburg High School	4.6
24	Lumiere Primary School	5.4
31	Afrikaans Hoërskool	5.6
22	Leewspruit Primary School	5.7
42	Vaalpark Hospital	6.1
21	Kopanelang Thuto Primary School	6.2
39	Vaalpark Articon Secondary School	6.5
26	Noord Primary School	6.7
30	Vaalpark Primary School	7.1
27	Taaibos Primary School	9.2
41	Vaal Christian Secondary School	11.2
40	Pele-ya-pele Secondary School	11.6
17	Vukuzake Primary School	14.4
16	Bokantsho Primary School	17.9