Report

Annual Air Quality – 2020

Richards Bay Clean Air Association (RBCAA)

Submitted to:

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Project 20200001 Report 014

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1. INTRODUCTION

This 22nd annual air quality report summarises the fine particulate (PM_{10}), sulphur dioxide (SO_2), total reduced sulphur (TRS), and meteorological monitoring conducted by the Richards Bay Clean Air Association (RBCAA) during 2020; the RBCAA network consists of 9 stations (Figure 1 and Table 1). The report also includes simulations of and comparisons to air impacts based on ambient meteorological conditions and the regional SO_2 emission inventory. The objective of the report is to highlight specific and predicted incidents and exceedances of the applicable ambient air quality guideline and standards.

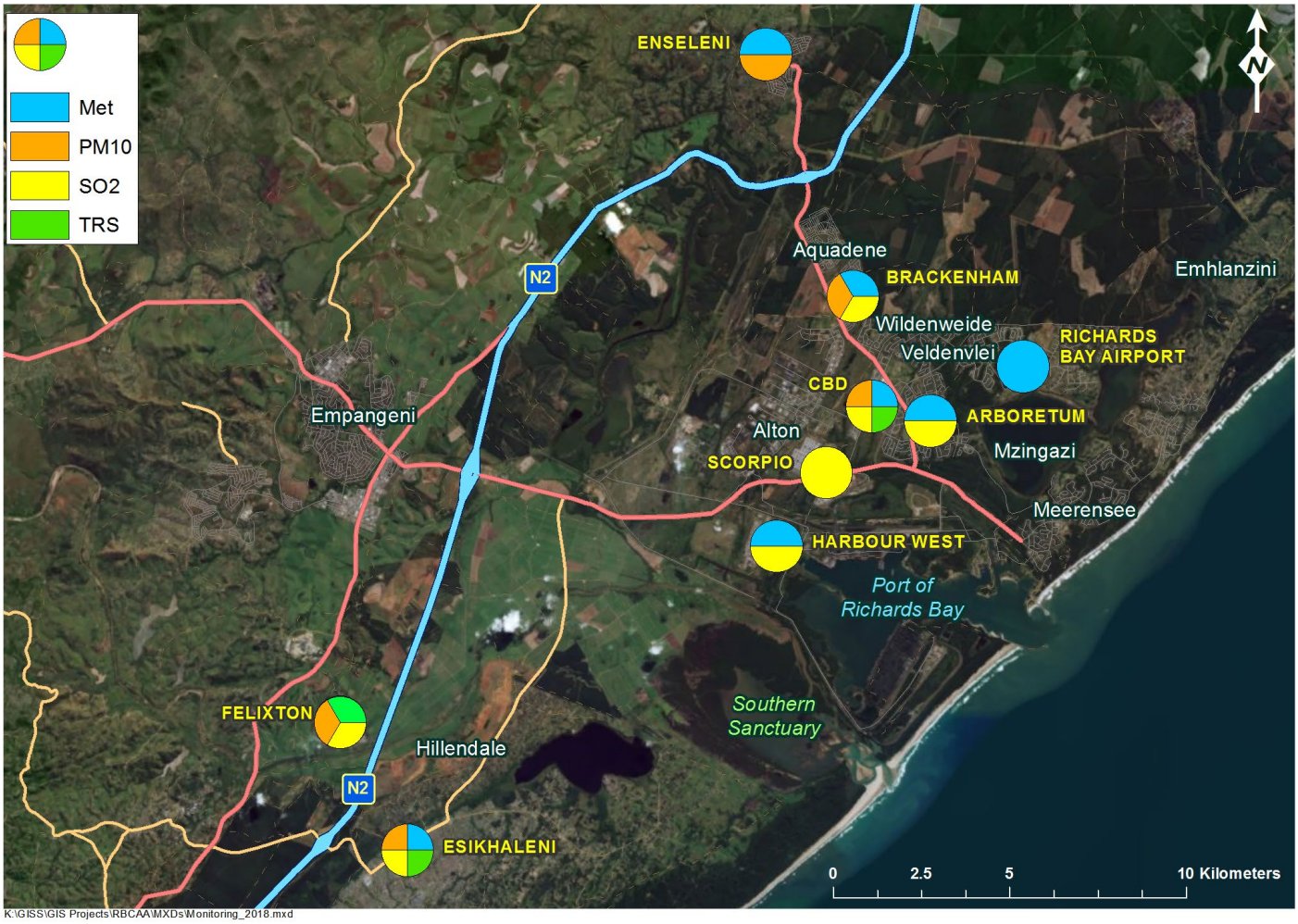


Figure 1: Map - local.

Table 1: Station co-ordinates.

Station	Latitude (°)	Longitude (°)
Airport	-28.738138	32.093333
Arboretum	-28.752380	32.062786
Brackenham	-28.731359	32.039108
CBD	-28.744803	32.054844
eNseleni	-28.662944	32.017770
eSikhaleni	-28.865283	31.911679
Felixton	-28.829261	31.893636
Harbour West	-28.787300	32.027160
Scorpio	-28.769696	32.034291

2. METEOROLOGY

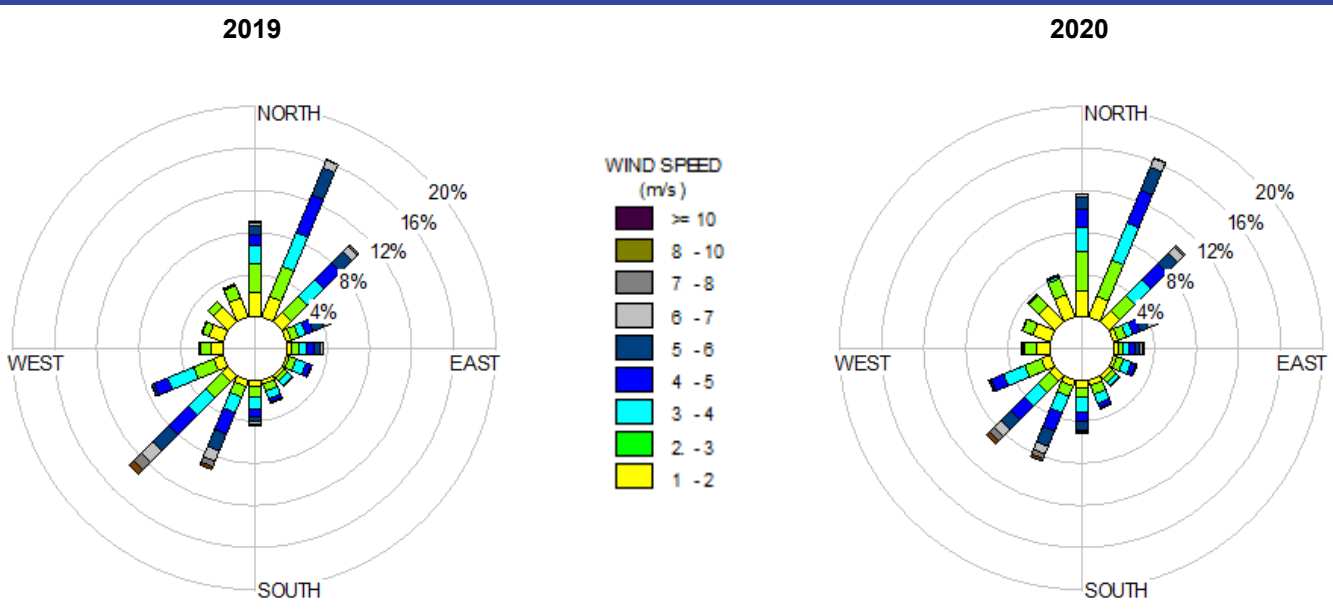
2.1. Wind Field

Annual wind roses for 2020 and 2019 for Arboretum indicate that wind blew predominantly along the NE and SW axis. NE wind is generally associated with fair weather, while SW wind is usually associated with the passage of coastal lows, cold fronts, and inclement weather (Figure 2).

Typically, there is an increase in light (1 to 3 m/s) to moderate (3 to 6 m/s) wind from the NNW during periods that include autumn and winter conditions and the seasonal increase in fresh (6 to 8 m/s) to strong (> 8 m/s) N to NE wind during periods that include spring and early summer. Strong southerly to SSW wind occurs throughout the year, typically associated with the arrival of coastal lows and cold fronts. Coastal lows tend to be more frequent during the summer months, hence the slightly higher proportion of these winds (Figure 3).

ESE to SSE wind is primarily in the form of sea breezes during the day and early evening, particularly during the warmer spring and summer months. In contrast, WNW to NNW wind is mainly in the form of land breezes at night and early morning, particularly during the colder and more stable autumn and winter months (Figure 4).

Arboretum

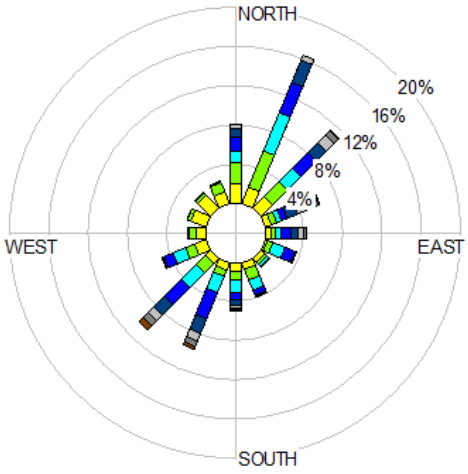


Period	Wind Speed	Dominant Sector 1		Dominant Sector 2		Calms	Valid Data
2019	3.5 m/s	N-NE	37%	SSW-WSW	31%	2.7%	97.3%
2020	3.4 m/s	N-NE	40%	SSW-WSW	25%	1.7%	96.5%

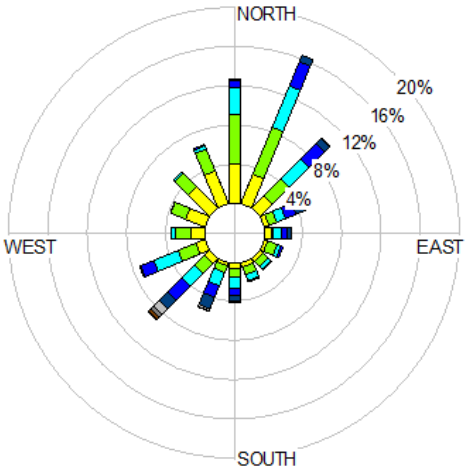
Figure 2: Wind roses - annual.

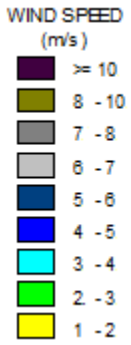
Arboretum 2020

Summer (Dec, Jan, Feb)

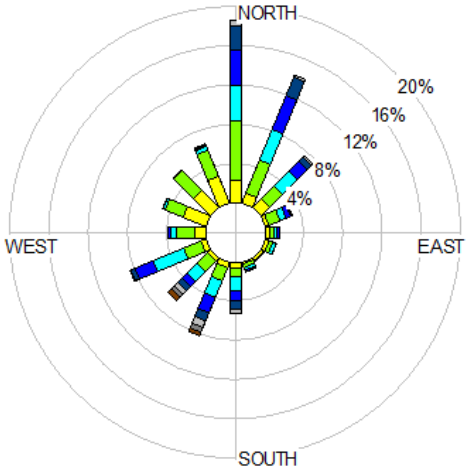


Autumn (Mar, Apr, May)

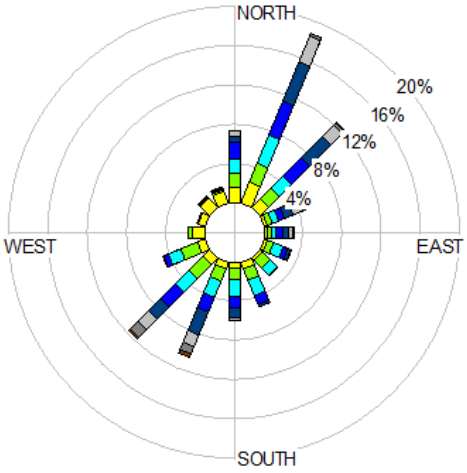




Winter (Jun, Jul, Aug)



Spring (Sep, Oct, Nov)

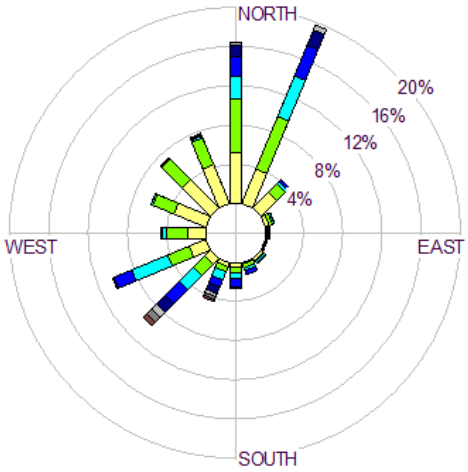


Period	Wind Speed	Dominant Sector 1		Dominant Sector 2		Calms	Valid Data
Summer (Dec-Feb)	3.6 m/s	N-ENE	45%	SSW-SW	21%	2.2%	94.3%
Autumn (Mar-May)	3.0 m/s	NNW-NE	47%	SW-WSW	17%	2.1%	99.1%
Winter (Jun-Aug)	3.3 m/s	NNW-NE	49%	SSW-WSW	24%	0.9%	96.1%
Spring (Sept-Nov)	3.9 m/s	N-NE	40%	SSW-SW	23%	1.7%	96.5%

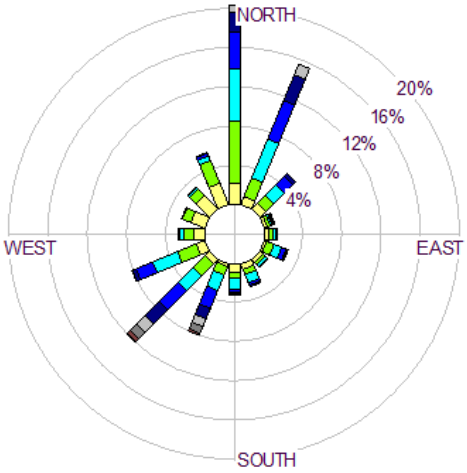
Figure 3: Wind roses - seasonal.

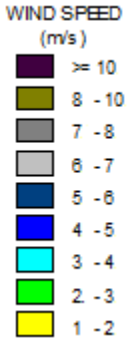
Arboretum 2020

00:00 – 05:59



06:00 – 11:59





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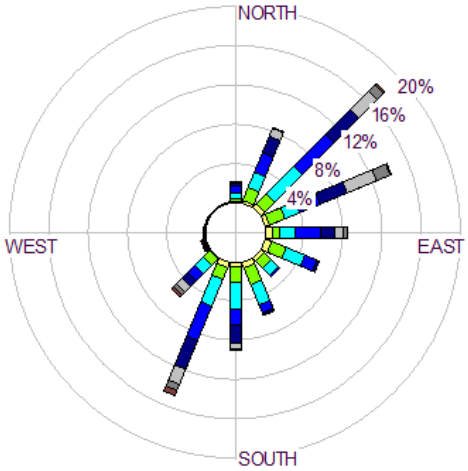
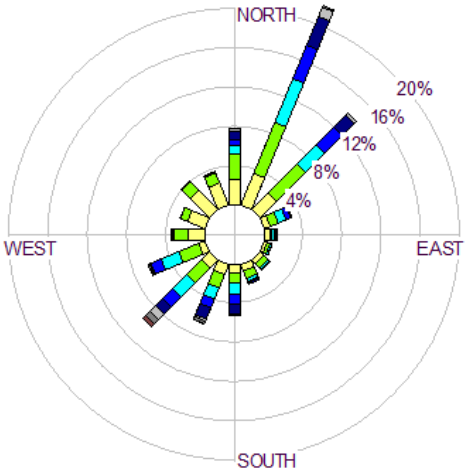


18:00 – 23:59



Period	Wind Speed	Dominant Sector 1		Dominant Sector 2		Calms	Valid Data
00:00-05:59	2.9 m/s	WNW-NNE	59%	SW-WSW	21%	1.9%	97.7%
06:00-11:59	3.5 m/s	N-NNE	38%	SSW-WSW	29%	1.7%	96.2%
12:00-17:59	4.3 m/s	NNE-E	51%	S-SSW	25%	0.4%	95.5%
18:00-23:59	3.1 m/s	N-NE	46%	SSW-WSW	24%	3.0%	96.5%

Figure 4: Wind roses - diurnal.

2.2. Precipitation

Precipitation is measured at three locations (Richards Bay, Felixton and RBCT). The average rainfall across the network during 2020 was 1192 mm, noticeable is the amount of rain received in February (252 mm, 21%), and the low rainfall received during January (50 mm, 4%) and December (82 mm, 7%) typically wetter months (Figure 5, Figure 6, Figure 7).

Compared to the five-year average, 2020 had significantly lower precipitation (Richards Bay -17%, Felixton -26% and RBCT -12%) (Figure 8 see APPENDIX E for tables).

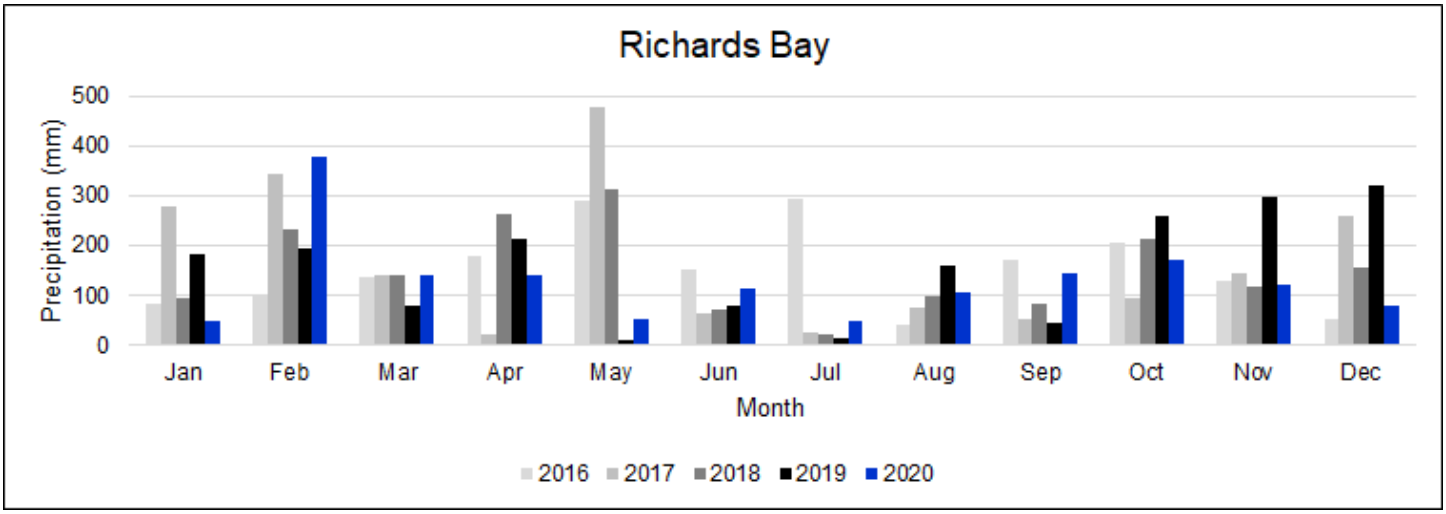


Figure 5: Precipitation –Richards Bay.

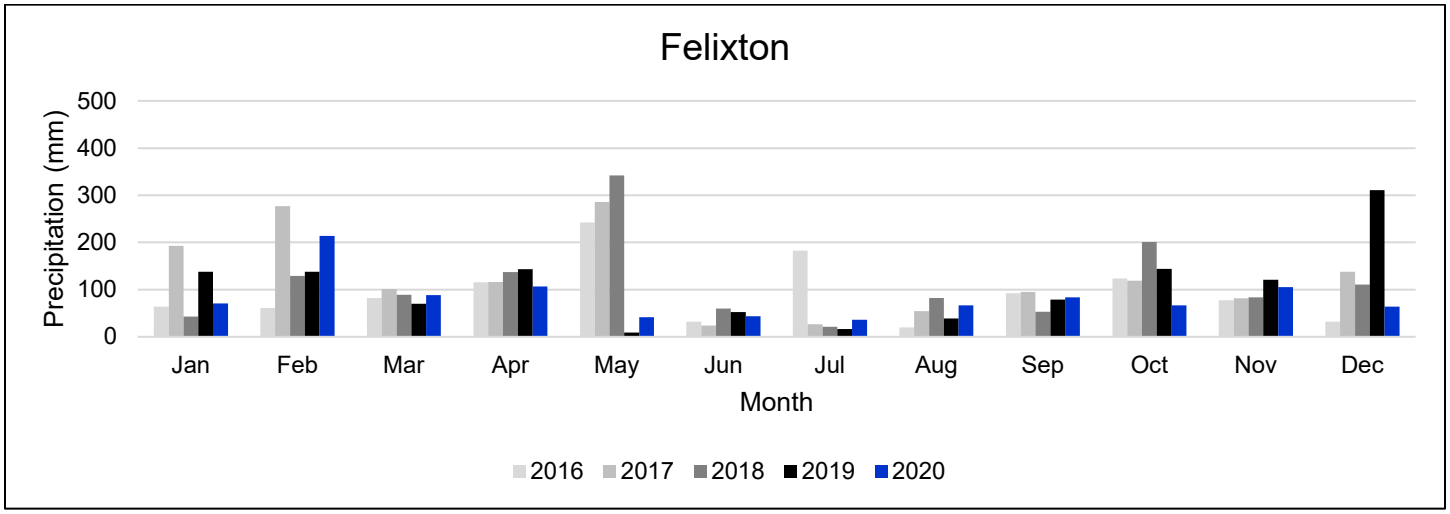


Figure 6: Precipitation – Felixton.

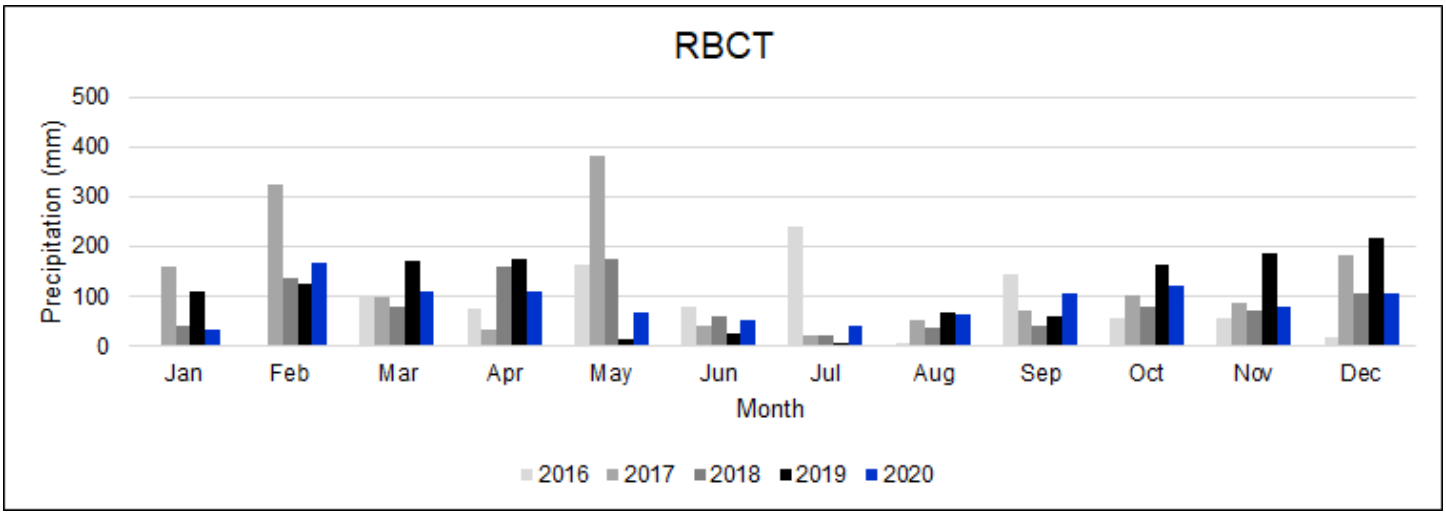


Figure 7: Precipitation – RBCT.

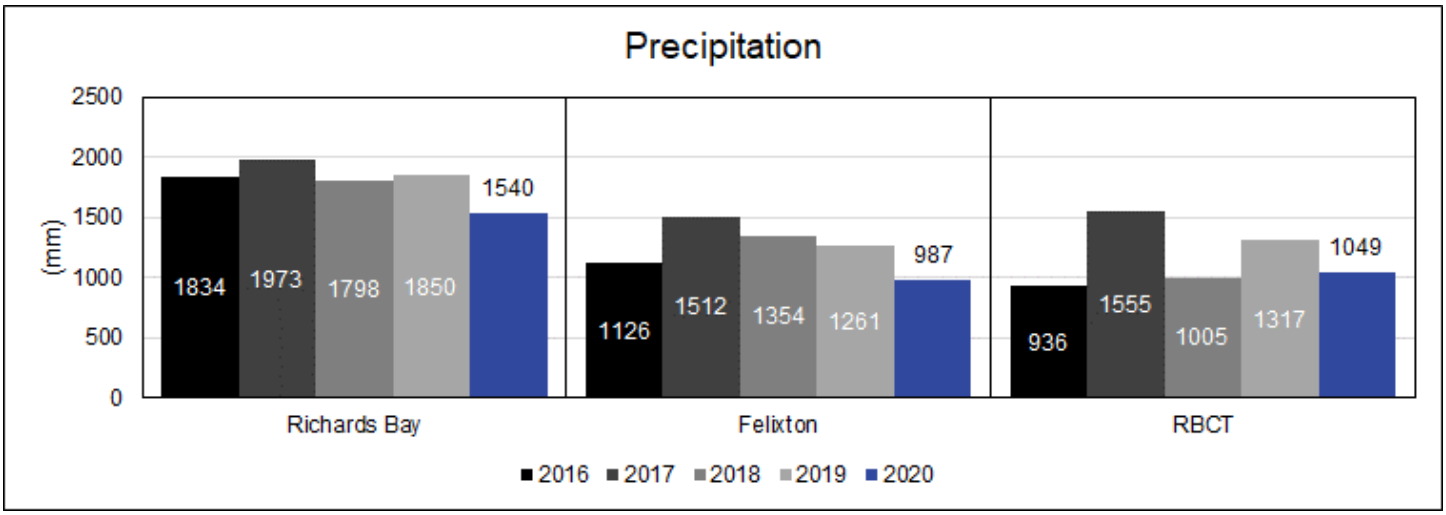


Figure 8: Precipitation - 2016 to 2020

2.3. Data Capture

The percentage of valid data received from the meteorological network for 2020 is shown in Table 2.

Table 2: Meteorological data capture.

Station	Height (m)	Station Availability (%)	Wind Direction & Speed (%)	Temperature (%)	Relative Humidity (%)	Pressure (%)	Solar Radiation (%)	Rain (%)
Airport	2	96		96	96	96	96	
Airport	10	96	96					
Arboretum	3	97		97				
Arboretum	18	97	97					
Brackenham	3	***91***		***91***				
Brackenham	10	***91***	***91***					
CBD	2	99		99	99			98
CBD	10	99	99					
eNseleni	2	***92***		***92***	***92***			
eNseleni	9	***92***	***92***					
eSikhaleni	2	***94***		***94***	***94***			
eSikhaleni	9	***94***	***94***					
Harbour West	2	100		100				
Harbour West	10	100	***49***					

Notes:
Red - Not acceptable for statistical purposes (<80%)
Orange – Does not meet SANAS data capture requirements (<90%)
Yellow – RBCAA reporting requirement (<=95%)

Missing Meteorology:

- *Harbour West (WD/WS) – January to July anemometer faulty, replacement delayed by lockdown regulations.*

3. AIR QUALITY COMPLAINTS

Detailed complaint records are maintained, updated, and distributed to the RBCAA's complaints mailing list weekly, see APPENDIX D for the complaints log.

Three hundred and thirty-three (336) air quality complaints were received during 2020; three months contained incidents with 15 or more complaints linked to a single event (February, March and May). August also had a significant amount of complaints (Figure 9).

- 2020 Incident Summary:
  - February 2020 - odorous emissions because of non-condensable gas being sent to the Mondi flare and not completely incinerated during a mill shut for repairs to a recovery boiler (18 complaints)
  - March 2020 - odorous emissions because of non-condensable gas being sent to the Mondi flare and not completely incinerated while the lime kiln was shut down (37 complaints)
  - May 2020 - odorous emissions from venting points because the emergency/back-up power to non-condensable gas system failed (159 complaints)
  - August 2020 – 9 separate incidents at Mondi (33 complaints)

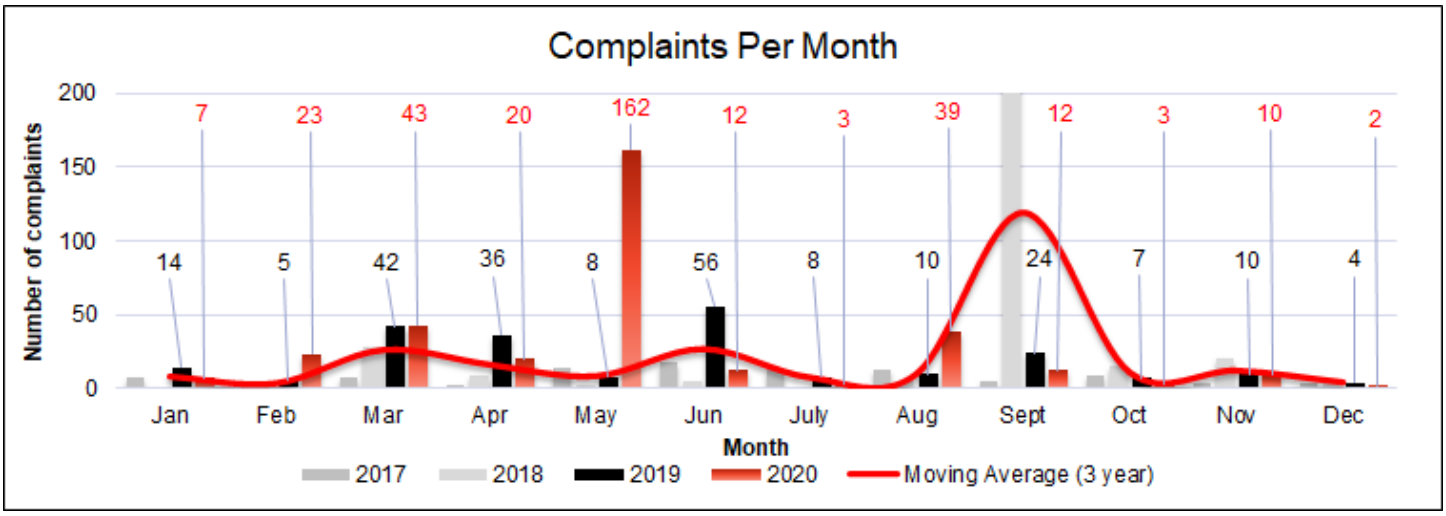


Figure 9: Complaints - historical monthly comparison.

Two hundred and twenty-four (224) air quality complaints were received during 2019; the months in which significant incidents occurred are listed below.

- 2019 Incident Summary:
  - March 2019 - a pressure safety valve on a container containing Mercaptan used to odorise LPG to detect leaks at Bidvest Tank terminals malfunctioned (26 complaints)
  - April 2019 - two incidents related to a shutdown at Mondi and the production of non-condensable gasses that could not be destroyed by flaring (24 complaints)
  - June 2019 – issues on Mondi's evaporation plant (48 complaints)
  - September 2019 – three separate incidents related to emissions from Mondi's flare, effluent plant, recovery boiler start-up (18 complaints)

3.1. Complaints distribution

The distribution of complaints by region, source and type is presented in Figure 10, Figure 11, and Figure 12; distributions for 2019 are included for comparison. During 2020 most complaints from the Meerensee, Arboretum, Veldenvlei and Birdswood areas were related to; incidents in February, March and especially May. In 2019 most of the complaints from the Mondi, Veldenvlei, Alton and CBD areas were associated with incidents in April, June, and September. Most of the complaints from Meerensee in 2019 were linked to the incident that occurred in March. In both years, the majority (more than 85%) of complaints were described as having odour and clinical effects.

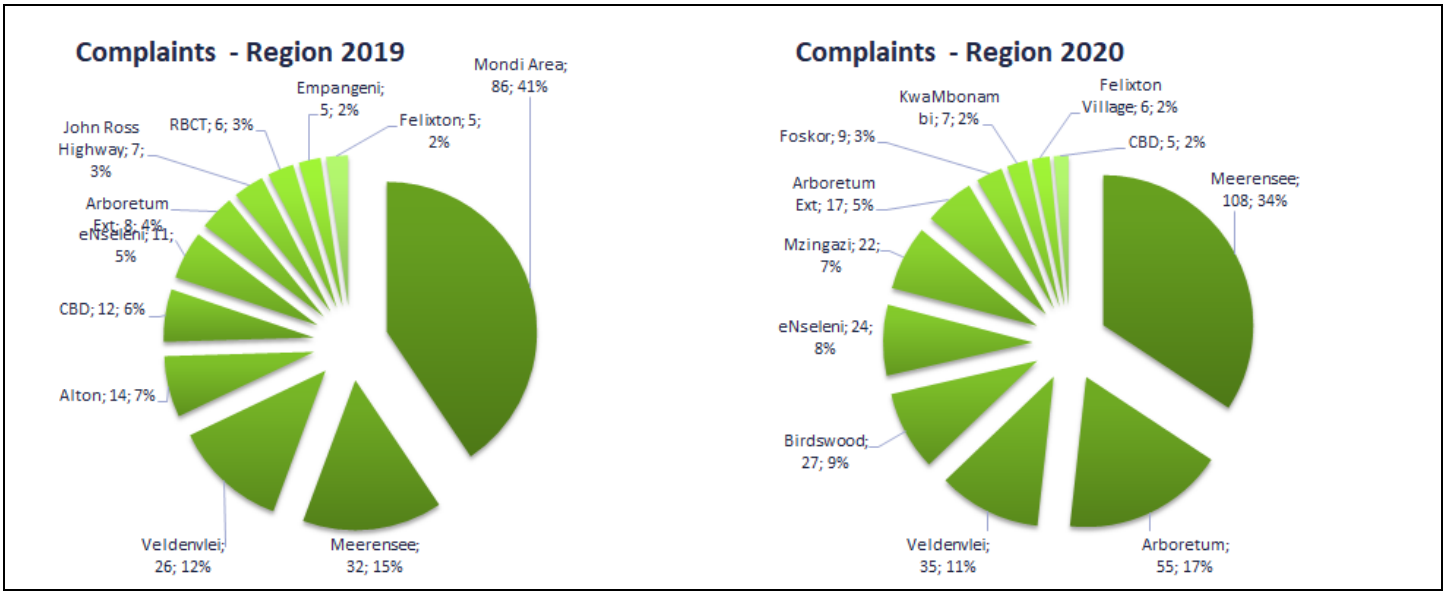


Figure 10: Complaints - region.

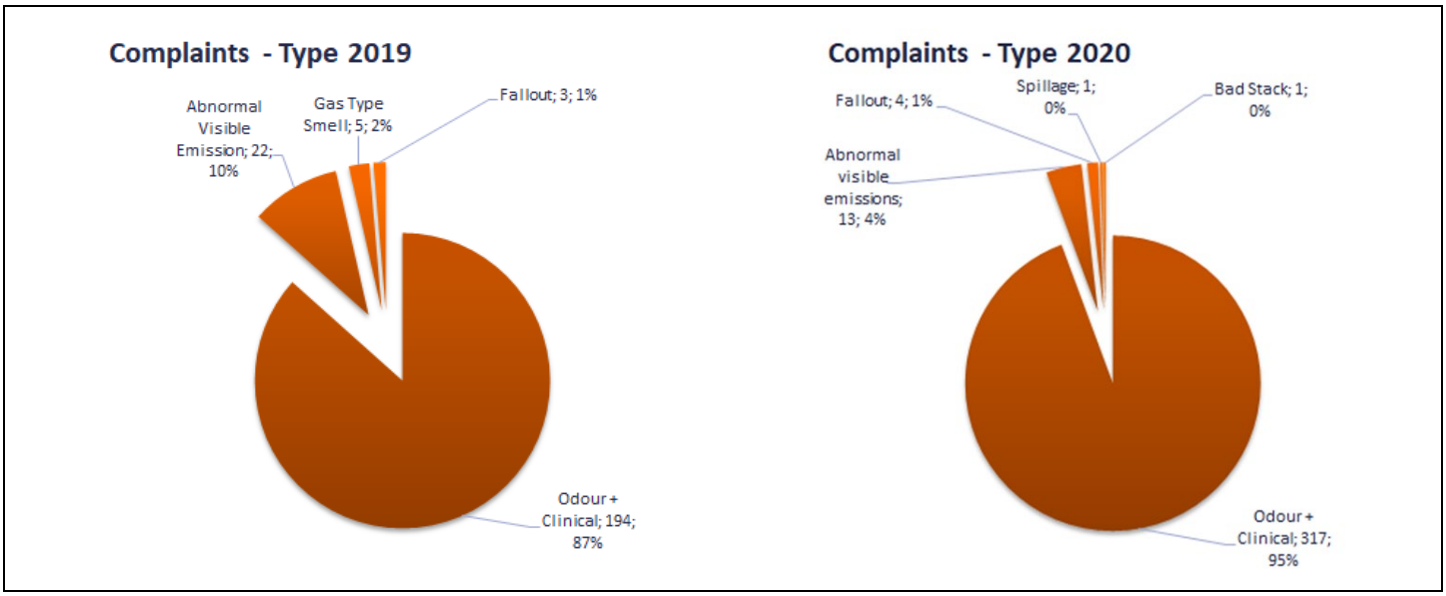


Figure 11: Complaints - type.

In 2020 the complaints received were allocated as follows: Mondi Richards Bay (308, 92%); Foskor (13, 4%) and other (15, 4%), and in 2019 Mondi Richards Bay (149, 68%); Bidvest Tank Terminals (28, 13%); Foskor (12, 6%) and other (28, 13%).

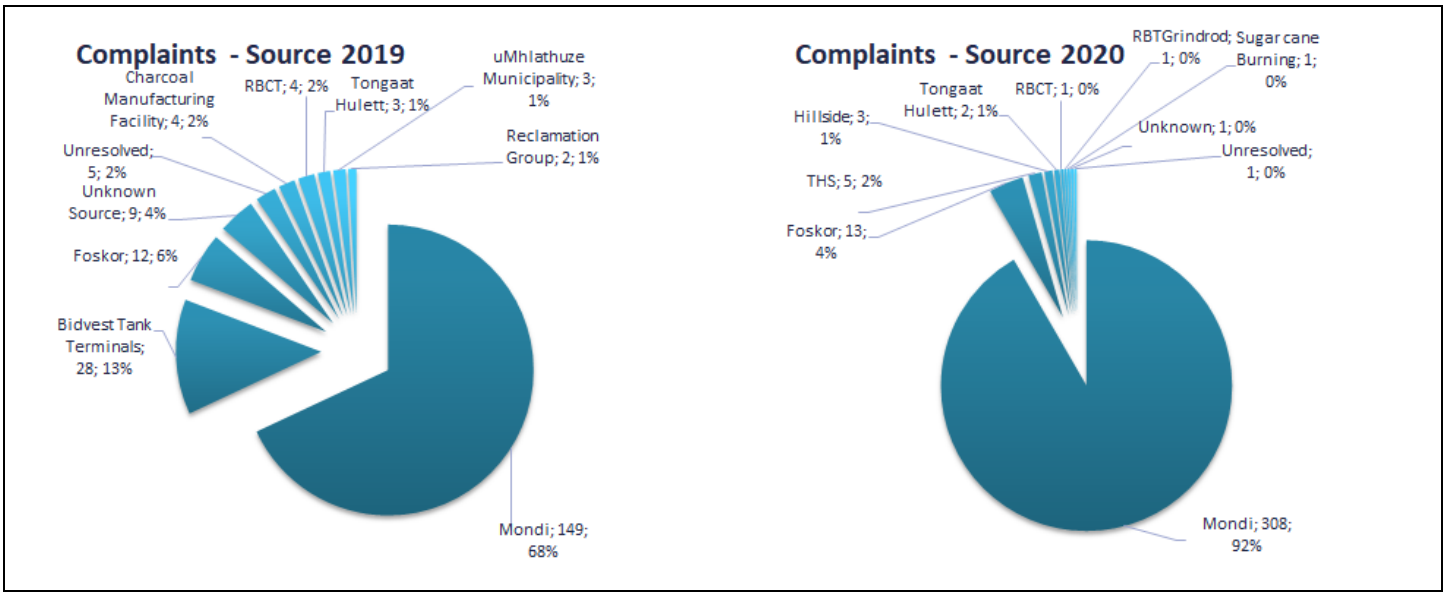


Figure 12: Complaints - source.

3.2. Complaints - Annual

The historical count of complaints per year since 2000 is reflected in Figure 13. From 2005 to 2017, there has been a downward trend; this has, however, reversed. The maximum number of complaints received in a single year was 418 in 2018. Note that most (318, 76%) of these complaints were associated with a single incident. The incident, which occurred in September 2018, was linked to a process fault at Mondi. The fault resulted in the production of H_2S, which could not be managed (converted) by flaring. In 2020, many complaints (159, 47%) were associated with an incident in May 2020 where odorous emissions from venting points occurred due to the emergency/back-up power to Mondi non-condensable gas system failing (159 complaints).

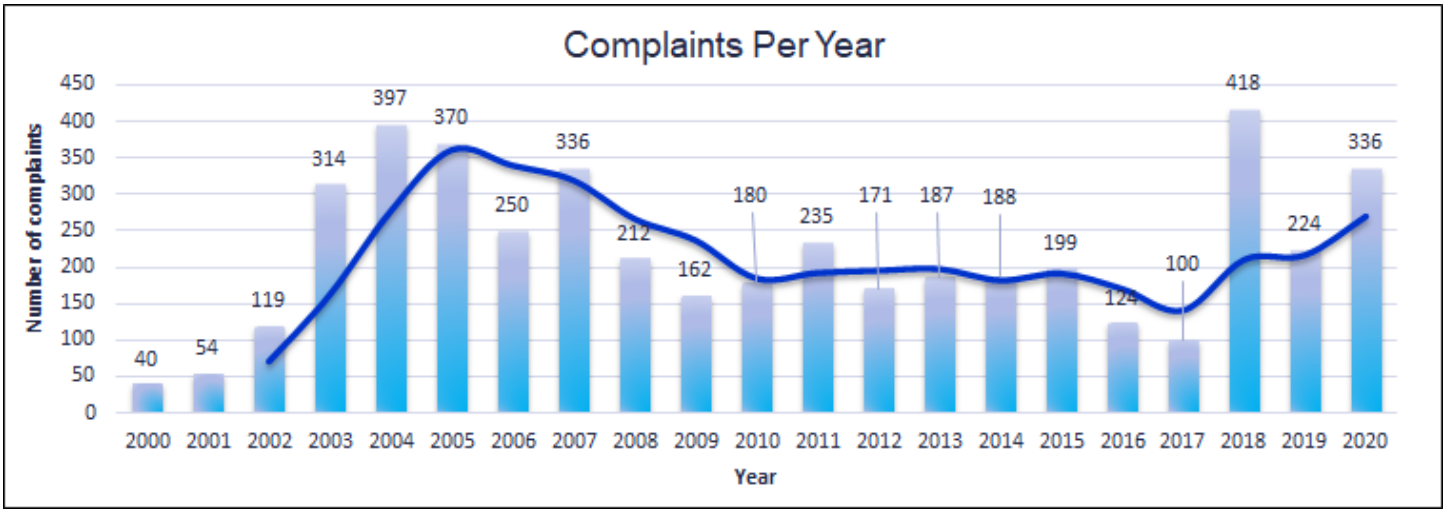


Figure 13: Complaints – annual comparison.

4. PARTICULATE MONITORING

The term "particulate matter" (PM) refers to solid particles and liquid droplets found in the atmosphere. Many anthropogenic and natural sources; emit PM directly or other pollutants that react to form PM. These solid and liquid particles can vary in size. Particles less than 10 micrometres (µm) in diameter are classified as PM_{10}; particles less than 2.5 micrometres (µm) in diameter are classified as $PM_{2.5}$.

PM_{10} and $PM_{2.5}$ can be inhaled and accumulates deep within the respiratory system; exposure to sustained high concentrations may result in:

- Reduced lung development in children
- Allergy related inflammatory reactions of the airway
- Asthma, nasal congestion, and sinus problems
- Increase in symptoms associated with the lower respiratory tract
- In severe cases, reduction in life expectancy

TEOM's (particulate analysers) at Brackenham, CBD, Mtunzini and eSikhaleni stations measure PM_{10} data continuously. PM_{10} monitoring undertaken at Felixton conducted using an E-sampler, an alternative sampling methodology used at the other stations.

4.1. PM Ambient Air Quality Standards

Ambient air quality standards for particulates are listed below (Table 3).

Table 3: Particulate ambient air quality standards.

Variable	Organisation	Daily average	Annual average
PM_{10}	NEMA [a]	75 µg/m³ [b]	40 µg/m³ [c]
	WHO [d]	50 µg/m³ [c]	20 µg/m³ [c]
$PM_{2.5}$	NEMA [e]	40 µg/m³ [b]	20 µg/m³ [c]
	WHO [d]	25 µg/m³ [c]	10 µg/m³ [c]

Notes:
a) Government Gazette 32816 (24th of December 2009) in terms of the National Environmental Management: Air Quality Act No. 39 of 2004, effective from 2015 (RSA-NEMAQA, 2009)
b) Not to be exceeded more than 4 times in one year
c) Not to be exceeded
d) World Health Organisation / International Finance Corporation (WHO, 2015) (IFC, 2007)
e) Government Gazette 35463 (29th of June 2009) in terms of the National Environmental Management: Air Quality Act No. 39 of 2004, effective from 2015 (RSA-NEMAQA, 2009) (RSA-NEMAQA, 2012)

4.2. PM_{10} Daily Concentrations

There were:

- **No measured exceedances** of the NEMA PM10 Daily Limit (75 µg/m3)
- Eight (8) measured exceedances of the or WHO Daily Guideline (50 µg/m3)

PM_{10} exceedances were associated with high wind speeds and the passage of cold fronts (Figure 14).

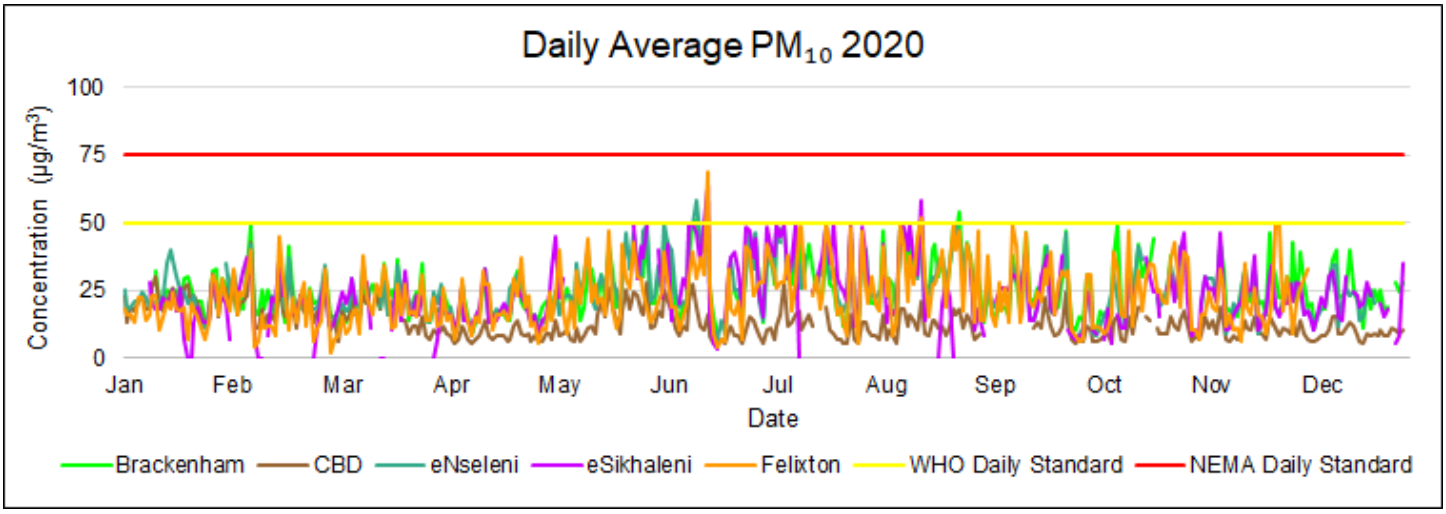


Figure 14: PM_{10} daily average concentrations.

4.3. PM_{10} Diurnal Concentrations

Diurnal PM_{10} concentrations dipped at 05:00 peaked at 19:00 (Figure 15).

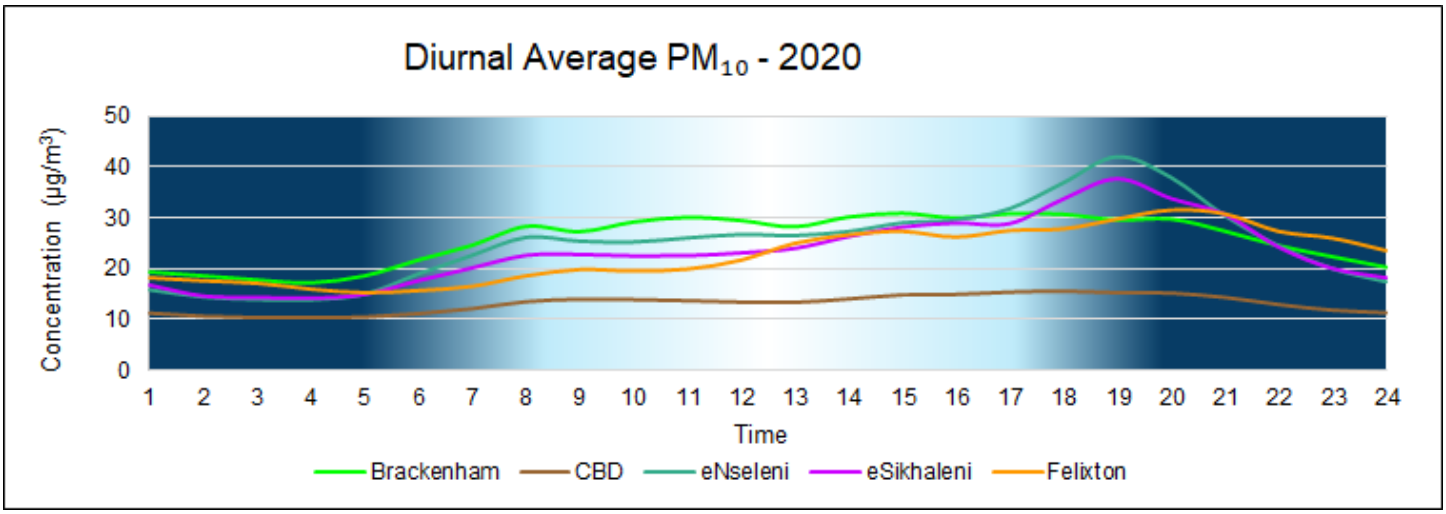


Figure 15: PM_{10} diurnal concentrations.

4.4. PM_{10} Monthly Concentrations

Monthly comparisons are provided in (Figure 16).

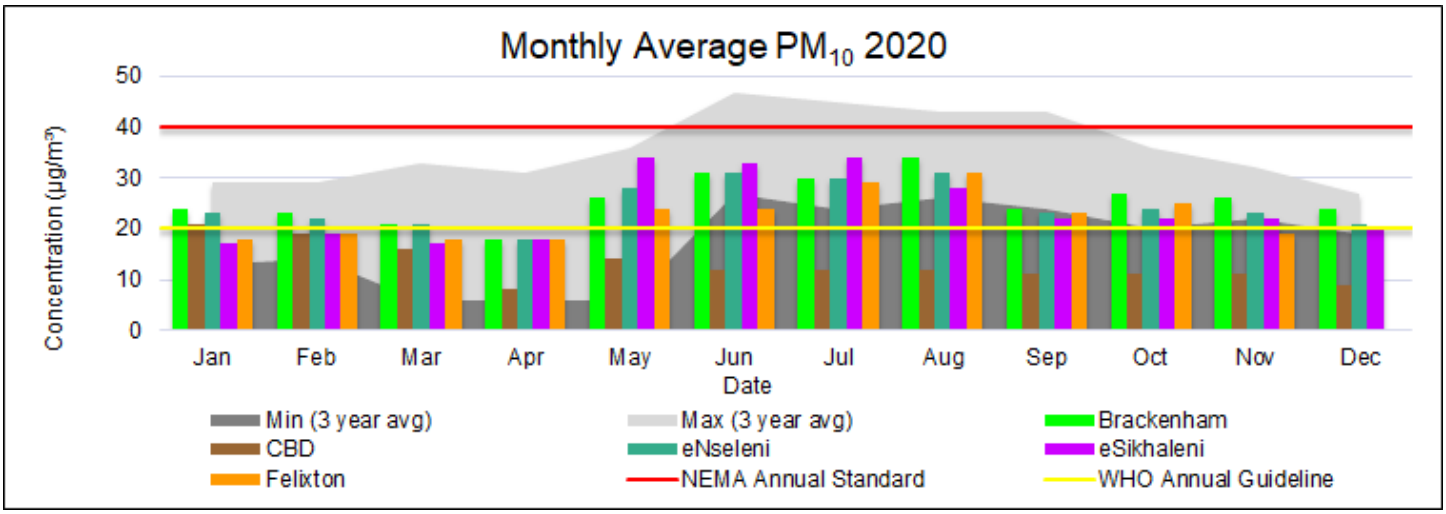


Figure 16: PM_{10} monthly comparison.

4.5. PM_{10} Annual Concentrations

PM_{10} concentrations exceeded the WHO annual guideline at Brackenham, eNseleni, eSikhaleni and Felixton. However, the NEMA annual standard was not exceeded (Figure 17).

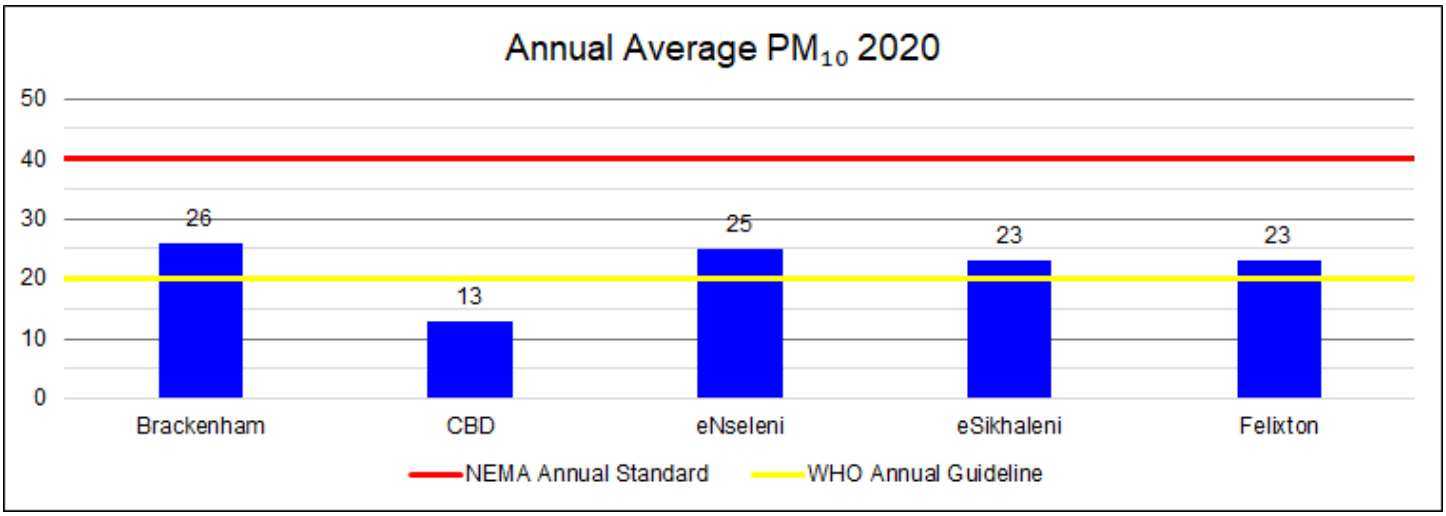


Figure 17: PM_{10} annual concentrations.

Compared to 2018 and 2019, the 2020 annual average PM_{10} concentrations at eNseleni, eSikhaleni and Felixton were similar (differed by 10% or less of the limit). However, values measured at Brackenham and CBD in 2020 were less than those measured during previous years (Figure 18).

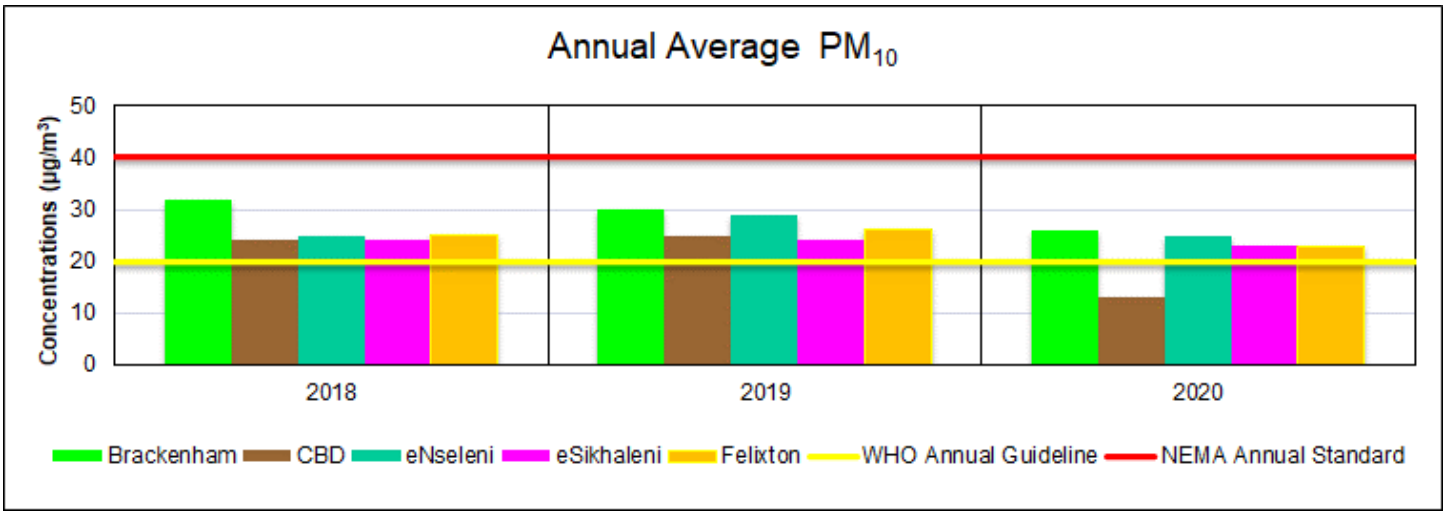


Figure 18: PM_{10} annual average concentration (2018 – 2020).

Annual average concentrations and trends dating back to 2004 are illustrated in Figure 19. A decreasing trend is noticeable from 2009 to 2012; this has reversed and stabilised since then; it is particularly evident at Brackenham, CBD, Felixton, and eSikhaleni. The reversal could be related to the proliferation of stockpiles in the area and the reduction in rainfall.

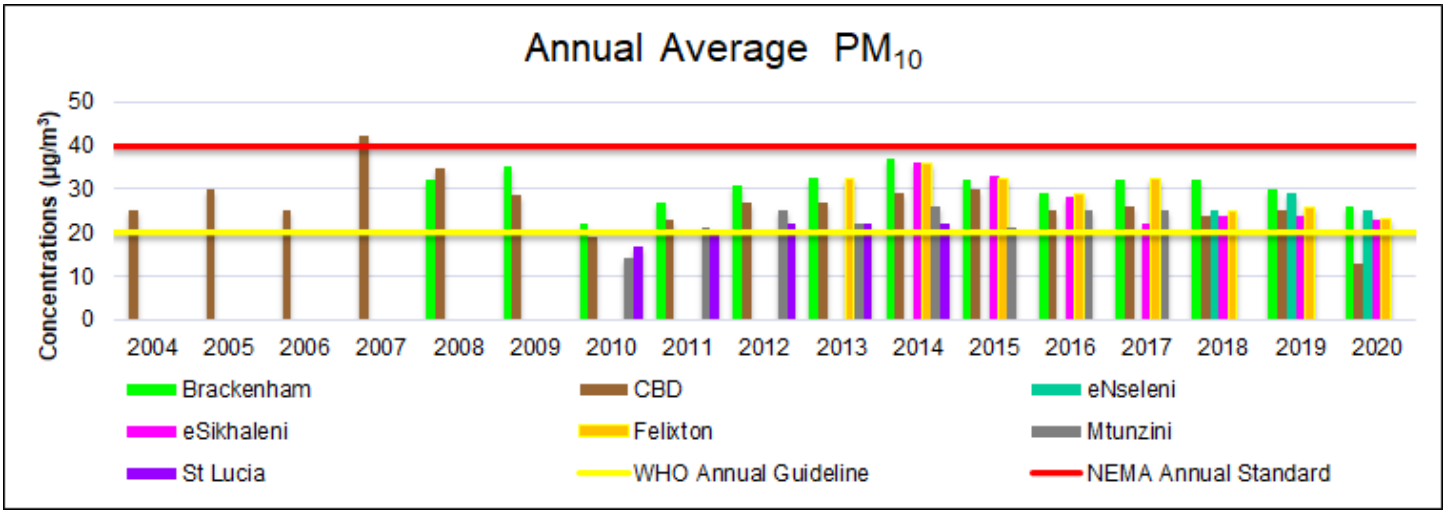


Figure 19: PM_{10} annual average concentrations.

4.6. PM_{10} Exceedances

The number of days on which exceedances occurred during the month plus comparisons to the previous year is shown in Figure 20 and Figure 21. There were fewer PM_{10} exceedances days at all stations during 2020. According to the relative Air Quality Index (AQI), the areas where no exceedances were measured may be considered good air quality with respect to PM_{10}.

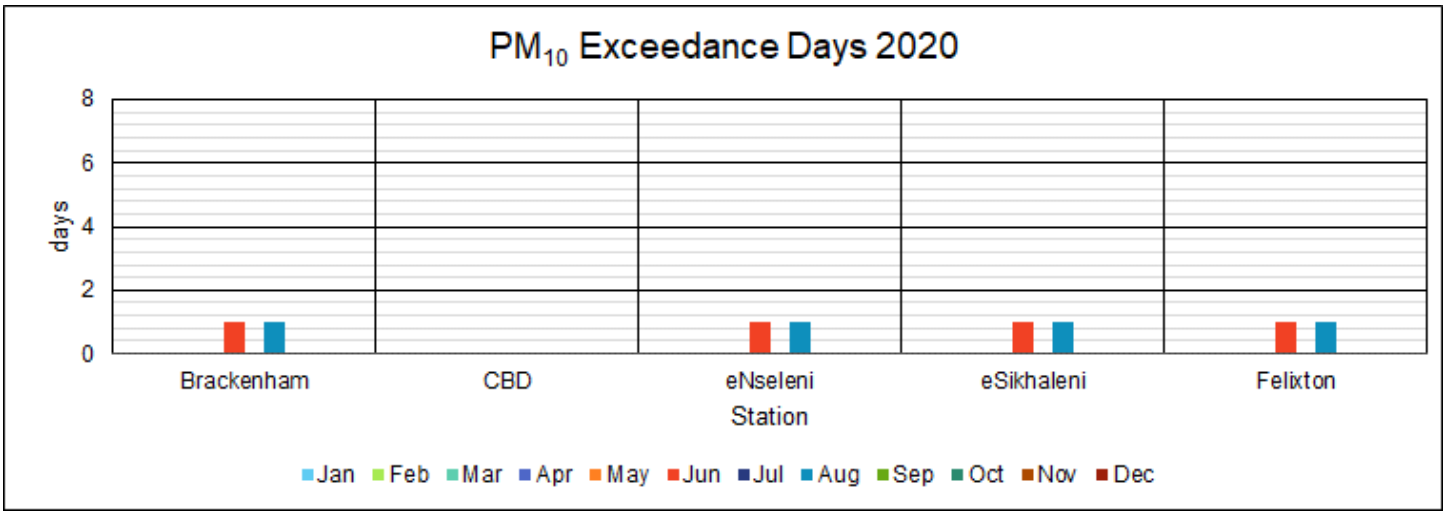


Figure 20: PM_{10} exceedance days 2020

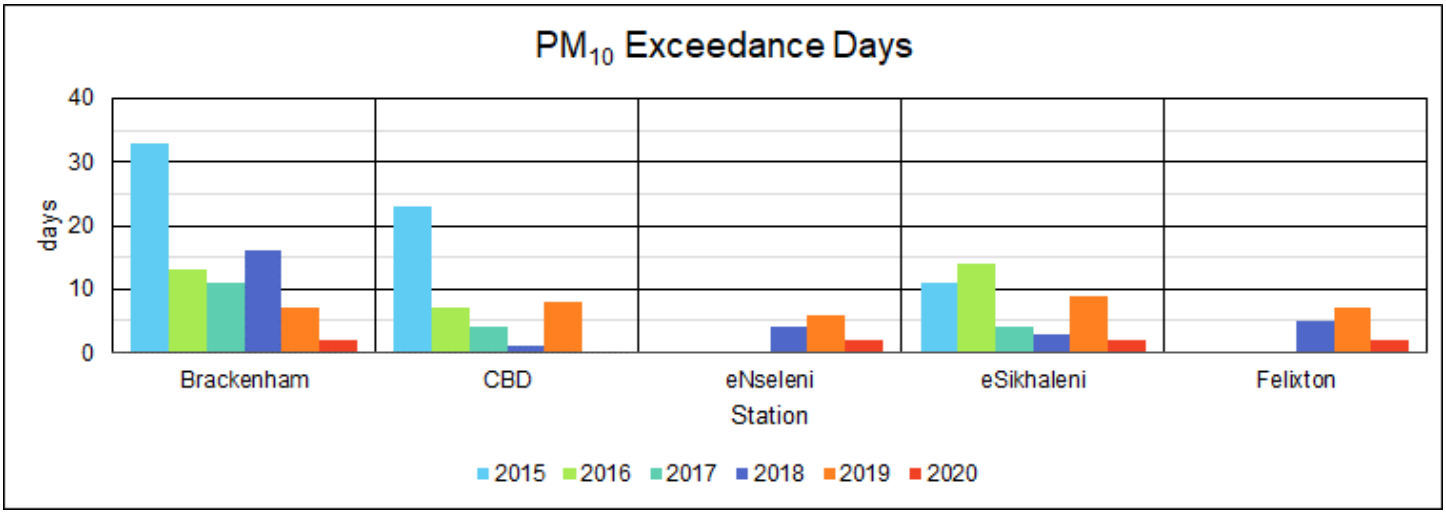


Figure 21: PM_{10} exceedance days 2015 - 2020

A summary of PM_{10} exceedances for the last three years per station is presented in Table 4. See Appendix E for the PM_{10} exceedance log.

Table 4: PM_{10} exceedance summary.

Standard / Guideline / Target	Station	2018	2019	2020
NEMA Daily Standard (75 µg/m³)	Brackenham	0	0	0
	CBD	0	0	0
	eNseleni	6	1	0
	eSikhaleni	1	2	0
	Felixton	0	0	0
WHO Daily Guideline (50 µg/m³)	Brackenham	16	7	2
	CBD	1	8	0
	eNseleni	4	6	2
	eSikhaleni	3	9	2
	Felixton	5	7	2
NEMA Annual Standard (40 µg/m³)	All stations	None Measured	None Measured	None Measured
WHO Annual Guideline (20 µg/m³)	Brackenham	1	1	1
	CBD	1	1	0
	eNseleni	1	1	1
	eSikhaleni	1	1	1
	Felixton	1	1	1

4.7. PM_{10} Data Capture

The percentage of valid data received from the PM_{10} analysers for 2020 is shown in Table 5.

Table 5: PM_{10} data capture.

Station	Station Availability (%)	PM_{10} (%)
Brackenham	***91***	***91***
CBD	99	***94***
eNseleni	***92***	***91***
eSikhaleni	***94***	***86***
Felixton	99	***90***
Notes: *Red - Not acceptable for statistical purposes (<80%)* *Orange – Does not meet SANAS data capture requirements (<90%)* *Yellow – RBCAA reporting requirement (<=95%)*		
Missing Data: *eSikhaleni (PM_{10})* • *March - load shedding, power outage, analyser not recovering 78% data capture* • *May – analyser faulty, repaired 40% data capture*		

5. SULPHUR DIOXIDE MONITORING

Sulphur dioxide (SO_2) is one gas of a group of highly reactive gasses known as "oxides of sulphur." Anthropogenic sources include fossil fuel combustion (particularly coal-burning power plants), industrial processes such as wood pulping, paper manufacture, petroleum and metal refining, metal smelting (particularly from sulphide containing ores, e.g., lead, silver, and zinc ores) and vehicle tailpipe emissions. Natural sources of SO_2 emissions include geothermal activity (including hot springs and volcanic activity) and the natural decay of vegetation on land in wetlands and oceans.

SO_2 is linked with several adverse effects on the respiratory system as it is highly soluble and thus readily absorbed by the mucous membranes of the nose and upper respiratory tract. Exposure to high concentrations may result in:

- Reduction in lung function (especially in asthmatics and children)
- Wheezing and coughing
- In severe cases, a decrease in life expectancy

5.1. SO_2 Ambient Air Quality Standards

South African ambient air quality standards for SO_2 are listed below (Table 6).

Table 6: SO_2 ambient air quality standards.

Variable	Organisation	10-min average	Hourly average	Daily average	Annual average
SO_2 Standard	NEMA [a]	500 µg/m³ [b]	350 µg/m³ [c]	125 µg/m³ [d]	50 µg/m³ [e]
		191ppb [b]	134 ppb [c]	48 ppb [d]	19 ppb [e]
SO_2 Interim Target 1	WHO [f]	-	-	125 µg/m³	-
		-	-	48 ppb	-
SO_2 Interim Target 2	WHO [f]	-	-	50 µg/m³	-
		-	-	19 ppb	-
SO_2 Guideline	WHO [f]	500 µg/m³	-	20 µg/m³	-
		191ppb	-	8 ppb	-

Notes:
a) SA Government Gazette 32816 (published 24th of December 2009) in terms of the National Environmental Management: Air Quality Act 39 of 2004 (RSA-NEMAQA, 2009)
b) Not to be exceeded more than 526 times in one year
c) Not to be exceeded more than 88 times in one year
d) Not to be exceeded more than 4 times in one year
e) Not to be exceeded
f) World Health Organisation / International Finance Corporation (WHO, 2015) (IFC, 2007)

5.2. SO_2 10-minute Average Concentrations

There were two hundred and seventy-five (275) measured exceedances of the NEMA and WHO 10-minute Standards (191 ppb). Over 95% of these exceedances included contributions from Foskor (Figure 22).

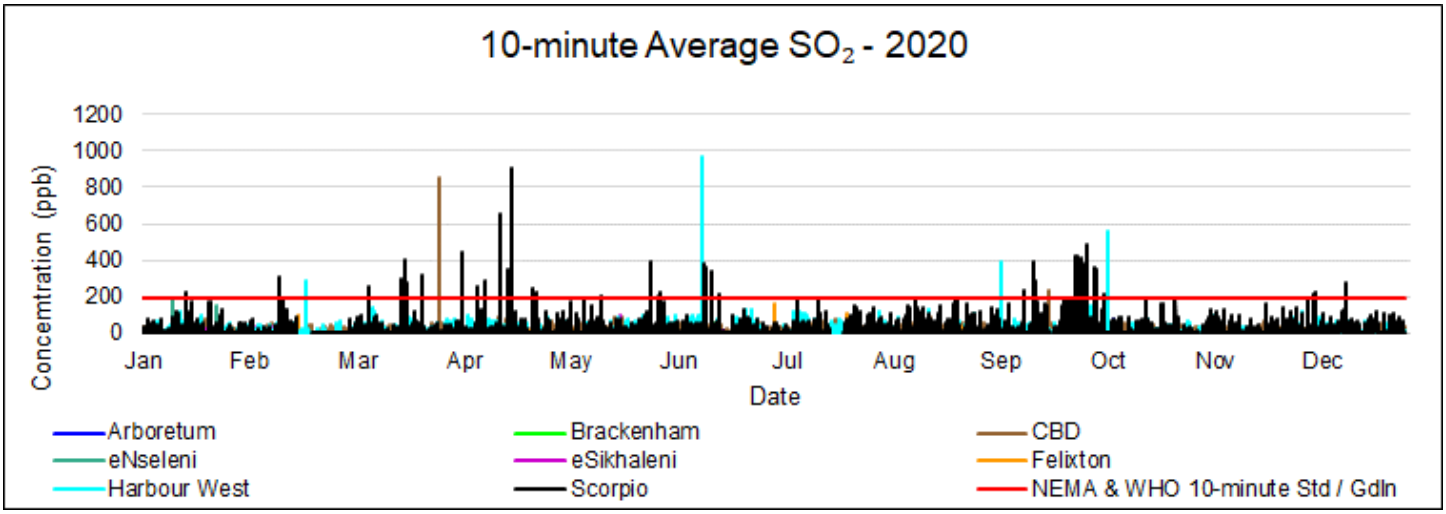


Figure 22: SO_2 10-minute average concentrations.

5.3. SO_2 Hourly Average Concentrations

There were seventy-three (73) measured exceedances of the NEMA Hourly Standard (134 ppb). Over 90% of these exceedances included contributions from Foskor (Figure 23).

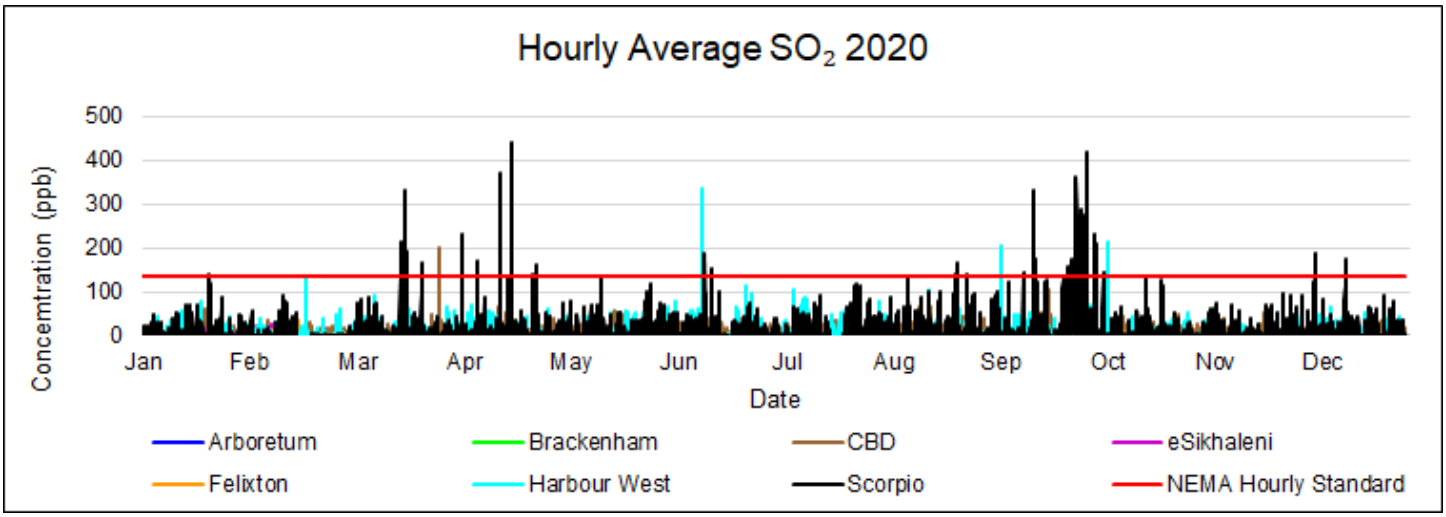


Figure 23: SO_2 hourly average concentrations.

5.4. SO_2 Daily Average Concentrations

Daily average SO_2 concentrations are shown below (Figure 24); there were:

- Eight (8) measured exceedances of the NEMA and WHO Daily Standard / Interim-Target 1 (48 ppb)
- Eighty-five (85) measured exceedance of the WHO Daily Interim Target 2 (19 ppb)
- Three hundred twenty-one (321) measured exceedances of the WHO Daily Guideline (8 ppb)

Industry participation to the exceedances of the NEMA and WHO Daily Standard / Interim-Target 1 (48 ppb) was as Foskor 88%, and South32 13%.

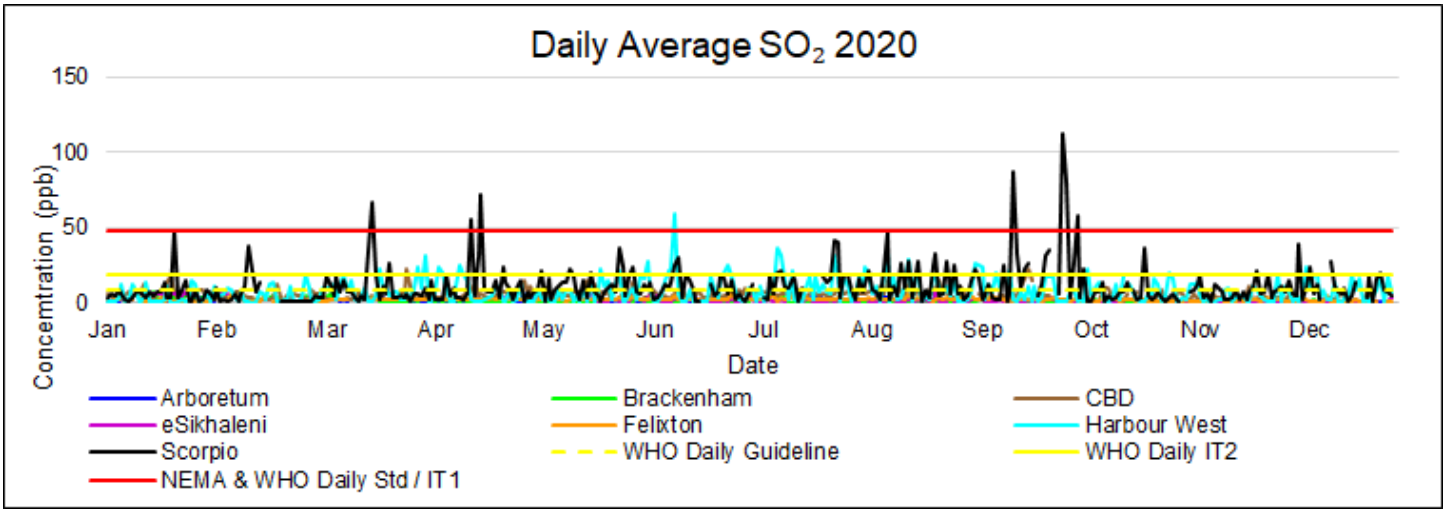


Figure 24: SO_2 daily average concentrations.

5.5. SO_2 Diurnal Concentrations

Diurnal SO_2 concentrations peaked in the morning and dipped in the evening (Figure 25).

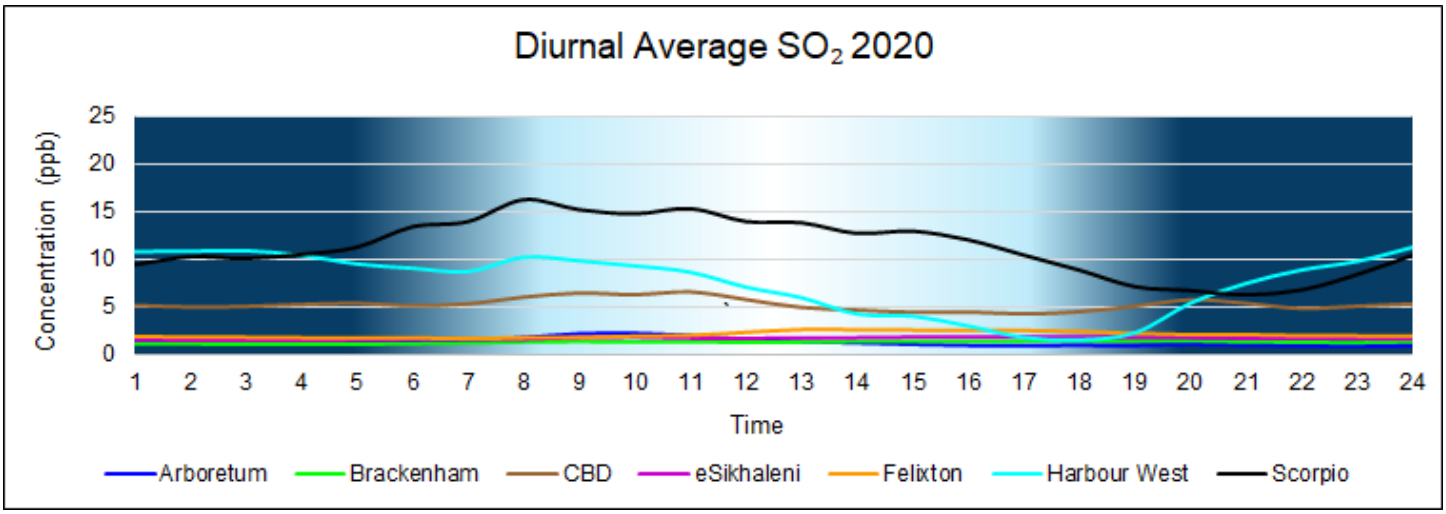


Figure 25: SO_2 diurnal concentrations.

5.6. SO_2 Monthly Concentrations

Monthly comparisons are provided in Figure 26.

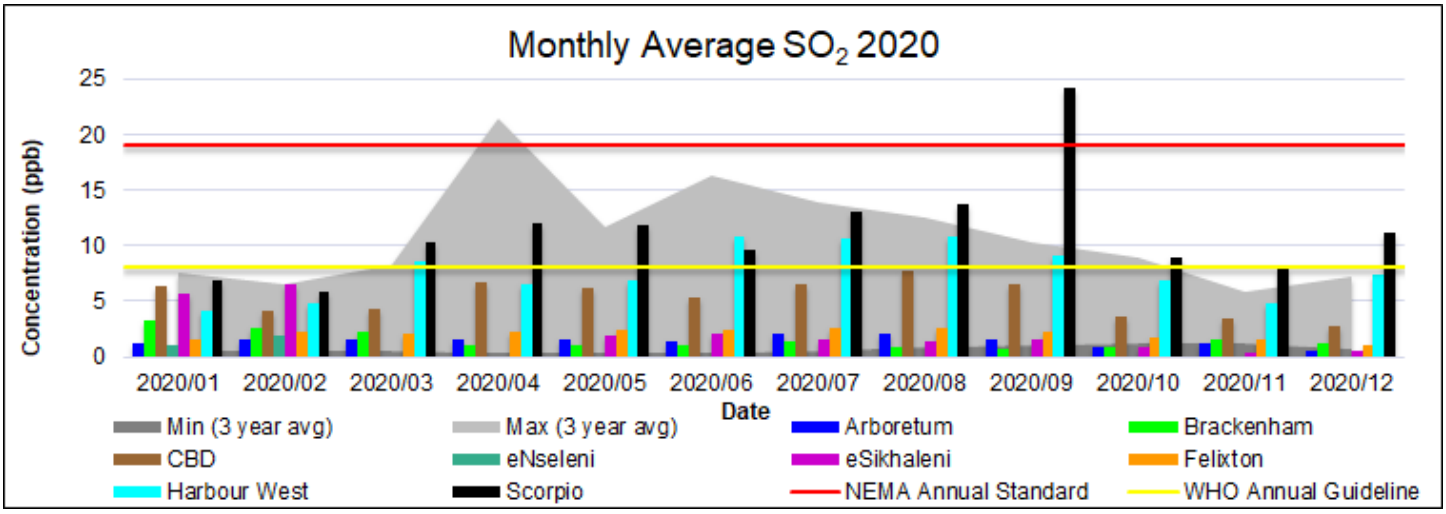


Figure 26: SO_2 monthly comparison.

5.7. SO2 Annual Concentrations

Annual average SO_2 concentrations did not exceeded NEMA annual standards, the WHO annual standard was exceeded at Scorpio (Figure 27). Data capture for eSikhaleni was below 80% (orange shading); it is presented for comparative purposes only and should not be used for statistical analysis.

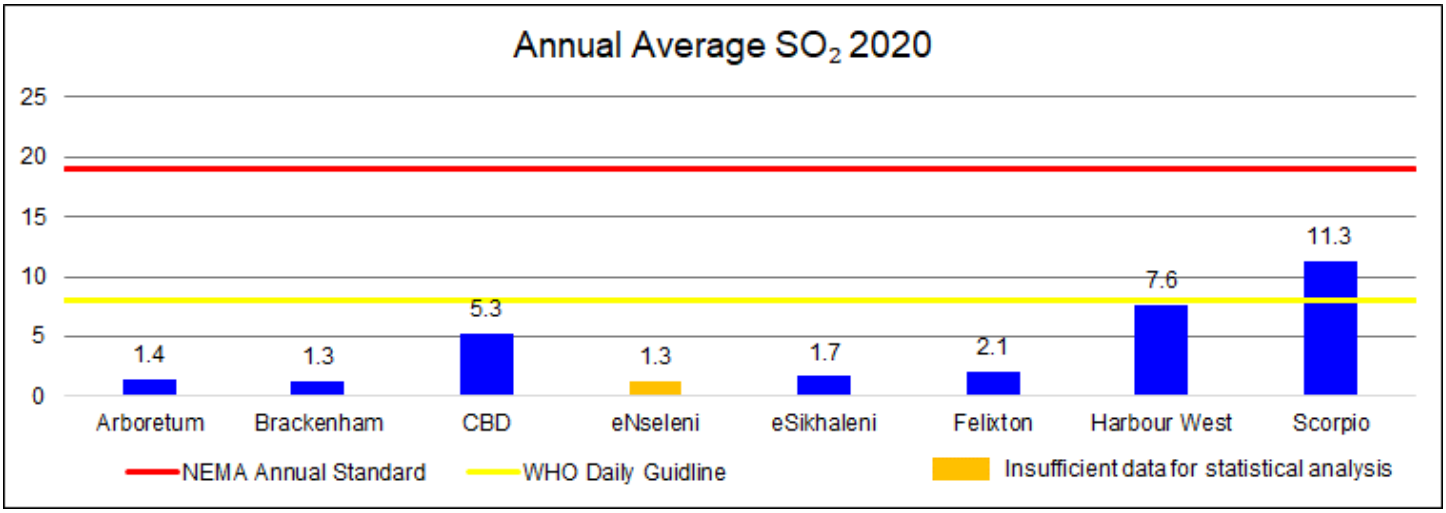


Figure 27: SO_2 annual concentrations.

Compared to 2018 and 2019, 2020 annual average SO_2 concentrations at most stations were similar (differed by 10% or less of the limit). However, values measured at Scorpio in 2020 were more than those measured during previous years (Figure 28).

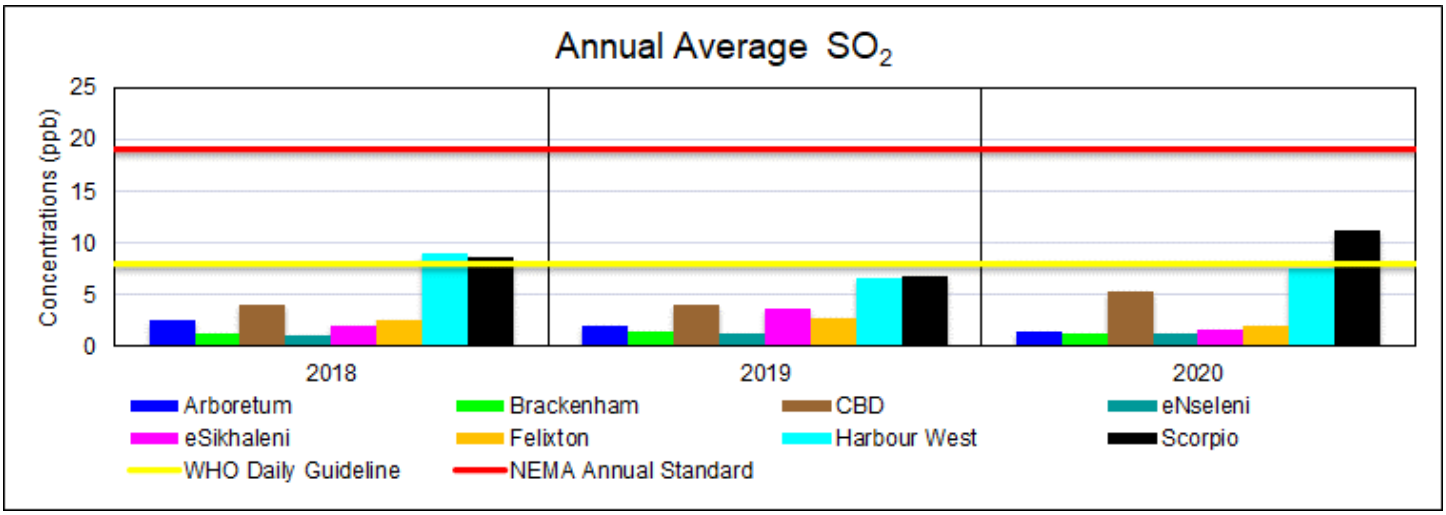


Figure 28: SO_2 annual average concentration 2018 – 2020.

Annual average SO_2 concentrations and trends are illustrated in Figure 29. There was a decrease in concentration from 2006 to 2010. This trend reversed from 2010 to 2014 but seemed to have stabilised (from 2014 to 2019). The reduction of SO_2 concentrations from 2014 to 2016 could be linked to numerous shutdowns at Foskor; the Foskor A-plant had an extended shutdown in 2015 that overlapped with the 2016 annual shutdown. During 2020 NEMA SO_2 Annual limit (19 ppb) was not exceeded.

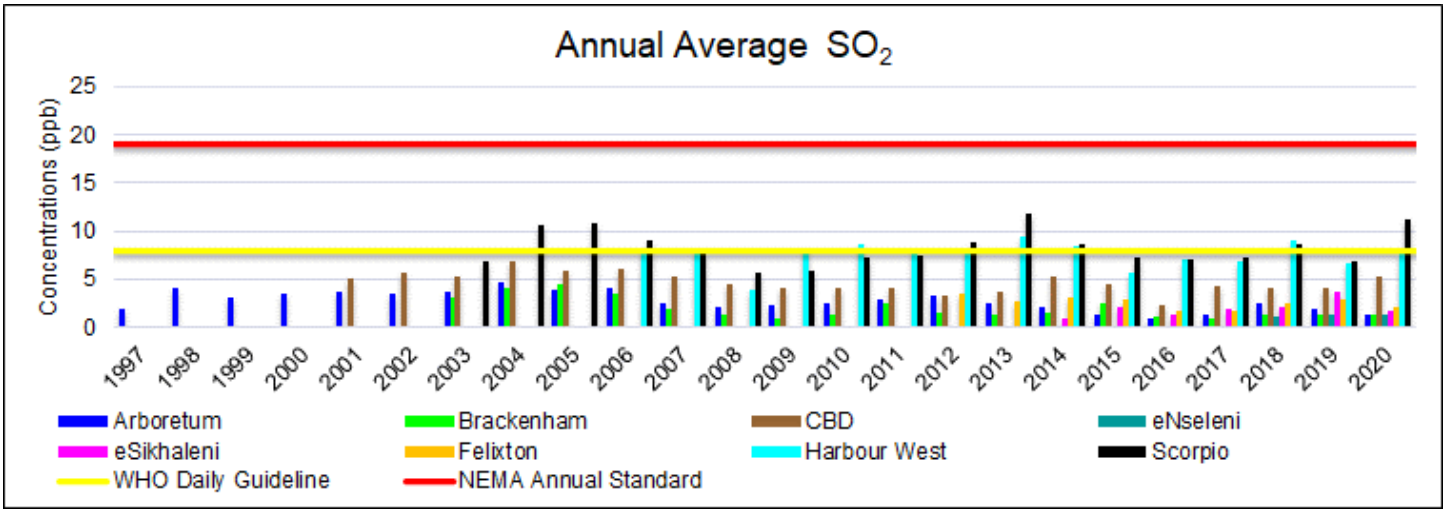


Figure 29: SO_2 annual average concentrations.

5.8. SO_2 Exceedances

SO_2 exceedances can be, associated with emissions because of process upsets (i.e., planned maintenance, plant shutdowns or start-up), leaks in equipment, pipelines, seals, valves (fugitive emissions) or an event (e.g. fires or emergency shutdowns). The number of days on which exceedances occurred per month plus comparisons to the previous year is shown in Figure 30 and Figure 31. There were more SO_2 exceedance days during 2020. According to the relative Air Quality Index (AQI), the areas where no exceedances were measured may be considered good air quality with respect to SO_2.

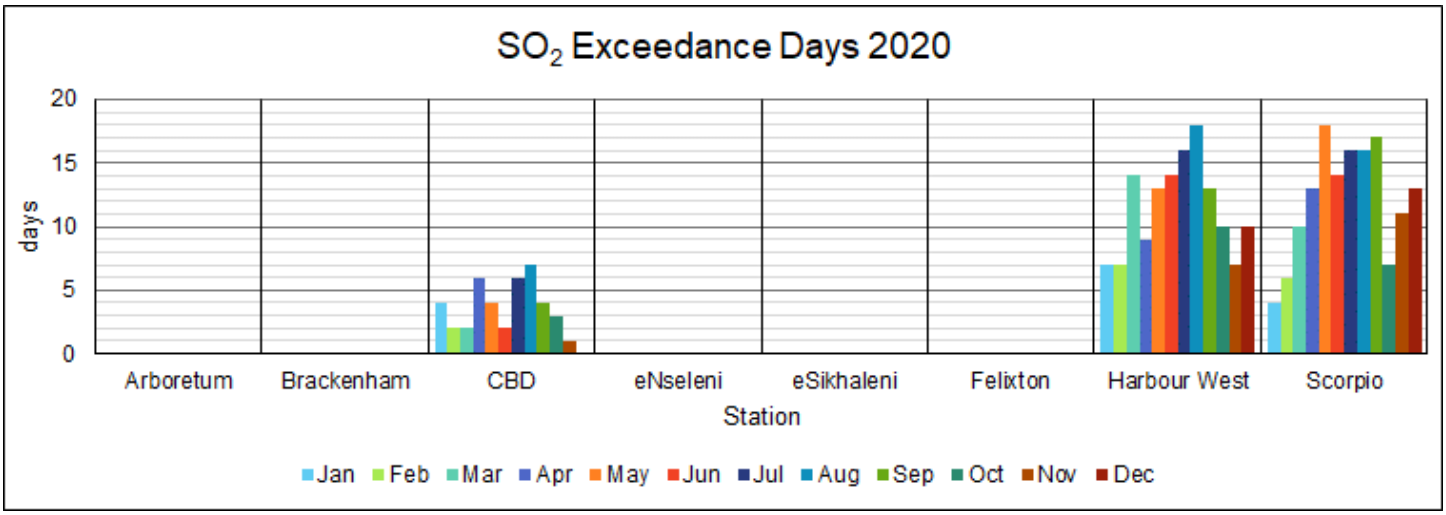


Figure 30: SO_2 exceedance days 2020

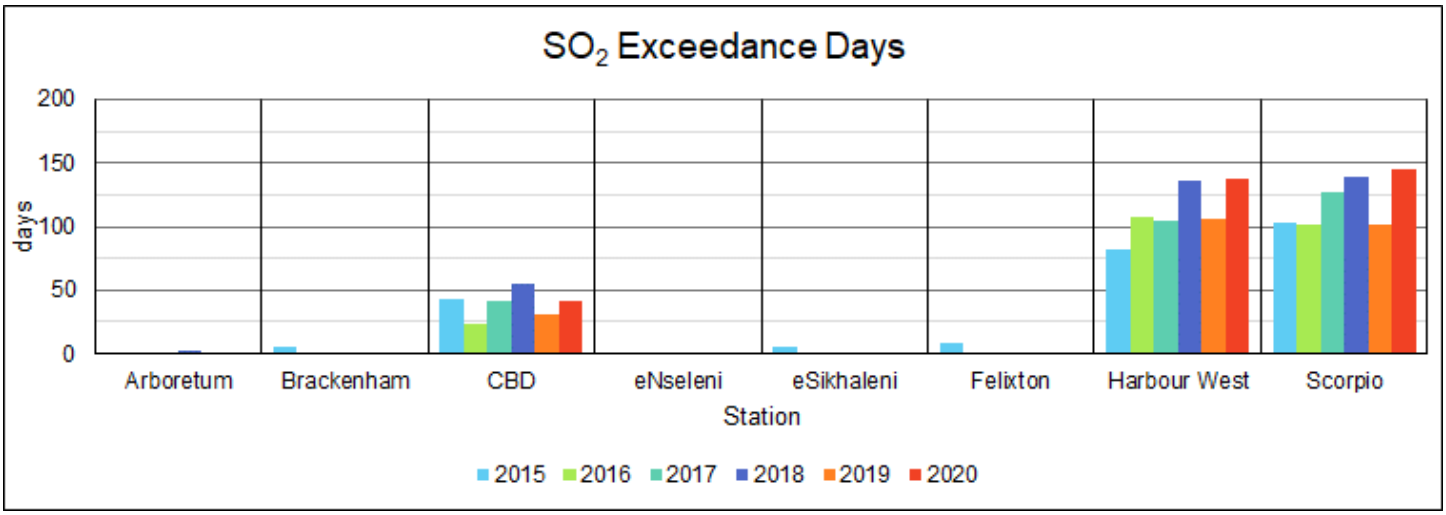


Figure 31: SO_2 exceedance days 2015 - 2020

A summary of the SO_2 exceedances for the last three years per station is presented in Table 7. See Appendix F for the SO_2 exceedance log.

Table 7: SO_2 exceedance summary.

Standard / Guideline / Target	Station	2018	2019	2020
NEMA & WHO 10-minute Standard / Target (191 ppb)	Arboretum	0	0	0
	Brackenham	0	0	0
	CBD	0	0	4
	eNseleni	0	0	No Monitoring
	eSikhaleni	0	0	0
	Felixton	0	0	0
	Harbour West	46	1	17
	Scorpio	45	13	254
NEMA Hourly Standard (134 ppb)	Arboretum	0	0	0
	Brackenham	0	0	0
	CBD	0	0	1
	eNseleni	0	0	No Monitoring
	eSikhaleni	0	0	0
	Felixton	0	0	0
	Harbour West	22	0	5
	Scorpio	12	5	67
NEMA & WHO Daily Standard / Interim Target 1 (48 ppb)	Arboretum	0	0	0
	Brackenham	0	0	0
	CBD	0	0	0
	eNseleni	0	0	No Monitoring
	eSikhaleni	0	0	0
	Felixton	0	0	0
	Harbour West	4	0	1
	Scorpio	1	1	7
WHO Daily Interim Target 2 (19 ppb)	Arboretum	0	0	0
	Brackenham	0	0	0
	CBD	2	2	2
	eNseleni	0	0	No Monitoring
	eSikhaleni	0	0	0
	Felixton	0	0	0
	Harbour West	40	3	28
	Scorpio	38	1	43

Standard / Guideline / Target	Station	2018	2019	2020
WHO Daily Guideline (8 ppb)	Arboretum	3	0	0
	Brackenham	0	0	0
	CBD	55	31	41
	eNseleni	0	0	No Monitoring
	eSikhaleni	0	0	0
	Felixton	0	0	0
	Harbour West	136	105	138
	Scorpio	139	100	142
NEMA Annual Standard (19 ppb)	All SO_2 stations	None Measured	None Measured	None Measured

5.9. SO_2 Data Capture

The percentage of valid data received from the SO_2 analysers for 2020 is shown in Table 8.

Table 8: SO_2 data capture.

Station	Station Availability (%)	SO_2 (%)
Arboretum	97	***81***
Brackenham	***91***	***82***
CBD	99	96
eNseleni	***92***	***12***
eSikhaleni	***94***	***66***
Felixton	99	96
Harbour West	100	99
Scorpio	96	96

Notes:

- *Red - Not acceptable for statistical purposes (<80%)*
- *Orange – Does not meet SANAS data capture requirements (<90%)*
- *Yellow – RBCAA reporting requirement (<=95%)*

Missing Data:

Arboretum (SO_2)

- *February - load shedding, data invalidated 7%*
- *March - unstable analyser data invalidated 70%*
- *July -circuit trip, load shedding, data invalidation 58%*

Brackenham (SO_2)

- *January - load shedding, analyser not responding after load shedding 57%*
- *February – load shedding, analyser not responding 37%*
- *March – unstable analyser data invalidated 76%*
- *November - station shutdown because of AC theft, power outages 79%*

eNseleni

- *Analyser decommissioned at eNseleni in February and moved to Scorpio*

eSikhaleni (SO_2)

- *February to May - analyser faulty, sent for repair*

5.10. SO_2 Dispersion Simulations

According to national standards and international guidelines, a summary of the predicted SO2 impacts at various locations is presented in Table 11; the table is colour code according to the Air Quality Index (AQI) shown in Table 9 and Table 10. The colour scale ranges from blue (indicating a low concentration relative to the standard/guideline), to red (indicating an exceedance of the standard/guideline).

Table 9: Air quality index (percentage of NEMA SO_2 limit value).

Air Quality Rating	Percentage of SO_2 limit value	Impact
Good	0% - 25%	There are no known harmful effects to soil, water, vegetation, animals, visibility, or human health.
Fair	26% - 50%	There is adequate protection against harmful effects on; soil, water, vegetation, animals, visibility, or human health.
Poor	51% - 100%	Not all aspects of the environment are adequately protected from adverse effects. Some long-term control action may be required depending on the measurement's frequency, duration, and circumstances.
Very Poor	>100%	Further deterioration of air quality and continued high readings could pose a risk to public health in this range.

Table 10: WHO

Air Quality Rating	Percentage of WHO SO_2 limit value
Good	0% - 25%
Fair	26% - 50%
Poor	51% - 100%
Very Poor	>100%

Table 11: SO_2 Prediction Summary.

	Percentage of Standard / Guideline					Frequency of exceeding Standard / Guideline				
Organisation	**NEMA/ WHO**	**NEMA**	**NEMA**	**NEMA**	**WHO**	**NEMA/WHO**	**NEMA**	**NEMA**	**NEMA**	**WHO**
Interval	**10-minute**	**Hourly**	**Daily**	**Annual**	**Daily**	**10-minute**	**Hourly**	**Daily**	**Annual**	**Daily**
Limit Value	**191**	**134**	**48**	**19**	**8**	**None**	**None**	**None**	**None**	**None**
Alton	20%	28%	30%	10%	**180%**	1	0	0	0	21
Aquadene	16%	20%	30%	10%	**182%**	0	0	0	0	13
Arboretum	14%	18%	20%	7%	**118%**	0	0	0	0	11
Arboretum Extension	15%	21%	20%	7%	**117%**	0	0	0	0	8
Birdswood	19%	25%	20%	14%	**123%**	0	0	0	0	24
Brackenham	12%	17%	20%	8%	**123%**	0	0	0	0	10
CBD	17%	23%	27%	12%	**160%**	0	0	0	0	30
Empangeni	18%	24%	26%	12%	**155%**	0	0	0	0	32
eSikhaleni	10%	14%	15%	4%	91%	0	0	0	0	2
Felixton	8%	10%	11%	6%	64%	0	0	0	0	0
Greenhill	7%	10%	13%	3%	79%	0	0	0	0	2
Mandlazini Agri-Village	15%	20%	17%	7%	100%	0	0	0	0	5
Meerensee	14%	19%	18%	10%	**107%**	1	0	0	0	6
Mzingazi Agri-Village	7%	10%	10%	3%	60%	2	0	0	0	1
Nseleni	20%	28%	43%	42%	**256%**	3	1	0	0	198
Southern Sanctuary	9%	12%	13%	5%	77%	0	0	0	0	0
Veldenvlei	7%	9%	11%	3%	69%	0	0	0	0	1
Vulindlela	16%	22%	20%	6%	**122%**	0	0	0	0	9
Wildenweide	6%	9%	10%	3%	59%	0	0	0	0	0
Bayside Aluminium	9%	11%	16%	5%	94%	0	0	0	0	3

	Percentage of Standard / Guideline					Frequency of exceeding Standard / Guideline				
Organisation	**NEMA/ WHO**	**NEMA**	**NEMA**	**NEMA**	**WHO**	**NEMA/WHO**	**NEMA**	**NEMA**	**NEMA**	**WHO**
Interval	**10-minute**	**Hourly**	**Daily**	**Annual**	**Daily**	**10-minute**	**Hourly**	**Daily**	**Annual**	**Daily**
Limit Value	**191**	**134**	**48**	**19**	**8**	**None**	**None**	**None**	**None**	**None**
Tronox	16%	22%	18%	7%	**109%**	0	0	0	0	6
Foskor	10%	13%	12%	5%	72%	0	0	0	0	0
Hillside Aluminium	15%	24%	22%	12%	**130%**	1	1	0	0	14
Mondi Richards Bay	13%	18%	16%	10%	98%	0	0	0	0	5
Port of Richards Bay	18%	25%	22%	11%	**131%**	0	0	0	0	21
Richards Bay Coal Terminal	14%	19%	22%	10%	**134%**	2	0	0	0	14
Richards Bay Minerals	8%	10%	9%	3%	54%	0	0	0	0	0
Richards Bay Alloys	17%	24%	32%	14%	**190%**	0	0	0	0	43

The following plots of SO_2 concentrations are provided:

- SO_2 10-minute Predicted Maxima (NEMA & WHO):
  - Regional (Figure 32)
  - Richards Bay (Figure 33)
- SO_2 Hourly Predicted Maxima (NEMA):
  - Regional (Figure 34)
  - Richards Bay (Figure 35)
- SO_2 Daily Predicted Maxima (NEMA):
  - Regional (Figure 36)
  - Richards Bay (Figure 37)
- SO_2 Daily Predicted Maxima (WHO):
  - Regional (Figure 38)
- SO2 Annual Average Prediction (NEMA):
  - Regional (Figure 39)
  - Richards Bay (Figure 40)
- SO_2 Annual Average Prediction (WHO):
  - Regional (Figure 41)
  - Richards Bay (Figure 42)

The plots are colour coded according to the Air Quality Index (AQI) in Table 9 and Table 10.

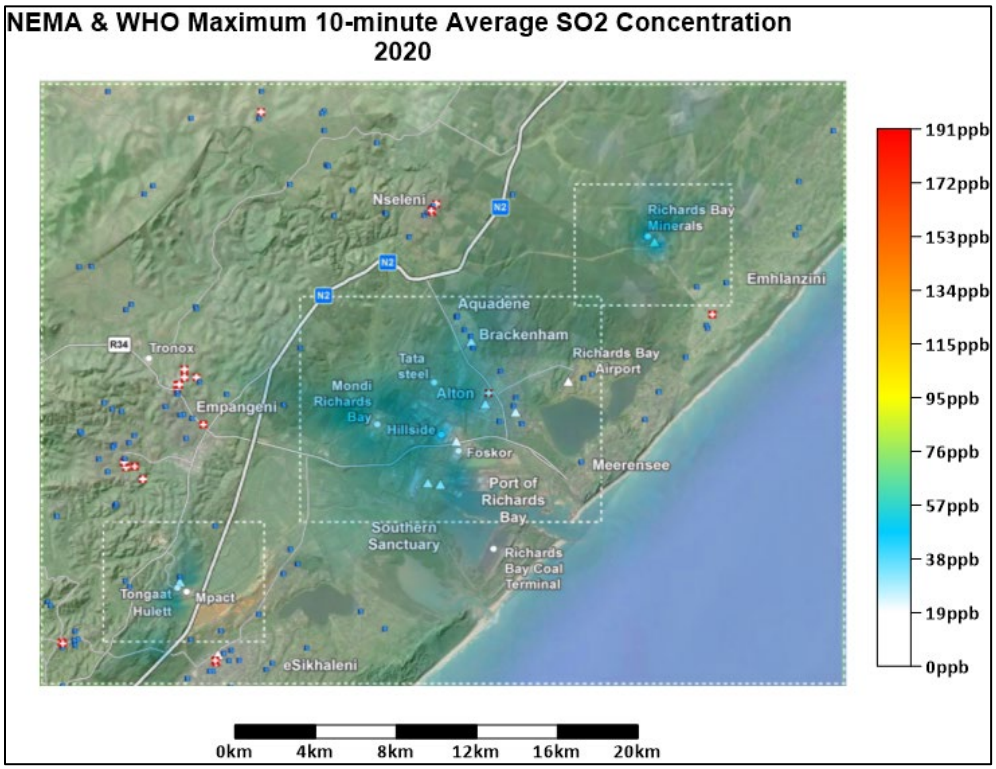


Figure 32: SO_2 maximum 10-minute average prediction (regional map).

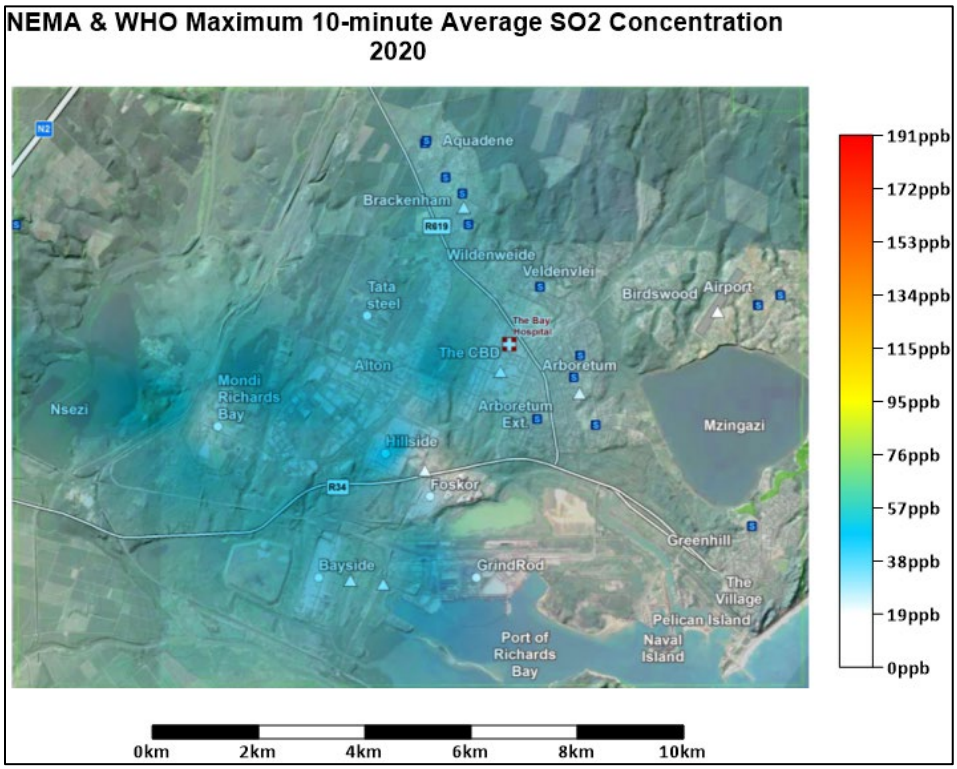


Figure 33: SO_2 maximum 10-minute average prediction (Richards Bay map).

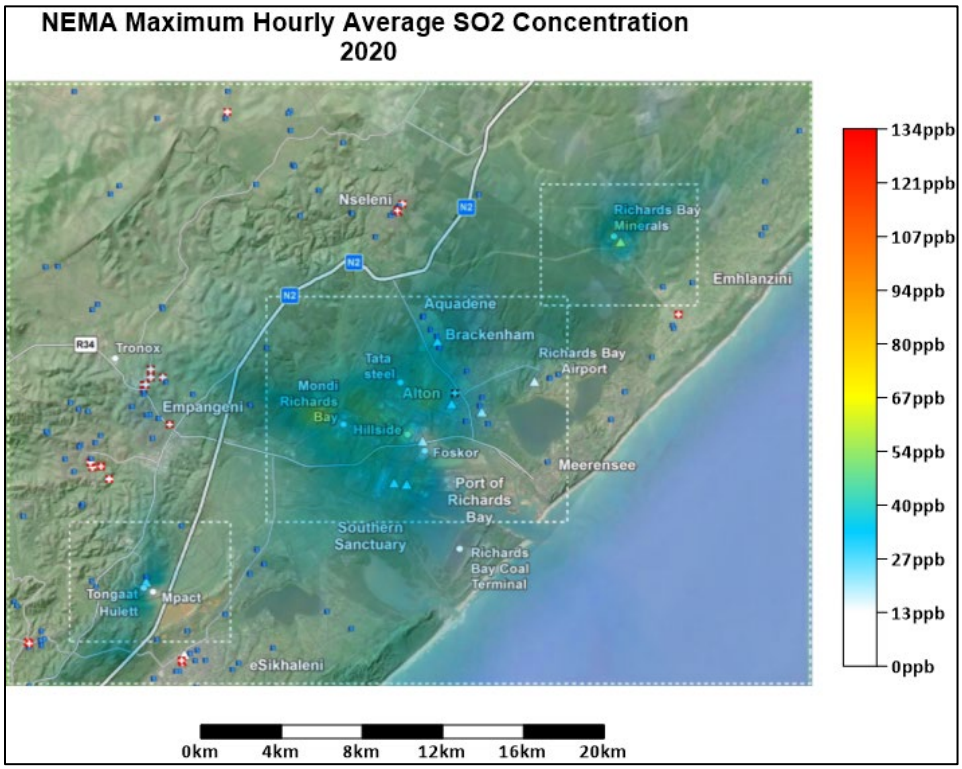


Figure 34: SO_2 maximum hourly average prediction (regional map).

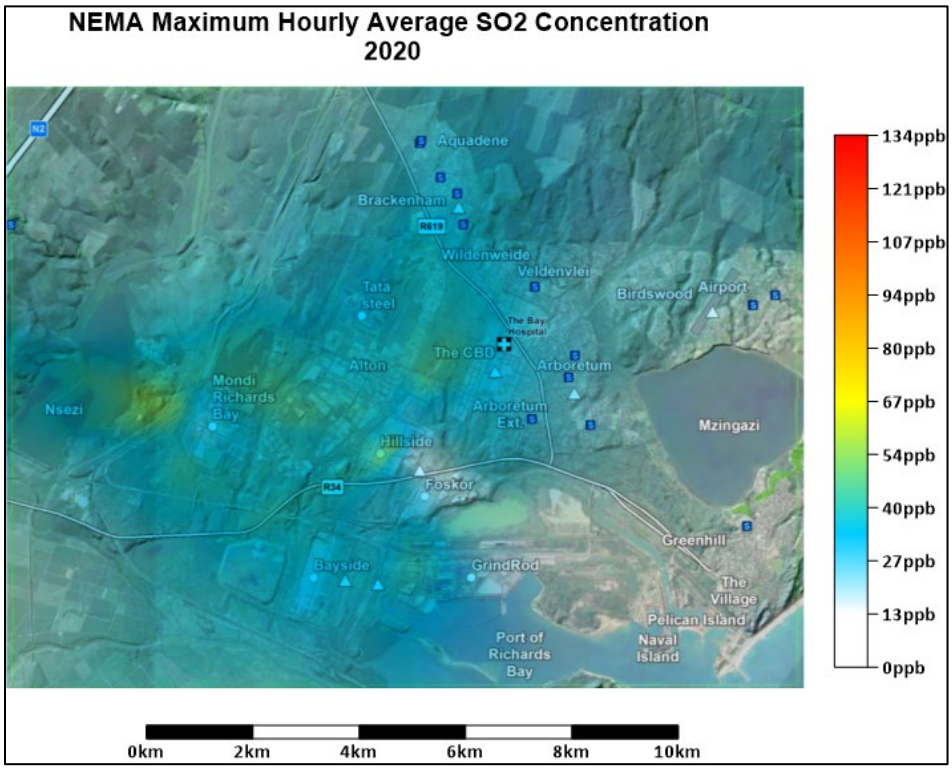


Figure 35: SO_2 maximum hourly average prediction (Richards Bay map).

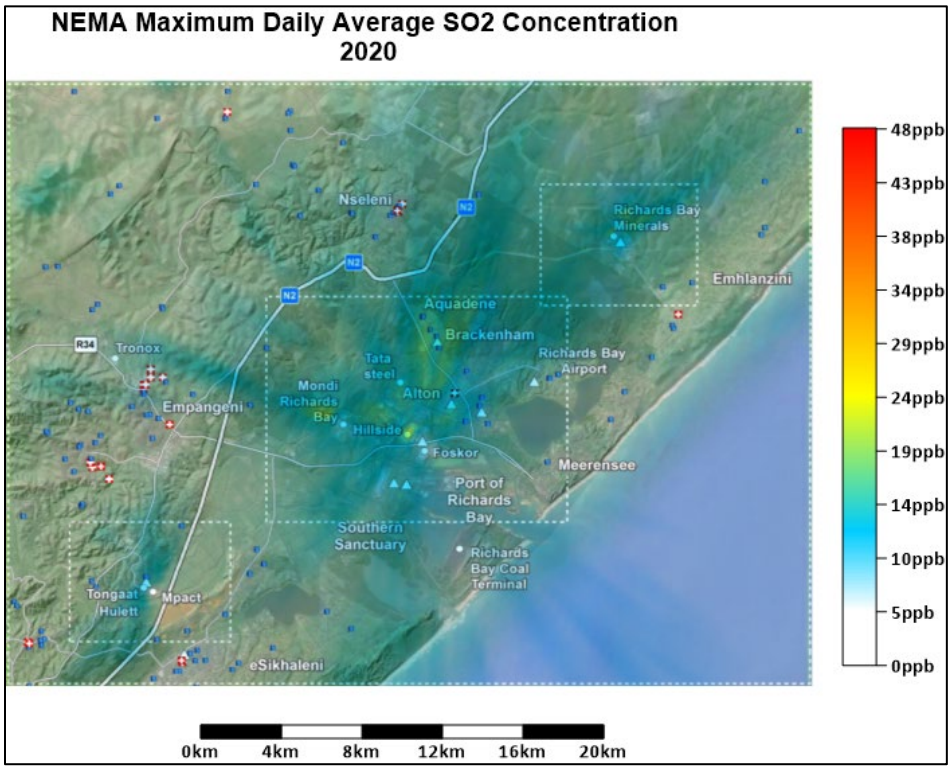


Figure 36: SO_2 maximum daily average prediction (regional map).

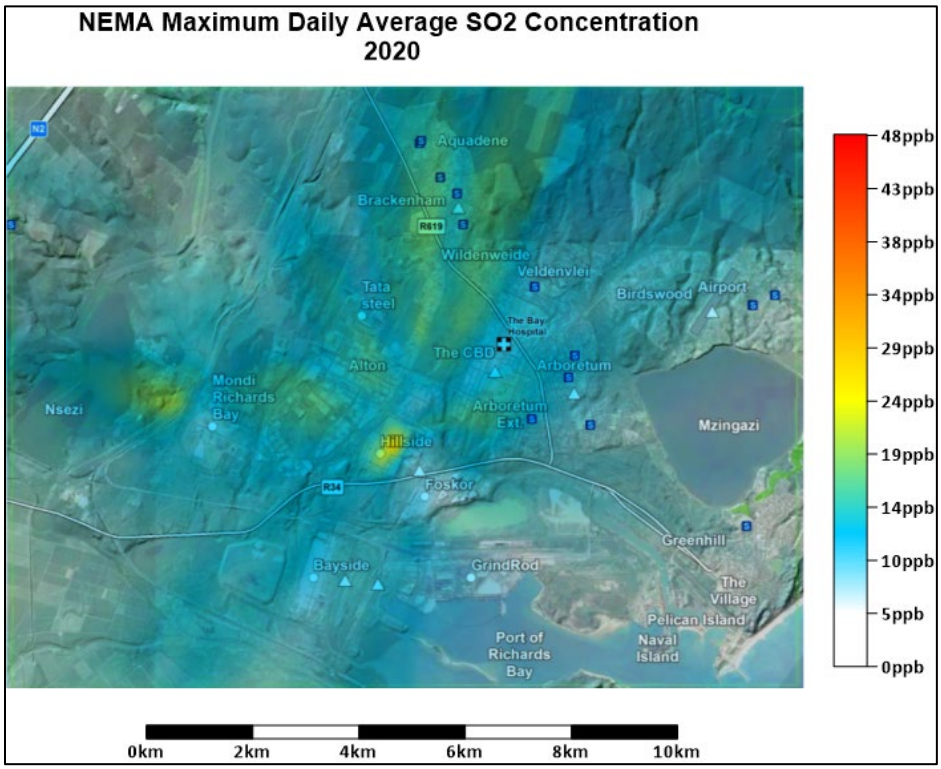


Figure 37: SO_2 maximum daily average prediction (Richards Bay map).

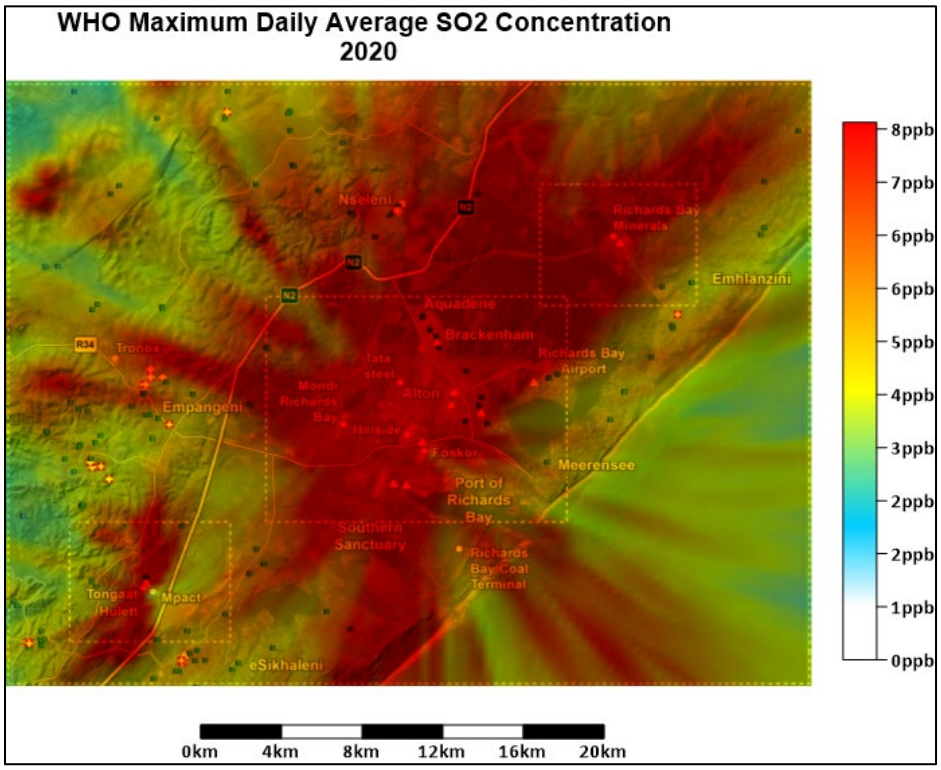


Figure 38: SO_2 maximum daily average prediction (regional map).

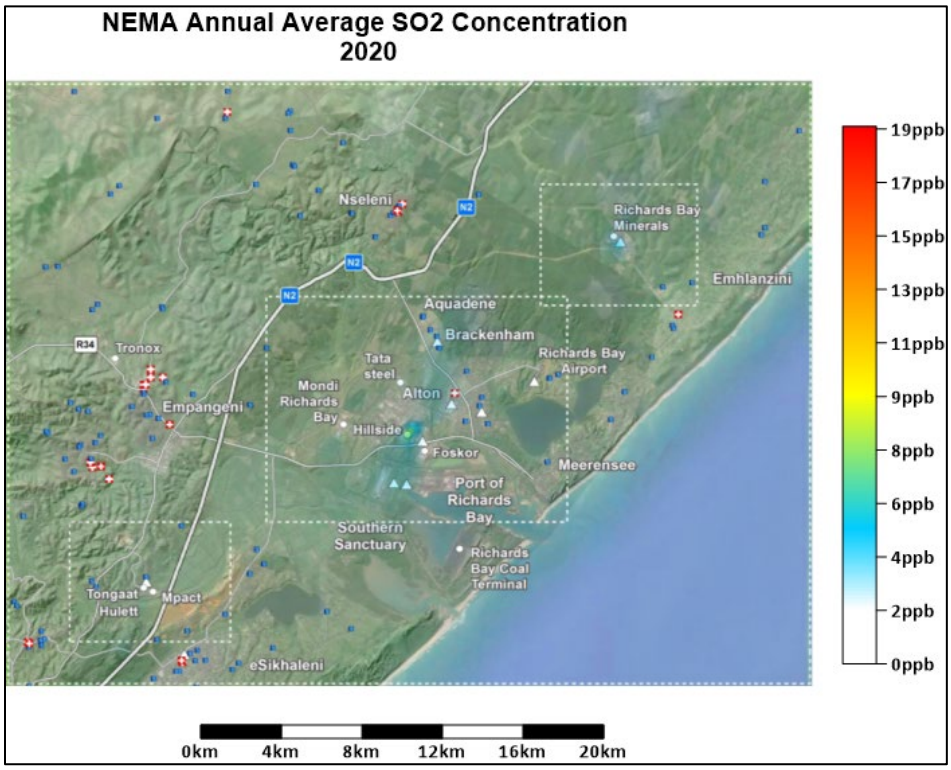


Figure 39: SO_2 annual average prediction (regional map).

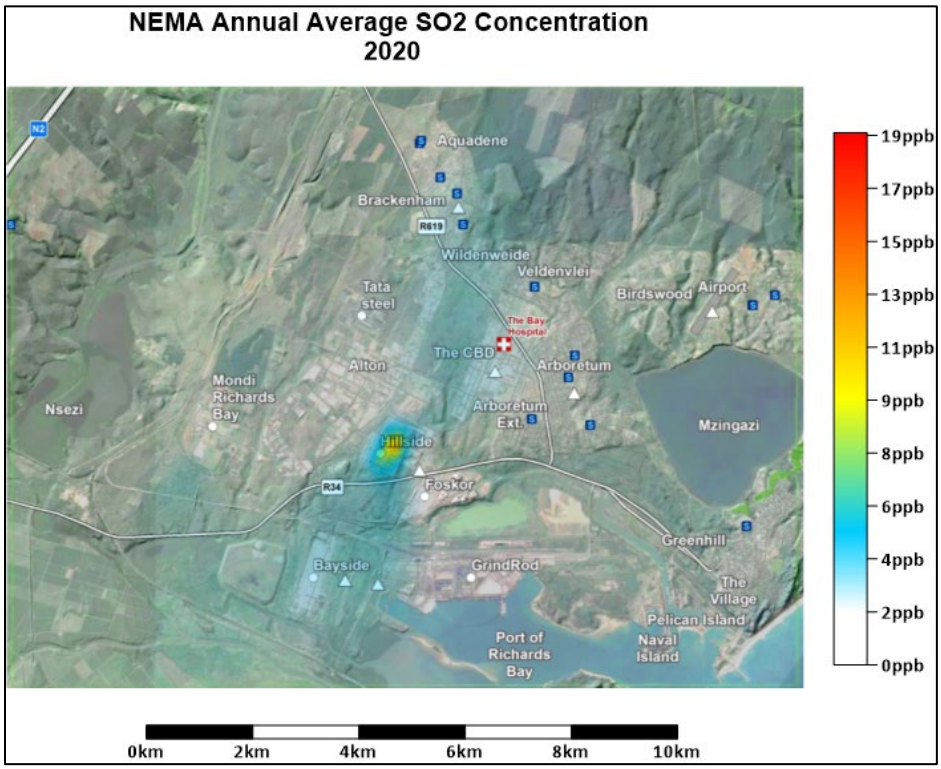


Figure 40: SO_2 annual average prediction (Richards Bay map).

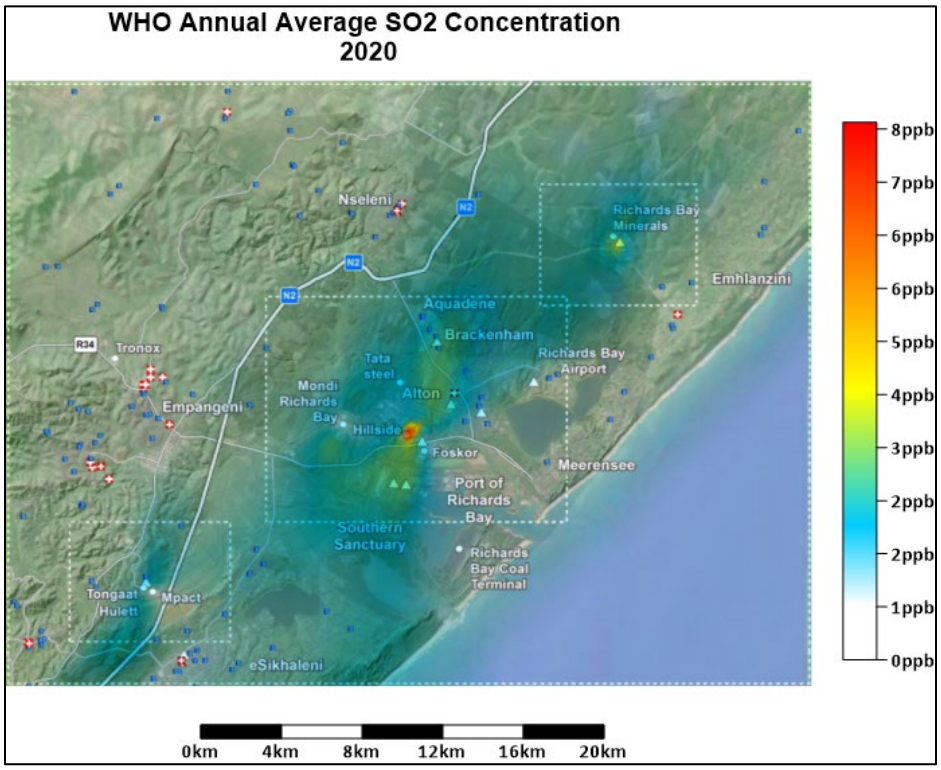


Figure 41: SO_2 annual average prediction (regional map).

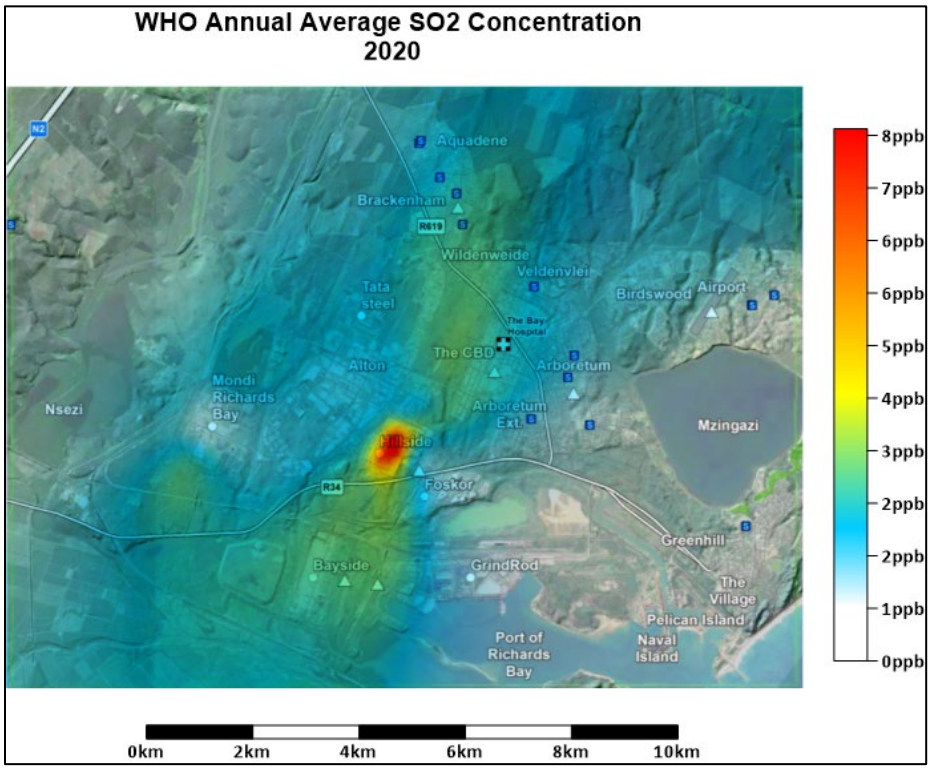


Figure 42: SO_2 annual average prediction (Richards Bay map).

5.11. SO_2 Model Correlation

The annual average SO_2 concentration measured at each RBCAA station and the CALPUFF predicted annual average is shown in Figure 43. The annual average for the same period the previous year is also provided. Compared to the previous year, the annual average SO_2 concentrations at all stations except Scorpio were similar (within 10% of the NEMA annual standard). Most stations' annual average predicted values were within accepted dispersion modelling norms (-50% to 200%). However, CBD, Harbour West, and Scorpio were under-predicted. The cause of the under predictions at these stations is most likely due to a combination of local fugitive emissions unaccounted for in the model and the model's tendency to underpredict in the near field. Compared to the measurements, predicted values at CBD, Harbour West, and Scorpio was lower, and at Arboretum, Brackenham, eNseleni, eSikhaleni and Felixton similar (within 10% of the standard).

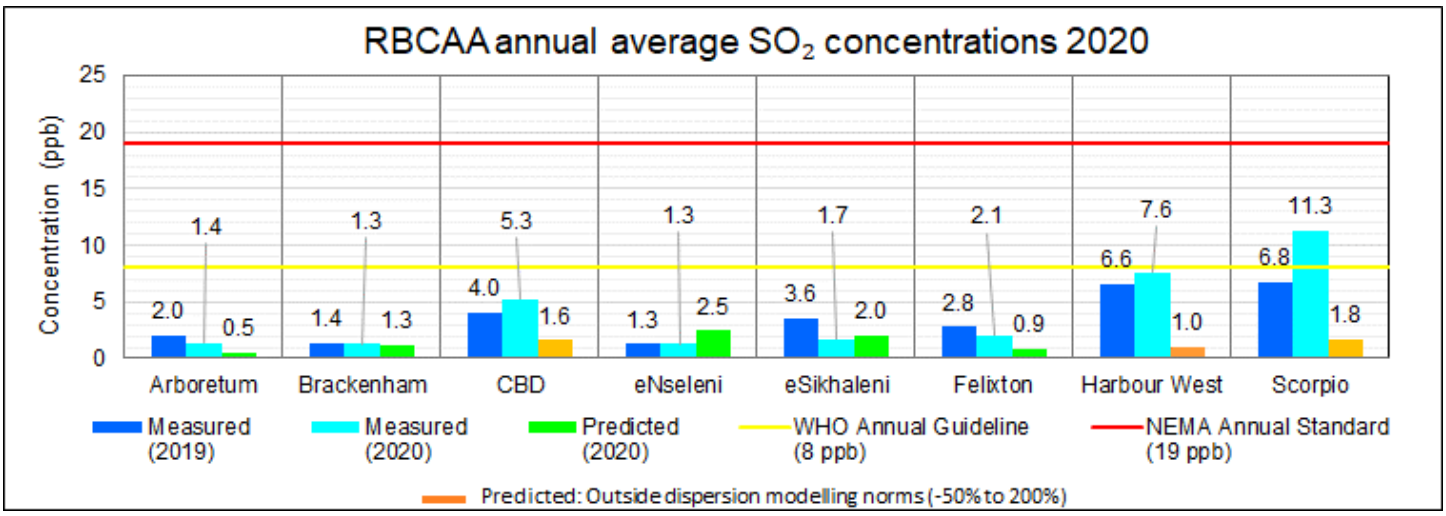


Figure 43: SO_2 annual average concentration and prediction.

6. TOTAL REDUCED SULPHUR MONITORING

Total reduced sulphur compounds (TRS), often associated with rotten egg or cooked cabbage odour, refer to a gaseous mixture of compounds consisting mainly of hydrogen sulphide (H_2S), methyl mercaptan (CH_3S-H), dimethyl sulphide (CH_3-S-CH_3) and dimethyl disulphide (CH_3-S-S-CH_3). While there are other ambient TRS compounds, these four are the most common, abundant, and generally referred to in TRS discussions. Once released into the atmosphere, oxidation products of TRS compounds, such as sulphuric acid, contribute to the environment's acidity.

The most often reported health concerns related to TRS substances are nausea and headaches, although each component has its characteristics and effects.

6.1. TRS Ambient Air Quality Standards

There are no South African standards for TRS.

The World Health Organization (WHO) recommends that to avoid substantial complaints about odour annoyance among the exposed population, hydrogen sulphide concentrations should not be allowed to exceed 7 µg/m^3 (5 ppb), with a 30-minute averaging period (WHO, 2000).

The Ontario Ministry for the Environment (OME) has derived the following standards for TRS for the Pulp and Paper sector (OME, 1999):

- A 24-hour average Ambient Air Quality Criterion (AAQC) of 14 µg/m^3 (10.1 ppb) for TRS, based on the adverse effects on the respiratory system (nasal lesions) of this mixture
- A 10-minute average AAQC of 13 µg/m^3 (9.3 ppb) for TRS, based on odour effects
- A 30-minute standard of 10 µg/m^3 (7.2 ppb) for TRS; based on both odour and health effects of this mixture

For all other sectors (including sectors such as Iron & Steel; Petroleum Refineries, Municipal Sewage Treatment Plants):

- A 24-hour average AAQC of 7 µg/m^3 (5.0 ppb) for TRS based on the adverse effects on the respiratory system of this mixture
- A 10-minute average AAQC of 13 µg/m^3 (9.3 ppb) for TRS based on odour effects
- A 30-minute standard of 10 µg/m^3 (7.2 ppb) for TRS; based on both odour and health effects of this mixture

The RBCAA has decided to implement the:

- WHO 30-minute H_2S Guideline
- OME daily and 10-minute standards for the Pulp and Paper sector
- RBCAA established a correlation between TRS concentrations exceeding 4.5 ppb and the number of complaints received; the RBCAA has therefore set this as its 10-minute target

6.2. TRS 10-minute Concentrations

There were:

- Two hundred and one (201) measured exceedances of the OME 10-minute TRS Standard (9.3 ppb)
- Seven hundred and forty-four (744) measured exceedances of the RBCAA 10-minute Target (4.5 ppb)

Most of the exceedances included contributions from Mondi (Figure 44).

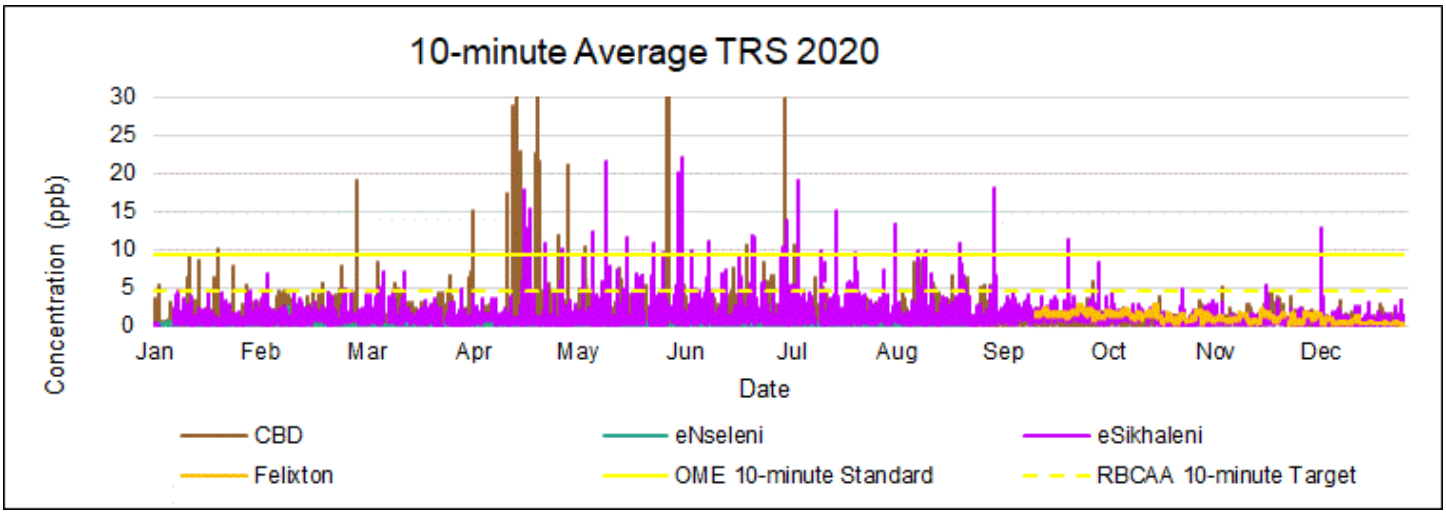


Figure 44: TRS 10-minute average concentrations.

6.3. TRS 30-minute Concentrations

There were; two hundred and seven measured (207) exceedances of the WHO 30-minute H_2S Guideline (5.0 ppb). Most of the exceedances included contributions from Mondi (Figure 45).

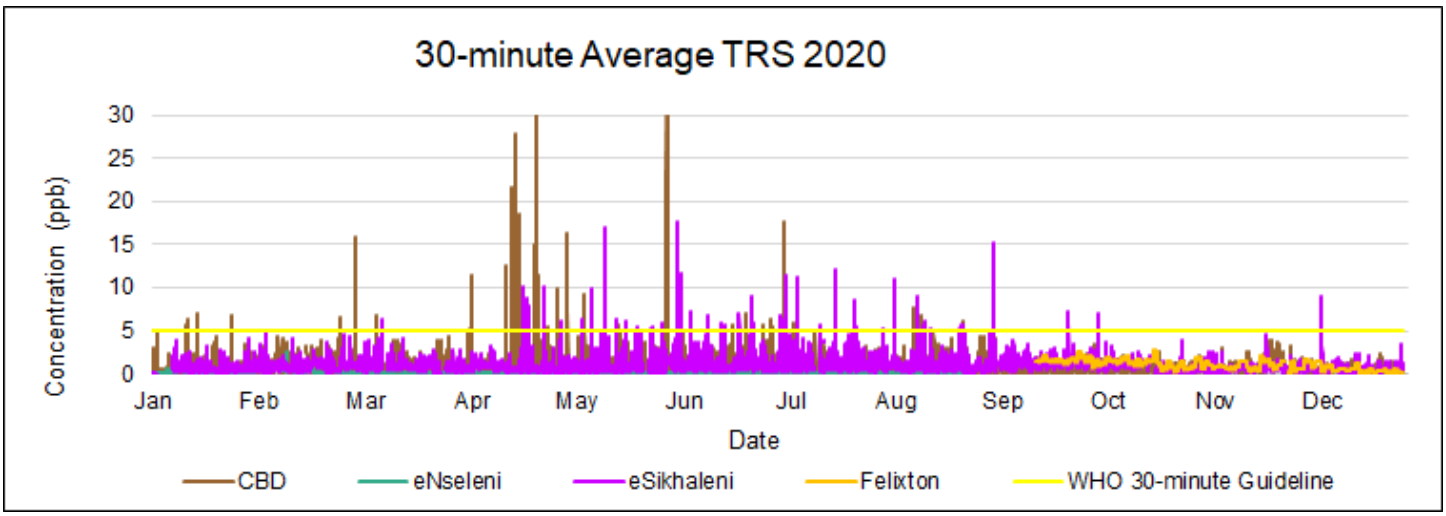


Figure 45: TRS 30-minute average concentration.

6.4. TRS Daily Concentrations

Daily average TRS concentrations at CBD are shown below (Figure 46). There were **no measured exceedances** of the OME daily TRS Standard (10.1 ppb).

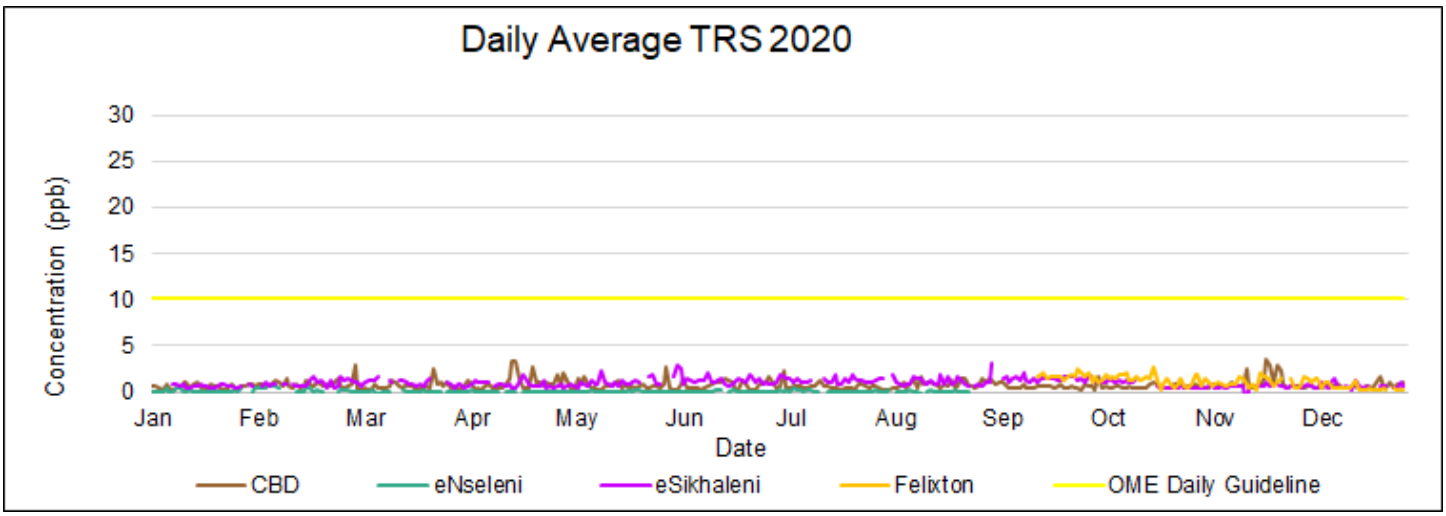


Figure 46: TRS daily average concentration.

6.5. TRS Diurnal Concentrations

The diurnal TRS concentrations did not vary much (Figure 47).

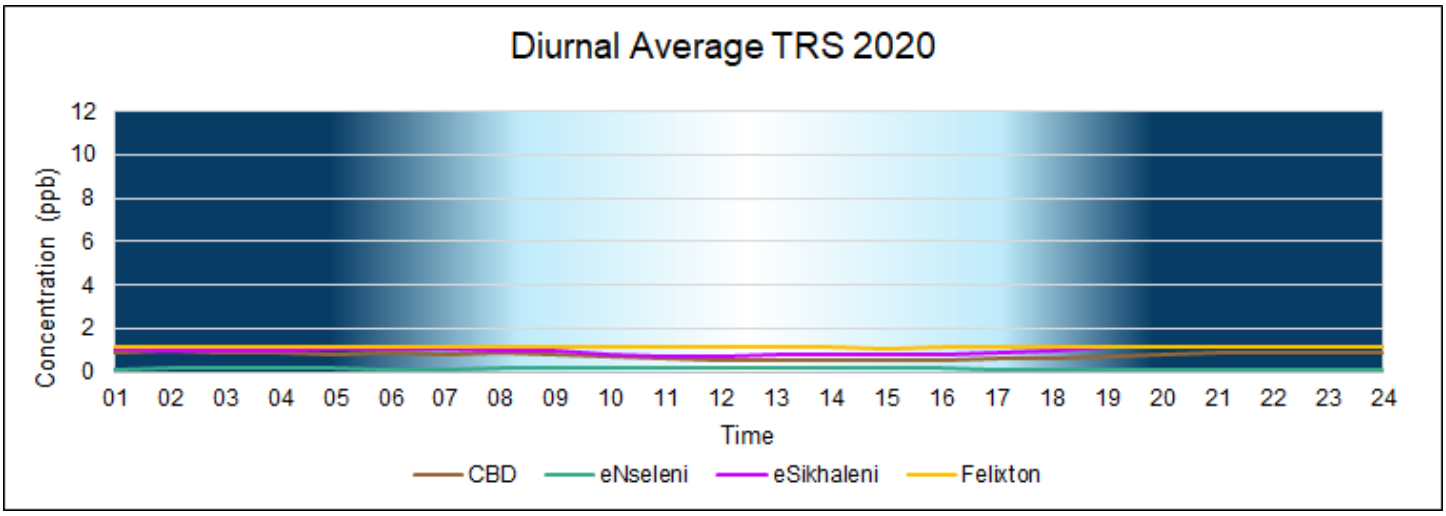


Figure 47: TRS diurnal concentrations.

6.6. TRS Monthly Concentrations

Monthly comparisons are provided in Figure 48.

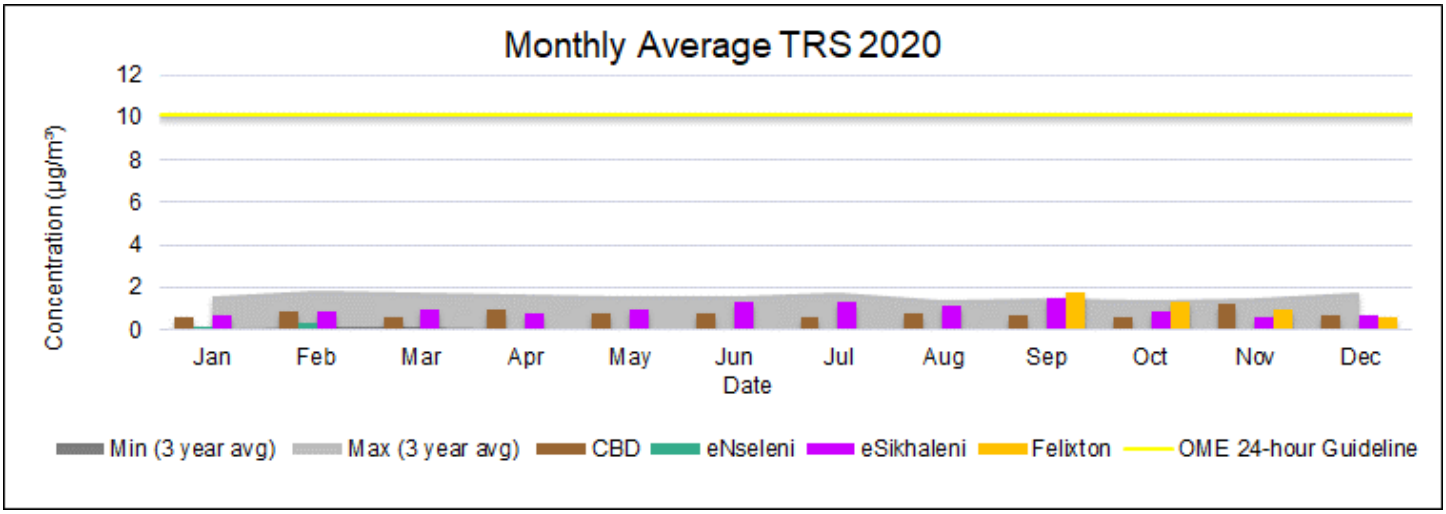


Figure 48: TRS monthly comparison.

6.7. TRS Annual Concentration

Monthly average TRS concentrations are shown in Figure 49.

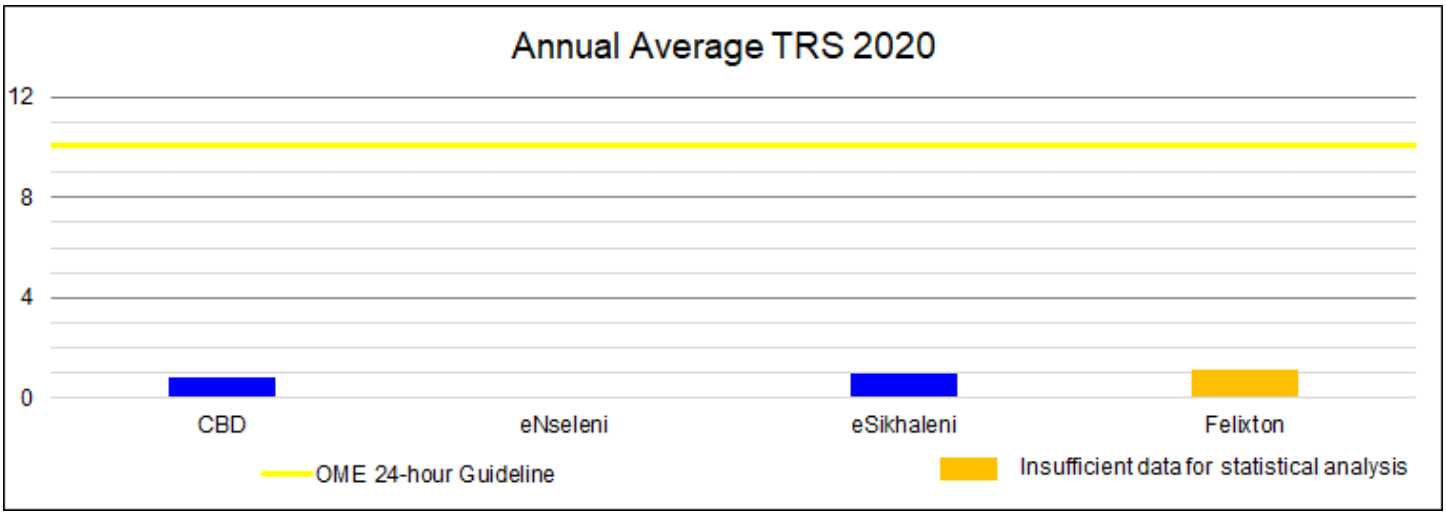


Figure 49: TRS annual concentrations.

Compared to 2018 and 20198, 2020 annual average TRS concentrations at all stations were similar (differed by less than 10% of the limit) (Figure 50).

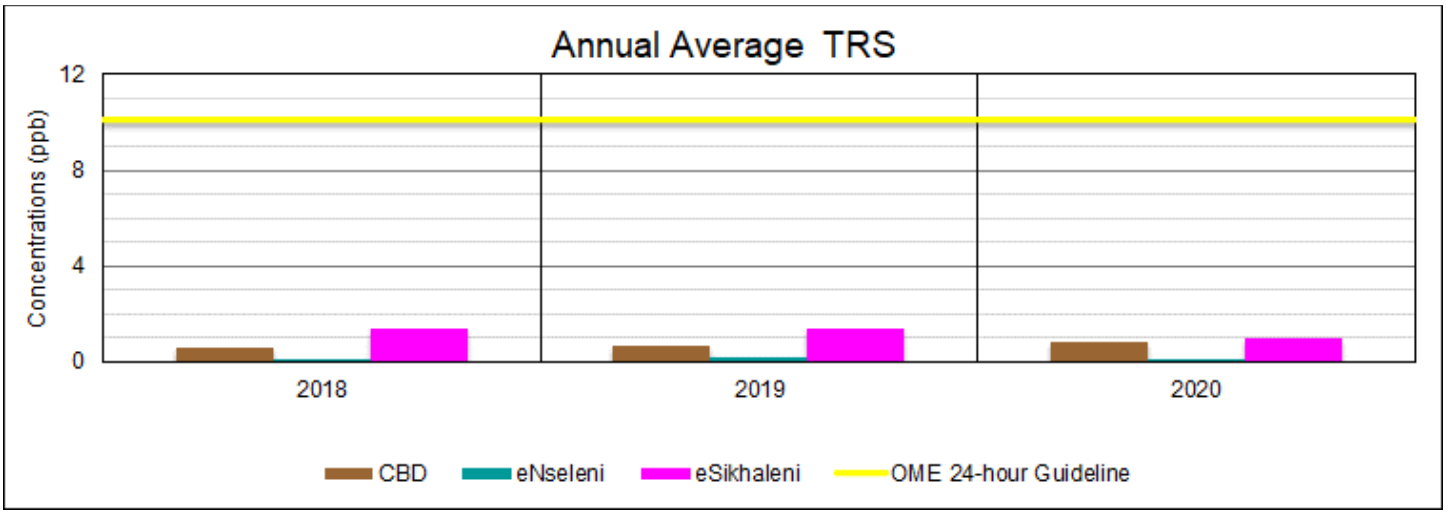


Figure 50: TRS annual average concentration 2018 - 2020

Annual average TRS concentrations are illustrated in Figure 51. There was a marked decrease in annual average TRS concentrations from 2008 to 2011; concentrations seem to have stabilised since then. In 2010 Mondi Richards Bay commissioned Phase 1 of their Odour Abatement Project; this involved installing carbon filters on all their odorous venting points. This phase would have resulted in a decrease in ambient TRS and does not explain the increase between 2010 and 2012 since Mondi continued with various smaller odour abatement projects, which should have resulted in a further decrease in TRS. It is possible that; weather conditions may have played a role. In 2012 Mondi Richards Bay commissioned Phase 2 of the Odour Abatement Project, which successfully reduced TRS emissions from their Chip Bin. However, during the winter of 2012, they experienced fugitive odour from their effluent plant due to a turpentine tube condenser taken out of service for repairs; the odour impact was unknown. This impact was addressed in 2012, and as a result, in 2013, TRS decreased. Ambient TRS increased again in 2014 due to mill power instability; 2015 to 2017 also proved to be difficult years with an increase in fugitive emissions from the effluent plant because of decreased water consumption.

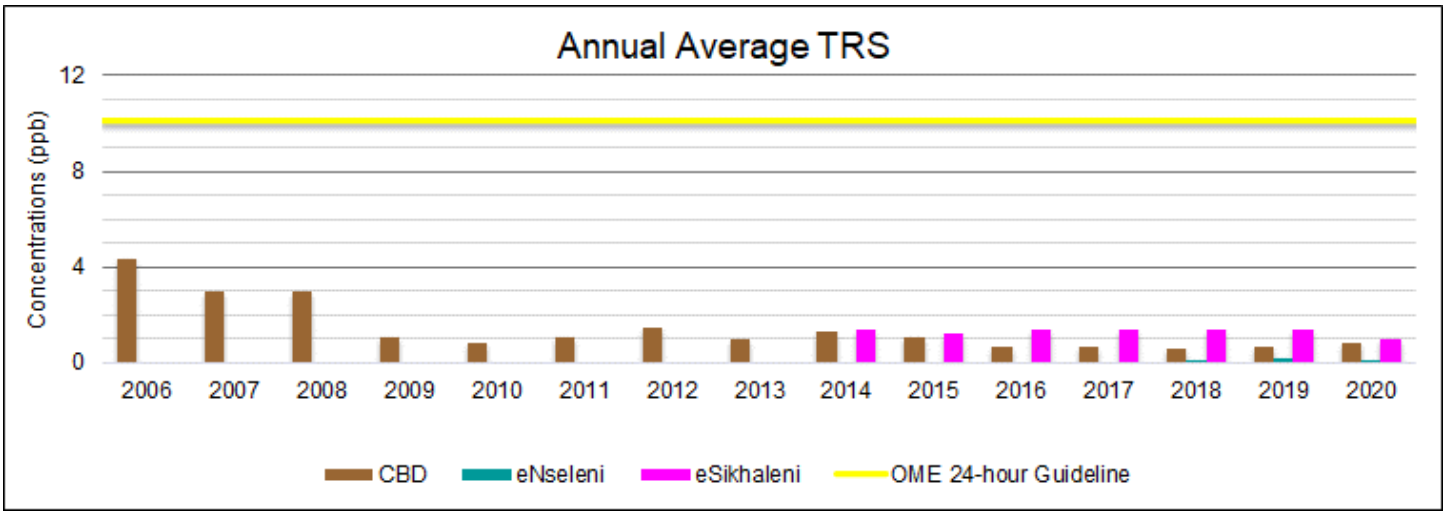


Figure 51: TRS annual average concentrations.

6.8. TRS Exceedances

TRS exceedances can be, associated with emissions because of process upsets (i.e., planned maintenance, plant shutdowns or start-up), leaks in equipment, pipelines, seals, valves (fugitive emissions) or an event (e.g. fires or emergency shutdowns). Most of the TRS exceedances recorded during 2020 were allocated to Mondi. The number of days on which exceedances occurred per month plus comparisons to the previous year are shown in Figure 52 and Figure 53. There were fewer TRS exceedance days during 2020. According to the relative Air Quality Index (AQI), the areas where no exceedances were measured may be considered good air quality with respect to TRS.

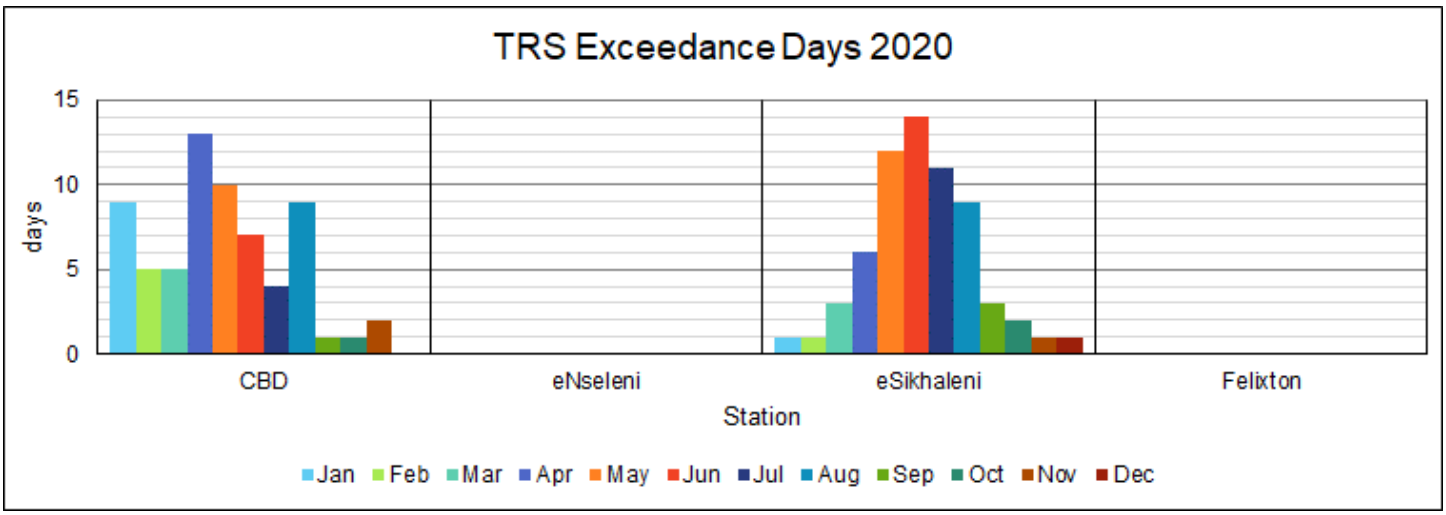


Figure 52: TRS exceedance days 2020.

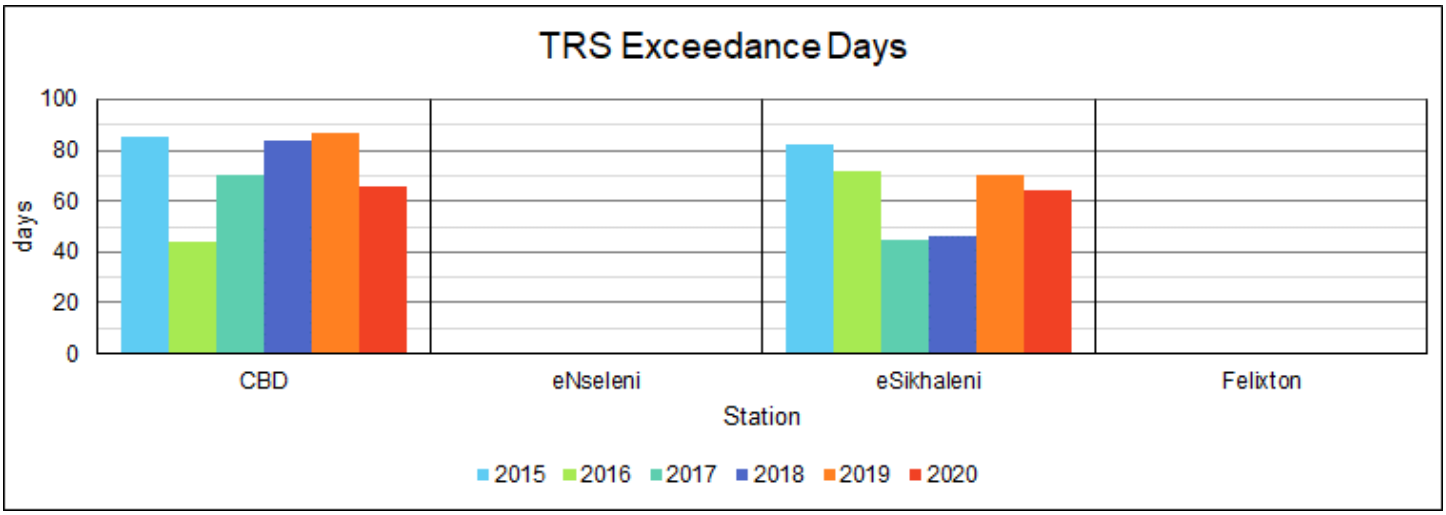


Figure 53: TRS exceedance days 2015 - 2020.

A summary of the TRS exceedances for the last three years per station is presented below (Table 12). See Appendix G for the TRS exceedance log.

Table 12: TRS exceedance summary.

Standard / Guideline / Target	Station	2018	2019	2020
OME 10-minute TRS Standard (9.3 ppb)	CBD	87	90	124
	eNseleni	No Monitoring	0	0
	eSikhaleni	46	144	77
RBCAA 10-minute Target (4.5 ppb)	CBD	450	489	403
	eNseleni	No Monitoring	0	0
	eSikhaleni	208	589	341
WHO 30-minute H_2S Guideline (5.0 ppb)	CBD	103	124	112
	eNseleni	No Monitoring	0	0
	eSikhaleni	50	151	95
OME Daily TRS Standard (10.0 ppb)	All TRS stations	None Measured	None Measured	None Measured

6.9. TRS Data Capture

The percentage of valid data received from the TRS analysers for 2020 is shown in Table 13.

Table 13: TRS data capture.

Station	Station Availability (%)	TRS (%)
CBD	99	99
eNseleni	***92***	***62***
eSikhaleni	***94***	***92***
Felixton	99	***29***
Notes: *Red - Not acceptable for statistical purposes (<80%)* *Orange – Does not meet SANAS data capture requirements (<90%)* *Yellow – RBCAA reporting requirement (<=95%)*		
Missing Data: *eNseleni & Felixton (TRS) - analyser decommissioned at eNseleni in September and moved to Felixton.*		

7. AIR QUALITY

Where possible, the RBCAA assesses data collected by its network against National Standards, International Guidelines, and Local Targets. The WHO air quality guidelines (AQGs) are intended for worldwide use but have been developed to support air quality actions that protect public health in different contexts. Air quality standards and local targets, on the other hand, are set by each country or region to protect the public health of their citizens and, as such, are an important component of national risk management and environmental policies. National standards and local targets vary according to the approach adopted for balancing health risks, technological feasibility, economic considerations, and various other political and social factors. These factors, in turn, depend on, among other things, the level of development and national capability in air quality management (WHO, 2005).

The determination of air quality with respect to pollutants measured and impacts simulated is based on comparison to and exceedances of; short term (10-minute, 30-minute, 1-hour and 24-hour averages) and long term (monthly and annual averages) targets, guidelines, and standards.

AIMS concludes that during 2020 based on:

- Short term averages, air quality, was compromised by:
  - PM_{10} at Brackenham, eNseleni, eSikhaleni and Felixton
  - SO_2 at CBD, Harbour West, and Scorpio
  - TRS at CBD and eSikhaleni
- Long term averages ambient air quality concentration measurements and comparison to the WHO Health Standard, of concern, is:
  - PM_{10} at Brackenham, eNseleni, eSikhaleni and Felixton

7.1. Comparison to the previous year

In comparison to 2019 for:

- PM_{10}
  - Short term averages, there were fewer exceedances
  - Long term averages, concentrations at eNseleni, eSikhaleni and Felixton were similar (differed by 10% or less of the limit), values measured at Brackenham, and CBD were less
- SO_2
  - Short term averages, there were more exceedances; this is particularly noticeable at Harbour West and Scorpio
  - Long term averages, concentrations at most stations were similar (differed by 10% or less of the limit) except for Scorpio, which showed an increase
- TRS
  - Short term averages, there were fewer exceedances
  - Long-term averages concentrations at all stations were similar (differed by less than 10% of the limit)

8. ACKNOWLEDGEMENT

This report was compiled by Air Impact Measurement Specialists for the Richards Bay Clean Air Association; contributors include:

- Lance Coetzee
- Alicia Garnica
- François Nel

Lance Coetzee
Director

9. REFERENCES

ASTM. (2010). *Designation: D1739 – 98 (Reapproved 2010) Standard Test Method for Collection and Measurement of Dust Fall (Settleable Particulate Matter).* American Society for Testing and Materials.

ASTM. (2017). *Designation: D1739 – 98 (Reapproved 2017) Standard Test Method for Collection and Measurement of Dust Fall (Settleable Particulate Matter).* American Society for Testing and Materials.

EC. (2015). *Air Quality Standards*. Retrieved from European Commission: Environment: http://ec.europa.eu/environment/air/quality/standards.htm

IFC. (2007). *Environmental, Health, and Safety Guidelines, General EHS Guidelines: Environmental Air Emissions and Ambient Air Quality.* World Bank Group, International Finance Corporation.

OME. (1999). *The Rationale for the Development of Ontario Air Standards for Total Reduced Sulphur (TRS) & Compounds: hydrogen sulphide (H2S), mercaptans (as methyl mercaptan), dimethyl sulphide (DMS), and dimethyl disulphide (DMDS).* Retrieved from Ontario Ministry of the Environment: http://www.ebr.gov.on.ca

RSA-NEMAQA. (2004). *National Environmental Management: Air Quality Act 39 of 2004.* Republic of South Africa, National Environmental Management: Air Quality Act 39 of 2004.

RSA-NEMAQA. (2009). *National Ambient Air Quality Standards.* Republic of South Africa, National Environmental Management: Air Quality Act 39 of 2004, Government Gazette no, 32816, 24 December 2009.

RSA-NEMAQA. (2012). *List of activities which results in atmospheric emissions which have or may have a significant detrimental effect on the environment, including human health, social conditions, economic conditions, ecological conditions, or cultural heritage.* Republic of South Africa, National Environmental Management: Air Quality Act 39 of 2004, Government Gazette no, 35894, November 2012.

RSA-NEMAQA. (2012). *National Ambient Air Quality Standard for Particulate Matter with Aerodynamic Diameter Less Than 2.5 Micron Metres (PM2.5).* Republic of South Africa, National Environmental Management: Air Quality Act 39 of 2004.

RSA-NEMAQA. (2013). *Declaration of a small boiler as a controlled emitter and establishment of emission standards.* Republic of South Africa, National Environmental Management: Air Quality Act 39 of 2004, Government Gazette no, 36973, November 2013.

RSA-NEMAQA. (2013). *National dust control regulations.* Republic of South Africa, National Environmental Management: Air Quality Act 39 of 2004, Government Gazette no, 36974, November 2013.

RSA-NEMAQA. (2015). *Amendments to the list of activities which results in atmospheric emissions which have or may have a significant detrimental effect on the environment, including human health, social, economic, ecological conditions or cultural heritage.* Republic of South Africa, National Environmental Management: Air Quality Act 39 of 2004, Government Gazette no, 38863, June 2015.

US-EPA. (1995). *Compilation of Air Pollutant Emission Factors, AP-42, Fifth Edition Volume 1.* Research Triangle Park, North Carolina: United States Environmental Protection Agency.

US-EPA. (2000). *Emission Factor Documentation for Ap-42 Section 3.2, Natural Gas-Fired Reciprocating Engines.*

WHO. (2000). *Air Quality Guidelines for Europe, Second Edition.* World Health Organisation.

WHO. (2005). *WHO Air Quality Guidelines for Particulate Matter, Ozone, Nitrogen Dioxide and Sulphur Dioxide, Global update 2005, Summary of Risk Assessment.* World Health Organisation.

WHO. (2015). *WHO Air Quality Guidelines for Particulate Matter, Ozone, Nitrogen Dioxide and Sulphur Dioxide, Global update 2005, Summary of Risk Assessment.* World Health Organisation.