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DEPARTMENT OF FORESTRY, FISHERIES AND THE ENVIRONMENT

NO. R. 6040 **26 March 2025**

NATIONAL ENVIRONMENTAL MANAGEMENT: AIR QUALITY ACT, 2004
(ACT NO. 39 OF 2004)

SECOND-GENERATION HIGHVELD PRIORITY AREA AIR QUALITY MANAGEMENT PLAN

I, Dion Travers George, Minister of Forestry, Fisheries and the Environment, hereby under section 19(5), read with Regulations promulgated in terms of section 20 of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004), publish the second-generation Highveld Priority Area Air Quality Management Plan for implementation as set out in the Schedule hereto.

DR DION TRAVERS GEORGE
MINISTER OF FORESTRY, FISHERIES AND THE ENVIRONMENT

SCHEDULE

SECOND-GENERATION HIGHVELD PRIORITY AREA AIR QUALITY MANAGEMENT PLAN

forestry, fisheries & the environment

Department: Forestry, Fisheries and the Environment
REPUBLIC OF SOUTH AFRICA

2030 NDP

EXECUTIVE SUMMARY

On 23 November 2007, the Highveld Priority Area (HPA) was declared in terms of section 18(1)(a) and (b) of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) (NEMAQA) (see Figure E-1). The declaration was triggered by air quality in the area that has consistently exceeded National Ambient Air Quality Standards. The HPA is also considered one of the major oxides of nitrogen (NO_x) hotspots in the world (Wenig, 2003; Lourens, 2012) and it was previously estimated that over 80% of sulphur dioxide (SO_2) and NO_x emissions in South Africa are from the Mpumalanga Province (Wells, 1996; NAEIS).

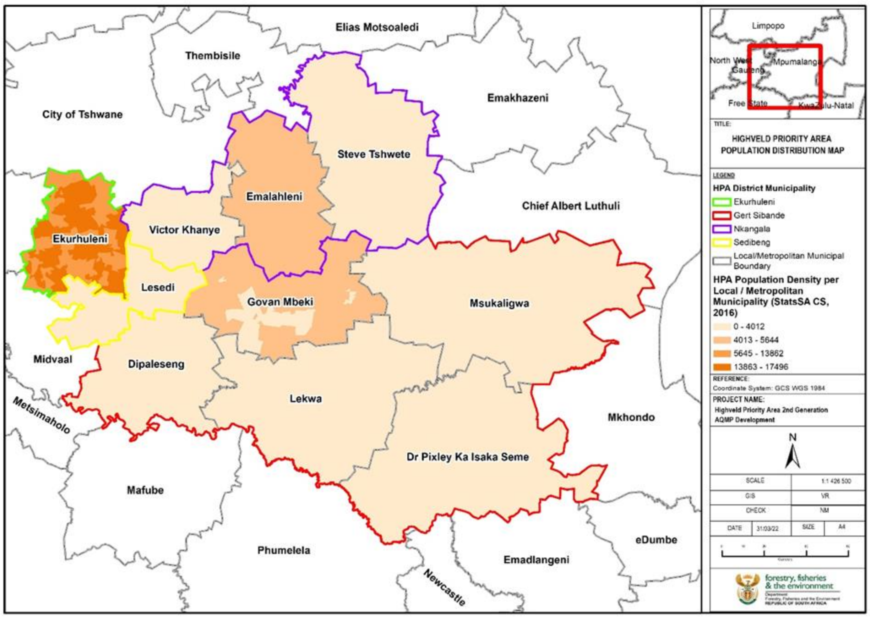

Figure E-1: Locality map depicting the geographical extent of the Highveld Priority Area.

FIRST GENERATION HIGHVELD PRIORITY AREA AIR QUALITY MANAGEMENT PLAN

SUMMARY OF FIRST GENERATION HPA AQMP

Following the declaration of the priority area, a first-generation Air Quality Management Plan (AQMP) was developed in 2012 in terms of section 19(5) of NEMAQA. The first-generation AQMP was developed to provide a strategic direction for the implementation of air quality interventions in the HPA, as well as an essential blueprint for action to reduce emissions in the area. The AQMP described the state of air quality in a priority area, sources of air pollution in the priority area, how air quality has been changing over the years, and what could be done to ensure improved air quality in a priority area. It provided the goals and objectives for a priority area and prescribes short- to long-term policies and controls to improve air quality in a priority area.

Air quality monitoring trends from the first-generation HPA AQMP indicated elevated concentrations of particulate matter (PM_{10}), NO_x and SO_2 occurring in the central and northern parts of the HPA. A comprehensive emission inventory was developed for the HPA, and included industry; residential fuel burning, mines and quarries, transport (motor vehicle emissions), biomass burning and, burning and smouldering coal dumps (spontaneous combustion) emissions. Industrial sources were the largest contributor of emissions in the HPA, accounting for 89% of PM_{10}, 90% of NOx and 99% of SO_2. Dispersion modelling was used to determine regions of concern for ambient air quality in the HPA at a regional scale. Nine hotspot areas in the HPA where ambient air quality standards for SO_2, NO_2, PM_{10} and O_3 are consistently exceeded were identified based on the modelling results. These hotspot areas included eMalahleni, Kriel, Steve Tshwete, Ermelo, Secunda, Ekurhuleni, Lekwa, Balfour and Delmas, resulting from emissions emanating from industries, residential fuel burning, vehicle, mining, and cross-boundary transport of pollutants into the HPA.

The first-generation HPA AQMP presented health risk estimates derived from historic literature that were directly relevant to the HPA based on 2002 data for two major areas, namely the Mpumalanga Highveld, and Johannesburg and the City of Ekurhuleni. Although the literature was rather dated at the time, the City of Ekurhuleni extended to a far greater population than considered in the extent of the Highveld Priority Area, which is still the case today. The key findings from the health risk assessments included proxies for respiratory hospital admissions from residential coal burning, wood burning, power generation as well as ambient concentrations in Johannesburg, the City of Ekurhuleni and Mpumalanga province. The study also highlighted that hospital admissions with respiratory conditions were estimated to be significantly higher in the Johannesburg and City of Ekurhuleni conurbation (more than 34 000 cases) when compared to admissions in the Mpumalanga Highveld as a whole (more than 8 600 cases).

An air quality management capacity assessment was undertaken as part of the first-generation HPA AQMP development process. Main findings included that the Mpumalanga Department of Economic Development and Tourism and Gauteng Department of Agriculture and Rural Development are both confident in implementing NEMAQA, however, require extensive capacity building.

SUMMARY OF THE HIGHVELD PRIORITY AREA HEALTH STUDY

A health study was conducted to determine the potential for health effects from ambient air pollution in communities in the HPA. The study was commissioned by the Department of Forestry, Fisheries and the Environment (the Department or DFFE) with the purpose of identifying the communities and vulnerable population groups mostly impacted by air pollution. The study comprised local and regional assessments to have a better understanding of the risks and impacts of air pollution on human health in the HPA. For this purpose, the report investigated the exposure of communities living near air quality monitoring stations (AQMS), and sources of SO_2, NO_2, particulate matter PM_{10} and $PM_{2.5}$ were considered. The study had three main assessments undertaken which include: (1) Human Health Risk Assessment; (2), Child Health Study; and (3) Community Survey.

The regional study involved the assessment of human health risks resulting from exposure to air pollution. Local studies comprised a community survey in seven communities, namely eMalahleni, Ermelo, Etwatwa, Grootvlei, Middelburg, Tembisa and Tsakane, in the priority area and a child health study.

Mortality attributed to air pollution was determined for two scenarios, which include the baseline scenario for PM_{10} and $PM_{2.5}$ and the NAAQS threshold (in other words, calculating the mortality rate if the local municipality met the current NAAQS scenario for PM_{10} and $PM_{2.5}$. StatsSA population, mortality data, and the modelled ambient concentrations were used as input in the baseline scenario. The PM_{10} and $PM_{2.5}$ attributable mortality decrease in meeting the annual NAAQS were then estimated and provided the following results:

- Based on simulated Hazard Quotients (HQ), the central, and towards the eastern parts of the Highveld Priority Area are at risk of the negative health impacts of exposure to SO_2. Within these areas, the communities most at risk are primarily located near intense industrial SO_2 emission sources.
- Based on simulated Hazard Quotients, a large portion of the western part of the Highveld Priority Area is at risk of the negative health impacts of exposure to PM_{10}. Within this western region, the communities most at risk are primarily located in the City of Ekurhuleni, the Govan Mbeki Local Municipality, and the Msukaligwa Local Municipality.
- The City of Ekurhuleni and the Govan Mbeki Local Municipality are the main vulnerable areas in the HPA. The main conditions affecting vulnerability to the effects of air pollution in these areas are population characteristics and socio-economic conditions.
- The estimated attributable mortality decrease in meeting the annual NAAQS for PM_{10} is 5125 people and 4881 people for $PM_{2.5}$.
- The largest percentage attributable to deaths from not meeting PM_{10} annual NAAQS occur in the City of Ekurhuleni and the Govan Mbeki Local Municipality. If the annual NAAQS for PM_{10} is met, all-cause mortality in the City of Ekurhuleni is expected to decrease by 18.75%.
- For $PM_{2.5}$, the largest percentage attributable to deaths from not meeting $PM_{2.5}$ annual NAAQS occur in the City of Ekurhuleni. If the annual NAAQS for $PM_{2.5}$ are met, all-cause mortality in the City of Ekurhuleni is expected to decrease by 16.62%.

The abovementioned results are consistent with the health impacts detailed in the first-generation HPA AQMP, which found that the City of Ekurhuleni, eMalahleni, Steve Tshwete, and Secunda are areas with large populations possibly at risk from the ambient concentrations of SO_2 and PM_{10}. Hospital admissions with respiratory conditions were estimated to be significantly higher in the Johannesburg and City of Ekurhuleni conurbation (more than 34000 cases) when compared to admissions in the Mpumalanga Highveld as a whole (more than 8600 cases).

During the 2015 and 2016, the Department conducted a mid-term review of the first-generation HPA AQMP through collaborative engagements with stakeholders within the priority area to assess whether progress had been made in implementing the AQMP and identify any shortfalls (Department of Environmental Affairs, 2017). The findings of the mid-term review indicated that, although most of the interventions in the AQMP had been implemented, air quality in the area did not improve significantly to a level where the air quality was brought into compliance with the air quality standards. The mid-term review recommended the development of the second-generation HPA AQMP build upon the strengths and successes of the first-generation AQMP.

SECOND GENERATION HIGHVELD PRIORITY AREA AIR QUALITY MANAGEMENT PLAN

The development of the second-generation AQMP was commissioned by the Department during 2021. The Plan is aimed at establishing emission reduction targets, based on a better understanding of the impact on ambient air quality in the HPA due to various emission reductions (brought about by interventions), that will ensure further improvement and eventual compliance within the priority area.

HPA BASELINE – AMBIENT AIR QUALITY

The number of monitoring stations have increased from 23 to 49 since the gazetting of the first-generation AQMP, and most of these air quality monitoring stations are reporting ambient data in real-time to the South African Air Quality Information System (SAAQIS) https://saaqis.environment.gov.za/. An assessment of historical ambient air quality data from 2007 to 2020, for Gert Sibande District Municipality, Nkangala District Municipality, as well as the City of Ekurhuleni was undertaken to assess ambient air quality trends in the region. The main findings from critical pollutants are as follows:

Particulate Matter

- **Daily trends:** While there has been a clear improvement in ambient air quality monitoring in some areas, ambient PM_{10} levels are still elevated over many areas in the HPA with daily exceedances of PM_{10} NAAQS (75 µg/m³). These elevated concentrations typically coincide with periods of low temperatures and stable atmospheric conditions associated with the winter months.
- **Annual trends:** Some areas have experienced significant improvements for PM_{10} and $PM_{2.5}$, namely Club, Camden and Elandsfontein from 2013 to 2020. However, very little-to-no improvement and even further deterioration has taken place at some sites, namely Bosjesspruit and Majuba. It is, therefore, recommended that more focused and strategic attention and intervention is paid in these areas.

Sulphur Dioxide (SO_2)

- **Monthly trends:** Monthly average trends show typical annual cycles with the highest SO_2 level peaking in the winter and the lowest levels in summer. Winter peaks at eMalahleni have consistently been the highest in the area, and nearly double the regional average. The priority area monthly average shows a noticeable and gradual decrease across the region, especially in the winter peaks. On average, these winter peaks have decreased from around 25 ppb in 2009 to around 13 ppb in 2019.
- **Annual trends:** Annual average SO_2 concentrations have been relatively higher than the other declared priority areas. The highest concentrations occurred in areas such as eMalahleni and Komati. Since 2007, annual SO_2 levels have decreased significantly in Ermelo, Hendrina, Secunda, eMalahleni, eMbalenhle and Phola. However, areas including Middelburg, Elandsfontein, Grootvlei, Komati and Leandra have seen significant increases in SO_2 levels during the same period. The rest of the stations showed that, even though there have been inter-annual variations, the levels of SO_2 have remained relatively unchanged over the entire period.

Nitrogen Dioxide (NO_2)

- **Hourly trends:** The hourly NO_2 NAAQS of 106 ppb was seldom exceeded after 2012 with these exceedances taking place at the Elandsfontein and Club ambient monitoring stations. It is also important to note that consistent exceedances of the NAAQS were noted at Club prior to 2012 with a clear improvement, thereafter, again speaking to the development of the priority area AQMP and the subsequent implementation from 2012 having an important bearing on the observed improvements.
- **Annual trends**: Annual average ambient NO_2 concentrations recorded at the AQMS of concern were well within the annual average NAAQS of 21 ppb except for exceedances taking place at the Verkykop, Ermelo, as well as Secunda Air Quality Monitoring Stations.

Ozone (O_3)

- **Eight-hour running averages:** There has been a clear improvement in ambient monitoring from 2012 onwards. While this clear improvement is evident, exceedances of the eight-hour O_3 running average NAAQS of 61 ppb was evident prior to 2012, with exceedances occurring at the Club and Bosjesspruit AQMS. Improved measurements were noted from 2016 to 2019. However, these measurements are still above the eight-hour running average O_3 NAAQS.

HPA BASELINE - EMISSIONS INVENTORY

Emissions were quantified for all main sources within the HPA for 2019, as well as sources from the surrounding areas to form input into air quality modelling. A comparison was made between the first-generation AQMP emission inventory and the 2019 emission inventory, which is the foundational input for the development of the second-generation HPA AQMP. Based on this comparison the main findings are:

- There are significant changes in emissions quantities between the first-generation AQMP emission inventory and the 2019 emission inventory, resulting in significantly less total emission quantified for SO_2 and NO_x in 2019.
- For PM_{10}, changes in emission quantities between the first-generation AQMP emission inventory and the 2019 emission inventory are minimal, with only a 6% reduction being experienced. This is due to increased emissions from industries, residential fuel burning; and biomass burning, with industries noted to have the most pronounced increase (14% increase or 15 388 tpa). At the same time, significant reductions in estimated PM_{10} emissions are also noted for on-road vehicle emissions and wind-blown particulates with 85% and 23% reductions respectively.
- It is also important to note that the 2019 emission inventory incorporates both emission sources and pollutants previously not quantified in the first-generation AQMP emission inventory, yet clear emission reductions were still noted across all three pollutants.

PHOTOCHEMICAL MODELLING

The Comprehensive Air Quality Model with Extensions (CAMx) photochemical model was used to simulate current ambient concentrations of pollutants within the HPA to assess ambient air quality on a more comprehensive spatial scale than what can be achieved with monitoring stations. Areas of elevated concentrations can be identified for expanded monitoring and when viewed within the context of the emission inventory, likely contributing sources are targeted for intervention strategies. A summary of the main findings for each pollutant pertaining to the modelling is detailed below:

Particulate matter (PM_{10} and $PM_{2.5}$)

- As illustrated in Figures E-2 and E-3, both the simulated PM_{10} and $PM_{2.5}$ concentrations tend to have similar characteristics in the spatial distribution of exceedances.
- For annual NAAQS, the same areas are also predicted to be impacted though the spatial extent is reduced for PM_{10}, while it has become even more extended for $PM_{2.5}$ exceedances.
- In terms of 24-hour exceedances, the central part of the HPA, in areas such as Secunda and west of Ermelo, as well as the north (eMalahleni) to north-west regions, the concentrations for PM_{10} and $PM_{2.5}$ are exceeding the permissible number of exceedances, with a large portion of Gauteng (including the Vaal Triangle Priority Area) predicted to be impacted by both pollutants.

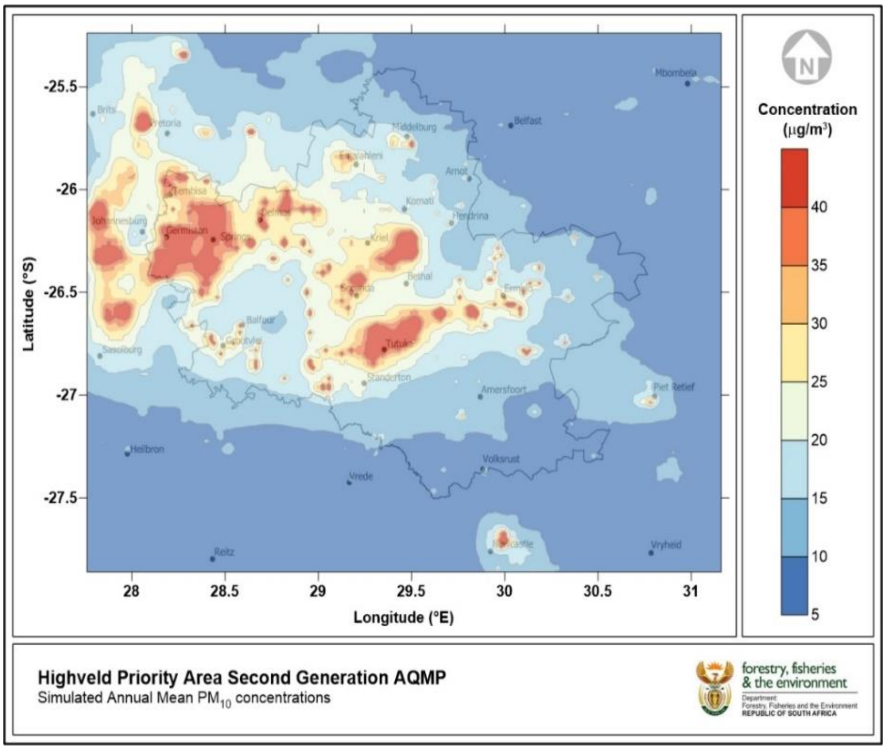

Figure E-2: Regional HPA map illustrating simulated annual mean PM_{10} concentrations.

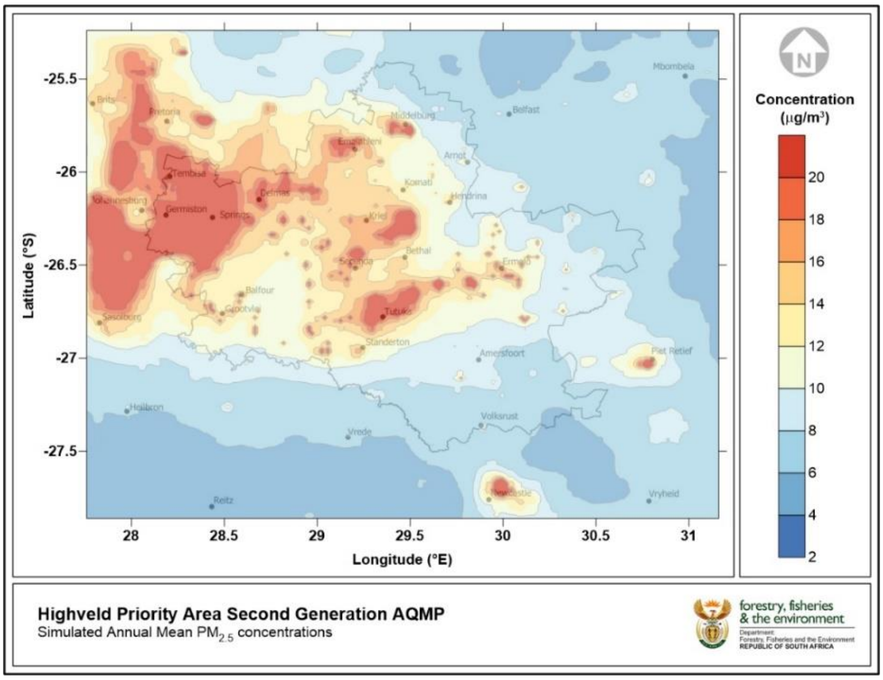

Figure E-3: Regional HPA map illustrating simulated annual mean $PM_{2.5}$ concentrations.

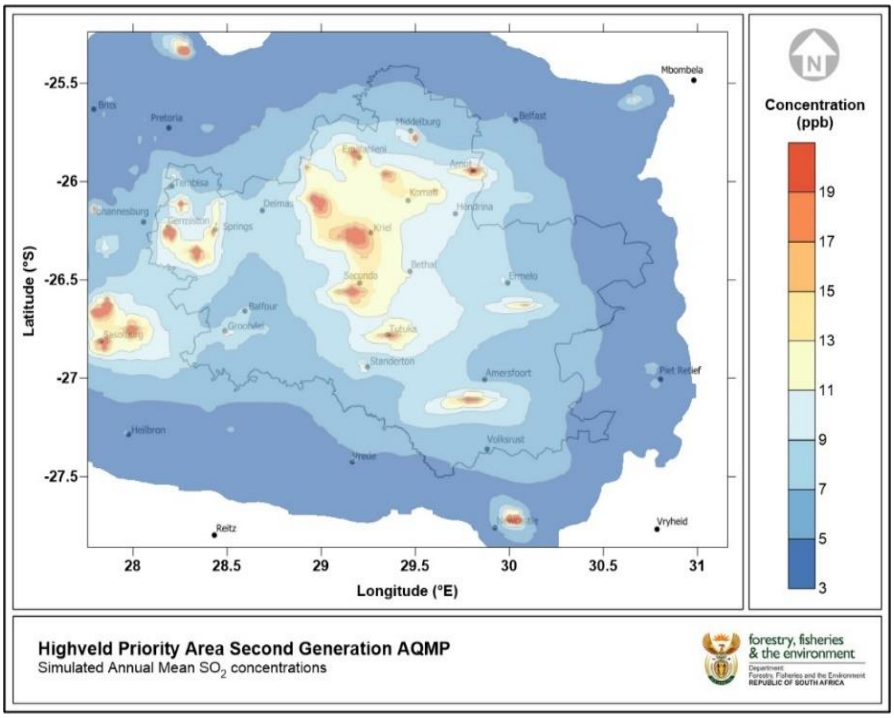

Figure E-4: Regional HPA map illustrating simulated annual mean SO_2 concentrations.

Sulphur Dioxide (SO_2)

- The annual SO_2 NAAQS (19 ppb) is exceeded primarily over the west (Sasolburg area, part of the Vaal Triangle Priority Area) with Secunda, eMalahleni, Witbank and the City of Ekurhuleni also illustrating pronounced areas of exceedance (Figure E-4).
- A hotspot to the north of Secunda seems to stand out from the other spots within the Highveld Priority Area and occurs for all average periods, with daily impact having the largest spatial extent bulging northward towards the boundaries of the HPA.
- Other Highveld Priority Area bounded hotspots, such as areas around Amersfoort, eMalahleni and the City of Ekurhuleni, become more significant regarding the 24-hour Frequency of Exceedance as they become more spatially extended.
- Various other hotspots are also predicted at the edges of the modelling domain over the west (Sasolburg area, part of the Vaal Triangle Priority Area) and the north-western region, which are outside the Highveld Priority Area.

Nitrogen Dioxide (NO_2):

- For annual NAAQS of NO_2 (21 ppb), limited number of areas were simulated to be impacted by the exceedances of the annual standard, including Secunda and in the north-western part of the HPA where a few numbers of hotspots were predicted in areas around Gauteng.

Ozone (O_3):

- The simulated annual O_3 concentrations over the modelling domain indicate a generally lower O_3 concentration towards the centre of the HPA, with distinct elevated concentrations towards the outer border of the modelling domain.

SOURCE APPORTIONMENT STUDY

The Department commissioned an HPA Source Apportionment Study (SAS) during July 2021 with the objective of better establishing the contribution from all emission sources to particulate matter loading in the HPA. The SAS was designed to assess ambient air quality, identification of major pollution emission sources (as well as emission profiles for the identified sources) through receptor modelling and to apportion the contributions of the various emission sources to the ambient air concentrations. Results from the SAS in the HPA were to guide and assist with emission reduction strategies in various regions within the HPA. However, the equipment used to sample particulate matter was found to be misrepresenting measurements due to factory faults, and the study was withdrawn.

EMISSION REDUCTION ASSESSMENT

Identifying and developing appropriate emission reduction targets that are likely to result in compliance with the NAAQS is important for the development of feasible interventions i.e., activities resulting in emission reductions at specific emission source categories intended to achieve compliance with the NAAQS in the HPA. There was a need to examine the potential future scenarios of emission reductions and to investigate consistent emission reduction options. Proposed emission reductions were modelled to assess the impact on achieving ambient standard compliance in the HPA. DFFE arranged a 2-day workshop involving the stakeholders in the HPA. The stakeholders were tasked with developing, refining, and characterizing a set of realistic emission reductions that encompass a wide range of conceivable futures. Various approaches and rationales were used to develop emission reductions for the following emission source categories:

(i) Industry
(ii) Mining and Reclamation Operations
(iii) Transport Emissions
(iv) Residential Fuel Burning
(v) Residential Waste Burning
(vi) Biomass Burning; and
(vii) Agricultural Emissions.

Table E-1 summarizes the emission reduction targets, which were composed of a series of revisions to emission source categories. Emission reduction targets for the year 2030 were investigated for all emission source categories aligned to the Regulations for Implementing and Enforcing Priority Area Air Quality Management Plans, 2024.

Table E-1: Summary of emission reductions applied to the baseline towards compliance by 2030.

Sector	2030 Emission Reduction Target from 2019 Baseline
Industry	40%
Mining and Reclamation Operations	40%
On-road Vehicle Sources	30%
Residential Fuel Burning	30%
Residential Waste Burning	100%
Biomass Burning	30%
Agriculture	20%

To gain an understanding around the relationship of ambient air quality in the HPA to the various emission reductions (brought about by interventions), photochemical modelling was used to translate the emission reduction targets to changes in ambient pollutant concentrations. The main findings from the emission reduction modelling are as follows:

- Simulated concentrations for PM_{10} and $PM_{2.5}$ indicate that through the emission reductions, the regions of exceedances are reduced considerably. However, there are still areas where the frequency of exceedance is above the permissible limit, especially in Ekurhuleni and Johannesburg regions.
- SO_2 concentrations, exceedances in the 1-hour, 24-hour, and annual baseline SO_2 NAAQS are observed primarily towards the west (Sasolburg area, part of the VTAPA), Secunda, Kriel, eMalahleni, Middelburg and Ekurhuleni. However, in the 2030 emission reduction scenario, the regions of exceedances shrink considerably with the Sasolburg and Kriel being the only areas with clearly persistent exceedances.
- Simulated NO_2 concentrations indicate that only the NAAQS for the baseline annual average is exceeded around Sasolburg and Secunda. The region of exceedances around these two areas does not reduce significantly in the 2030 emission reductions. Most reductions in ambient are seen further afield from both Sasolburg and Secunda.
- Simulated O_3 concentrations are generally lower towards the centre of the priority area, with distinct elevated levels towards the outer border of the modelling domain for the 2019 baseline. The 2030 emission reductions illustrate a similar profile with a slightly smaller spatial extent. Ozone remains problematic in the 2030 emission reduction scenario possibly due to the transboundary impacts into and out of the HPA, making it a regional management issue.

EMISSION REDUCTION PLAN

Based on the results from the emission reduction modelling, strategies were identified to develop feasible emission reduction interventions with the potential to improve the quality of air quality in the HPA. This was done using the goal setting and Objectives and Key Results (OKRs) model, which provides a structured approach to goal setting, tracking progress, and fostering a culture of accountability and continuous improvement towards achieving the desired emission reduction outcomes. In addition to this, the PESTEL framework was used to identify and analyse external factors that are likely to impact the success of the emissions reduction plan for the Highveld Priority Area. The tables below provide sector specific emission reduction plans, which are based on the following conditions: (1) Objectives; (2) Key results; and (3) Levels of responsibility.

The above-mentioned conditions will assist in both the implementation and performance tracking of each emission reduction plan. These sector-specific emission reduction plans will apply to the following stakeholders identified in section 3(2) of the Regulations for Implementing and Enforcing Priority Area Air Quality Management Plans, 2024:

a. any person conducting a listed activity;
b. any person operating a controlled emitter;
c. any holder of a right related to a prospecting operation, exploration operation, mining operation and production operation;
d. any person conducting reclamation; and
e. any government departments, organs of state and relevant national, provincial, or local spheres of government.

Industries

Target 1: Reduce emissions from industrial sources (from the 2019 baseline) by 40% in 2030.

Table E-2: Emission Reduction Activities for Industrial Sources

Objectives	Key Activities/Opportunities	Responsibility
Reduce emissions from industries	Compliance with the minimum emission standards and other atmospheric emission licence conditions.	Identified stakeholders in regulation 3(2)(a) and 3(2)(b).
	Assessment of compliance monitoring reports.	Identified stakeholders in regulation 3(2)(e): DFFE, Provinces, Metros, Districts and Local municipalities
	Development and implementation of emission reduction plans.	Identified stakeholders in regulation 3(2)(a) and 3(2)(b).
	Monitor and enforce compliance.	Identified stakeholders in regulation 3(2)(e): DFFE, Provinces, Metros, Districts and Local municipalities
	Identify opportunities and incentive schemes to support industries to implement air quality improvement initiatives.	Identified stakeholders in regulation 3(2)(e): DTIC, DFFE, Provinces, Metros, Districts and Local municipalities
	Establish incentive schemes for energy efficiency improvements and fuel switching that directly reduce air emissions.	Identified stakeholders in regulation 3(2)(e): DTIC, DFFE, Provinces, Metros, Districts and Local municipalities

Notes: DTIC – Department of Trade, Industry and Competition, DFFE – Department of Forestry, Fisheries and the Environment

Domestic Waste Burning

Target 2: Eliminate all emissions from domestic waste burning (from the 2019 baseline) by 2030.

Table E-3: Emission Reduction Plan for Domestic Waste Burning

Objectives	Key Activities/Opportunities	Responsibility
Reduce domestic waste burning emissions	Development and review of Integrated Waste Management Plans (IWMP)	Identified stakeholders in regulation 3(2)(e): Provinces, Metros, Districts and Local municipalities
	Implementation of updated Integrated Waste Management Plans (IWMP)	Identified stakeholders in regulation 3(2)(e): Provinces, Metros, Districts and Local municipalities
	Development and Implementation of emission reduction plans	Identified stakeholders in regulation 3(2)(e): Provinces, Metros, Districts and Local municipalities
	Improve public awareness on waste minimization, reuse, recycling and about the health impacts of waste.	Identified stakeholders in regulation 3(2)(e): Provinces, Metros, Districts and Local municipalities
	Initiation of projects/programmes for Waste diversion	Identified stakeholders in regulation 3(2)(e): Metros, Districts and Local municipalities

Vehicle Emission Sources

Target 3: Reduce emissions from on-road vehicles from the 2019 baseline by 30% in 2030.

Table E-4: Emission Reduction Plan for Vehicle Emissions

Objectives	Key Activities/Opportunities	Responsibility
Reduce emissions from vehicles	Conduct awareness campaigns and provide support on measures to reduce transport emissions (e.g., use of public transport, lift clubbing etc.).	Identified stakeholders in regulation 3(2)(e): DOT, DFFE, Provinces, Metros, Districts and Local municipalities.
	Implementation of the Clean Fuel II fuel specifications.	Identified stakeholders in regulation 3(2)(e): DMRE
	Introduction of vehicle fleets with cleaner fuels.	Identified stakeholders in regulation 3(2)(a), 3(2)(b) and 3(2)(e): Industry, DFFE, Provinces, Metros, Districts and Local municipalities
	Development and Implementation of emission reduction plans	Identified stakeholders in regulation 3(2)(e): Metros, Districts and Local municipalities

Notes: DOT – Department of Transport, DMRE – Department of Mineral Resources

Domestic Fuel Burning

Target 4: Reduce domestic fuel burning emissions from the 2019 baseline by 30% by 2030.

Table E-5: Emission Reduction Activities Towards Reducing Domestic Fuel Burning Emissions

Objectives	Key Activities/Opportunities	Responsibility
Reduce domestic fuel burning emissions	Conduct public awareness on air pollution	Identified stakeholders in regulation 3(2)(e): Local municipalities, DOH
	Conduct public awareness on indoor air pollution	Identified stakeholders in regulation 3(2)(e): DOH
	Solar Water Heating (SWHs) installed in beneficiary households in participating municipalities	Identified stakeholders in regulation 3(2)(e): DMRE
	Households electrified with grid.	Identified stakeholders in regulation 3(2)(e): DMRE
	Develop and implement emission reduction and management plan	Identified stakeholders in regulation 3(2)(e): DHS and DMRE

Notes: DHS – Department of Human Settlements, DOH – Department of Health

Forestry and Veld Fire (Biomass) Burning

Target 5: Reduce biomass burning emissions from the 2019 baseline by 30% by 2030.

Table E-6: Emission Reduction Plan for Biomass Burning

Objectives	Key Activities/Opportunities	Responsibility
Reduce biomass burning emissions	Develop and finalize a national strategy for reducing emissions from deforestation and forest degradation (REDD+)	Identified stakeholders in regulation 3(2)(e): DFFE
	Establish partnerships with Fire Protection Associations that enforce the Veld and Forest Fires Act 1998 (Act No. 101 of 1998).	Identified stakeholders in regulation 3(2)(e): Municipal Fire departments, traditional leaders/local government
	Develop and implement emission reduction and management plan	Identified stakeholders in regulation 3(2)(e): Metros, Districts and Locals (Where applicable)
	Conduct education and awareness campaigns in the communities on the impact and prevention of veld fires.	Identified stakeholders in regulation 3(2)(e): DFFE, Fire Protection Associations

Agriculture

Target 6: Reduce emissions from agricultural activities (from the 2019 baseline) by 20% in 2030.

Table E-7: Emission Reduction Activities on Agricultural Emissions

Objectives	Key Activities/Opportunities	Responsibility
Management of the release of ammonia and particulate dust from agricultural activities.	Conduct awareness campaigns on the impact of ammonia on the environment and measures to reduce the use of inorganic fertilizers.	Identified stakeholders in regulation 3(2)(e): Provinces, Metro/District and Local Government, farmers associations
	Develop and implement emission reduction and management plan.	Identified stakeholders in regulation 3(2)(e): DALRRD
	Application of crop residue management techniques e.g., incorporation of crop residue into the soil.	Farmers
	Establishment of firebreaks on farmlands.	Farmers

Notes: DALRRD – Department of Agriculture, Land Reform and Rural Development

Windblown Dust

Target 7: Reduce windblown dust emissions from residential areas (from the 2019 baseline) by 40% in 2030.

Table E-8: Emission Reduction Activities for Windblown Dust Emissions in Residential Areas

Objectives	Key Activities/Opportunities	Responsibility
Reduce windblown dust emissions in residential areas	Identify unpaved roads with high traffic activity and implement mitigation measures to minimise dust on these roads.	Identified stakeholders in regulation 3(2)(e): Local municipalities
	Plant vegetation near unpaved roads to serve as a dust barrier.	Identified stakeholders in regulation 3(2)(e): Local municipalities
	Create partnerships between municipalities and stakeholders on upgrading unpaved roads in low-income settlements.	Identified stakeholders in regulation 3(2)(a), 3(2)(b) and 3(2)(e): DOT, Industry, DFFE, Provinces, Metros, Districts and Local municipalities
	Plant trees outside the forest footprint	Identified stakeholders in regulation 3(2)(e): DFFE
	Increase the number of hectares approved for afforestation	Identified stakeholders in regulation 3(2)(e): DFFE

Target 8: Reduce windblown dust emissions in mining areas (from the 2019 baseline) by 40% in 2030.

Table E-9: Emission Reduction Plan for Mining Emissions

Objectives	Key Activities/Opportunities	Responsibility
Reduce emissions from mines	Effective implementation of National Dust Control Regulations	Identified stakeholders in regulation 3(2)(c)
	Development and Implementation of emission reduction plans and EMPs	Identified stakeholders in regulation 3(2)(c)
	Implementation of the rehabilitation strategy (derelict and ownerless mine sites)	Identified stakeholders in regulation 3(2)(e): DMRE, DFFE
	Monitor and enforce compliance in terms of MPRDA	Identified stakeholders in regulation 3(2)(e): DMRE

Table E-10: Emission Reduction Plan for Mine Reclamation Emissions

Objectives	Key Activities/Opportunities	Responsibility
Reduce emissions from mining reclamation processes	Effective implementation of National Dust Control Regulations	Identified stakeholders in regulation 3(2)(c) and 3(2)(d)
	Development and Implementation of emission reduction plans and EMPs	Identified stakeholders in regulation 3(2)(c) and 3(2)(d)
	Implementation of the rehabilitation strategy (derelict and ownerless mine sites)	Identified stakeholders in regulation 3(2)(e): DMRE, DFFE
	Monitor and enforce compliance in terms of MPRDA	Identified stakeholders in regulation 3(2)(e): DMRE

Education, Awareness and Resource Mobilisation

Table E-11: Emission Reduction Plan for education, awareness and resource mobilisation

Objectives	Key Activities/Opportunities	Responsibility
To promote education	Provide materials to guide training across the priority area with a view to creating a generation of climate, environment, and health-conscious citizens and green economic operators.	Identified stakeholders in regulation 3(2)(e): DFFE
	Capacitate authorities and stakeholders.	Identified stakeholders in regulation 3(2)(e): DFFE
To promote awareness	Follow up on plans/ programmes and reduction commitments to ensure that the emission reduction commitments in the plans of stakeholders are fully implemented.	Identified stakeholders in regulation 3(2)(e): Authorities
	Support better governance on air pollution by offering new insights into overall pollution levels and impacts and by monitoring whether emission reduction plans implementation is on track to achieve the agreed objectives.	Identified stakeholders in regulation 3(2)(e): DFFE/DOH
	Enable local authorities to share best practices, success stories and experiences to drive improvement.	Identified stakeholders in regulation 3(2)(e): DFFE
	District, Provincial and National Compliance and Enforcement Officers should conduct campaigns on a yearly basis: • At least two campaigns a year as individual entities. • At least one campaign a year as a joint entity.	Identified stakeholders in regulation 3(2)(e): DFFE
	Evaluate and, where necessary, strengthen the provisions on public participation and access to justice.	NGOs
	Provide updated best practices to make tangible progress in identifying and reducing exposure to environmental risks in vulnerable groups.	NGOs
To promote resource mobilisation	Explore donor funding opportunities and government partnerships with other governments (bilateral agreements on environment etc.) and get support from them with clear guidance on their funding, and tools.	Identified stakeholders in regulation 3(2)(e): DFFE
	Mobilisation of private capital for environmentally sustainable investments that support the zero pollution objectives.	NGOs

Notes: NGO – Non-Government Organisation.

MONITORING AND EVALUATION OF AQMP IMPLEMENTATION

Monitoring involves tracking the progress made by identified stakeholders in achieving the goals set out in the second-generation AQMP. Monitoring is key in determining whether the rate of implementation of the current emission reduction measures needs to be increased or whether the current emission reduction plan or strategy needs to be revised. The monitoring process will commence once the implementation of the second-generation AQMP for the HPA has begun. The identified stakeholders are required to submit progress reports on an annual basis to verify progress made, identify any challenges being experienced in implementing the emission reduction measures, come up with remedial actions and adjust timeframes so that the challenges are dealt with in the regulated reporting timelines. The submission of progress reports on an annual basis is also important in facilitating transparency and accountability amongst the identified stakeholders.

In addition to the above, the following activities will be carried out to complement the annual progress reports and further assist in the monitoring process:

(1) **Ambient Air Quality Monitoring:** The monitoring of ambient air quality is crucial for assessing pollutant concentrations and identifying areas where air quality standards are exceeded in the HPA. The ambient air quality data collected from the HPA monitoring network must be subjected to rigorous quality assurance and quality control processes to ensure accuracy and reliability. The monitoring results should be reported regularly to relevant authorities and stakeholders to provide insights into air quality trends, and exceedances of air quality standards, and to identify areas requiring further intervention.

(2) **Emissions Inventory Tracking:** As part of the monitoring process, the second-generation HPA emissions inventory will have to be continuously updated. Regularly updating the emissions inventory is vital to capture changes in emissions over time and to assess the effectiveness of emission reduction measures. It also allows for the identification of emerging sources and trends, supports the evaluation of the second-generation HPA AQMP, and facilitates the tracking of progress towards achieving the air quality goals set in the AQMP and

(3) **Inter-governmental and Stakeholder Engagement:** This involves engaging with relevant stakeholders so as to gather diverse perspectives on the effectiveness of the AQMP identify challenges, and gather feedback for improvement. There are several forums in place in the Highveld Priority Area to ensure inter-governmental communication and cooperation as well as engagement with various stakeholders. These forums will be used optimally to ensure the successful and continuous and successful implementation of the second-generation HPA AQMP.

Evaluation is an essential element of the AQMP implementation as it allows for a thorough assessment of the AQMP including the shortcomings and strengths evident in the implementation. It involves assessing whether the goals set out in the second-generation HPA AQMP have been achieved. The following activities will be carried out as part of the evaluation process:

(1) The annual progress reports submitted by the identified stakeholders should be assessed against the emissions reduction targets set out in the second-generation HPA AQMP. This will help determine whether there is a need to make operational or functional changes that will improve the performance of the identified stakeholders in reducing their emissions; and

(2) The annual progress reports submitted by the identified stakeholders will be compared with the state of air reports (ambient air quality monitoring data) so as to determine whether there has been progress made in meeting the National Ambient Air Quality Standards in the Highveld Priority Area.

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ABBREVIATIONS, SYMBOLS AND UNITS

°C	Degree Celsius
AEL	Atmospheric Emissions Licence
AQMP	Air Quality Management Plan
AQMS	Air Quality Monitoring Station
CoE	City of Ekurhuleni
CO	Carbon Monoxide
CO_2	Carbon Dioxide
DEA	Department of Environmental Affairs, South Africa
DFFE	Department of Forestry, Fisheries and the Environment
EIA	Environmental Impact Assessment
EMP	Environmental Management Programme
g/kg	Gram per kilogram
GHGs	Greenhouse gases
GLCs	Ground Level Concentrations
GN	General Notice
HPA	Highveld Priority Area
I&AP	Interested and affected parties
ISO	International Organisation for Standardisation
$kg.yr^{-1}$	Kilograms per year
$\mu g/m^3$	Micro grams per cubic meter (concentration)
MES (S21)	Minimum Emission Standards (S21 MES): List of Activities which Result in Atmospheric Emissions from the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004)
MSW	Municipal Solid Waste
N/A	Not applicable
n/av	Not available
NAAQS	National Ambient Air Quality Standards (South Africa)
NAEIS	National Atmospheric Emissions Inventory System
NAQO	National Air Quality Officer
NCAR	National Centre for Atmospheric Research
NEM: AQA	National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004)
NO	Nitrogen Oxide
NO_2	Nitrogen dioxide
NO_x	Oxides of Nitrogen (expressed as NO_2)
PM	Particulate Matter
PM_{10}	Particulate Matter with an aerodynamic diameter of ≤ 10 micrometers
$PM_{2.5}$	Particulate Matter with an aerodynamic diameter of ≤ 2.5 micrometers
PMT	Project Management Team
ppm	Parts per million (g/Mg)
PSD	Particle Size Distribution
PSC	Project Steering Committee
SA/RSA	South Africa
SAS	Source Apportionment Study
SANRAL	South African National Roads Agency SOC Ltd
SANS	South African National Standard

SO_2	Sulphur dioxide
SO_x	Oxides of sulphur
$Tg.yr^{-1}$	Terra Grams per Year
TOC	Total Organic Compounds
TSP	Total Suspended Particulates (also refers to particulate matter with reference to this report)
US/USA	United States of America
US-EPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound
WHO	World Health Organisation

1 INTRODUCTION

On 23 November 2007, the Highveld Priority Area (HPA) was declared in terms of section 18(1) (a) and (b) of the National Environmental Management: Air Quality Act, 2004, (Act No. 39 of 2004) (NEMAQA). The declaration was triggered by air quality in the area that has consistently exceeded National Ambient Air Quality Standards (NAAQS). The HPA is also considered one of the major oxides of nitrogen (NO_x) hotspots in the world (Wenig, 2003; Lourens, 2012) and it was previously estimated that over 80% of sulphur dioxide (SO_2) and NO_x emissions in South Africa are from the Mpumalanga Province (Wells, 1996; NAEIS).

Following the declaration of the priority area, a first-generation Air Quality Management Plan (AQMP) was developed in 2012 in terms of section 19(5) of NEMAQA. The first-generation AQMP was developed to provide a strategic direction for the implementation of air quality interventions in the HPA, as well as an essential blueprint for action to reduce emissions in the area. The AQMP described the state of air quality in a priority area, sources of air pollution in the priority area, how air quality has been changing over the years, and what could be done to ensure improved air quality in a priority area. It provided the goals and objectives for a priority area and prescribes short- to long-term policies and controls to improve air quality in a priority area.

Air quality monitoring trends from the first-generation HPA AQMP indicated elevated concentrations of particulate matter (PM10), NOx and SO_2 occurring in the central and northern parts of the HPA. A comprehensive emission inventory was developed for the HPA, and included industry; residential fuel burning, mines and quarries, transport (motor vehicle emissions), biomass burning and, burning and smouldering coal dumps (spontaneous combustion) emissions. Industrial sources were the largest contributor of emissions in the HPA, accounting for 89% of PM_{10}, 90% of NOx and 99% of SO_2. Dispersion modelling was used to determine regions of concern for ambient air quality in the HPA at a regional scale. Nine hotspot areas in the HPA where ambient air quality standards for SO_2, NO_2, PM_{10} and O_3 are consistently exceeded were identified based on the modelling results. These hotspot areas included eMalahleni, Kriel, Steve Tshwete, Ermelo, Secunda, Ekurhuleni, Lekwa, Balfour and Delmas, resulting from emissions emanating from industries, residential fuel burning, vehicle, mining, and cross-boundary transport of pollutants into the HPA.

Between 2015 and 2016, a mid-term assessment of the HPA AQMP was undertaken by the Department in conjunction with stakeholders within the priority area. This evaluation sought to measure the progress achieved in implementing the AQMP and recognise any shortfalls (Department of Environmental Affairs, 2017). The outcome of this mid-term review revealed that while numerous measures from the AQMP had been executed, the air quality situation had not notably improved to a degree where the Minister would consider discontinuing the priority status of the area. Furthermore, the mid-term evaluation recommended the review of the plan to establish a second-generation HPA AQMP. The new plan would build upon the achievements and effective aspects of the 2012 AQMP. The AQMP seeks to design emission reduction strategies grounded in a deeper comprehension of the correlation between ambient air quality within the HPA and the diverse emission reductions attributed to various interventions. These strategies are intended to facilitate further enhancements in air quality and eventual alignment with the NAAQS in the area.

1.1 General Description of the Highveld Priority Area

The HPA encompasses the following municipalities and provinces, as illustrated in Figure 1-1:

- The City of Ekurhuleni (CoE) in the Gauteng province.
- Lesedi Local Municipality (LM) situated within the Sedibeng District Municipality (DM) of Gauteng province.
- Victor Khanye, Steve Tshwete, and eMalahleni Local Municipalities (LMs) in the Nkangala District Municipality (DM) of Mpumalanga province.
- Govan Mbeki, Dipalaseng, Msukaligwa, Lekwa, and Pixley ka Seme Local Municipalities (LMs) located in the Gert Sibande District Municipality (DM) of Mpumalanga province.

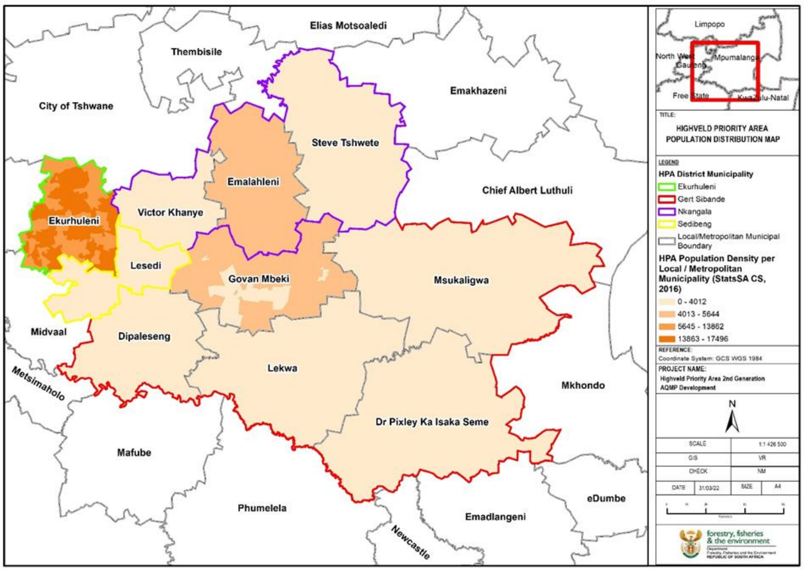


Figure 1-1: Map depicting the geographical extent of the Highveld Priority Area.

1.1.1 Topography

The geographical features of an area contribute significantly to how air pollutants disperse. In regions with hilltops and open spaces, moderate winds tend to scatter pollutants effectively. However, in valleys and low-lying areas, like the HPA, air movement struggles to penetrate, leading to the entrapment of pollutants and consequently higher pollution levels. The dispersion of pollutants over complex terrains, unlike flat landscapes, is more intricate due to interactions between the atmosphere and the landscape's shape at various scales.

The HPA is situated on South Africa's elevated inland plateau. The terrain in the HPA is generally flat or gently rolling (as shown in Figure 1-2). It gradually slopes from around 1,400 meters in the northwest within Delmas, EMalahleni, and Steve Tshwete local municipalities, to roughly 1,500 meters in the central parts, and slightly over 1,600 meters in the east within Msukaligwa. The elevation rises to 1,800 meters in the southeast within Pixley Ka Seme. The southern region of the HPA descends to about 1,400 meters into the Vaal River basin. This predominantly level landscape is intermittently dotted with relatively small hills and rocky formations.

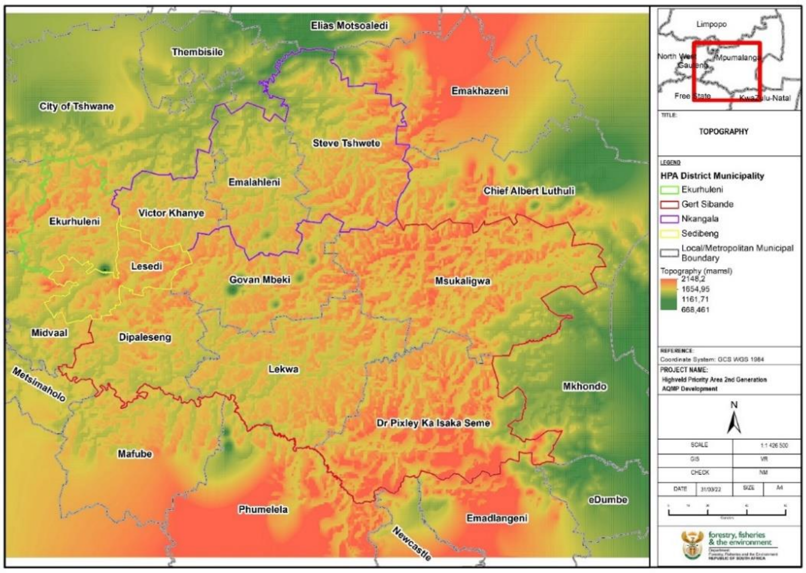


Figure 1-2: Topography of the Highveld Priority Area

1.1.2 Climatic Conditions

The extent to which air pollution will accumulate or disperse in the atmosphere is dependent on the degree of thermal and mechanical turbulence within the earth's boundary layer. Dispersion comprises vertical and horizontal components of motion. The vertical component is defined by the stability of the atmosphere and the depth of the surface mixing layer, whereas the horizontal dispersion of pollution in the boundary layer is primarily a function of the wind field.

The wind speed will determine both the distance of downwind transport and the rate of dilution because of plume dispersion. The generation of mechanical turbulence is similarly a function of the wind speed, in combination with the surface roughness. The wind direction and the variability in wind direction, will determine the general path pollutants follow, as well as the extent of crosswind spreading. Therefore, pollution concentration levels fluctuate in response to changes in atmospheric stability, concurrent variations in the mixing depth and to shifts in the wind field.

Spatial variations, and diurnal and seasonal changes, in the wind field and stability regime are functions of atmospheric processes operating at various temporal and spatial scales. There is a predominance of northerly and north-easterly winds over the HPA region, with average wind speeds varying between 2 m/s and 7 m/s.

The warmest temperatures in the area occur from December to February, while the coldest are in June or July (Figure 1-3). Rainfall varies across the HPA, with higher areas in the east averaging around 900 mm, and about 650 mm in the west. Rainfall mainly occurs as showers and thundershowers in summer (October to March), peaking in January. Winters are generally dry, but there's still some rainfall Table 1-1).

Table 1-1: Total annual precipitation (mm/annum) at selected monitoring stations in the HPA (2011-2020)

Station	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Camden	589.7	529,7	774,9	374,9	335,3	125,7	67,8	494,9	338,1	-
Elandsfontein	513,7	530,8	-	286,3	167,6	84,0	49,9	495,5	249,1	354,7
Ermelo	1 323,7	1 644,8	303,5	204,0	44,3	47,2	658,8	528,6	599,1	358,1

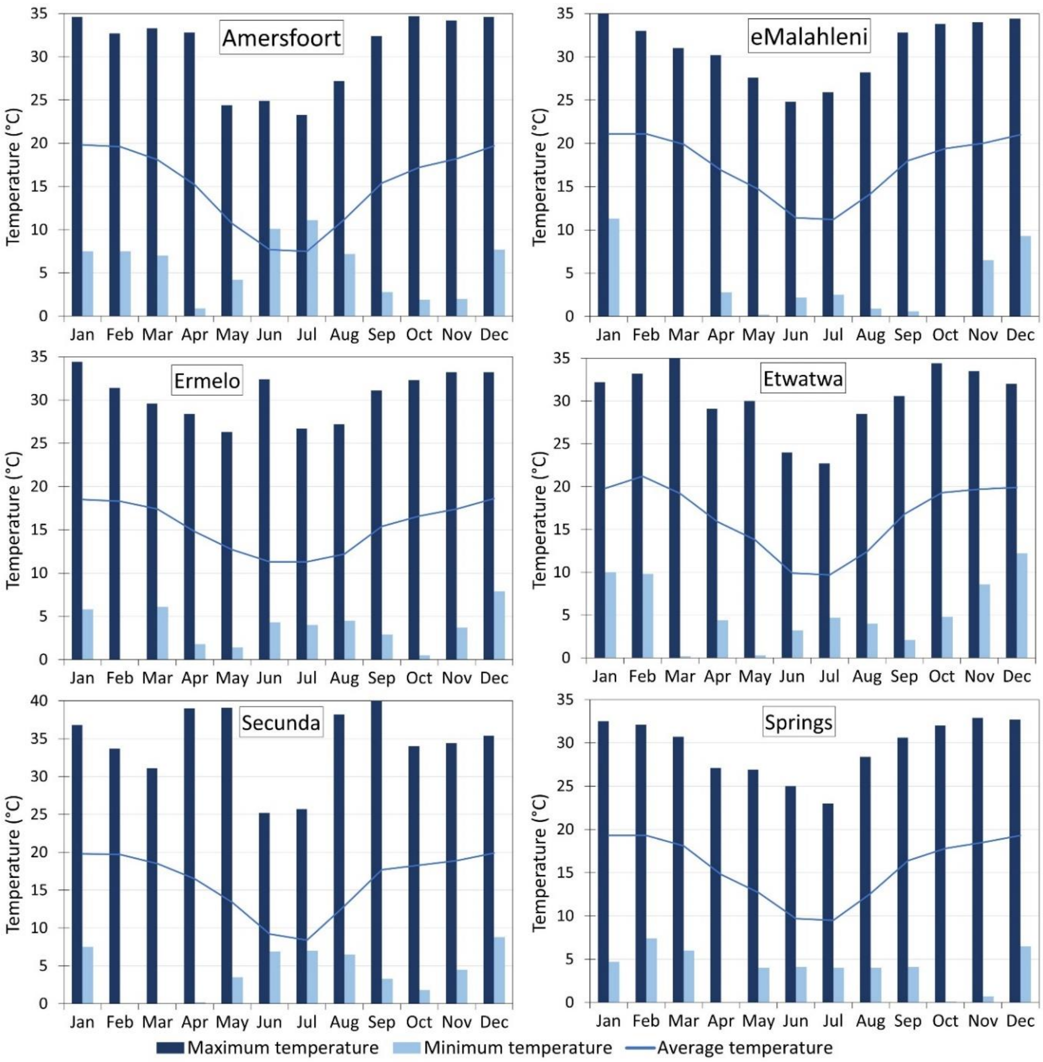


Figure 1-3: Monthly average, maximum and minimum temperatures at selected monitoring stations in the Highveld Priority Area (2007-2020)

2 ASSESSMENT OF THE FIRST-GENERATION AQMP

2.1 Ambient Air Quality Monitoring

During the formulating the first-generation HPA AQMP, a total of twenty-three (23) air quality monitoring stations were considered to assess the trends in ambient pollution. These stations had varying monitoring periods and different levels of data completion. An examination of these monitoring stations demonstrated that increased concentrations of PM_{10}, NO_X, and SO_2 were recorded in the central and northern parts of the HPA.

2.2 Emission Inventory

The first-generation HPA AQMP estimated emissions from seven different sources:

- Industry.
- Residential fuel burning.
- Mines and quarries.
- Transport (motor vehicle emissions).
- Biomass burning.
- Burning and smouldering coal dumps (spontaneous combustion).

Among these sources, industries were identified as the primary emission contributors within the HPA, being responsible for 89% of PM_{10}, 90% of NO_X, and 99% of SO_2 emissions.

2.3 Air Dispersion Modelling

The CALPUFF model suite was used during the development of the first-generation HPA AQMP to determine regions of concern for ambient air quality on the HPA at a regional scale. Nine extensive areas (hotspots) in the HPA where ambient air quality standards for SO_2, NO_2, PM_{10} and O_3 are consistently exceeded were identified based on the modelling results. These hotspots areas include eMalahleni, Kriel, Steve Tshwete, Ermelo, Secunda, Ekurhuleni, Lekwa, Balfour and Delmas and result from a combination of emissions from industries, residential fuel burning, vehicle, mining, and cross-boundary transport of pollutants into the HPA.

2.4 Pollution and Health

The initial version of the HPA AQMP included health risk assessments taken from the research conducted by Scorgie, Annegarn, and Burger (2004). These assessments were directly applicable to the HPA and were based on data from 2002, focusing on two significant regions: the Mpumalanga Highveld, and Johannesburg along with the City of Ekurhuleni (Scorgie et al., 2004). Although the data might be somewhat dated, it remains relevant.

Notably, at the time of the research, the City of Ekurhuleni encompassed a much larger population compared to what was considered within the extent of the HPA. This remains consistent even today. The key findings from the health risk assessments are as follows:

- Respiratory hospital admissions were estimated to result primarily from residential coal, followed by wood burning (56% and 21%, respectively) in Johannesburg and the City of Ekurhuleni.
- Power generation activities were estimated to be the primary driver for hospital admissions in the Mpumalanga province, with a 51% contribution, followed by the Sasol Secunda complex at 17% and residential coal burning also made a significant contribution (12%).
- The City of Ekurhuleni, eMalahleni, Steve Tshwete, and Secunda are the areas with large populations possibly at risk from the ambient concentrations of SO_2 and PM_{10}.

- Hospital admissions with respiratory conditions were estimated to be significantly higher in the Johannesburg and City of Ekurhuleni conurbation (more than 34 000 cases) when compared to admissions in the Mpumalanga Highveld as a whole (more than 8 600 cases).

2.5 Air Quality Management Capacity

An initial capacity assessment undertaken as part of the first-generation HPA AQMP development process found that Mpumalanga Department of Economic Development and Tourism (MDEDET) and Gauteng Department of Agriculture and Rural Development (GDARD) required extensive capacity building. Needs were expressed by MDEDET for capacity building in the areas of monitoring, modelling, emission inventory development and the assessment of emission impacts. GDARD only expressed needs in the development and application of the Atmospheric Emission Licence (AEL) function.

Similarly, in 2014, the Department of Environmental Affairs (DEA) conducted a Status Quo Report to Evaluate the Requirements for Municipalities and Provinces to Effectively Perform Air Quality Functions. The report's findings highlighted the existing challenges within both municipal and provincial government levels concerning the comprehensive implementation of the NEMAQA. The report emphasized that the capability of air quality functions is significantly influenced by three key factors: limitations in human resources, inadequate budget allocation, and insufficient technical resources. These factors are equally critical for municipalities to efficiently carry out their primary air quality management tasks.

2.6 Summary of the Highveld Priority Area Health Study

A HPA health study was conducted by DFFE to support the implementation of air quality management in the region. The research encompassed both local and regional evaluations, enhancing comprehension of the risks and consequences of air pollution on human health within the HPA. The report specifically investigated the exposure of communities residing near air quality monitoring stations and emission sources of atmospheric pollutants such as SO_2, NO_2, as well as particulate matter PM_{10} and $PM_{2.5}$.

The study comprised three primary assessments:

- Human Health Risk Assessment (HHRA) to identify potential health risks for the entire HPA population associated with the physical and chemical attributes of air pollutant concentrations.
- Child Health Study; and
- Community Survey aimed to gauge the overall impact of air pollution on human health within the HPA.

The main findings of this study are summarised below:

- Based on simulated Hazard Quotients (HQs), the central and towards the eastern parts of the HPA are at risk to the negative health impacts of exposure to SO_2. Within these areas, the communities most at risk are primarily located near intense industrial SO_2 emitters.
- Based on simulated HQs, a large portion of the western part of the HPA is at risk to the negative health impacts of exposure to PM_{10}. Within this western region, the communities most at risk are primarily located in the Ekurhuleni, Govan Mbeki, and the Msukaligwa.
- The Ekurhuleni and Govan Mbeki are the main vulnerable areas in the HPA. The main conditions affecting vulnerability to the effects of air pollution in these areas are population characteristics and socio-economic conditions.

- If the annual NAAQS for PM_{10} and $PM_{2.5}$ are met, estimated attributable mortality in the HPA is expected to decrease to 5 125 people for PM_{10} and 4 881 people for $PM_{2.5}$.
- The largest percentage attributable to deaths from not meeting PM_{10} annual NAAQS occur in the Ekurhuleni and Govan Mbeki. If the annual NAAQS for PM_{10} is met, all-cause mortality in Ekurhuleni is expected to decrease by 18.75%.
- For $PM_{2.5}$, the largest percentage attributable to deaths from not meeting $PM_{2.5}$ annual NAAQS occur in the City of Ekurhuleni. If the annual NAAQS for $PM_{2.5}$ are met, all-cause mortality in Ekurhuleni is expected to decrease by 16.62%.

The abovementioned results are consistent with the health impacts detailed in the first-generation HPA AQMP, which found that the Ekurhuleni, eMalahleni, Steve Tshwete, and Secunda are areas with large populations possibly at risk from the ambient concentrations of SO_2 and PM_{10}. Hospital admissions with respiratory conditions were estimated to be significantly higher in the Johannesburg and Ekurhuleni conurbation (more than 34 000 cases) when compared to admissions in the Mpumalanga Highveld as a whole (more than 8 600 cases).

The analysis for impact assessment was carried out on a local municipal level, assuming that the entire population within a municipality was exposed to the same average annual ambient PM concentrations. However, it's important to note that this assumption may not always align with the actual situation. This introduces an element of uncertainty into the assessment, potentially leading to either overestimation or underestimation of the determined impacts.

While the health study is acknowledged as a comprehensive effort, it's considered a foundational step in accurately determining health impacts within the HPA.

Furthermore, there have been prior and ongoing studies focused on estimating the effects of pollution on mortality in the HPA. It will be valuable to compare the methodologies, inputs, and conclusions of these studies. This comparative analysis holds significance in enhancing our understanding of the impacts of PM pollution on mortality within the HPA and eventually refining the accuracy of impact estimations.

3 SECOND-GENERATION HPA AQMP BASELINE ASSESSMENT

As part of the development process for the second-generation AQMP, an initial baseline assessment was carried out. The technical report containing the details of this baseline assessment can be accessed through South African Air Quality Information Systems (SAAQIS). The primary objective of this baseline assessment served a dual purpose: firstly, to determine the status of air quality within the HPA, and secondly, to evaluate whether the interventions established by the first-generation HPA AQMP yielded improvements in ambient air quality.

The key findings presented in this section predominantly stem from the background assessment, the analysis of ambient air quality across the HPA, the 2019 emission inventory, and the related photochemical modelling. These elements collectively provided a comprehensive understanding of the prevailing air quality status within the HPA, along with insights into the contributions from various sources to the levels of ambient pollution.

3.1 Ambient Air Quality

Since the declaration of the HPA and subsequent development of the first-generation AQMP in 2012, there has been an improvement in ambient air quality monitoring. The number of monitoring stations has increased from twenty-three (23) to forty-nine (49) (as reported on SAAQIS) since the gazetting of the first-generation HPA AQMP. An assessment of historical ambient air quality data spanning from 2007 to 2020 was conducted for the Gert Sibande, Nkangala, as well as Ekurhuleni, with the aim to assess trends in the region. A detailed analysis of ambient air quality trends may be found in the HPA AQMP Baseline Assessment Report.

The main findings are as follows:

3.1.1 Particulate Matter:

- Daily averages: The analysis of the available monitored data (2007-2020) illustrates that while there was a clear improvement in ambient air quality monitoring since the development of the HPA AQMP and implementation of the HPA AQMP, ambient PM_{10} levels are still elevated over many areas in the HPA with exceedances of the PM_{10} daily NAAQS of 75 µg/m³. These elevated concentrations typically coincide with periods of low temperatures and stable atmospheric conditions associated with the winter months.
- Annual trends: The analyses of the annual trends illustrate that some areas have witnessed significant improvements in PM_{10}, namely Club, Camden and Elandsfontein from 2012 to 2020. On the other hand, very little-to-no improvement and even further deterioration has taken place at some sites such as Komati, Bosjesspruit and Majuba. It is, therefore, recommended that these areas require more focused and strategic attention and intervention in terms of compliance and enforcement in respect of all regulated activities, including communities.

Figure 3-1 indicates that non-compliance with the annual PM_{10} standard is observed in all stations, with few exceptions. There is a distinct increase in measured ambient PM_{10} concentrations in 2018 and 2019 with decreased measured concentrations in 2020 coinciding with decreased monitoring at various air quality monitoring station.

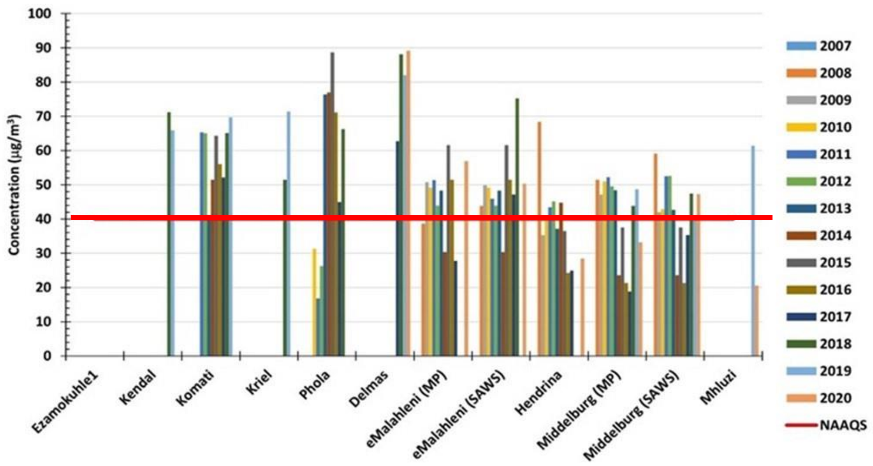


Figure 3-1. Annual average PM10 trends in Nkangala between 2007 and 2020 (NAAQS: 40 µg.m-3).

Figure 3-2 below illustrates numerous instances where the $PM_{2.5}$ annual NAAQS was exceeded at all air quality monitoring station during the period under review. Significant $PM_{2.5}$ annual averages are also noted between 2018 and 2019 with a distinct reduction in 2020 in some of the stations.

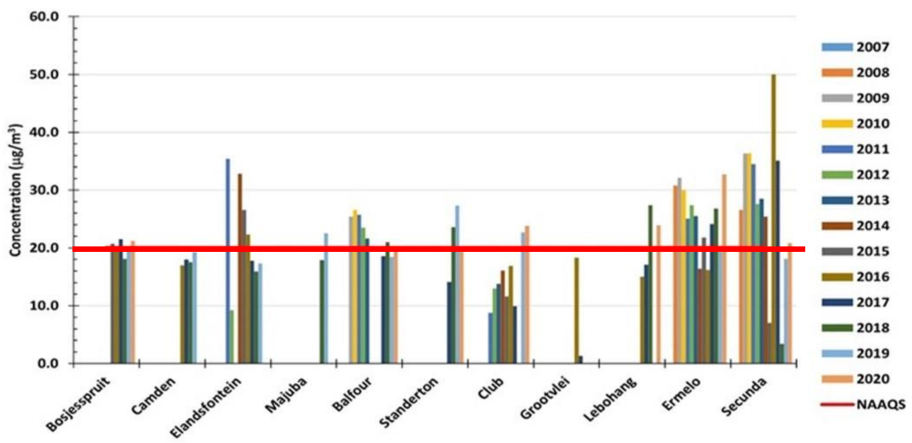


Figure 3-2. Annual average PM 2.5 trends in Gert Sibande between 2007 and 2020 (NAAQS: 20 µg.m-3).

3.1.2 Sulphur dioxide (SO_2)

- Hourly averages: While there was a clear improvement in ambient air quality monitoring since the development and implementation of the HPA AQMP, the hourly averages for SO_2 still show several exceedances of the hourly NAAQS of 134 ppb. These exceedances occur at a large majority of stations for most of the years under review. What is also evident is a clear decrease in the level of monitoring in 2020 with only three stations with useable data.

- Daily averages: Unlike the hourly concentration detailed above, an increased level of compliance with the daily NAAQS of 48 ppb is noted. What is also clear is a pronounced increase in compliance from 2014 to 2020 with consistent compliance noted at Club, Bosjesspruit, Camden and Majuba. Again, what is also evident is a clear decrease in the level of monitoring in 2020 with only three stations with useable data.
- Annual trends: Annual average ambient SO_2 concentrations indicate adequate compliance with the annual NAAQS of 19 ppb, which was evident even prior to the development and implementation of the first-generation HPA AQMP.

Figure 3-3 indicates that a majority of air quality monitoring station in the Nkangala DM were determined to illustrate continuous and consecutive periods of compliance with an instance of non- compliance noted at both eMalahleni and Komati stations with a single non-compliance noted at Hendrina in 2009.

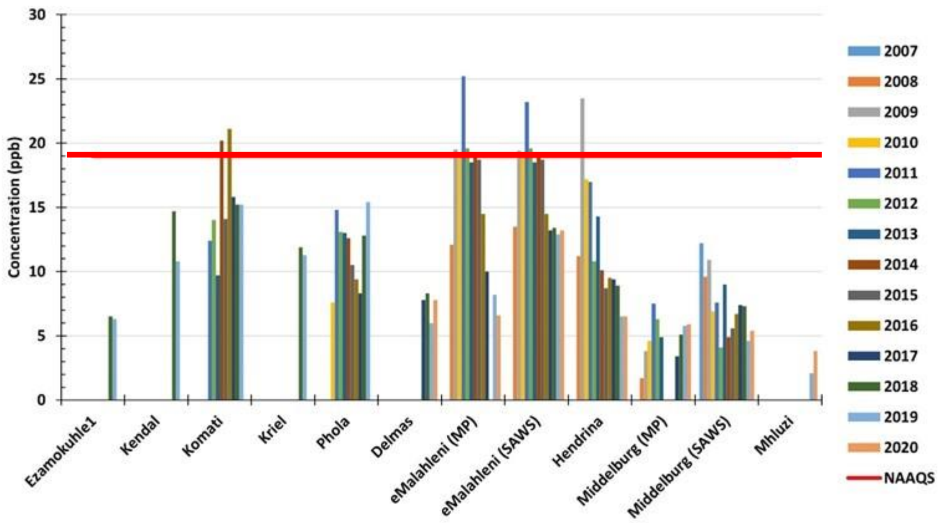


Figure 3-3. Annual average SO2 trends in Nkangala between 2007 and 2020 (NAAQS: 19 ppb).

3.1.3 Nitrogen dioxide (NO_2):

- Hourly averages: The hourly NO_2 NAAQS of 106 ppb was seldom exceeded after 2012 with these exceedances taking place at the Elandsfontein and Club AQMSs. It is also important to note that consistent exceedances of the NAAQS were noted at the Club AQMS prior to 2012 with a clear improvement, thereafter, again speaking to the development of the priority area AQMP and the subsequent implementation from 2012 having an important bearing on the observed improvements.
- Annual trends: Annual average ambient NO_2 concentrations recorded at the AQMS of concern were well within the annual average NAAAQS of 21 ppb, with the exception of exceedances taking place at the Verkykop, Ermelo, as well as Secunda Air Quality Monitoring Stations.

Figure 3-4 indicates seldom instances where the annual NO_2 NAAQS was exceeded by various air quality monitoring station with the with the Secunda site illustrating less pronounced exceedances in 2016 and 2017.

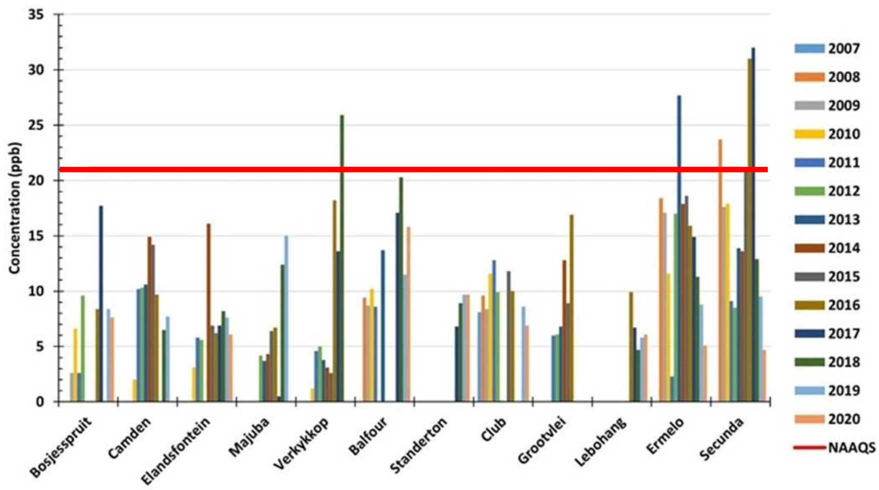


Figure 3-4. Annual average NO2 trends in Gert Sibande between 2007 and 2020 (NAAQS: 21 ppb).

3.1.4 Ozone (O_3):

- Eight-hour running averages: There is a clear improvement in ambient monitoring from 2012 onwards. While this clear improvement is evident, exceedances of the eight-hour O_3 running average NAAQS of 61 ppb was evident prior to 2012 with exceedances occurring at the Club and Bosjesspruit. Improved measurements are noted from 2016 to 2019. However, these measurements are still above the eight-hour running average O_3 NAAQS.

Figure 3-5 below indicates improved O_3 from 2011 onwards with most air quality monitoring station recording annual average O_3 concentrations below 40 ppb from 2013 onwards. No enforceable annual O_3 NAAQS has not been promulgated in South Africa.

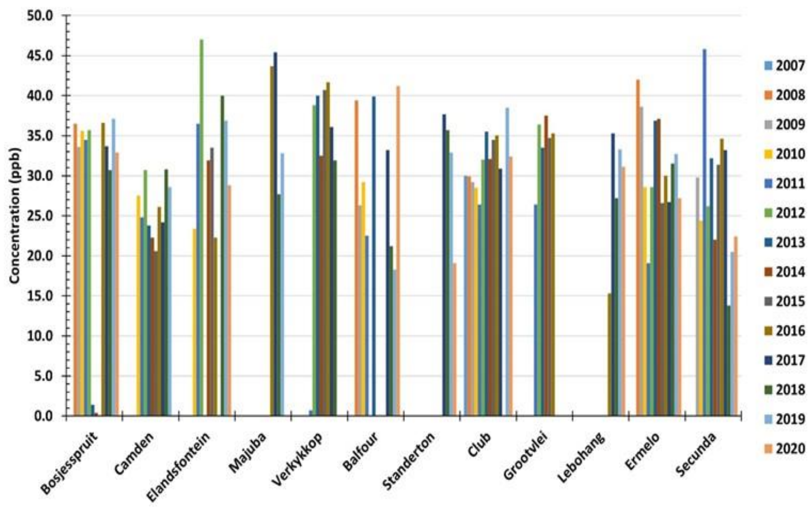


Figure 3-5. Annual average O3 trends in Gert Sibande between 2007 and 2020.

3.2 Emissions Inventory

An emission inventory was compiled with dual objectives; firstly, to demonstrates emissions originating within the HPA, tailored for air quality management within the priority area. Secondly, it encompasses emissions from neighbouring regions, serving as input for atmospheric modelling. A detailed report on the compilation of the emissions inventory may be found in the HPA AQMP Baseline Assessment Report. Emissions were quantified for all primary sources within the HPA, as well as those from the surrounding regions to contribute to air quality modelling. The presented emission inventory focuses exclusively on the sources within the HPA. These include the following:

- Industrial and energy generation sectors: Sources of air pollutants represent mostly stationary facilities operating under licences or registration, of which the emissions are reported to the authorities annually (Section 21 and Section 23 sources). A total of 866 individual point sources were identified across 117 facilities in the HPA, mostly in Ekurhuleni and the Nkangala DM. The industrial emission inventory was compiled from 2019 emission inventory reports submitted to the National Atmospheric Emission Inventory System (NAEIS).
- Windblown dust: Particulates are the typical form of pollutants associated with mining activities. Open-cast mining, which forms the bulk of mining activities in the Mpumalanga region, can emit pollutants near ground-level over potentially large areas. The recent surge in the need for Critical Minerals in consumer countries (Nwaila, 2021), coupled with improved mineral extraction methods, presents an opportunity for mine dumps, tailing and stockpile reclamations. This process involves the extraction of residual minerals from mine dumps or tailings storage facilities (especially gold and platinum group mineral dumps), usually through a method called hydraulic mining. The disturbance and movement of tailings material during mineral retrieval can generate dust, which can become airborne and contribute to particulate emissions. To quantify these windblown particulate emission rates, the Airborne Dust Dispersion Model from Area Sources (ADDAS) developed by Airshed Planning Professionals (Burger, 2011) was utilized. The sources of windblown particulates include exposed topsoil areas.
- Transport related emissions: Accounting for vehicles travelling on arterial and main roads, national freeways, secondary roads, slipways, off- and onramps and streets. Use was made of SANRAL national counts for 2016 and the Mpumalanga Road Assets Management System (MP RAMS) traffic count data (2019 update). A top-down and bottom-up approach was followed.
- Residential fuel burning: Fuel combustion for energy use in the residential environment in the HPA. Both a top-down (for gas and paraffin) and bottom-up (for wood and coal) approach was used for residential fuel use emissions. Community Survey 2016 data were used to proportionally disaggregate national fuel consumption to provincial and then SAL geographic units.
- Residential waste burning: Residential waste combustion for energy use in the residential environment in the HPA. A bottom-up approach was used for residential waste burning emissions. Community Survey 2016 data were used to proportionally disaggregate national fuel consumption to provincial and then SAL geographic units.
- Biogenic volatile organic compounds (VOC): The CAMS global emissions dataset was used to provide biogenic VOC emission estimates. These emissions were simulated using the MEGAN model.
- Agricultural ammonia: The CAMS global emissions dataset was used to provide NH_3 emission estimates from agriculture (livestock [animal excreta], soils [fertiliser application] and agricultural waste burning).
- Forest and Veld Fire – Biomass burning: Biomass burning emissions from large-scale agricultural burning and natural fires for 2019 were obtained from the Fire Inventory from NCAR (FINN). This dataset uses active fire count observations, landcover cover from MODIS sensors and estimated fuel consumption to quantify biomass burning emissions.

- Spontaneous combustion related emissions: Currently, there is no acceptable standard method for estimating emissions from spontaneous combustion. This is due to the difficulty in obtaining reliable measurements in coal mining areas. For the HPA, emissions emanating from spontaneous combustion were estimated by multiplying emission rates obtained from Cook and Lloyd (2012), with the area of each coal mine operating in the HPA.

Table 3-1 below provides a summary of the total annual emissions from each sector covered in the HPA emissions inventory.

Table 3-1: Emission inventory summary for all sources within the Highveld Priority Area (tpa – tonnes per annum)

Emission Source	CO	NO_x	NMVOC's	SO_2	$PM_{2.5}$	PM_{10}
On Road Vehicles	13 321	38 093	913	734	837	-
Residential Waste Burning	2 892	221	-	87	628	665
Residential Fuel Burning	130 054	3 769	-	9 092	19 228	19 741[b]
Windblown Particulate	-				30 465	104 901
Biomass Burning	98 018	1 438		1 080	9 901	10 290
Industry and Energy Generation	107 360	790 620	226 000	1 277 290	64 730	127 170
Spontaneous Combustion	7 815	149		924 [a]		
Total	**359 460**	**834 290**	**226 913**	**1 289 207**	**125 789**	**262 767**

Note: (a) Emissions are estimated as SO_X
(b) Emissions are estimated as the sum of PM_{10} and $PM_{2.5}$

3.3 HPA Photochemical Modelling

The Comprehensive Air Quality Model with Extensions (CAMx) chemical air quality model was used to simulate current ambient concentrations of pollutants within the HPA to assess ambient air quality on a more comprehensive spatial scale than what can be provided with monitoring stations. Areas of elevated concentrations can be identified for expanded monitoring and when viewed within the context of the emission inventory, likely contributing sources are targeted for intervention strategies.

The CAMx is a computational tool used for simulating and predicting chemical air quality. It's designed to model the complex interactions of various pollutants in the atmosphere, including pollutants emitted from sources like vehicles, industries, and natural processes. CAMx takes into account factors such as emissions, meteorology, chemical reactions, and atmospheric dispersion to provide insights into how pollutants disperse, react, and contribute to air quality levels in a specific region. This model is widely preferred since it is employed by researchers, environmental agencies, and policymakers to assess the potential impacts of different emission reduction strategies and to formulate effective air quality management plans.

Figure 3-6 summarises the input data requirements of CAMx, whilst Figure 3-7 illustrates the CAMx grid configuration used for simulations. A parent grid of ~6 km resolution extends over much of the eastern half of South Africa, while a nested grid of ~2 km resolution caters for simulation over the HPA. CAMx was run over the HPA from 2018 to 2020.

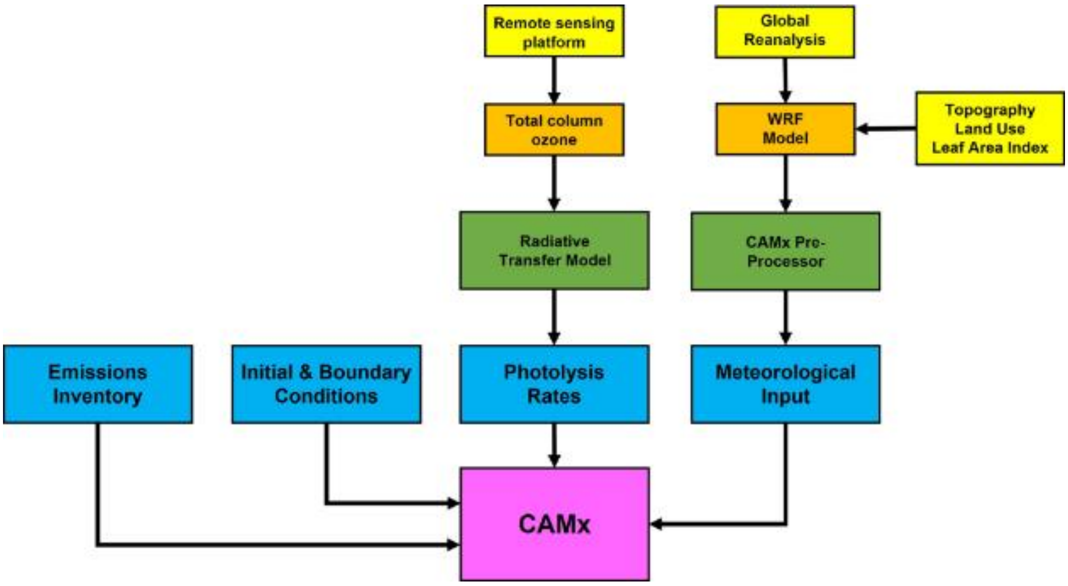


Figure 3-6. Schematic diagram of the CAMx modelling system.

CAMx requires gridded meteorological data for the required meteorological parameters. The data are required on an hourly basis and, as such, the most preferred way to generate this information is via a meteorological model. The Weather Research and Forecasting Model (ARW core) was used to generate meteorological data for input into CAMx.

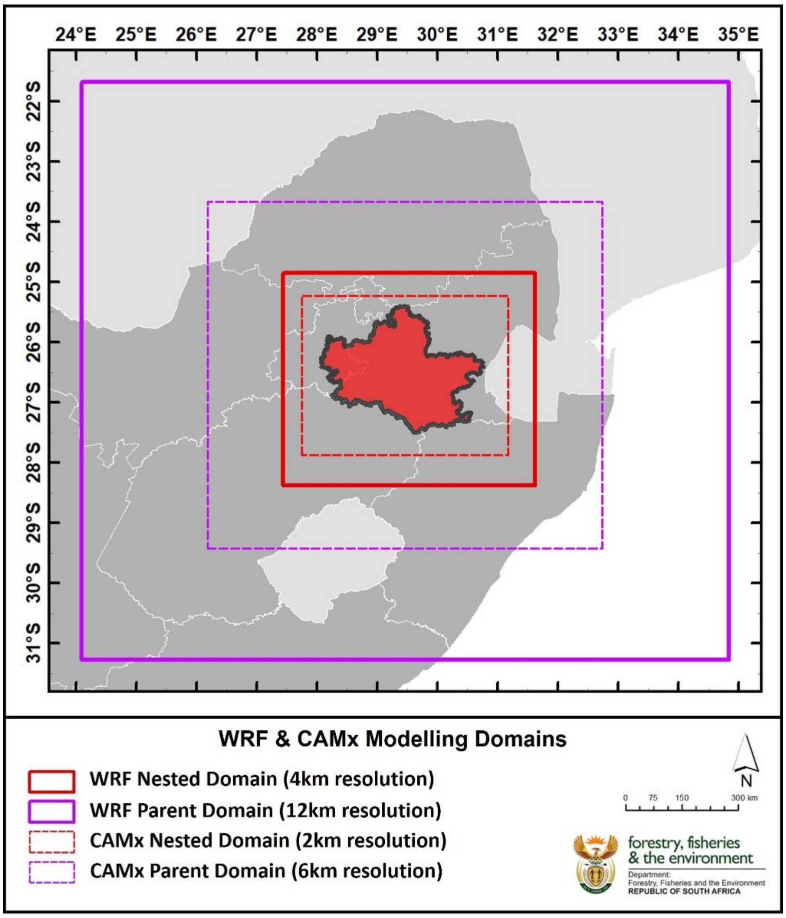


Figure 3-7. Weather Research and Forecasting (WRF) Parent Domain (12km), Weather Research and Forecasting Nested (WRF) Domain (4km), CAMx Parent Domain (6km), CAMx Nested Domain (2km).

Concentration maps of pollutants have been prepared using the time-averaging applicable to each pollutant according to the NAAQS. A summary of the main finding for each pollutant is detailed below.

3.3.1 Particulate Matter (PM_{10} and $PM_{2.5}$):

- For PM, both the simulated PM_{10} and $PM_{2.5}$ concentrations tend to have similar characters in the spatial distribution of exceedances.
- For annual NAAQS, the same areas are also predicted to be impacted though the spatial extent is reduced for PM_{10}, while it has become even more extended for $PM_{2.5}$ exceedances (Figures 4-4 and 4-6).
- In terms of 24-hour exceedances, the central HPA region in areas such as Secunda and west of Ermelo, as well as the north (eMalahleni) to north-west regions, the concentrations for PM_{10} and $PM_{2.5}$ are exceeding the permissible number of exceedances, with a large portion of Gauteng (including the VTAPA region) predicted to be impacted by both pollutants (see Figures 4-5 and 4-7).

3.3.2 Sulphur Dioxide (SO_2):

- It is noted that annual SO_2 NAAQS (19 ppb) is exceeded primarily over the west (Sasolburg area, part of the VTAPA) with Secunda, eMalahleni, Witbank and Ekurhuleni also illustrating pronounced areas of exceedance (Figure 4-1).
- A hotspot to the north of Secunda seems to stand out from the other spots within the HPA and occurs for all average periods, with daily impact having the largest spatial extent bulging northward towards the HPA boundaries (see Figure 4-1).
- Other HPA bounded hotspots, such as areas around Amersfoort, eMalahleni and Ekurhuleni, become more significant with regard to the 24-hour Frequency of Exceedance as they become more spatially extended (Figure 4-3).
- Various other hotspots are also predicted at the edges of the modelling domain over the west (Sasolburg area, part of the VTAPA) and the north-western region, which are outside the HPA region.

3.3.3 Nitrogen Dioxide (NO_2):

- For annual NAAQS of NO_2 (21 ppb), limited number of areas were simulated to be impacted by the exceedances of the annual standard, including Secunda and in the north-western part of the HPA where a few numbers of hotspots were predicted in areas around Gauteng, as indicated by the red spots (Figure 4-8 and Figure 4-9).

3.3.4 Ozone (O_3)

- The simulated annual O_3 concentrations over the modelling domain indicate a generally lower O_3 concentration towards the centre of the HPA region, with distinct elevated concentrations towards the outer border of the modelling domain (Figure 4-10).

4 SECOND-GENERATION HPA AQMP: EMISSION REDUCTION ASSESSMENT

Feasible strategies were identified to create emission reduction plans aimed at addressing the seven significant emission sectors that contribute to the current air quality challenges in the HPA. These complexes encompass various sectors:

i. Industry and Energy Generation;
ii. Mining and Windblown Dust;
iii. On Road Vehicles;
iv. Residential Fuel Burning;
v. Residential Waste Burning;
vi. Biomass Burning; and
vii. Agricultural Emissions.

To ensure effectiveness, it was necessary to examine potential future stages of emission reductions and explore consistent combinations for reduction. The formulated emission reduction strategies were then subjected to modelling in order to evaluate their impact on achieving compliance with ambient air quality standards in the HPA. Stakeholders were tasked with collaboratively developing, refining, and characterizing a practical set of emission reduction strategies that encompassed a diverse array of potential scenarios. Drawing upon the collective input from stakeholders, the Department subsequently presents a concise summary of modifications and a focused set of actionable tasks.

Guided by this collaborative effort, the recommended measures for emission reduction were outlined. This process aimed to ensure a comprehensive approach to improving air quality and minimizing the impact of the identified problem complexes in the HPA.

4.1 Emission Reduction Targets

The objective of reducing atmospheric emissions in the HPA is to achieve the overall compliance with National Ambient Air Quality Standards by 2030:

Objective	Year achieved
To achieve compliance with National Ambient Air Quality Standards	2030

During a two-day workshop involving HPA stakeholders, diverse methods and justifications were employed to analyse the emission source categories under examination. Table 4-1 provides a summary of the emission reduction goals, encompassing a set of modifications to the emission source categories. Within this context, distinct emission reduction targets were explored. Notably, the 2030 Target represents the designated moment when all emission source categories should successfully attain the predetermined emission reduction levels.

Table 4-4-1: Emission reduction targets for the HPA

Sector	2030
Industry and Energy Generation	40% Reduction on the baseline
Residential Waste Burning	100% Reduction on the baseline
On-road Vehicle	30% Reduction on the baseline
Residential Fuel Burning	30% Reduction on the baseline
Biomass Burning	30% Reduction on the baseline
Agriculture	20% Reduction on the baseline
Windblown Dust	40% Reduction on the baseline

4.2 Emission Reduction Modelling

Emission reduction modelling was undertaken for the seven previously mentioned source categories, employing the CAMx model. The foundational emission inventory for this modelling was based on the 2019 HPA emission inventory. This served as the baseline against which emission reduction targets were evaluated using the CAMx model. The following detailed reductions were applied and modelled:

4.2.1 Industry and Energy Generation

By 2030 all industrial and energy generation sources will have reduced their emissions by 40% compared to the baseline of 2019. Table 4-2 details emissions for the 2030 emission reduction targets.

Table 4.2: Emission (kt/a) for each emission reduction target in the nest domain for industrial emissions

Emission Target	PM_{10}	$PM_{2.5}$	SO_2	NO_X	CO	VOC	NH_3
Baseline	168.8	83.7	1541.2	929.5	912.8	281.6	1.0
2030 (i.e., 40% Reduction on the baseline)	101.3	50.2	924.7	557.7	547.7	168.9	0.6

4.2.2 Mining and Windblown Dust

The first-generation HPA AQMP (2012), conducted a dust-related emissions inventory study based on a characterization of open dust sources over a defined time span. The investigation, completed in accordance with US-EPA AP42 requirements, discovered that dust created by mine haul roads accounted for 93.3% of total emissions from the mine, with topsoil handling accounting for the next biggest source. In contrast, the dust-related emissions listed in the second-generation HPA AQMP focused on emissions from exposed topsoil and mine reclamation processes, which include mine dumps, rather than haulage highways. As a result, emission reduction objectives and efforts are now aligned with exposed topsoil, mine reclamation processes, and mine wastes.

Given this, the erosion losses from grassed slopes measured by Blight (1989) were found to be in the order of 100 t/ha/year compared to uncontrolled slopes from which losses of up to 500 t/ha/year were recorded (DFFE, 2020). This relates to an 80% control efficiency due to effective vegetation cover. According to the Australian National Pollutant Inventory (NPI, 2012), the control efficiency of vegetation is 40% for non-sustaining vegetation and 90% for re-vegetation. For the purpose of emission reduction modelling, a control efficiency of 40% to be achieved by

2030 was applied to all tailings storage facilities (TSFs) within the HPA. Table 4-3 details PM10 emissions for the 2030 emission reduction targets.

Table 4-3: Emission (kt/a) for each emission reduction target in the nest domain for windblown particulates emissions

Emission Target	PM_{10}	$PM_{2.5}$	SO_2	NO_X	CO	VOC	NH_3
Baseline	118.9	32.7	-	-	-	-	-
2030 (i.e., 40% Reduction on the baseline)	71.3	19.6	-	-	-	-	-

4.2.3 On Road Vehicles

This modification in the emission sector only applies to the 2030 emission reduction objective. It was based on a variety of assumptions supported by the City of Joburg Vehicle Emissions Control Strategy and Action Plan (CoJ, 2021), as CoJ vehicle emissions account for a major amount of total HPA vehicle emissions. The strategy outlines specific emission reduction targets and interventions, such as activities to reduce annual vehicle mileage, passenger vehicles, and high emitter vehicles older than 15 years, all of which are expected to reduce vehicle emissions by more than 30%. Table 4-4 shows emissions for the 2030 emission reduction objective.

Table 4-4: Emission (kt/a) for each emission reduction target in the nest domain for mobile sources emissions

Emission Target	PM_{10}	$PM_{2.5}$	SO_2	NOx	CO	VOC	NH_3
Bassline		1.7	1.6	79.2	28.1	1.9	
2030 (i.e., 30% Reduction on the baseline)	-	1.2	1.1	55.4	19.7	1.3	-

4.2.4 Residential Fuel Burning

Residential fuel burning: As stated in the second-generation VTAPA AQMP (DFFE, 2020), electrification of informal settlement households would not necessarily result in a decrease in solid fuel use, while it should also be noted that residents of informal settlements are not the only users of fossil fuels as part of residential fuel burning. Furthermore, given the present economic and global climate, transitioning from coal to LPG is not a financially realistic alternative for many South Africans. As a result, the installation of ceilings/insulation mechanisms, as proposed by the Department of Human Settlements (DHS) report on the Evaluation of the Impact of Human Settlements Development Programmes on the Environment (2nd Ed) (DHS, 2017), would be a feasible intervention to mitigate the effects of climate change. Coupled with this intervention could be the implementation of low smoke stoves through the *Basa njengo Magogo* campaign piloted by the DM, which is essentially a top-down fire lighting method for mbawula stoves as short- to medium-term solution to address domestic fuel burning while insulation gathers momentum. In the conventional bottom-up fire ignition approach, the order of preparing a fire is paper, wood then coal, however with the Basa njengo Magogo method the order is reversed with a few pieces of coal placed on the top. The idea is that the fire burns from the top down, improving the combustion of the coal through increased oxygen flow created by an updraft through the fire, requiring less coal to reach cooking temperature and resulting in up to 50% less smoke emissions. Significant reductions in particulates (87%) and CO emissions have been noted, with little to no effect on CO_2 emissions (WSP, 2020). A 30% reduction derived from the emission reduction target analysis exercise is detailed in Table 4-5 below.

Table 4-5: Emission (kt/a) for each emission reduction target in the nest domain for residential fuel Burning emissions.

Emission Target	PM_{10}	$PM_{2.5}$	SO_2	NOx	CO	VOC	NH_3
Baseline	54.7	53.3	25.0	10.2	360.1	37.9	-
2030 (i.e., 30% Reduction on the baseline)	38.3	37.3	17.5	7.1	252.1	26.5	-

4.2.5 Residential Waste Burning

As a result of poor municipal solid waste collection rates, informal garbage burning was recognized as a significant cause of air pollution at a local level within the HPA, as described in the Stats SA Community at a Glance Reports (2016). Intervention measures to reduce this low-level emission source are consistent with the government's goal of collecting 100% of municipal solid trash by 2030. As a result, no emissions are projected for residential waste burning in 2030 (See Table 4-6), which is consistent with the DFFE's Chemicals and Waste Management Directorate initiatives, which aim to achieve complete residential waste collection by 2030.

Table 4-6: Emission (kt/a) for each emission reduction target in the nest domain for residential waste burning emissions.

Emission Target	PM_{10}	$PM_{2.5}$	SO_2	NOx	CO	VOC	NH_3
Baseline	2.2	2.1	0.3	0.7	9.7	-	-
2030 (i.e., 100% Reduction on the baseline)	0	0	0	0	0	-	-

4.2.6 Forest and Veld Fire – Biomass Burning

Although the second-generation HPA AQMP made use of NCAR's Fire INventory (FINN), which provides daily, high-resolution fire emissions data for atmospheric chemistry models, emissions from biomass burning are difficult to quantify due to the seasonal and irregular nature of this emissions source. Furthermore, unplanned fires are a natural component of many ecosystems' functioning and fire prevention strategies can be useful in preventing uncontrolled human-caused fires, as envisaged in the National Veld and Forest Fire Act, 1998 (Act No 101 of 1998) (WSP, 2020). Public awareness and outreach initiatives are a low-cost method of avoiding unintentional fires and teaching people about the hazards and consequences for air quality and human health. Community forums, television, radio, and other kinds of media are all possibilities. The following interventions are proposed for the HPA to implement:

- Seasonal restrictions on burning practices.
- Emission reduction techniques (e.g., stipulating the use of specific burning techniques such as 'backburning' for increased combustion efficiency, etc.).
- Meteorological scheduling to optimize the atmospheric dispersion potential (e.g., middle of the day).
- The role of the fire services in air pollution control needs to be identified in the Local Municipalities.

- Each local Fire Department should maintain and update a database of the locations of veld fires and the extent of the areas burnt. This will assist with the quantification of biomass burning emissions.
- Public awareness among farm owners should be raised about the dangers associated with uncontrolled fires and the implications for air quality and human health.

The reduction derived from the emission reduction development analysis exercise for biomass burning emissions is detailed in Table 4-7.

Table 4-7: Emission (kt/a) for each emission reduction target in the nest domain for biomass burning emissions.

Emission Target	PM_{10}	$PM_{2.5}$	SO_2	NOx	CO	VOC	NH_3
Baseline	48.8	44.7	4.8	5.7	402.3	-	5.4
2030 (i.e., 30% Reduction on the baseline)	34.2	31.3	3.4	4	281.6	-	3.8

4.2.7 Agricultural Emissions

Agriculture emits ammonia (NH_3) into the atmosphere as a result of the volatilization of livestock waste and inorganic mineral fertilizers. The following planned agricultural NH_3 emission reduction strategies in the HPA are aimed at lowering NH_3 volatilization:

- Solid manure composting prior to application to agricultural fields. The frequency of mechanical turning of composted manure must be kept to a minimum during the composting process. This has the advantage of minimizing NH_3 losses while also boosting compost quality since nitrogen is conserved.
- Appropriate application of manure and fertilizer. Manure or fertilizer applications should be done shortly before a light rain on a cool, overcast day, or in the early morning or evening, to avoid smothering the soil.

These techniques should be shared with farmers in the HPA to ensure that agricultural emission reduction targets are achieved.

Table 4-8: Emission (kt/a) for each emission reduction target in the nest domain for agricultural emissions.

Emission Target	PM_{10}	$PM_{2.5}$	SO_2	NOx	CO	VOC	NH_3
Baseline	-	-	-	-	-	-	39.6
2030 (i.e., 20% Reduction on the baseline)	-	-	-	-	-	-	31.7

4.3 Emission Reduction Simulations – 2030 Ambient Air Quality Levels

To gain an understanding around the relationship of ambient air quality in the HPA to the various emission reductions (brought about by interventions), photochemical modelling was used to translate the emission reduction targets to changes in ambient pollutants levels. The following maps illustrate the impact on ambient air quality resulting from the emission reduction targets. Pollutants shown are PM_{10}, $PM_{2.5}$, SO_2, NO_2, and O_3. For each pollutant, only the relevant averaging periods are shown (i.e., only averaging periods for which there is a NAAQS).

For each averaging period, the first map shows the baseline concentrations, whereas the second map illustrates the 2030 Emission Reduction Target simulation that is seen as a cumulative result, and thus the percentage decrease from baseline to the 2030 Target shows the total reduction.

4.3.1 SO_2 Emission Reduction Simulation

For SO_2 concentrations (Figure 5-1), it is noted that the annual baseline SO_2 NAAQS (19 ppb, indicated by the red isopleths) is exceeded primary towards the west (Sasolburg area, part of the VTAPA) with Secunda, Kriel, eMalahleni, Middelburg and Ekurhuleni also illustrating areas of exceedances. Exceedances were also simulated around Tutuka and towards the south of Amersfoort. In terms of the 2030 Target, the spatial extent of the areas of exceedance is smaller with more localized exceedance hotspots that persist in the west of the HPA as well as the central HPA (Secunda).

The frequency of exceedances (1-hour and 24-hour) indicated in Figures 5-2 and 5-3 are also more to the west and central part of the HPA in the baseline which shrinks considerably in the 2030 Target with the Sasolburg and Kriel being the only areas with clearly persistent frequency of exceedance in the 2030 emission reduction target.

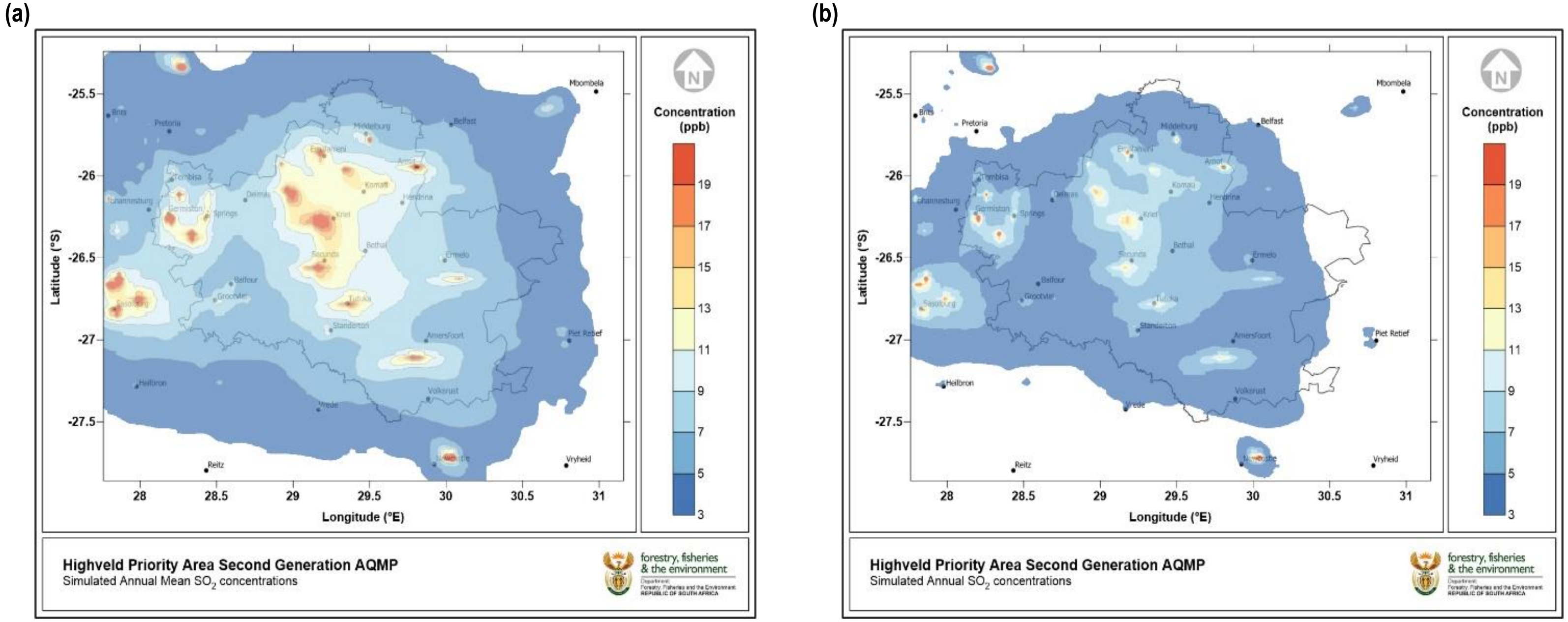


Figure 4-1: Concentration maps indicating annual simulated SO_2 concentrations for the (a) baseline and (b) 2030 Emission Reduction Target.

(a) (b)

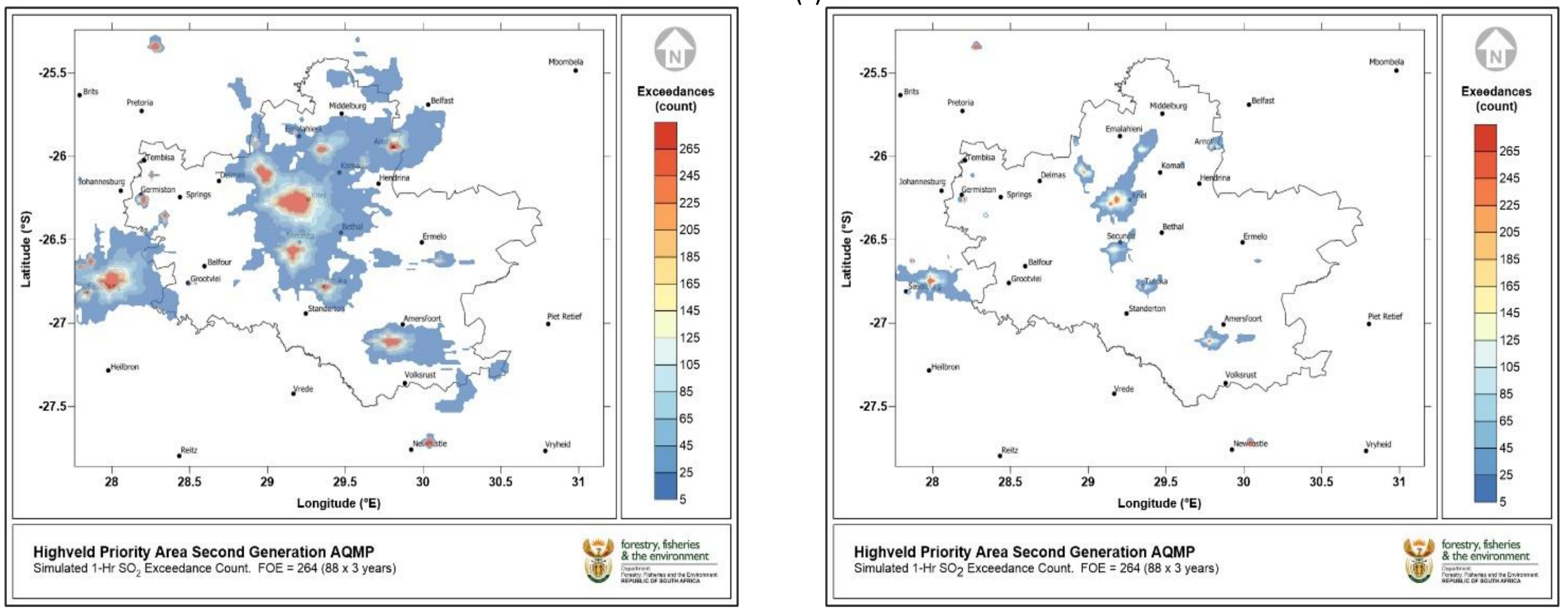


Figure 4-2: Concentration maps indicating 1-hour simulated SO_2 concentration exceedance counts for the (a) baseline and (b) 2030 Emission Reduction Target.

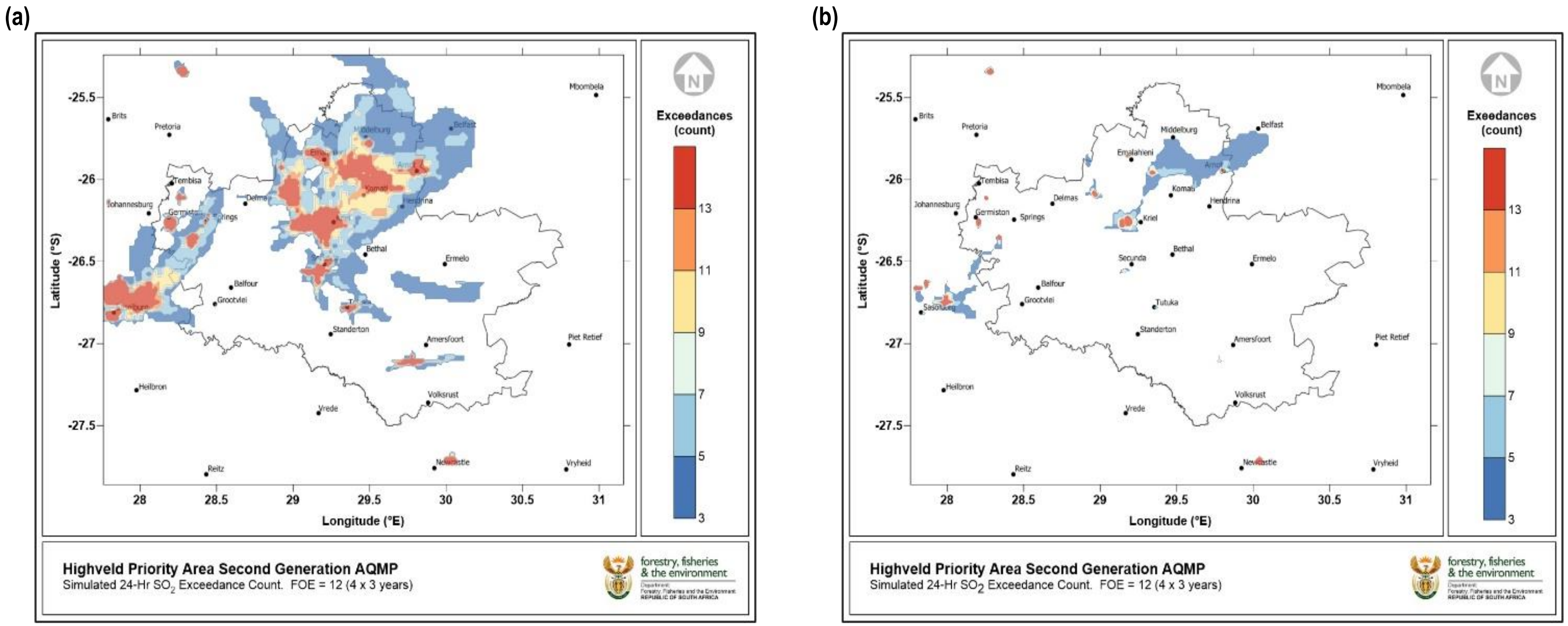
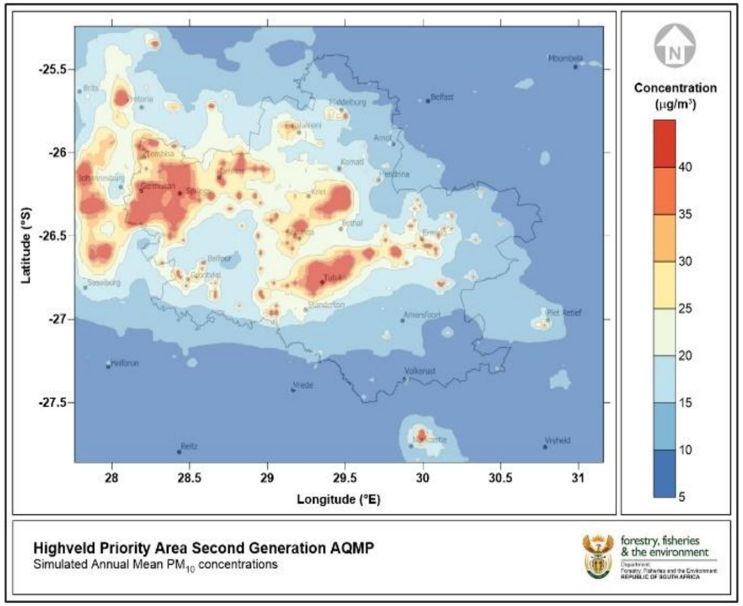


Figure 4-3: Concentration maps indicating 24-hour simulated SO_2 concentration exceedance counts for the (a) baseline and (b) 2030 Emission Reduction Target.

4.3.2 PM_{10} Emission Reduction Simulation

For the baseline (Figure 5-4), high PM_{10} concentrations (NAAQS is 40µg/m^3, indicated by the red isopleths) are simulated over the central and western region of the HPA (Secunda, Tutuka, Kriel and majority of Ekurhuleni, Johannesburg, Vereeniging, and Tshwane). There are also smaller regions around eMalahleni, Middelburg and Ermelo. While these regions are reduced considerably in the 2030 emission reduction target for the annual mean. The same can be said for the frequency of exceedance in the baseline and 2030 emission reduction target (Figure 5-5) where the frequency of exceedances are still persistent in the 2030 emission reduction target albeit the spatial extent is noticeably smaller.

(a)



(b)

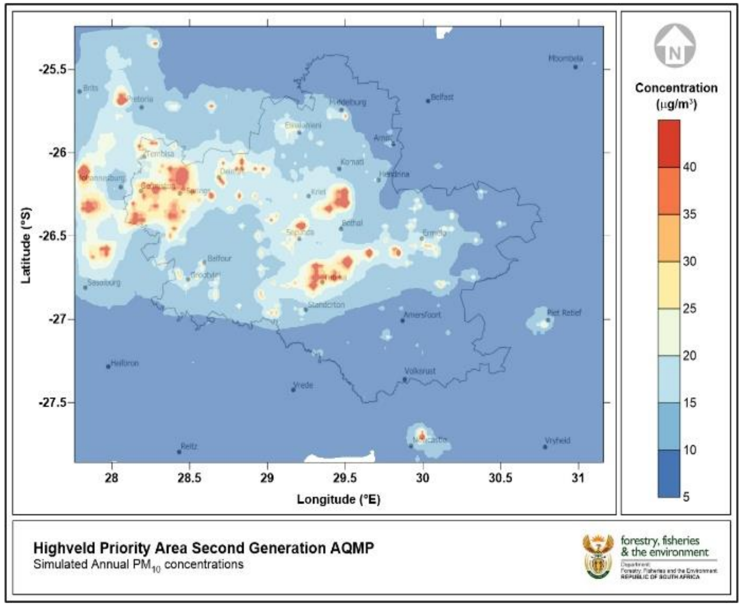


Figure 4-4: Concentration maps indicating annual simulated PM_{10} concentrations for the (a) baseline and (b) 2030 Emission Reduction Target.

(a) (b)

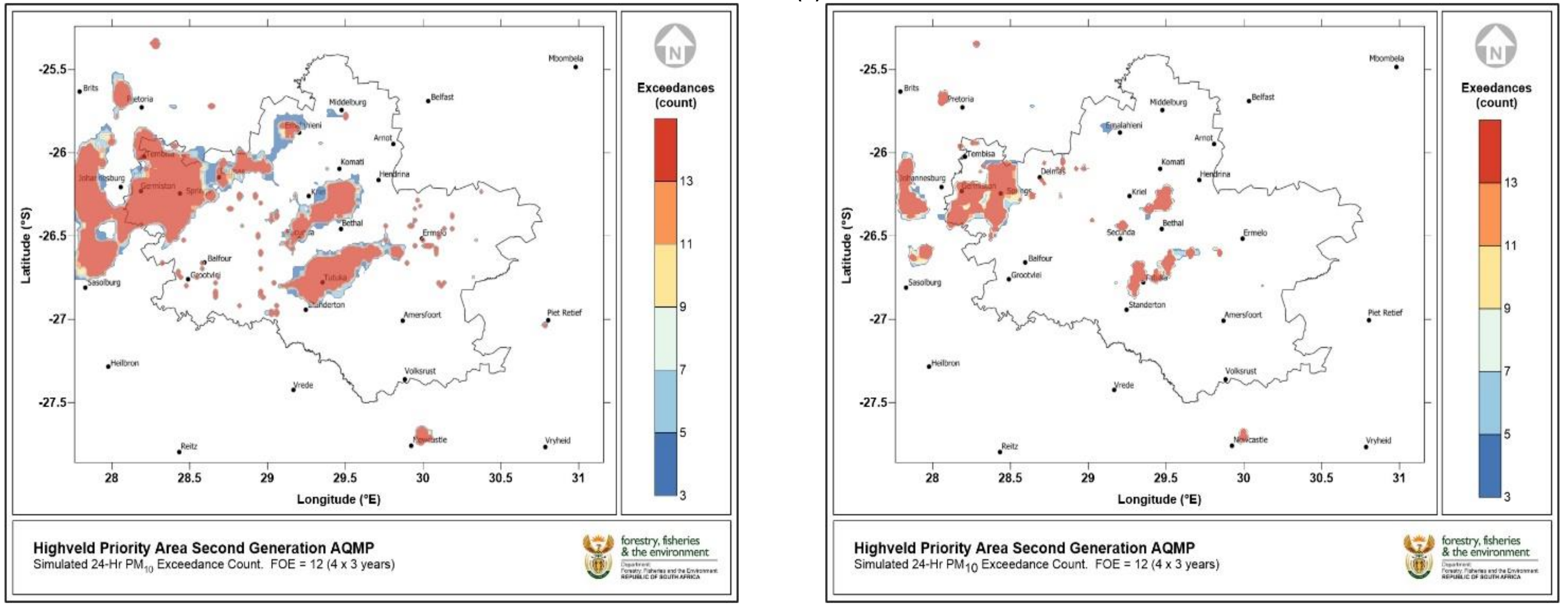


Figure 4-5: Concentration maps indicating 24-hour simulated PM_{10} concentration exceedance counts for the (a) baseline and (b) 2030 Emission Reduction Target.

4.3.3 $PM_{2.5}$ Emission Reduction Simulation

Both the simulated annual mean PM_{10} and $PM_{2.5}$ (Figures 5-4 and 5-6) concentrations tend to have a similar character in the spatial distribution. High $PM_{2.5}$ concentrations (NAAQS is 20µg/m^3, indicated by the red isopleths) are simulated over the central and western region of the HPA (Secunda, Tutuka, Kriel and majority of Ekurhuleni, Johannesburg, Vereeniging, and Tshwane). There are also smaller regions around eMalahleni, Middelburg and Ermelo. Once again, the regions of exceedances are reduced considerably in the 2030 emission reduction target for the annual mean (Figure 5-7). The same can be concluded for the frequency of exceedance in the baseline and 2030 emission reduction target where the frequency of exceedances are still persistent in the 2030 emission reduction target albeit the spatial extent is noticeably smaller. However, there are still areas where the frequency of exceedance is above the permissible limit which are centralised to the west of the HPA in the Ekurhuleni and Johannesburg regions.

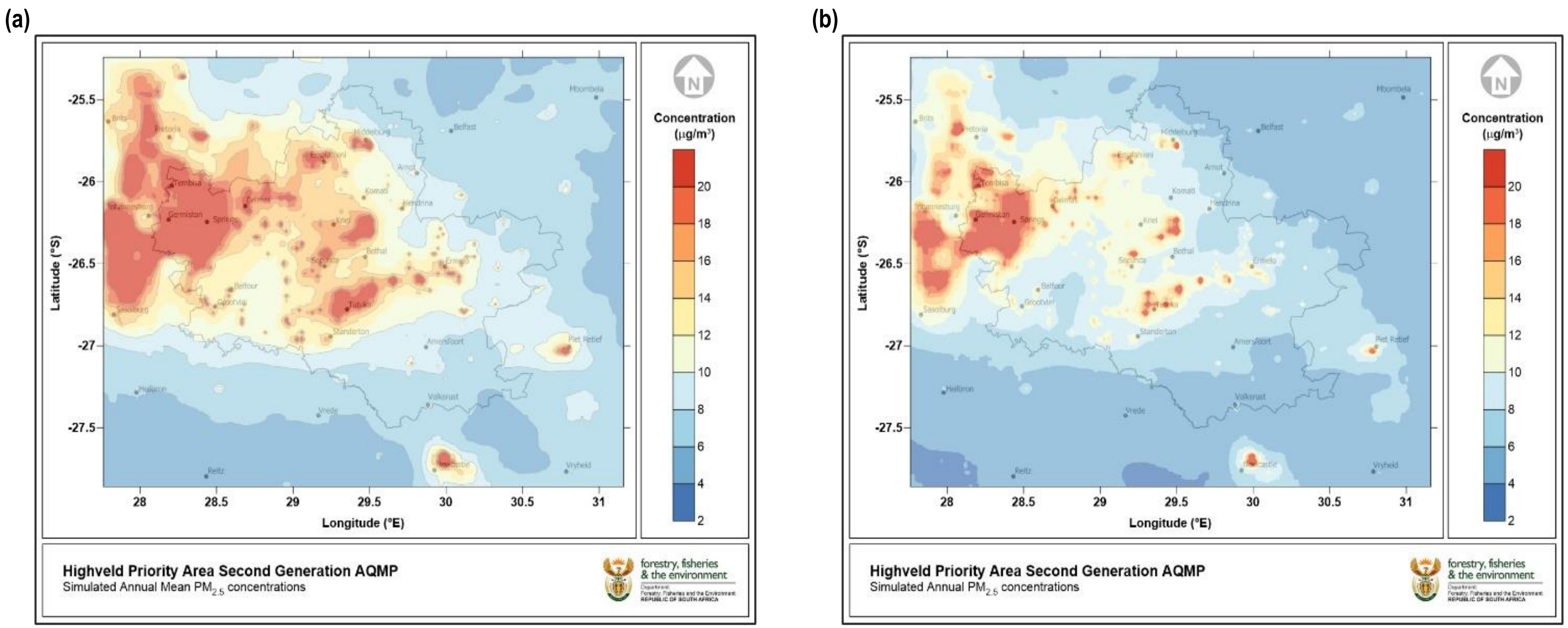


Figure 4-6: Concentration maps indicating annual simulated $PM_{2.5}$ concentrations for the (a) baseline and (b) 2030 Emission Reduction Target.

(a) (b)

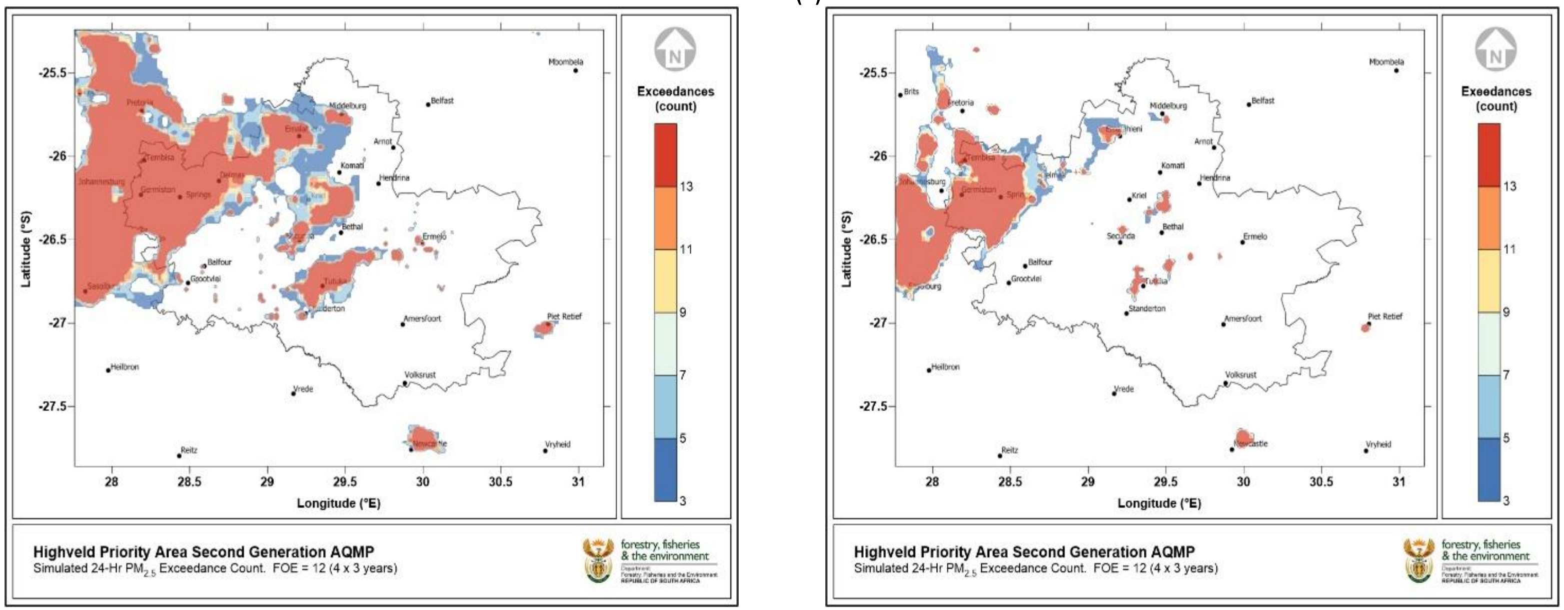


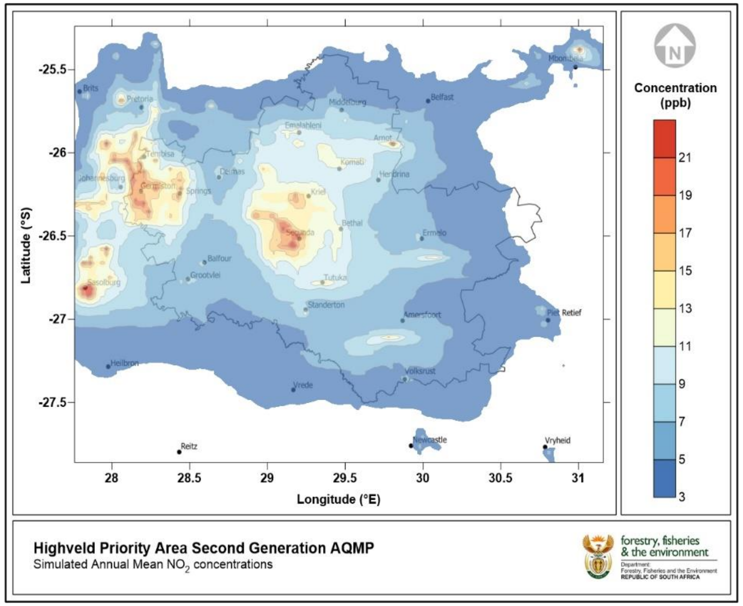
Figure 4-7: Concentration maps indicating 24-hour simulated $PM_{2.5}$ concentration exceedance counts for the (a) baseline and (b) 2030 Emission Reduction Target.

4.3.4 NO_2 Emission Reduction Simulation

The NAAQS of NO_2 (21 ppb, indicated by the red isopleths) highlights the areas above the NAAQS. These regions include Secunda, Sasolburg. NO_2 images also highlight that most of the HPA are complying with the annual NO_2 NAAQS which is particularly true for the 2030 emission reduction target (Figure 5-8). The permissible number of exceedances is 264, and the red isopleth indicates regions exceeding this permissible number of exceedances.

Simulated 1-hour results as illustrated indicate no regions in the HPA exceeding the permissible number of exceedances for both the baseline and 2030 emission reduction targets (Figure 5-9).

(a)



(b)

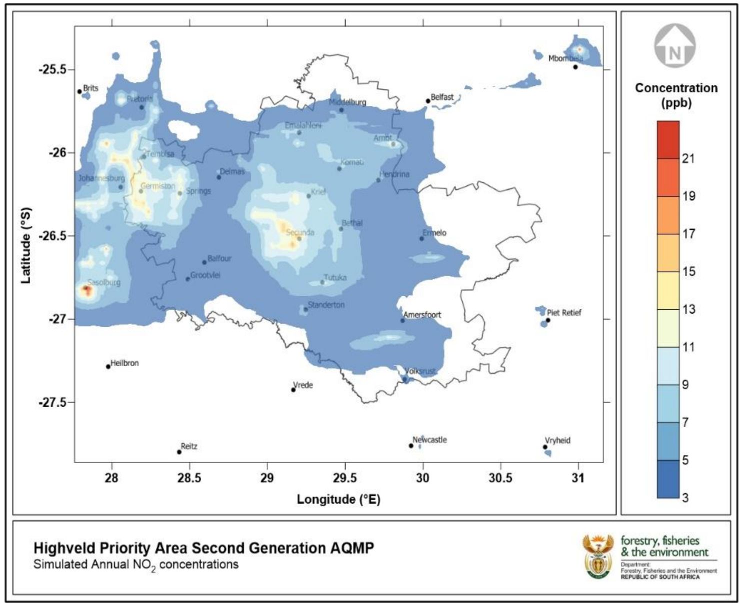


Figure 4-8: Concentration maps indicating annual simulated NO_2 concentrations for the (a) baseline and (b) 2030 Emission Reduction Target.

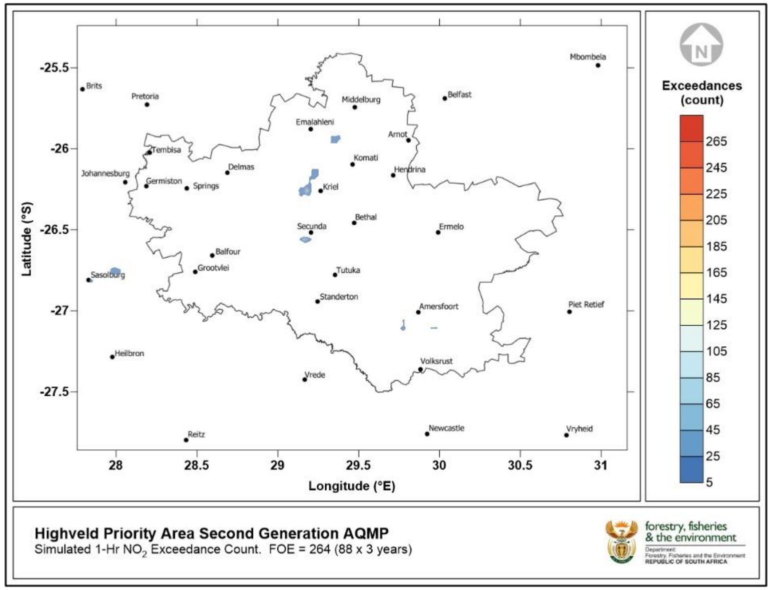


Figure 4-9: Concentration map indicating 1-hour simulated baseline NO_2 concentration exceedance counts.

4.3.5 O_3 Emission Reduction Simulation

The simulated annual O_3 concentrations (Figure 5-10) over the modelling domain indicate a generally lower O_3 concentration towards the centre of the HPA region, with distinct elevated concentrations towards the outer border of the modelling domain for the baseline. The 2030 emission reduction target illustrates a similar profile with a slightly smaller spatial extent. It should be noted that the O_3 simulations are applicable for the current modelling domain, as well as the boundary conditions utilised. If the modelling domain is increased and the boundary conditions are updated, the simulated ambient O_3 could be adjusted. In terms of the permissible frequency of exceedance (Figure 5-11), the spatial extent remains similar.

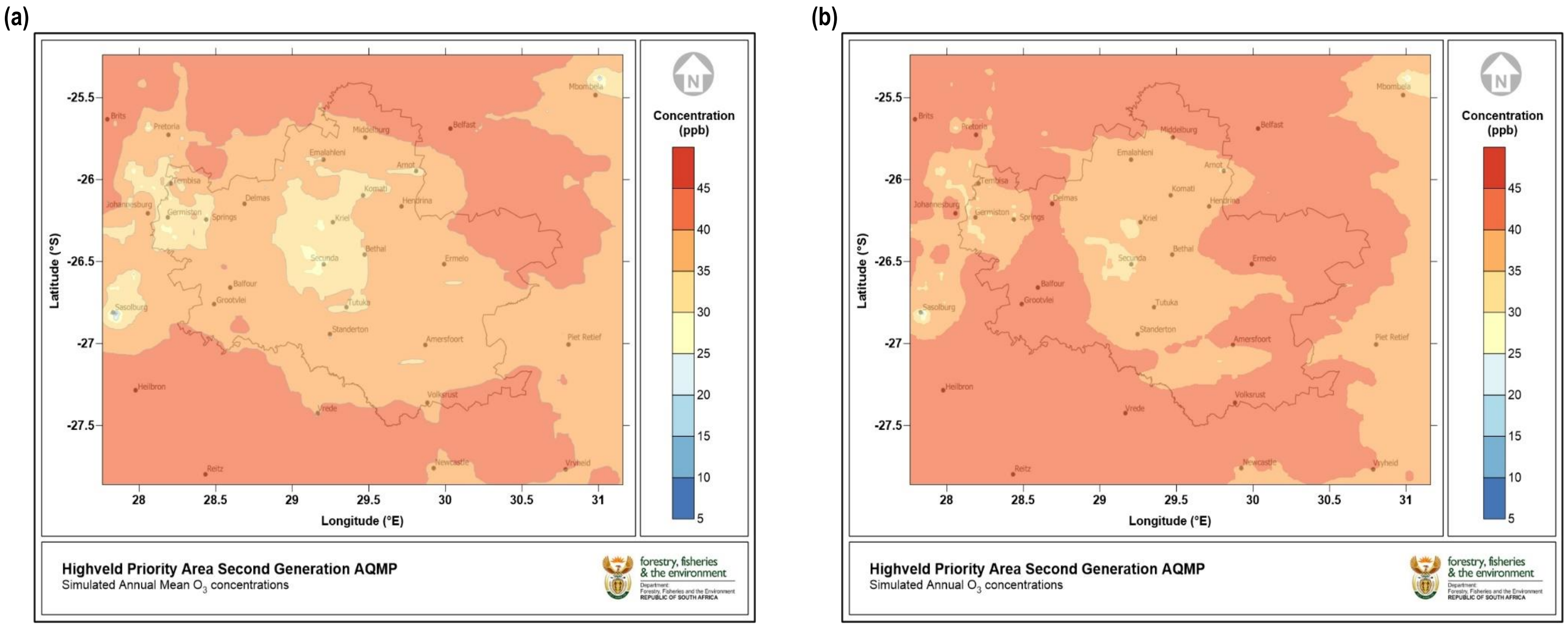
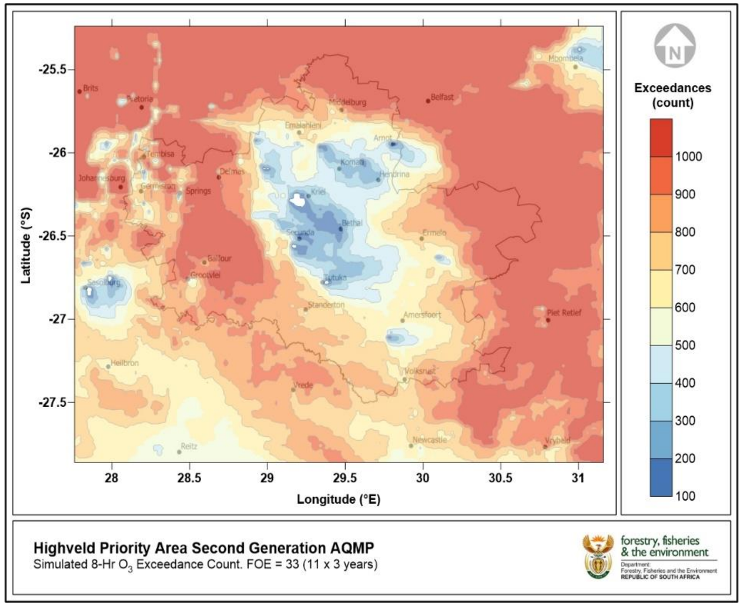


Figure 4-10: Concentration maps showing annual simulated O_3 concentrations for the (a) baseline and (b) 2030 Emission Reduction Target.

(a)



(b)

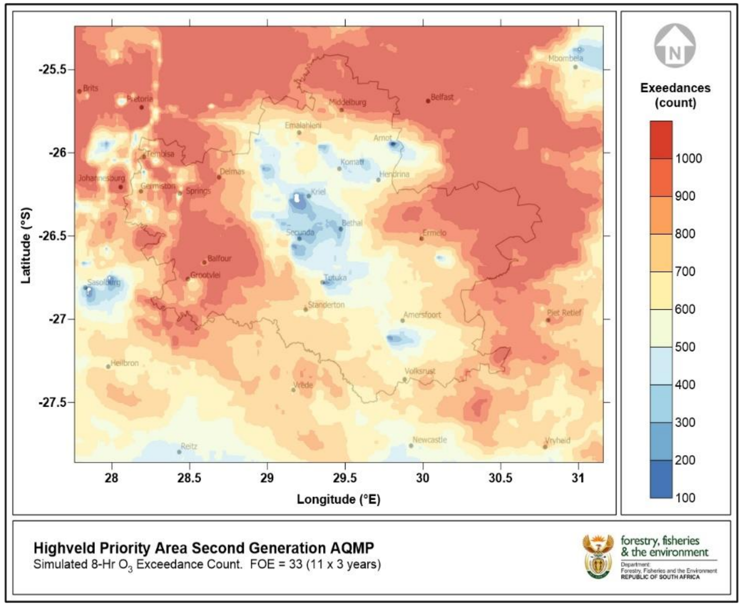


Figure 4-11: Concentration maps indicating 8-hour simulated O_3 concentration exceedance counts for the (a) baseline and (b) 2030 Emission Reduction Target.

5 SECOND-GENERATION HPA AQMP: EMISSION REDUCTION PLAN

The main objective of the air quality management program in the Highveld Priority Area is to establish emission reduction strategies to attain and sustain compliance with national ambient air quality standards. This is pursued in alignment with the Constitutional principle of progressively realizing improvements in air quality. The AQMP serves as a comprehensive framework for the implementing spheres of governments, departments and industries within the HPA.

Setting the right goals and paving the way to achieving them is critical for realising effective air quality management in the HPA. A combination of the Objectives and Key Results (OKR) and goal setting techniques was utilized. The Goal Setting and Objectives and Key Results (OKRs) model can be applied to the emission reduction targets in the HPA to provide a structured framework for goal setting, tracking progress, and achieving desired outcomes.

Goal Setting: The first step was to define clear and measurable goals for emission reduction in the HPA. These goals should be specific, time-bound, and aligned with the overall objective of reducing emissions. For example, the goal is to achieve a 40% reduction in emissions from the industry and energy generation sectors by 2030.

For Objectives: Objectives are specific, actionable outcomes that contribute to the overall goal. Each objective should be ambitious yet achievable and should align with the emission reduction targets set for different sectors in the HPA. For instance, objectives include achieving industry compliance with the 2020 MES, reducing windblown particulates by 40%, and reducing emissions from mobile sources by 30%.

For Key Results: Key Results are measurable milestones or metrics that indicate progress towards the objectives. They provide a way to track and evaluate the effectiveness of the strategies and initiatives implemented. Key results should be quantifiable, time-bound, and specific. For example, key results could include the percentage of industries complying with the 2030 emission reduction target, the percentage reduction in windblown particulates, or the reduction in emissions from mobile sources in tonnes.

By applying the Goal Setting and OKRs model, the emission reduction targets for the HPA can be transformed into actionable objectives and key results. This provides a structured approach to goal setting, tracking progress, and fostering a culture of accountability and continuous improvement towards achieving the desired emission reduction outcomes.

A brief overview of the PESTEL framework was conducted. In addition to formulating objectives and highlighting pivotal accomplishments in realizing the goals of the emission reduction plan, it's crucial to account for external influences that could significantly affect the plan's execution. These external influences encompass political, economic, social, technological, environmental, and legal (PESTEL) factors. Although not exhaustive, the PESTEL framework was employed as a crucial tool to recognise and assess external elements that may exert an influence on the effectiveness of the emission reduction plan in the HPA. These external factors include but are not limited to:

Collaboration and Stakeholder Engagement: For emission reduction measures to be successful, collaboration and stakeholder engagement with a variety of stakeholders is essential. The strategy encourages inclusivity and makes sure that all viewpoints and areas of expertise are taken into account by the multi-stakeholder, implementation task team and the committee. Participants in regular meetings and workshops are encouraged to communicate, share knowledge, and work together to develop and implement practical solutions.

Policy and Regulatory Framework: To promote emission reduction, strong policies and Regulations were established. The strategy places a strong emphasis on the implementation of the requirements of the Regulations for Implementing and Enforcing Priority Area Air Quality Management Plans, 2024.

Education and Awareness: Raising public awareness about the impacts of air pollution and the benefits of emission reduction is a key component of the strategy. Public awareness campaigns and educational programs target different audiences, including students, community members, and industry professionals. By disseminating information about emission reduction initiatives and success stories, the strategy aims to foster behaviour change and promote a culture of sustainability.

Political buy-in: Political buy-in will be crucial in the implementation because it involves getting the support and commitment of key stakeholders, such as managers, employees, customers, and suppliers. Without their buy-in, it will be difficult to execut successful implementation. Political buy-in can help to ensure that all parties are aligned with the same goals and objectives, leading to better communication, collaboration, and cooperation. It can also help to overcome resistance to change and foster a sense of ownership among stakeholders. Ultimately, political buy-in is important because it can mean the difference between the success or failure of implementation.

The tables in the sections below provide sectors specific emission reduction plans which are based on the following conditions:

- Objectives
- Key results
- Levels of responsibility

The above-mentioned conditions will assist in both the implementation and performance tracking of each emission reduction plan. It's important to note that the Minister of Forestry, Fisheries, and the Environment has established the Regulations for Implementing and Enforcing Priority Area Air Quality Management Plans, 2024, in terms of section 20 read in conjunction with section 53(a), (o), and (p) of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004). These Regulations are applicable to stakeholders who bear responsibilities as designated in this priority area air quality management plan. These stakeholders encompass:

(a) Any person conducting a listed activity;
(b) any person operating a controlled emitter;
(c) any holder of a right or permit related to a prospecting operation, exploration operation, mining operation, or production operation;
(d) any person conducting reclamation; and
(e) any department of state or administration in the national, provincial, or local sphere of government.

The emission reduction plan is coordinated with the application of these Regulations as they pertain to the assignment of responsibilities. The stakeholders identified in the AQMP will be obligated to formulate and submit an emission reduction and management plan. This emission reduction and management plan aims to minimize, prevent, and manage emissions, contributing to the achievement of emission reduction targets stipulated in the priority area air quality management plans.

5.1 Industries and Energy Generation

The proposed strategies to reduce industrial emissions in the HPA were developed in line with the 2020 Minimum Emission Standards (MES). The strategies that have been proposed to reduce industrial emissions in the HPA are detailed in Table 5-1 below.

Target 1: Reduce emissions from industrial sources (from the 2019 baseline) by 40% in 2030.

Table 5-1: Emission Reduction Activities for Industrial Emissions

Objectives	Key Activities/Opportunities	Responsibility
Reduce emissions from industries	Compliance with the MES and other atmospheric emission licence conditions	Identified stakeholders in regulation 3(2)(a) and 3(2)(e) of the Regulations for Implementing and Enforcing Priority Area Air Quality Management Plans, 2024.
	Assessment of compliance monitoring reports	Identified stakeholders in regulation 3(2)(e): DFFE, Provinces, Metros, Districts and Local municipalities
	Development and Implementation of emission reduction plans	Identified stakeholders in regulation 3(2)(a) and 3(2)(b).
	Monitor and enforce compliance	Identified stakeholders in regulation 3(2)(e): DFFE, Provinces, Metros, Districts and Local municipalities
	Identify opportunities and incentive schemes to support industries to implement air quality improvement initiatives.	Identified stakeholders in regulation 3(2)(e): DTIC, DFFE, Provinces, Metros, Districts and Local municipalities
	Establish incentive schemes for energy efficiency improvements and fuel switching that directly reduce air emissions.	Identified stakeholders in regulation 3(2)(e): DTIC, DFFE, Provinces, Metros, Districts and Local municipalities

Notes: DTIC – Department of Trade, Industry and Competition, DFFE – Department of Forestry, Fisheries and the Environment

5.2 Domestic Waste Burning

The proposed strategies to reduce residential waste burning emissions in the HPA were adapted from the National Waste Management Strategy (NWMS) 2020 and the Industry Waste Tyre Management Plan 2024 (IndWTMP), which provides government policy and strategic interventions for the waste sector. The NWMS is supported by three strategic pillars which are Waste Minimisation, Effective and Sustainable Waste Services, and Compliance, Enforcement and Awareness. The IndWTMP provides the requirements for the implementation of effective and efficient waste tyre management in South Africa. The IndWTMP seeks to establish a waste tyre processing sector in South Africa which will reduce the negative environmental impacts of waste tyres and support enterprise development and job creation in a circular economy. The strategies that have been proposed to tackle the challenge of domestic waste burning are detailed in Table 5-2.

Target 2: Eliminate emissions from domestic waste burning by 100% (from the 2019 baseline) by 2030.

Table 5-2: Emission Reduction Plan for Domestic Waste Burning Emissions

Objectives	Key Activities/Opportunities	Responsibility
Reduce domestic waste burning emissions	Development and review of Integrated Waste Management Plans (IWMP)	Identified stakeholders in regulation 3(2)(e) of the Regulations for Implementing and Enforcing Priority Area Air Quality Management Plans, 2024: Provinces, Metros, Districts and Local municipalities
	Implementation of updated Integrated Waste Management Plans (IWMP)	Identified stakeholders in regulation 3(2)(e): Provinces, Metros, Districts and Local municipalities
	Development and Implementation of emission reduction plans	Identified stakeholders in regulation 3(2)(e): Provinces, Metros, Districts and Local municipalities
	Improve public awareness on waste minimization, reuse, recycling and about the health impacts of waste.	Identified stakeholders in regulation 3(2)(e): Provinces, Metros, Districts and Local municipalities
	Initiation of projects/programmes for Waste diversion	Identified stakeholders in regulation 3(2)(e): Metros, Districts and Local municipalities

5.3 On Road Vehicle Emission Sources

Continual growth in the transport sector is likely to have an increasing impact on air quality which will in turn lead to significant negative human health impacts through the increased risk of respiratory diseases, heart disease and lung cancer. The proposed strategies to reduce transport emissions in the HPA were adapted from the Green Transport Strategy for South Africa (2018-2050) and the 2014 South Africa's Greenhouse Gas (GHG) Mitigation Potential Analysis. The strategies that have been proposed to reduce vehicle emissions in the HPA are detailed in Table 5-3 below.

Target 3: Reduce emissions from on-road vehicles (from the 2019 baseline) by 30% in 2030.

Table 5-3: Emission Reduction Plan for Vehicle Emissions

Objectives	Key Activities/Opportunities	Responsibility
Reduce emissions from vehicles	Conduct awareness campaigns and provide support on measures to reduce transport emissions (e.g., use of public transport, lift clubbing etc.).	Identified stakeholders in regulation 3(2)(e) of the Regulations for Implementing and Enforcing Priority Area Air Quality Management Plans, 2024: DOT, DFFE, Provinces, Metros, Districts and Local municipalities.

Objectives	Key Activities/Opportunities	Responsibility
	Implementation of the Clean Fuel II fuel specifications.	Identified stakeholders in regulation 3(2)(e): DMRE
	Introduction to vehicle fleets with cleaner fuels	Identified stakeholders in regulation 3(2)(a), 3(2)(b) and 3(2)(e): Industry, DFFE, Provinces, Metros, Districts and Local municipalities
	Development and Implementation of emission reduction plans	Identified stakeholders in regulation 3(2)(e): Metros, Districts and Local municipalities

Notes: DOT – Department of Transport, DMRE – Department of Mineral Resources

5.4 Domestic Fuel Burning

Domestic fuel burning in South Africa is an air polluting activity that can expose communities to respiratory diseases. The intensity of this activity is highest amongst low-income/poor communities. The key drivers of this activity include the lack of financial resources to afford cleaner fuel options and the need for space heating due to poor housing insulation. The strategies that have been proposed to tackle the challenge of domestic fuel burning in low-income settlements are detailed in Table 5-4 below.

Target 4: Reduce domestic fuel burning emissions from the 2019 baseline by 30% by 2030.

Table 5-4: Emission Reduction Activities Towards Reducing Domestic Fuel Burning Emissions

Objectives	Key Activities/Opportunities	Responsibility
Reduce domestic fuel burning emissions	Conduct public awareness on air pollution	Identified stakeholders in regulation 3(2)(e) of the Regulations for Implementing and Enforcing Priority Area Air Quality Management Plans, 2024: Local municipalities, DOH
	Conduct public awareness on indoor air pollution	Identified stakeholders in regulation 3(2)(e): DOH
	Solar Water Heating (SWHs) installed in beneficiary households in participating municipalities	Identified stakeholders in regulation 3(2)(e): DMRE
	Households electrified with grid.	Identified stakeholders in regulation 3(2)(e): DMRE
	Develop and implement emission reduction and management plan	Identified stakeholders in regulation 3(2)(e): DHS and DMRE

Notes: DHS – Department of Human Settlements, DOH – Department of Health

5.5 Biomass Burning

The proposed strategies to reduce biomass burning emissions in the HPA were adapted from the National Veld and Forest Fire Act 1998 (Act No. 101 of 1998) which seeks to promote sustainable forest management, reduce food security threats, and prevent or minimise harm to the environment. The strategies that have been proposed to reduce biomass burning emissions in the HPA are detailed in Table 5-5.

Target 5: Reduce biomass burning emissions from the 2019 baseline by 30% by 2030.

Table 5-5: Emission Reduction Plan for Biomass Burning

Objectives	Key Activities/Opportunities	Responsibility
Reduce biomass burning emissions	Develop and finalize a national strategy for reducing emissions from deforestation and forest degradation (REDD+)	Identified stakeholders in regulation 3(2)(e) of the Regulations for Implementing and Enforcing Priority Area Air Quality Management Plans, 2024: DFFE
	Establish partnerships with Fire Protection Associations that enforce the National Veld and Forest Fire Act, 1998 (Act No. 101 of 1998).	Identified stakeholders in regulation 3(2)(e): Municipal Fire departments, traditional leaders/local government
	Develop and implement emission reduction and management plan	Identified stakeholders in regulation 3(2)(e): Metros, Districts and Locals (Where applicable)
	Conduct education and awareness campaigns in the communities on the impact and prevention of veld fires.	Identified stakeholders in regulation 3(2)(e): DFFE, Fire Protection Associations

5.6 Agriculture

The proposed strategies to reduce agricultural emissions in the HPA were adapted from the 2019 Actionable guidelines for the implementation of climate smart agriculture in South Africa which seeks to increase food production whilst reducing the risk of harm to the environment. The strategies that have been proposed to reduce agricultural emissions in the HPA are detailed in Table 5-6 below.

Target 6: Reduce emissions from agricultural activities (from the 2019 baseline) by 20% in 2030.

Table 5-6: Emission Reduction Activities on Agricultural Emissions

Objectives	Key Activities/Opportunities	Responsibility
Management of the release of ammonia and particulate dust from agricultural activities.	Conduct awareness campaigns on the impact of ammonia on the environment and measures to reduce the use of inorganic fertilizers.	Identified stakeholders in regulation 3(2)(e) of the Regulations for Implementing and Enforcing Priority Area Air Quality Management Plans, 2024: Provinces, Metro/District and Local Gov, farmers associations
	Develop and implement emission reduction and management plan.	Identified stakeholders in regulation 3(2)(e): DALRRD
	Application of crop residue management techniques e.g., incorporation of crop residue into the soil.	Farmers
	Establishment of firebreaks on farmlands.	Farmers

Notes: DALRRD – Department of Agriculture, Land Reform and Rural Development

5.7 Windblown Dust

5.7.1 Residential Areas

Due to the prevailing dry conditions experienced in South Africa, windblown dust emissions are a significant nuisance problem to communities residing in urban and peri-urban areas. The strategies that have been proposed to reduce windblown dust emissions in the HPA are detailed in Table 5-7 below.

Target 7: Reduce windblown dust emissions from residential areas (from the 2019 baseline) by 40% in 2030.

Table 5-7: Emission Reduction Activities for Windblown Dust Emissions in Residential Areas

Objectives	Key Activities/Opportunities	Responsibility
Reduce windblown dust emissions in residential areas	Identify unpaved roads with high traffic activity and implement mitigation measures to minimise dust on these roads.	Identified stakeholders in regulation 3(2)(e) of the Regulations for Implementing and Enforcing Priority Area Air Quality Management Plans, 2024: Local municipalities
	Plant vegetation near unpaved roads to serve as a dust barrier.	Identified stakeholders in regulation 3(2)(e): Local municipalities
	Create partnerships between municipalities and stakeholders on upgrading unpaved roads in low-income settlements.	Identified stakeholders in regulation 3(2)(a), 3(2)(b) and 3(2)(e): DOT, Industry, DFFE, Provinces, Metros, Districts and Local municipalities

	Plant trees outside the forest footprint	Identified stakeholders in regulation 3(2)(e): DFFE
	Increase the number of hectares approved for afforestation	Identified stakeholders in regulation 3(2)(e): DFFE

5.7.2 Mining and Reclamation Sectors

Pollutants typically emitted from mining activities are particulates, with smaller quantities associated with vehicle exhaust emissions. The proposed strategies to reduce particulate emissions from mines in the HPA were adapted from the National Dust Control Regulations, 2013. The strategies that have been proposed to reduce mine emissions in the HPA are detailed in Table 5-8 below. Additionally, strategies specifically aimed at reducing emissions induced by mine reclamation processes within the HPA are outlined in Table 5-9.

Target 8: Reduce windblown dust emissions in mining areas (from the 2019 baseline) by 40% in 2030.

Table 5-8: Emission Reduction Plan for Mining Emissions

Objectives	Key Activities/Opportunities	Responsibility
Reduce emissions from mines	Effective implementation of National Dust Control Regulations	Identified stakeholders in regulation 3(2)(c) of the Regulations for Implementing and Enforcing Priority Area Air Quality Management Plans, 2024
	Development and Implementation of emission reduction plans and EMPs	Identified stakeholders in regulation 3(2)(c)
	Implementation of the rehabilitation strategy (derelict and ownerless mine sites)	Identified stakeholders in regulation 3(2)(e): DMRE, DFFE
	Monitor and enforce compliance in terms of MPRDA	Identified stakeholders in regulation 3(2)(e): DMRE

Table 5-9: Emission Reduction Plan for Mine Reclamation Emissions

Objectives	Key Activities/Opportunities	Responsibility
Reduce emissions from mining reclamation processes	Effective implementation of National Dust Control Regulations	Identified stakeholders in regulation 3(2)(c) and 3(2)(d) of the Regulations for Implementing and Enforcing Priority Area Air Quality Management Plans, 2024
	Development and Implementation of emission reduction plans and EMPs	Identified stakeholders in regulation 3(2)(c) and 3(2)(d)
	Implementation of the rehabilitation strategy (derelict and ownerless mine sites)	Identified stakeholders in regulation 3(2)(e): DMRE, DFFE

Objectives	Key Activities/Opportunities	Responsibility
	Monitor and enforce compliance in terms of MPRDA	Identified stakeholders in regulation 3(2)(e): DMRE

5.8 Education, Awareness and Resource Mobilisation

Education, awareness, and resource are key enablers for achieving the goals set out in the emission reduction plan for the HPA. Education and awareness are important as they enable capacity development (i.e., through training and workshops) and behavioural change amongst stakeholders. Resource mobilisation will play a crucial role towards managing air quality in the HPA as adequate funding and resources are necessary for the implementation of the emission reduction strategies introduced in the plan. Mobilising resources also facilitates collaboration among various stakeholders which leads to a more comprehensive and coordinated approach to implementing the emission reduction plan. Table 5-10 below provides an outline of the proposed strategies to promote education, awareness, and resource mobilisation.

Table 5-10: Plan for Education, Awareness and Resource Mobilisation

Objectives	Key Activities/Opportunities	Responsibility
To promote education	Provide materials to guide training across the priority area with a view to creating a generation of climate, environment, and health-conscious citizens and green economic operators.	Identified stakeholders in regulation 3(2)(e) of the Regulations for Implementing and Enforcing Priority Area Air Quality Management Plans, 2024: DFFE
	Capacitate authorities and stakeholders.	Identified stakeholders in regulation 3(2)(e): DFFE
To promote awareness	Follow up on plans/ programmes and reduction commitments to ensure that the emission reduction commitments in the plans of stakeholders are fully implemented.	Identified stakeholders in regulation 3(2)(e): Authorities
	Support better governance on air pollution by offering new insights into overall pollution levels and impacts and by monitoring whether emission reduction plans implementation is on track to achieve the agreed objectives.	Identified stakeholders in regulation 3(2)(e): DFFE/DOH
	Enable local authorities to share best practices, success stories and experiences to drive improvement.	Identified stakeholders in regulation 3(2)(e): DFFE
	District, Provincial and National Compliance and Enforcement Officers should conduct campaigns on a yearly basis:	Identified stakeholders in regulation 3(2)(e): DFFE

Objectives	Key Activities/Opportunities	Responsibility
	• At least two campaigns a year as individual entities. • At least one campaign a year as a joint entity.	
	Evaluate and, where necessary, strengthen the provisions on public participation and access to justice.	NGOs
	Provide updated best practices to make tangible progress in identifying and reducing exposure to environmental risks in vulnerable groups.	NGOs
To promote resource mobilisation	Explore donor funding opportunities and government partnerships with other governments (bilateral agreements on environment etc.) and get support from them with clear guidance on their funding, and tools.	Identified stakeholders in regulation 3(2)(e): DFFE
	Mobilisation of private capital for environmentally sustainable investments that support the zero pollution objectives.	NGOs

Notes: NGO – Non-Government Organisation

6 SECOND-GENERATION HPA AQMP: MONITORING AND EVALUATION

6.1 Monitoring

Monitoring involves tracking the progress made by identified stakeholders in achieving the goals set out in the second-generation HPA AQMP. Monitoring progress is key in determining whether the rate of implementation of the current emission reduction measures needs to be increased, or whether the current emission reduction plan or strategy needs to be revised. The monitoring process will commence once the implementation of the second-generation AQMP for the HPA has begun.

The identified stakeholders are required to submit progress reports on an annual basis to check the progress made, identify any challenges being experienced in implementing the emission reduction measures, come up with remedial actions and adjust timeframes so that the challenges are dealt with in the regulated reporting timelines. The submission of progress reports on an annual basis is also important in facilitating transparency and accountability amongst the identified stakeholders.

In addition to the above, the following activities should be carried out to complement the annual progress reports and further assist in the monitoring process:

6.1.1 Ambient Air Quality Monitoring

The monitoring of ambient air quality is crucial for assessing pollutant concentrations and identifying areas where air quality standards are exceeded in the HPA. All monitoring networks, including private stations, must form part of the Monitoring system, and their availability must be guaranteed until the priority area is undeclared. The ambient air quality data collected from the HPA AQMS monitoring network must be subjected to rigorous quality assurance (QA) and quality control (QC) processes to ensure accuracy and reliability.

The monitoring results should be reported regularly to relevant authorities and stakeholders to provide insights into air quality trends, and exceedances of air quality standards, and to identify areas requiring further intervention.

6.1.2 Emissions Reduction and Management

As part of the monitoring process, the second-generation HPA emissions inventory will have to be continuously updated. Annual updating the emissions inventory is vital to capture changes in emissions over time and to assess the effectiveness of emission reduction measures. It also allows for the identification of emerging sources and trends, supports the evaluation of the second-generation HPA AQMP, and facilitates the tracking of progress towards achieving the air quality goals set in the AQMP.

Annual progress reports on emission reduction measures/interventions from identified stakeholders must be incorporated in the AELs. The annual updating of the emissions inventory would also enable the effective operation of NAEIS with current, accurate and credible data. Compliance monitoring and enforcement of regulatory tools (e.g., NDCR) must be utilised.

6.1.3 Inter-governmental and Stakeholder Engagement

This involves engaging with relevant stakeholders to gather diverse perspectives on the effectiveness of the AQMP, identify challenges, and gather feedback for improvement. There are several forums in place in the HPA to ensure inter-governmental communication and cooperation as well as engagement with various stakeholders. These forums should be used optimally to ensure the successful and continuous and successful implementation of the second-generation HPA AQMP. Action for these forums could include:

1. Inter-governmental forums

- HPA Authorities should meet to set clear targets with implementation timeframes and accountability for non-performance.

2. Stakeholder forums

- The Multi-Stakeholder Reference Group (MSRG) should continue to meet bi-annually but with a focus on information communication and awareness raising, track clear targets for implementation and hold responsible parties accountable for non-performance.
- The Implementation Task Team (ITT) quarterly meetings should serve as interim follow-ups on specific actions as well as consequences for actions not taken.

Table 6-1 is a summary of the Monitoring Mechanisms proposed to be included in the second-generation HPA AQMP.

Table 6-1: Monitoring Mechanisms for the second-generation HPA AQMP.

Monitoring Mechanisms	NEMAQA Regulatory Tools	Principals
Ambient air quality monitoring	• NAAQS • SAAQIS	• Effective operation of monitoring networks with current, accurate and credible data. • All monitoring networks (including private stations must form part of the Monitoring & Evaluation system) and their availability must be guaranteed until the PA is undeclared. • Effective operation of SAAQIS for information dissemination.
Emissions Reduction and Management	• Regulations for Implementing and Enforcing Priority Area Air Quality Management Plans, 2024 • NAEIS • AEL • NDCR	• Emission reduction interventions incorporated AELs. • Compliance monitoring and enforcement of regulatory tools. • Effective operation of NAEIS with current, accurate and credible data.
Inter-governmental Coordination and Stakeholder Engagement	• MSRGs • ITT • Priority Area Committee • Intergovernmental Relations (National/Provincial/Local)	• Adequate government capacity for effective implementation of AQMPs. • Inclusion of sector departments with role and responsibilities in the AQMP and the Regulations for Implementing and Enforcing Priority Area Air Quality Management Plans, 2024.

6.2 Evaluation

Evaluation is an essential element of the AQMP implementation as it allows for a thorough assessment of the AQMP including the shortcomings and strengths evident in the implementation. It involves assessing whether the goals set out in the second-generation HPA AQMP have been achieved. The following activities should be carried out in the evaluation process:

1. The annual progress reports submitted by the identified stakeholders should be assessed against the emissions reduction targets set out in the second-generation HPA AQMP. This will help determine whether there is a need to make operational or functional changes that will improve the performance of the identified stakeholders in reducing their emissions.
2. The annual progress reports submitted by the identified stakeholders should be compared with the state of air reports (ambient air quality monitoring data) to determine whether there has been progress made in meeting the NAAQS in the HPA.

7 CONCLUSIONS

A second-generation AQMP has been developed for the HPA. The Plan describes the current state of air quality in a priority area, sources of air pollution in the priority area, how air quality has been changing over the years, and what could be done to ensure clean air quality in the priority area. It also provides the goals and targets for the HPA and prescribes medium-term emission reduction plans, targeting specific sectors, and that will ensure further improvement and eventual compliance within the area. The development of the second-generation HPA AQMP followed a five-phase approach with each task or output having a verifiable indicator and a means of verification.

The main objective of the Air Quality Management Program in the Highveld Priority Area is to attain and sustain compliance with national ambient air quality standards. Key emission reduction targets for the second-generation HPA AQMP are summarised in Table 7-1. These targets will be achieved through the implementation of several interventions by stakeholders listed in the Regulations for Implementing and Enforcing Priority Area Air Quality Management Plans, 2024.

Table 7-3: Emission reduction targets for the HPA

Sector	2030
Industry, mining and reclamation	40% Reduction on the baseline
Residential Waste Burning	100% Reduction on the baseline
On-road Vehicle Sources	30% Reduction on the baseline
Residential Fuel Burning	30% Reduction on the baseline
Biomass Burning	30% Reduction on the baseline
Agriculture	20% Reduction on the baseline
Windblown Particulates	40% Reduction on the baseline

The monitoring process will commence once the implementation of the second-generation AQMP for the HPA has begun. This will involve the submission of progress reports by identified stakeholders on an annual basis for the first five years. In between these five years, annual evaluation will be conducted through the assessment of annual progress reports submitted by the identified stakeholders. The outcomes of these evaluations will help inform and guide the stakeholders as to whether there is a need for a revision of the second-generation HPA AQMP.

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