GOVERNMENT NOTICE

DEPARTMENT OF ENVIRONMENTAL AFFAIRS

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

HIGHVELD PRIORITY AREA AIR QUALITY MANAGEMENT PLAN

I, Bomo Edith Edna Molewa, Minister of Water and Environmental Affairs, hereby in terms of section 19(5)(a) of the National Environmental Management: Air Quality Act, 2004 (Act No.30 of 2004), publish the Highveld Priority Area Air Quality Management Plan for information and implementation.

BOMO EDITH EDNA MOLEWA
MINISTER OF WATER AND ENVIRONMENTAL AFFAIRS

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

HIGHVELD PRIORITY AREA AIR QUALITY MANAGEMENT PLAN

2011

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- The provincial environmental departments in the HPA, Gauteng Department of Agriculture and Rural Development, and the Mpumalanga Department of Economic Development, Environment and Tourism
- The district, metropolitan and local municipalities in the HPA
- Stakeholders who participated in the Air Quality Officer's Forum (AQOF) and Multi-Stakeholder Reference Group (MSRG) fora, including other government departments, private sector businesses and associations, and civil society organisations
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- Those who submitted comments on the draft baseline assessment and Air Quality Management Plan (AQMP)
- Participants in the Logical Framework Workshop (LFA) workshop
- Industries who submitted industrial action plans

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EXECUTIVE SUMMARY

Introduction

The Highveld area in South Africa is associated with poor air quality, and elevated concentrations of criteria pollutants occur due to the concentration of industrial and non-industrial sources (Held *et al*, 1996; DEAT, 2006). The Minister of Environmental Affairs and Tourism, Martinus van Schalkwyk, therefore, declared the Highveld Priority Area (HPA) on 23 November 2007. The priority area covers 31 106 km^2, including parts of Gauteng and Mpumalanga Provinces, with a single metropolitan municipality, three district municipalities, and nine local municipalities (Figure E1). As the area overlaps provincial boundaries, the Department of Environmental Affairs (DEA) functions as the lead agent in the management of the priority area and is required in terms of Section 19(1) of the National Environmental Management: Air Quality Act (Act 39 of 2004) (AQA) to develop an Air Quality Management Plan (AQMP) for the priority area.

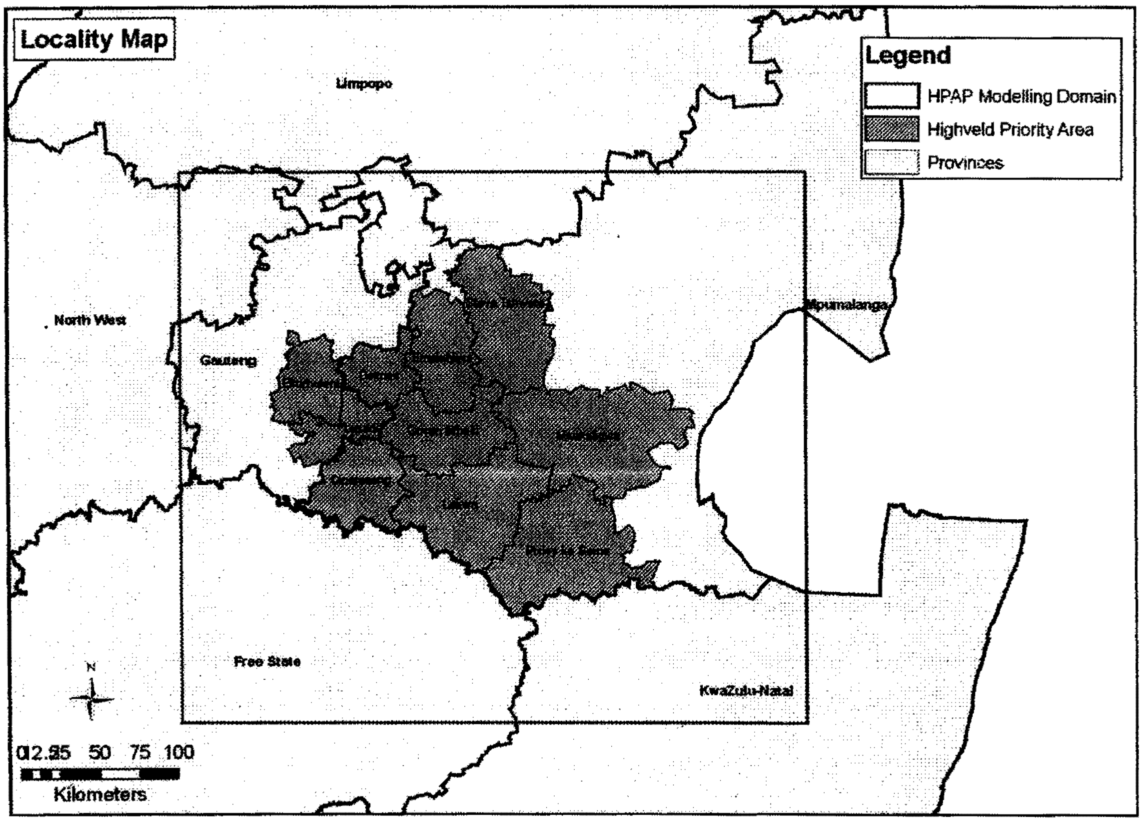


Figure E1: Locality map depicting the Highveld Priority Area (HPA), showing the three district municipalities, their constituent local municipalities and the single metropolitan municipality.

The baseline assessment for the HPA provides a succinct presentation of the major issues to be addressed, specifically highlighting the geographical areas of concern within the HPA where dedicated Air Quality Management (AQM) interventions are to be focused. The constraints and developments in the abatement technology used and available, as well as the capacity of officials who will carry the majority of the responsibility for implementation of the AQMP have also been noted as part of the baseline assessment. These issues were carried forward as gaps and priorities into the AQMP development, of which the most significant aspect was the Logical Framework Approach (LFA) workshop. The LFA workshop scrutinised the air quality problems identified in the baseline assessment and developed problem and objective trees, and specific interventions. The workshop outcomes were taken into detailed strategy analysis and intervention development, and formed the initial draft of the AQMP.

The primary motivation of the priority area AQMP is to achieve and maintain compliance with the ambient air quality standards across the HPA, using the Constitutional principle of progressive realisation of air quality improvements. The AQMP for the HPA provides the framework for implementing departments and industry to include AQM in business planning to ensure effective implementation and monitoring.

The plan has been designed at a strategic level, indicating high-level tasks for responsible parties. The specific planning at an operational level, such as budgeting, human resource allocation, and detailed activity planning, has been excluded from the plan. This is to allow parties to tailor their implementation activities to their specific context, particularly organisational constraints, while still achieving the overall objective of the AQMP. The activities listed in the plan must be unpacked further by responsible parties into organisation-specific activity and intervention plans, and captured in the policy and strategic documents, such as business and investment plans, Integrated Development Plans (IDPs), and Environmental Implementation Plans (EIPs).

Summary of immediate objectives, outputs, verifiable indicators and means of verification.

Immediate Objective	Output	Verifiable Indicator	Means of Verification
A. The Participation Objective	A.1. Efficient and effective intergovernmental coordination and cooperation	Efficient and effective intergovernmental coordination and cooperation.	Meeting Minutes.
	A.2. Efficient and effective public participation	Efficient and effective public participation.	Meeting Minutes and stakeholder feedback.
	A.3. Project website	A project webpage containing current and relevant information relating to the project as available through the department's website.	Stakeholder feedback and webpage hits.
	A.4. Public outreach events and workshops	Well-organised public events ensure broad-based public participation.	Event report and feedback.
B. The	B.1. Process	A clear and unambiguous	Implementation of the

Planning Objective	Plan	plan on how Output B is to be generated.	process plan results in the desired outcome.
	B.2. Problem Analysis	The causes of current and, potential, future poor air quality in the area are clearly defined and described.	The efficiency of the plan is ensured through interventions that deal with the real causes of poor air quality in the area.
	B.3. Strategy Analysis	All possible pollution mitigation strategies are described and reviewed.	The plan is directed by practical strategies that ensure a high probability for success.
	B.4. Intervention Descriptions	Interventions are clearly described that, once implemented, will have a measurable positive impact on ambient air quality in the area.	The plan describes interventions that ensure a high probability for success.
	B.5. Draft Priority Area Air Quality Management Plan	A draft plan based on current, accurate and relevant information, informed by best practice in the field of air quality management and that provides a clear and practical plan to efficiently and effectively bring air quality in the area into sustainable compliance with National Ambient Air Quality Standards within agreed timeframes.	Draft plan published in the *Gazette* for public comment.
	B.6. Priority Area Air Quality Management Plan	A plan based on current, accurate and relevant information, informed by best practice in the field of air quality management and that provides a clear and practical plan to efficiently and effectively bring air quality in the area into sustainable compliance with National Ambient Air Quality Standards within agreed timeframes.	Plan published in the *Gazette*.
C. The Capacity Development	C.1. National Priority Area Management	Active involvement of departmental staff in the implementation of the	Staff able to efficiently and effectively manage future priority areas

Objective	Capacity	project.	
	C.2. Implementation Initiated	Assistance provided in the initial plan implementation phase.	Implementation successfully launched.

Emission sources

The total estimated annual emissions of fine particulate matter (PM_{10}) on the HPA is 279 630 tons, of which approximately half is attributed to particulate entrainment on opencast mine haul roads (Table E1). The emission of PM_{10} from the primary metallurgical industry accounts for 17% of the total emission, with 12% of the total from power generation. By contrast, power generation contributes 73% of the total estimated oxides of nitrogen (NO_x) emission of 978 781 tons per annum and 82% of the total estimated sulphur dioxide (SO_2) emission of 1 633 655 tons per annum.

The emission inventory for industrial sources was relatively complete and included all industries on the HPA with scheduled processes in terms of the APPA. It is recognised that these sources comprise the major industrial sources, with non-registered sources being very small in comparison. In addition, specific methodologies were used for determining emissions from residential fuel burning, coal mining, transport, biomass burning and burning coal mines and smouldering coal dumps. Source categories where emissions could not be determined were landfills, incinerators, wastewater treatment works, tyre burning, biogenic sources, odour and agricultural dust. The issues relating to these emissions will be addressed through the implementation of the AQMP.

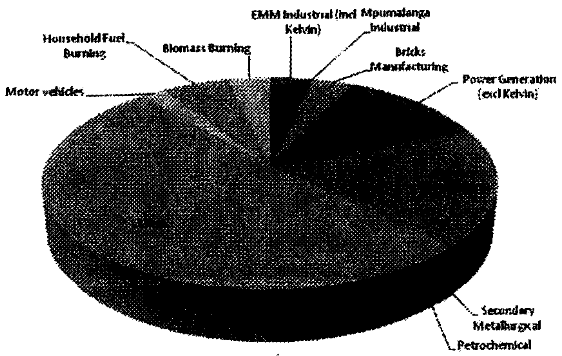
Industrial sources in total are by far the largest contributor of emissions in the HPA, accounting for 89% of PM_{10}, 90% of NO_x and 99% of SO_2. Major industrial source contributors were grouped into the following categories:

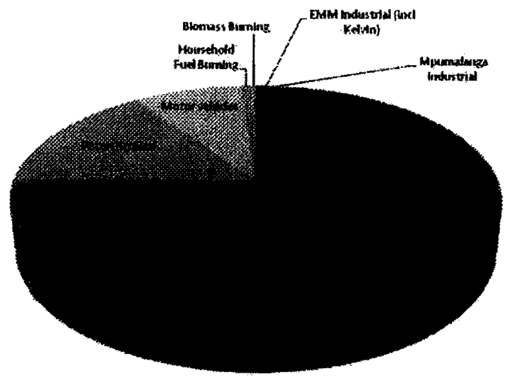
1. Power Generation
2. Coal Mining
3. Primary Metallurgical Operations
4. Secondary Metallurgical Operations
5. Brick Manufacturers
6. Petrochemical Industry
7. Ekurhuleni Industrial Sources (excluding the above)
8. Mpumalanga Industrial Sources (excluding the above)

Table E1: Total emission of PM_{10}, NO_x and SO_2 from the different source types on the HPA (in tons per annum), and the percentage contribution for each source category

	PM_{10}		NO_x		SO_2	
Source category	**t/a**	**%**	**t/a**	**%**	**t/a**	**%**
Ekurhuleni MM Industrial (incl Kelvin)	8 909	3	15 636	2	25 772	2
Mpumalanga Industrial	684	0	590	0	5 941	0
Clay Brick Manufacturing	9 708	3	-		9 963	1
Power Generation	34 373	12	716 719	73	1 337 521	82
Primary Metallurgical	46 805	17	4 416	0	39 582	2
Secondary Metallurgical	3 060	1	229	0	3 223	0
Petrochemical	8 246	3	148 434	15	190 172	12
Mine Haul Roads	135 766	49	-		-	
Motor vehicles	5 402	2	83 607	9	10 059	1
Household Fuel Burning	17 239	6	5 600	1	11 422	1
Biomass Burning	9 438	3	3 550	0	-	
TOTAL HPA	**279 630**	**100**	**978 781**	**100**	**1 633 655**	**101**

NB. SO_2 percentage contributions aggregate is greater than 100 due to rounding of numbers.





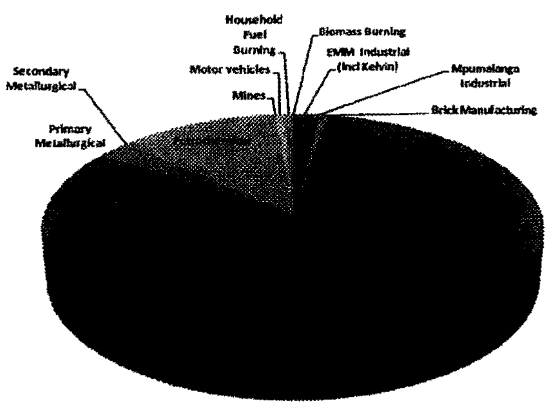


Figure E2: Relative contribution by the respective sectors to the total emission of PM_{10} (top left), NO_x (top right) and SO_2 (bottom left)

Ambient air quality

Most of the HPA experiences relatively good air quality, but ambient air quality standards for SO_2, PM_{10} and ozone (O_3) concentrations are exceeded in nine extensive areas. These "hot spots" are illustrated in Figure E3 by the number of modelled exceedances of the 24-hour SO_2 and PM_{10} standards, and are confirmed by ambient monitoring data (Table E2). The air quality hot spots result mostly from a combination of emissions from the different industrial sectors and residential fuel burning, with motor vehicle emissions, mining and cross-boundary transport of pollutants into the HPA adding to the base loading.

Available monitoring confirms that the areas of concern are in the vicinity of Witbank 2, Middelburg, Secunda, Ermelo, Standerton, Balfour, and Komati where exceedances of ambient SO_2 and PM_{10} air quality standards occur (Table E2). Kendal 2 is specifically positioned to monitor power station impacts and it reflects emissions from Kendal power station under given meteorological conditions. The Kendal 2 station is strategically sited to measure emissions largely from the power station's activities for research purposes only.

Table E2: Exceedances at HPA sites based on historic and new monitoring data

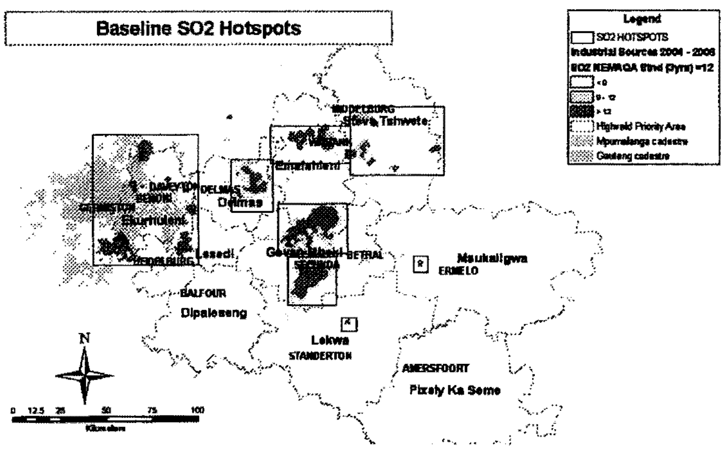
		NO_2 *1-hr (88)*	O_3 *8-hr (11)*	PM_{10} *24-hr (4)*	SO_2 *24-hr (4); 1-hr (88)*
Emalahleni LM	Kendal 2	1	**58**		**34; 343**
	Phola	0		3	7; 27
	Witbank	37	9	9	4; 51
	Witbank 2		17	25	1; 11
Steve Tshwete LM	Columbus				
	Komati 2			**26**	1; 14
	Hendrina	1	22	3	1; 2
	Middelburg	71	60	7	1; 4
	Middelburg 2		1	7	0; 1
Govan Mbeki LM	Sasol Club	1		0	0; 25
	Langverwacht	1		0	2; 78
	Bosjesspruit				2; 27
	Elandsfontein	0	**73**	3	4; 33
	Leandra				6; 114
	eMbalenhle	2	4	39	0; 1
Msukaligwa LM	Camden	0	**24**	1	0; 4
	Ermelo	1	73	22	21; 10
Pixley Ka Seme LM	Amersfoort				
	Majuba 1				4; 87
	Majuba 2				
	Verkykkop	0	**46**	0	1; 7
Lekwa	Standerton	4	10	29	1; 6
Dipaleseng	Balfour		29	8	0; 4

NB. - Row 1: The averaging period for the relevant pollutant's standard is represented below the pollutant and following the allowed frequency of exceedance in brackets

- Stations in grey blocks represent new monitoring data for the period 2008-2009

- Exceedances in bold are greater than the permitted frequency in the standard for the monitoring period. The permitted frequency of exceedance varies according to period for which data is presented at each monitoring site, and for Eskom and Sasol stations must be assessed against a cumulative permitted frequency of exceedance for 3 years of data

The effects of poor dispersion conditions in the winter, particularly when low-level emissions are trapped near the surface, are evident throughout the monitoring record for all pollutants, resulting in greater frequency of exceedances of the standards. PM_{10} displays this seasonal trend most strikingly, showing a sharp contrast between wintertime peaks and summer minimum values at monitoring sites. Seasonal trends are clearly observed for O_3 in the monitoring record, as springtime peaks are easily identified. Monitoring data show carbon monoxide (CO) and benzene to be within acceptable limits at the new sites. Trends in pollutant concentrations, based on current data, cannot be conclusively identified, marred in particular by poor data collection.



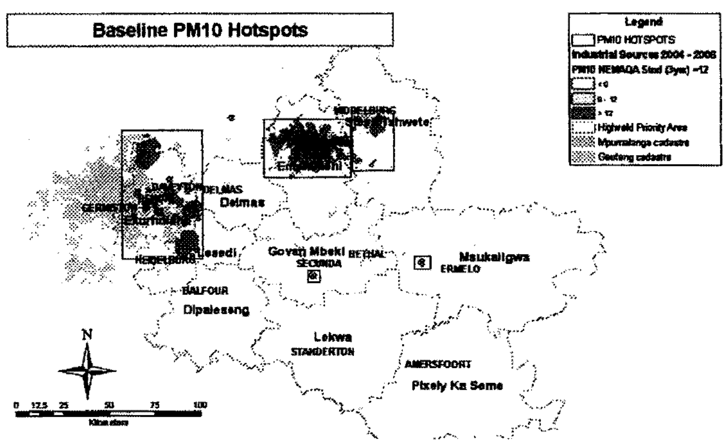


Figure E3: Modelled frequency of exceedance of 24-hour ambient SO_2 and PM_{10} standards in the HPA, indicating the modelled air quality Hot Spot areas

Exceedances of ambient air quality standards present situations where potential impacts on human health can occur. Ambient monitoring and dispersion modelling have identified nine areas on the HPA where ambient concentrations of PM_{10}, SO_2 or NO_2 exceed, or are predicted to exceed, the ambient standards. Pixley ka Seme is discussed as a hotspot however, only exceedances of O_3 have been confirmed through monitoring and this is regarded as a regional-scale problem. Exposure may be high where these exceedances coincide with populated areas and the risks to human health may be significant. The air quality hot spots on the HPA are summarised in Table E3 with an indication of the pollutants of concern.

Table E3: HPA air quality hot spots

Hot Spot	PM_{10}	SO_2	NO_2
Emalahleni	✓	✓	
Kriel		✓	
Steve Tshwete	✓	✓	✓
Ermelo	✓	✓	
Secunda	✓	✓	✓
Ekurhuleni	✓	✓	
Lekwa	✓	✓	
Balfour	✓		
Delmas		✓	

It is important to note that all residential areas where wood and coal are combusted experience high concentrations of particulates and CO, particularly those that are densely populated. Here, exposure can be particularly high. Due to the relatively local scale of their air pollution problem, they may not fall directly into one of the identified hot spot areas in Table E3. They are equally as important in terms of AQM.

High ambient ozone concentrations are a regional-scale problem with the 8-hour ambient standard frequently exceeded over much of the HPA. Ozone is not a source-specific pollutant, but its formation depends on the ideal ratios of NO_x and volatile organic compounds (VOC), together with incident ultra-violet radiation from the sun. Both NO_x and VOC are emitted by different sources on the HPA.

Air pollution and health

Mortality outcomes have been calculated for South African urban areas (Norman *et al*, 2007a). This study estimates that outdoor air pollution caused 3.7% of total mortality from cardiopulmonary disease in adults aged 30 years and older, 5.1% of mortality attributable to cancers of the trachea, bronchus, and lung in adults, and 1.1% of mortality from acute respiratory infections in children under 5 years of age.

Indoor air quality is affected by outdoor ambient air quality issues through outside ventilation, such as windows and doors, as well as specific indoor sources, particularly domestic fuel burning. Exposure to indoor air pollution was associated with a number of health outcomes, including chronic obstructive pulmonary disease (COPD), lung cancer, nasopharyngeal cancer, tuberculosis, cataracts, asthma, birth defects, and acute lower respiratory infections (ALRI) among children younger than 5 years (Norman *et al*, 2007b). ALRIs were the leading cause of death of children under 5 years worldwide, and similarly, fourth highest in South African children.

The total ALRI burden on children under 5 years was 24% in 2000, attributable to indoor air pollution from household fuel use (Norman *et al*, 2007b). Similarly for COPD, the female population experienced more than double the male attributable burden. Lung cancer burden was relatively minor from indoor air pollution as a result of household fuel use. Indoor air pollution from household fuel use was responsible for 2 489 deaths, or 0.5% of the total health burden on the individual, and resulted in the loss of 60 934 disability adjusted life years, or 0.4% of the total burden (Norman *et al*, 2007b).

Abatement technology problems

Table E4: Summary of technology challenges and developments in key HPA sectors

	Challenges	Developments
Industrial sources	• Management of fugitive and non-point sources • SO_2 and NO_2 emission management and control • Environmental and technical constraints on abatement choices	• Listed Activity minimum emission standards and Atmospheric Emission License (AEL) conditions may begin to address current shortcomings in abatement
Clay brick manufacturing	• Poor uptake of Tunnel kiln technology • Lack of abatement on clamp kilns, particularly of PM and CO emissions	• Tunnel kiln technology is promoted in new, regulated operations
Opencast coal mining	• Control of PM from mine haul roads	• Water spraying is a cheap and effective means of control, which needs to be consistently applied across mines in the HPA
Domestic fuel burning	• Poor uptake of technology due to economic circumstances • Pace of settlement growth	• Rollout of awareness and technology promotion activities is increasing
Motor vehicle emissions	• Slow infiltration of new technology vehicles • Growth in vehicle parc • Diffuse VOC emissions from filling stations and fuel storage facilities	• Vehicle emission standards continue to improve • Drive towards cleaner fuels and low emission vehicles is increasing • Vapour recovery units can address re-fuelling emissions

Air quality management capacity

Table E5: Summary of capacity challenges in the HPA

	Level of capacity
Human resources and skills	2 municipalities are not confident to implement the AQA 5 municipalities have not made Air Quality Officer (AQO) appointments 12 municipalities and both provincial departments have identified capacity building needs, ranging from technical to legal to general AQM training and assistance
Monitoring	6 municipalities indicated that no ambient air quality monitoring takes place Existing monitoring initiatives are not integrated, there is no standardised monitoring, reporting and quality control approach No in-house technical skills for maintenance and operation of stations
Emission inventory	12 municipalities and 1 provincial department have undertaken an emission inventory exercise The HPA project has produced a relatively comprehensive emission inventory, this needs to be completed and maintained

AEL preparation	2 district municipalities and 1 provincial department have not initiated steps to prepare for the delegation of the AEL function with the repeal of the Atmospheric Pollution Prevention Act (APPA)

AQMP overall objective

The overall objective for the HPA AQMP has been developed through multi-stakeholder interactions and is informed by policy and developments in AQM in South Africa. The overall objective is:

Ambient air quality in the HPA complies with all national ambient air quality standards

Seven goals of the AQMP each address different aspects of addressing the identified problems and meeting the overall objective, these are:

Goal 1: *By 2015, organisational capacity in government is optimised to efficiently and effectively maintain, monitor and enforce compliance with ambient air quality standards*

To achieve the goal, it is necessary to focus on institutional arrangements, resource availability, cooperation and collaboration, and maximisation of regulatory and management tools. The goal addresses capacity development in the AQMP, looking at the necessary structures, systems, skills, incentives, inter-relationships and strategy.

Goal 2: *By 2020, industrial emissions are equitably reduced to achieve compliance with ambient air quality standards and dust fallout limit values*

The goal will be achieved through a combination of emission determination and reduction, technological improvement, improved resource allocation and information provision. The use of regulatory tools and best practice principles is also provided for. Political and social awareness, alternative energy and energy efficiency, fugitive dust emissions and greenhouse gas emission reduction are also promoted as aspects towards achieving the goal. The maintenance of vehicles and equipment on sites and industrial plants addressed. Spontaneous combustion is addressed as a contribution from the industrial mining sector.

Goal 3: *By 2020, air quality in all low-income settlements is in full compliance with ambient air quality standards*

Effective interventions, research, awareness raising and education are major aspects in achieving the goal. Technological improvements are also critical, together with addressing the social and economic drivers of poor environmental practices.

Goal 4: *By 2020, all vehicles comply with the requirements of the National Vehicle Emission Strategy*

This goal focuses on the implementation of the National Vehicle Emission Strategy, as it will provide direction on emission reduction, technological improvement, and a conducive regulatory environment. Emission testing is recognised as a major driver for current reductions in vehicle emissions, which can be instituted by provincial and local authorities.

Goal 5: *By 2020, a measurable increase in awareness and knowledge of air quality exists*

Achieving the goal is linked to access to information, resources, improving governance and authorities' capacity, and promoting air quality issues amongst stakeholders.

Goal 6: *By 2020, biomass burning and agricultural emissions will be 30% less than current*

Management and regulatory tools are keys to achieving the goal, together with improved individual practices such as reduction of polluting inputs, awareness of unsuitable conditions and use of control measures.

Goal 7: *By 2020, emissions from waste management are 40% less than current*

In achieving the goal, it is necessary to improve waste processing, promote best practice principles and technological improvements, and address planning and delivery shortcomings, and improve regulatory control of all aspects of waste management.

In the ***Implementation Plan,*** each of the seven goals is sub-divided into logical and related objectives. In turn, activities are allocated to the respective objectives and time frames and responsibilities are allocated accordingly. The timeframes are: Short-term (1-2 years); Medium-term (3-5 years); Long-term (>5 years), and the responsibilities are allocated to the principal implementing entity (P), entities providing input (I) and entities with an oversight role only (O). Indicators to measure progress with implementation of the activities for the respective objectives are also assigned.

1. By 2015, organisational capacity in government is optimised to efficiently and effectively maintain, monitor and enforce compliance with ambient air quality standards

Objectives	Activities	Timeframe	Responsibility	Indicator
1) Goals and objectives of HPA AQMP are implemented through respective business plans	Use HPA AQMP to inform business planning for air quality function	Short, On-going	P – DEA, MDEDET, GDARD, Municipalities	• Business plans include HPA AQMP goal and objectives
	Draft municipal-level AQMP case study using HPA implementation plan	Short	P – DEA I - MDEDET, GDARD, Municipalities	• HPA AQMP incorporated within IDP/ EIPs • Council resolution passed adopting municipal AQMPs
	Adopt HPA AQMP as part of IDPs and EIPs	Short	P - MDEDET, GDARD, Municipalities	
2) Air quality function is assigned to the most appropriate section of municipalities and provinces	Consultation between local, district and provincial authorities to identify the most appropriate sphere for AQM function on behalf of each municipality	Short	P – MDEDET, GDARD, affected municipalities	• AQM function allocation or delegation made for every municipality • Functional analysis conducted and assignment made
	Create database of AQM functional analyses conducted	Short	P – DEA I – Provincial environmental authorities, Municipalities	
	Conduct functional analysis or Section 77/78 Municipal Systems Act analysis to determine suitable section/department for AQM and assign function accordingly	Short	P – MDEDET, GDARD, affected municipalities O – MDEDET, GDARD, DEA	
3) Institutional arrangements accommodate AQM function	Revise organograms to create air quality structure and designation, where needed	Short	P – affected municipalities	• AQO appointed • AQM responsibilities allocated to personnel • Staff appointed to fill
	Optimise air quality resource availability	Short	P – affected municipalities	

Objectives	Activities	Timeframe	Responsibility	Indicator
	Fill AQM posts with appropriately skilled staff	Short	P – affected municipalities	AQM posts in organogram • AQM scarce skills retention policy developed
	Develop/ revise retention policies to retain scarce AQM skills	Short	P – MDEDET, GDARD, Municipalities	
4) Cooperative governance and collaboration occurs between well- and poorly- skilled AQM sections	Establish statutory inter-governmental cooperation mechanism to harmonise AQM decision making (under IGRFA) e.g. joint licensing tribunal	Short, On-going	P – DEA, MDEDET, GDARD, Municipalities	• Cooperation mechanism established and regular meetings held • Forum established and regular meetings held • Reports made to HPA Standing Committee
	Provide guidance and assistance in AQM to provincial and local authorities	Short, On-going	P – DEA, provinces, municipalities	
	Establish inter-governmental forum to coordinate air quality governance in the HPA and reporting mechanism for the Standing Committee	Short, On-going	P – MDEDET, GDARD O – DEA I – Municipalities	
5) Personnel are equipped to perform AQM function and use AQM tools effectively	Cooperatively develop training guideline document to identify skills training needs for AQM	Short	P-DEA I - MDEDET, GDARD, Municipalities	• Training guideline developed • Skills gap analysis conducted • Skills development plans implemented • Standard courses used for training • Consultation with tertiary and other training institutions to develop standard and specialised AQM courses • AQM research needs
	Conduct AQM skills gap analysis to identify areas of capacity development for assigned sections/departments	Short	P – MDEDET, GDARD, Municipalities	
	Develop skills development plans to address identified gaps	Short	P – MDEDET, GDARD, Municipalities	
	Implement skills development plans	Short, On-going	P – MDEDET, GDARD, Municipalities	

Objectives	Activities	Timeframe	Responsibility	Indicator
	Engage with tertiary institutions to offer standardised, accredited AQM courses (undergraduate and post-graduate level) and other training institutions to offer specialised accredited AQM training short courses	Short, On-going	P – DEA I - MDEDET, GDARD, Municipalities	identified and communicated
	Coordinate officials' schedules to enable attendance of courses	Short, On-going	P – DEA, MDEDET, GDARD, Municipalities	
	Engage with NACA on sponsorship of AQM capacity development	Short	P – DEA I - MDEDET, GDARD, Municipalities	
	Determine areas of research needed in AQM and communicate to relevant research institutions	Short	P- DEA I - MDEDET, GDARD, Municipalities, Research institutions	
6) Financial resources are available for air quality governance	Develop AQM implementation plan and budget to give effect to adopted HPA AQMP and include in IDP/ EIP	Short	P – MDEDET, GDARD, Municipalities	• AQM implementation plan and budget developed and included in IDP/ EIP • Consultation meetings held with D-COGTA and SALGA
	Engage with D-COGTA and SALGA to address specific financial and performance management needs of priority areas	Short	P – DEA, Municipalities	
7) All AELAs and AQOs have extensive practical experience in air quality governance	Responsible personnel undergo AEL training	Short	P - AELAs	• AEL training completed • AEL system established • APPA Registration Certificates converted to AELs • Air quality noted in Environmental Impact Assessment (EIA) process
	AEL system is established by AELAs	Short	P - AELAs I - DEA	
	Convert APPA Registration Certificates to AELs	Short – medium	P - AELAs I - DEA	
	Contribute to EIA decision-making and environmental authorisations through commenting on air quality impact assessments	Short, On-going	P – MDEDET, GDARD, Municipalities	

Objectives	Activities	Timeframe	Responsibility	Indicator
	Conduct regular inspections to monitor plant performance and compliance	Short, On-going	P – MDEDET, GDARD, Municipalities I - DEA	• Industrial plant comply with AEL conditions • Emission reporting regulation published • Emission reports submitted regularly • Mechanism developed for recognition of good performance • Presentations made and discussion held on AQM activities
	Develop and publish emission reporting regulation for reporting to authorities	Short	P – DEA I – MDEDET, GDARD	
	Enforce emission reporting regulation	Short, On-going	P - AELAs	
	Acknowledge good performance/compliance e.g. annual awards	Medium, On-going	P - MDEDET, GDARD I – DEA, Municipalities	
	Carry out enforcement action on all non-compliant incidences	Short, On-going	P - AELAs I – Other non-AELA municipalities	
	Use established inter-governmental governance forum as an experience-sharing platform	Short, On-going	P – MDEDET, GDARD, Municipalities I/O - DEA	
8) Development planning in the HPA recognises the objectives of the AQMP	Include air quality in environmental decision-making tools for land use planning	Short, On-going	P – MDEDET, GDARD, Municipalities	• Air quality criteria are included in planning decision-making and discussed in policy • Status quo case study prepared
	Align and integrate municipal and provincial AQMPs and other environmental planning tools with the IDP/ EIP in the HPA	Short, On-going	P – MDEDET, GDARD, Municipalities	
	Draft status quo assessment case study for use in AQMPs and other planning tools	Short	P – DEA I - MDEDET, GDARD, Municipalities	
	Develop HPA pilot for national AQMP support programme	Short	P - DEA	

Objectives	Activities	Timeframe	Responsibility	Indicator
9) Use of air quality management tools such as ambient monitoring, emission inventories, dispersion modelling, etc. are optimised and expanded	Develop monitoring station purchase and operation guideline, including capacity development activities	Short	P – DEA, I - MDEDET, GDARD, EMM	• Improved data availability at stations • Publicly available data has undergone quality assurance and control and is up-to-date • Annual monitoring and emission reports are available • Annual reports are presented at Air Quality Governance Lekgotla • Updated HPA emission database is available • Emission database is 80 % complete • Scenario modelling is carried out for HPA
	Conduct quality control and assurance on all data to assist compliance monitoring	Short, On-going	P – DEA, MDEDET, GDARD, EMM	
	Upload monitoring data to SAAQIS routinely	Short, On-going	P – DEA, MDEDET, GDARD, EMM	
	Compile annual reports on monitored data, for technical and AQM purposes	Short, On-going	P – DEA, MDEDET, GDARD, EMM	
	Improve HPA emission data base to make it current and representative	Short	P – DEA I – MDEDET, GDARD, Municipalities	
	Maintain the database to ensure it remains current and representative	Short, On-going	P – DEA I – MDEDET, GDARD, Municipalities	
	Compile annual reports on emissions data, for technical and AQM purposes	Short, On-going	P – DEA I - MDEDET, GDARD, Municipalities, Industries	
	Configure HPA dispersion model	Short	P – DEA I – Industries	
	Use HPA dispersion model to assist planning and decision making	Short, On-going	P –DEA I – MDEDET, GDARD, Municipalities	
10) Progress on the implementation of the HPA AQMP is monitored	Establish a Standing Committee with governance stakeholders to assess and report on progress with the HPA AQMP implementation	Short, On-going	P –DEA I – MDEDET, GDARD, Municipalities	• Standing Committee established and operational • Progress reports on

Objectives	Activities	Timeframe	Responsibility	Indicator
	Develop progress reports regularly	Short, On-going	P –DEA, MDEDET, GDARD, Municipalities	AQMP implementation available

2. By 2020, industrial emissions are equitably reduced to achieve compliance with ambient air quality standards and dust fallout limit values

Objectives	Activities	Timeframe	Responsibility	Indicator
1) Emissions are quantified from all sources	Establish and maintain a site emission inventory that includes all point and diffuse sources for all significant pollutants	Short, On-going	P - Industries	• Site emission inventories completed • Emission reports available
	Submit emission inventory report as per emission reporting regulation	Short, On-going	P - Industries O - AELAs	
2) Gaseous and particulate emissions are reduced	Determine equitable emission reduction for specific industries: • Identify significant emitters in HPA • Submit AIR's using a regulated modelling approach • Determine equitable emission reduction using AIR submissions and industrial action plans (Appendix 6) • Issue AELs with emission reduction requirements and industrial action plan commitments	Short	P – DEA, AELAs, Industries I – Other non-AELA municipalities	• AELs issued with emission reductions • Emission reduction measures implemented by industries • Maintenance plans implemented • Reduced disruptions to plant operations
	Develop and implement maintenance plan for each plant	Short	P – Industries	
	Schedule and conduct repairs to coincide with plant offline times	On-going	P – Industries	
	Incorporate equipment changes into maintenance schedule	On-going	P – Industries	
	Operate plants with minimum disruption e.g. back-up plan for energy consumption/ generation	Short, On-going	P – Industries	
3) Fugitive emissions are minimised	Develop fugitive emission management plan	Short	P – Industries I - DEA, AELAs	• Fugitive emission management plan developed and implemented • Reduction in fugitive emissions
	Implement appropriate interventions e.g. LDAR programme	Short, On-goin	P – Industries O - DEA, AELAs	

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Objectives	Activities	Timeframe	Responsibility	Indicator
4) Emissions from dust-generating activities are reduced	Develop and implement dust reduction programmes in line with industry best practice, considering technology and management interventions	Short, On-going	P – Industries O - DEA, AELAs	• Dust reduction programme implemented • Fleet maintenance carried out • Alternate haulage and waste management investigated
	Investigate feasibility of using alternative means for haulage e.g. conveyer, rail	Medium	P – Industries	
	Plan and carry out regular fleet maintenance .	Short, On-going	P – Industries	
	Investigate opportunities to market waste as raw material inputs to other industries e.g. discard coal	Medium	P – Industries	
5) Greenhouse gas emissions are reduced	Include greenhouse gas emissions in site emission inventory	Short	P – Industries	• Site greenhouse gas emission inventories compiled • Energy efficiency plans implemented
	Develop and implement a site energy efficiency plan	Short	P – Industries I - DEA, MDEDET, GDARD, Municipalities	
	Consider climate change implications in AQM decision-making	Short, On-going	P – Industries	
	Investigate opportunities for co-generation e.g. off-gas as an energy source	Short – Medium	P – Industries	
	Investigate feasibility of renewable energy	Short – Medium	P – Industries	
6) Incidences of spontaneous combustion are reduced	Promote research needs regarding spontaneous combustion	Short	P – DEA I - MDEDET, GDARD, Municipalities	• Research needs communicated • Consultation with DMR on abandoned mines • Reduced incidences of spontaneous combustion
	Communicate the need to determine abandoned mine ownership to facilitate rehabilitation and/or closure	Short	P – DEA	
	Promote the need for compliance monitoring of abandoned mines	Short	P – DEA	

Objectives	Activities	Timeframe	Responsibility	Indicator
	Implement and enforce discard dump management regulations	Short	P – DEA	
	Improve supply and demand forecasting to reduce coal stockpile size and limit coal stockpile retention time	Medium	P – Industries	
7) Abatement technology is appropriate and operational	Install and/or maintain appropriate air pollution abatement technology compliant with requirements of AEL and achieving Section 21 emission standards	Short – Long	P – Industries	• Air pollution abatement technology installed • Equipment operated optimally • Individual technology benchmarks completed
	Train operators to ensure optimal operation of abatement equipment	On-going	P – Industries	
	Promote individual benchmarking of abatement technology	Medium	P - DEA	
	Motivate for and undertake research to improve abatement technology and reduce retrofitting costs	Medium	P – DEA, Industries, Research institutions	
8) Industrial AQM decision making is robust and well-informed, with necessary information available	Establish sector information sharing fora	Short	P – Industries	• Sector fora established • Sector best practice guidelines available • Benchmarking promoted
	Compile best practice documents for the sectors	Short – Medium	P – DEA I - AELAs	
	Conduct international benchmarking within the sectors	Medium	P – Industries O – DEA	
	Make sector emission performance information available for company benchmarking	Medium	P – DEA I – Industries	
	Make best practice information available on SAAQIS	Medium	P - DEA	
9) Clean technologies and processes are implemented	Incorporate cleaner technology considerations into AEL	Short	P - AELAs I - DEA	• AEL includes clean technology recommendations • Clean technology feasibility studies conducted
	Investigate feasibility of introducing clean technologies on plant-specific basis	Medium	P – Industries	
	Implement feasible technology options on plant-specific basis	Medium – Long	P – Industries	

Objectives	Activities	Timeframe	Responsibility	Indicator
	Investigate regulatory mechanisms to facilitate introduction of new technology	Medium	P – DEA, MDEDET, GDARD	• Clean technology options implemented
	Investigate feasibility of switching to clean fuels at times of poor dispersion	Medium	P – Industries	
	Investigate alternative design and process options to improve plume dispersion	Medium	P – Industries	
	Implement feasible alternative design and process options	Medium - Long	P – Industries	
10) Adequate resources are available for AQM in industry	Revise organograms to create air quality structure and designation, where needed	Short	P – Industries	• AQM personnel designated • Abatement and measurement financial planning complete
	Optimise environmental management resource availability to accommodate air quality function	Short	P – Industries	
	Fill AQM posts with appropriately skilled staff, where needed	Short	P – Industries	
	Input into financial planning to implement emission abatement and measurement requirements of AEL and Section 21 emission standards	Short	P – Industries	
	Investigate the possible use of offset programmes to reduce financial investments	Medium	P – Industries I - DEA, AELAs	
11) Ambient air quality standard and dust fallout limit value exceedances as a result of industrial emissions are assessed	Conduct ambient air quality monitoring in accordance with AEL requirements	Short, On-going	P – Industries O - AELAs I – DEA	• Ambient air quality and dust fallout monitoring carried out • Monitoring results reported and available on SAAQIS • AIRs updated to include monitoring results
	Conduct dust fallout monitoring in accordance with legislative requirements, and consider advances in monitoring technology	Short, On-going	P – Industries O - AELAs I – DEA	
	Report ambient monitoring results, to relevant AQO and publish on SAAQIS	Short, On-going	P – Industries O – DEA, AELAs	
	Update AIR submissions	Short, On-going	P – Industries O – DEA, AELAs	

Objectives	Activities	Timeframe	Responsibility	Indicator
12) A line of communication exists between industry and communities	Conduct quarterly consultative community meetings	Short, On-going	P – Industries	• Quarterly meetings held between industry and communities

3. By 2020, air quality in all low income settlements is in full compliance with ambient air quality standards

Objectives	Activities	Timeframe	Responsibility	Indicator
1) Implementation of the strategy for dense low income settlements	Promote the objectives of the strategy in dense low income settlements on the HPA	Medium, On-going	P – MDEDET, GDARD I – DEA, Municipalities	• Planning of dense low income settlements considers the objectives of the strategy
2) Clean fuels and technology are used that are affordable and easily available	Coordinate BnM rollout in HPA PM_{10} "hot spot" settlements	Short, On-going	P – MDEDET, GDARD I – DEA, Municipalities, DoE, Industries	• BnM demonstrations held across HPA • Mechanisms to provide clean energy are investigated
	Communicate the air quality benefits of subsidy provision for clean combustion technology (stoves) and clean fuels (anthracite coal, gas) to implementing stakeholders	Short, On-going	P – DEA I – MDEDET, GDARD, Municipalities	
	Motivate for other regulatory and financial mechanisms to improve affordability of clean energy	Short, On-going	P – DEA I – MDEDET, GDARD, Municipalities	
	Communicate the benefit of accessing CDM funding for fuel switching projects in HPA	Short, On-going	P – DEA I – MDEDET, GDARD, Municipalities	
3) Service delivery to low income residential areas is improved	Communicate the air quality benefits of improved service delivery to relevant departments, particularly: • Electrification • Road surfacing • Refuse removal • Greening	Short, On-going	P – DEA, MDEDET, GDARD, Municipalities	• Benefits of service provision are understood in relevant departments • Electrification program is revised to address identified air quality hot spots as priority
	Participate in development of prioritisation methodology for electricity provision	Short	P – DEA, MDEDET, GDARD, Municipalities	
	Engage Eskom to electrify areas of poor air quality in hot spots as a priority	Short, On-going	P – DEA, MDEDET, GDARD	

4) Adequate scientific, health and economic information is available on domestic fuel burning and air quality	Identify and communicate research needs to research institutions and organisations to motivate research on domestic fuel use, particularly emission reduction measures	Short, On-going	P – DEA I – MDEDET, GDARD, Municipalities	• Research on domestic fuel burning and related topics conducted • Research outcomes on domestic fuel burning and related topics available on SAAQIS
	Develop linkage between HPA website and SAAQIS database of available information	Short, On-going	P – DEA I - MDEDET, GDARD, Municipalities, Research institutions, Industries	
5) Low-income and informal households are energy efficient	Participate in the revision of low cost housing design principles	Short	P – DEA, DoHousing, MDEDET, GDARD, Municipalities	• Low cost housing design principles consider energy efficiency
	Communicate the air quality benefits of large-scale subsidised solar water heating and other energy efficient fittings	Short	P – DEA	
	Communicate the benefit of accessing CDM funding for energy efficiency projects in HPA	Short	P – DEA	
6) Social upliftment and development has air quality benefits	Promote air quality-related corporate social investment in low income communities in hot spot areas	Short, On-going	P – DEA, MDEDET, GDARD, Municipalities	• Corporate investment occurs in low income communities in hot spot areas

4. By 2020, all vehicles comply with the requirements of the National Vehicle Emission Strategy

Objectives	Activities	Timeframe	Responsibility	Indicator
1) Regulations for motor vehicle emission reduction is in place	Implement requirements of the national vehicle emission strategy	Short - Medium	P – DEA, DoT, DoE	• National vehicle emission strategy implemented
2) Emission testing capacity is extended	Develop emission testing regulation	Short	P – relevant municipalities	• Emission testing regulated and implemented • Emission testing report compiled
	Acquire emission testing equipment	Short	P – relevant municipalities	
	Conduct training programme for testing personnel	Short	P – relevant municipalities I – MDEDET, GDARD, EMM, Other municipalities with testing function	
	Conduct regular inspections	Short, On-going	P - relevant municipalities	
	Compile report on emission testing activities and effectiveness	Short, On-going	P - relevant municipalities	

5. By 2020, a measurable increase in awareness and knowledge of air quality exists

Objectives	Activities	Timeframe	Responsibility	Indicator
1) Air quality information is easily accessible to all stakeholders	Simplify technical reports and management plans for public consumption	Short, On-going	P – DEA, MDEDET, GDARD, Municipalities	• Air quality information is available in hard copy and electronic formats • Air quality information is available in official languages • Simplified technical information is available
	Disseminate information in areas accessible to all stakeholders (e.g. community libraries in the HPA)	On-going	P – DEA, MDEDET, GDARD, Municipalities	
	Use media to share information on air quality	Short, On-going	P – DEA, MDEDET, GDARD, Municipalities	
	Use organisations' websites for distribution of information	Short, On-going	P – DEA, MDEDET, GDARD, Municipalities	
	Develop educational material on air quality impacts in relevant official languages aimed at individuals, communities and government officials	Short	P - DEA	
2) Air quality information is communicated to all stakeholders	Conduct educational campaigns within all HPA communities	Short, On-going	P – MDEDET, GDARD, Municipalities	• Educational campaigns conducted across HPA • Stakeholder fora established • Training and awareness-raising courses held for community leaders and councillors • Air quality criteria considered in development planning policy and initiatives • Use of fire danger index promoted • Reduction in incidents of burning (controlled and uncontrolled)
	Conduct educational awareness programmes at schools which host monitoring stations	Short, On-going	P – DEA, MDEDET, EMM	
	Establish a community forum/fora (NGOs, CBOs and FBOs) to address stakeholder education, awareness and capacity building	Short	P – MDEDET, GDARD, Municipalities	
	Organise seminars, workshops and training courses for community leaders and councillors on air quality issues	Short	P – DEA, MDEDET, GDARD, Municipalities	
	Conduct air quality awareness raising activities accompanied by elected officials	Short	P – DEA, MDEDET, GDARD, Municipalities	
	Increase awareness of development planners to consider air quality criteria in planning decision-making	Short	P – MDEDET, GDARD, Municipalities	

	Conduct awareness-raising activities and educational programmes on correct use of fire and vegetation management	Short, On-going	P – DEA, DoA, MDEDET, GDARD, Municipalities	
	Publicise the existing fire danger index as part of AQM	Short	P – MDEDET, GDARD, Municipalities	
	Promote the "Follow the smoke" campaign	Short	P – DEA I - MDEDET, GDARD, Municipalities	
3) Research is considerate of stakeholders in the area of study	Consult communities, local leaders, community organisations etc as part of research process	Short, On-going	P – Research institutions	• Community knowledge is included in air quality studies
	Incorporate indigenous information/ knowledge into air quality studies	Short, On-going	P – MDEDET, GDARD, Municipalities, Research institutions	
4) Opportunities for public participation and involvement in air quality decision-making are readily available	Use stakeholder fora to provide communication platform to communities	Short, On-going	P – Municipalities	• Community communication platform established • Community are able to access AQM officials in emergencies
	Publish contact details of relevant AQOs in communities	Short	P – Municipalities	
	Investigate feasibility of establishing a toll free number for air quality incidents for the HPA	Short	P – DEA, MDEDET, GDARD	

6. By 2020, biomass burning and agricultural emissions will be 30% less than current

Objectives	Activities	Timeframe	Responsibility	Indicator
1) Emissions from biomass burning and agricultural activities on the HPA are quantified	Develop emission estimate for biomass burning (natural and controlled)	Short	P – DEA I – DoA, DoAFF	• Current emission estimate available for biomass burning and agriculture
	Maintain information on fires on HPA using AFIS and other resources	On-going	P – DEA	
	Develop emission estimate for agriculture: • Pesticides • Odour-related pollutants • Dust	Short	P – DEA I – DoA, GDARD	
2) Management alternatives to burning are available	Promote grass cutting and baling in agricultural, protected and road reserve areas, to be used as a resource e.g. fodder, compost, smokeless fuel	Short, On-going	P – DEA, DoA, DoT I – MDEDET, GDARD	• Reduction in burning in agricultural, protected and road reserve areas
	Motivate for research on veld management practices/ strategies for alternatives to burning and on the relationship between fire and environmental factors	Short	P – DEA, DoA	
3) Legal requirements discourage vegetation burning	Optimise the use of existing regulatory tools to prevent agricultural burning in poor conditions	Short	P – DEA, DoA	• Regulation restricting burning is promulgated
	Motivate for specific conditions for creating fire breaks in Veld and Forest Fires Act	Short – Medium	P – DEA, DoAFF	
	Motivate for regulation of burning in sensitive ecosystems and surrounding areas	Medium	P – DEA, DoA, DoAFF	
4) Dust entrainment, odour, and pesticide emissions are reduced	Cooperatively investigate the feasibility of the development and publication of weather forecasts for optimum ploughing time and spraying of pesticides	Short	P – DEA, SAWS, DoA	Feasibility report prepared on agricultural forecast available

7. By 2020, emissions from waste management are 40% less than current

Objectives	Activities	Timeframe	Responsibility	Indicator
1) Emissions from waste management activities on the HPA are quantified	Develop and maintain emission estimate for landfills, waste water treatment works and incinerators	Short	P – DEA	• Emission estimates available for waste management facilities • Greenhouse gas emission estimates available
	Include Greenhouse gas emissions in emission inventory	Short	P – DEA	
2) Management of waste processing sites considers air pollutant and greenhouse gas emission reductions	Develop emission reduction plan for all process and fugitive sources	On-going	P – Operating Entities O – DEA, AELAs	• Emission reduction plans developed and implemented
	Implement emission reduction and maintenance plan for all emission sources resulting from waste management activities	Short, On-going	P – Operating Entities O – DEA, AELAs	
	Investigate feasibility of methane extraction for energy generation	Short – Medium	P - Operating Entities	
	Promote the use of best available technology in waste management	Medium	P – DEA, MDEDET, GDARD, Municipalities	
3) Emissions from burning of waste are reduced	Motivate for regular collection of waste from skips	Short	P – Municipalities	• Waste burning is regulated
	Apply/ develop regulatory tools to control waste burning	Short – Medium	P - MDEDET, GDARD, Municipalities I – DEA	
	Motivate for enforcement action on incidences of waste burning	Short – Medium	P - MDEDET, GDARD, Municipalities	

Co-benefits from projects by other governance departments

As part of the AQMP development, work by stakeholders not directly related to air quality but having co-benefits for improved air quality in the HPA has been included. The projects listed are under development, have been implemented, or are proposed following consultation, and possible collaboration.

Table E6: Collaborative working and support projects

Implementing agent	Project
Department of Health	• Implementation of the guideline on indoor air pollution • Cooperatively develop healthcare admission methodology to include air pollution exposure parameters
Department of Transport	• Motivate for the inclusion of emission testing as part of roadworthiness certification
Department of Energy	• Revision of fuel specifications as part of National Vehicle Emissions Strategy
Department of Energy, Eskom	• Develop promotional material and tools to inform energy efficient and alternative energy choices
Department of Education	• Promote revision of school curriculum to include AQM • Distribute DEA air quality educational material to educators in the HPA • Promote AQM as a career path at schools and tertiary institutions
Department of Justice	• Motivate for stricter enforcement action through prosecution and stiff penalties for arson offenders
Department of Agriculture	• Promote research on improving farming techniques and good agricultural practices e.g. minimum tillage, application of pesticides • Promote best practice for the conversion of animal waste to manure and fertiliser
Department of Water Affairs and DEA	• Compile best practice documents for the waste management sector • Develop promotional material on air quality benefits of household waste minimisation

Monitoring

Monitoring the progress of the implementation of the AQMP is a key factor in maintaining momentum for the rollout of interventions and provides a means to update key stakeholders. Working groups are the preferred mechanism for monitoring, as they are the primary means for initiation of implementation. The outcomes of the meetings will be taken forward into the annual evaluation exercise.

Responsibility	DEA, Working Groups
Method	Progress meeting/Level of completion of interventions
Timeframe	6 months

Evaluation

On-going evaluation is an essential element of AQMP implementation as it allows for a thorough assessment of the AQMP. Evaluation is an internal mechanism to measure the performance of the AQMP implementation. Annual evaluation of the AQMP is suggested as a minimum timeframe and is ideally incorporated into the annual performance review mechanisms.

AQMP evaluation comprises an internal evaluation of the final AQMP, and an on-going evaluation, which addresses implementation outcomes. This component is regarded as a limited peer review mechanism, as the MSRG has technical and management background in AQM and is able to refine the AQMP. An evaluation checklist is provided in DEA's AQMP Manual, which deals with all aspects that require assessment.

Indicators have been developed for the AQMP implementation plan. These are ideally incorporated into the annual reports to be submitted to the Minister, as indicated in Section 17 of the AQA. These reports, together with the regular progress reports proposed in the implementation, will be incorporated into the National AQO's Annual Report, which is submitted to the Minister as well, and available to all stakeholders.

Review

AQMP review comprises internal and external review components, and addresses further developments in the science as well as management of air quality.

With regards to the formal review of the AQMP and the implementation, a review period of every *five years* is recommended in the DEA Manual. The definition of the review period is subject to funding and political cycles, as well as implementation outcomes.

The process of five-yearly review is anticipated to be initiated through an internal review mechanism and incorporate the annual evaluation exercise, effectively assessing the five-year performance of the AQMP, and leading to revision of the AQMP.

Responsibility	DEA, Working Groups, MSRG
Method	Compilation of annual evaluations
Timeframe	5 year

1 INTRODUCTION

1.1 Background

The overarching constitutional right to an environment that is not harmful to health or well-being is captured in the objectives of the National Environmental Management: Air Quality Act (No. 39 of 2004) (hereinafter "the AQA"). Importantly, the promulgation of the AQA marked a turning point in the approach to air pollution control and governance in South Africa, introducing the philosophy of effects based Air Quality Management (AQM), in line with international policy developments and the environmental right, i.e. Section 24 of the Constitution (Act No. 108 of 1996). The focus shifted from source control to management of pollutant levels in the ambient environment. The AQA makes provision for a number AQM tools and instruments, including the establishment of Priority Areas (Sections 18 to 20) in so-called "hot-spot" areas where ambient air quality standards are exceeded or may be exceeded.

The Priority Area tool has three strategic drivers:

i. It effectively allows for the concentration of limited AQM capacity (human, technical and financial) for dealing with acknowledged problem areas in order to obtain measurable air quality improvements in the short-, medium- and long-term;

ii. It prescribes a cooperative governance approach;

iii. It allows for the implementation of 'cutting edge' AQM methodologies that take into account all contributors to the air pollution problem, i.e. "air-shed"-level management.

The declaration of the Vaal Triangle Airshed Priority Area (VTAPA) on 21 April 2006 was the first priority area initiative, aimed at managing poor air quality in an air pollution "hot-spot" area that crossed the Gauteng and the Free State provincial boundaries. The Priority Area Air Quality Management Plan (PAQMP) (DEAT, 2008) describes the status of air quality in the VTAPA, identifies the root of the air pollution problems, sets objectives and defines interventions to achieve the objectives of the Air Quality Management Plan (AQMP).

The Highveld region in South Africa is also associated with poor air quality and elevated concentrations of criteria pollutants occur due to the concentration of industrial and non-industrial sources (Held *et al*, 1996; DEAT, 2006). The Minister of Environmental Affairs therefore declared the Highveld Priority Area (HPA) on 23 November 2007. As the area declared overlaps provincial boundaries, the Department of Environmental Affairs (DEA) functions as the lead agent in the management of the priority area and is required in terms of Section 19(1) of the AQA to develop an AQMP for the priority area.

The Highveld Priority Area covers 31 106 km^2, including parts of Gauteng and Mpumalanga Provinces, with a single metropolitan municipality, three district municipalities, and nine local municipalities (Figure 1, Table 1).

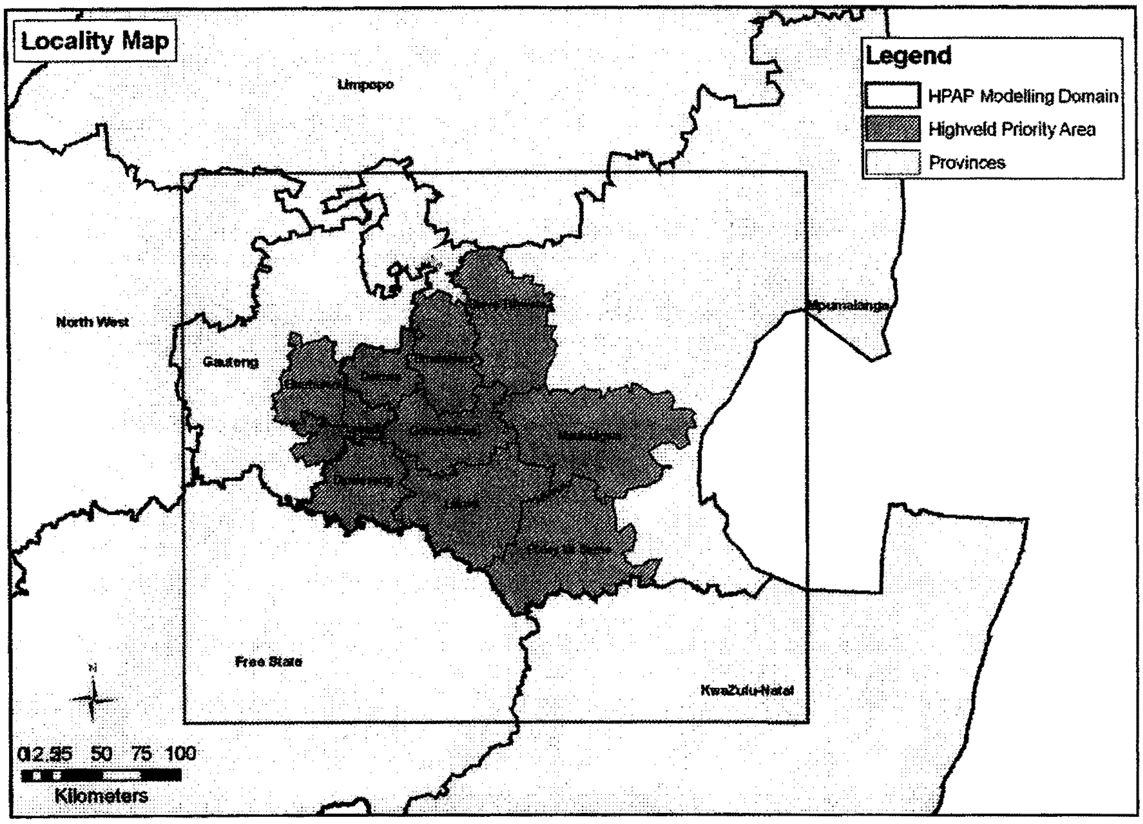


Figure 1: Locality map depicting the Highveld Priority Area (HPA), showing the three district municipalities, their constituent local municipalities, and the single metropolitan municipality. The modelling domain for the study is also shown.

Table 1: Respective levels of government involved in the HPA

NATIONAL GOVERNMENT : PRIORITY AREA MANAGEMENT	**Province**	**Metro / District**	**Local Municipality**
	Gauteng	Ekurhuleni Metro	
		Sedibeng DM	Lesedi
	Mpumalanga	Gert Sibande DM	Govan Mbeki
			Dipaleseng
			Lekwa
			Msukaligwa
			Pixley ka Seme
		Nkangala DM	Delmas
			Emalahleni
			Steve Tshwete

1.2 AQMP development process

From a procedural perspective, cooperative governance and public participation are essential components of the AQMP process. At the project inception, a Project Steering Committee (PSC) was established to provide management and administrative guidance; and an Air Quality Officers Forum (AQOF), to provide governance and technical guidance. The initial Project Steering Committee comprised of DEA officials and the consultants. The

AQOF had a broader scope and included representatives from other relevant and affected National government Departments and other affected Provincial Departments. The AQOF was subsequently invited to become members of the Project Steering Committee and attend project management meetings. A questionnaire was used to engage with municipalities and provincial environmental departments on AQM practices and capacity as well.

A Multi-Stakeholder Reference Group (MSRG) was also established, to incorporate formally broader stakeholders into the HPA AQMP development. The MSRG includes industries, industry sector associations, Non-Governmental Organisations (NGO's), universities, individual members of the public, and other interested parties. MSRG meets regularly to communicate project progress and significant developments.

A public participation process was conducted as part of the development of the AQMP. The MSRG,LFA & NGOs were constituted for several meetings in major centres in the HPA to address the needs of local stakeholders during the project (**Error! Reference source not found.**). The development of the draft baseline assessment and AQMP were presented during these sessions.

Table 2: Details of AQOF/MSRG meetings

DATE	EVENT
9 April 2008	Highveld PA AQOF Inception meeting following declaration (Steve Tshwete Municipal Offices Middleburg)
23 September 2008	Combined meeting of the Highveld Forum/MSRG (Witbank)
23 October 2008	The first combined HPA AQOF/MSRG meeting to introduce the service provider (Protea Hotel in Witbank)
19-20 January 2009	HPA Air Quality Research Workshop (Ekurhuleni Kempton Park Council Chambers)
16 April 2009	2nd HPA AQMP AQOF/MSRG (Multilink Conference Centre, Trichardt-Secunda)
20 July 2009	The first draft Problem Analysis was presented to the MSRG meeting (Delmas Country Lodge)
08 – 10 September 2009	Air Quality Management Capacity Building training workshop was conducted (Witbank-Protea Hotel)
19 April 2010	Presentation of the 1st draft HPA AQMP to MSRG (EMM Offices, Council Chambers, Kempton Park)
19 May 2010	HPA AQMP MSRG meeting held (Civic Centre Gert Sekoto Library)
03 -04 June 2010	HPA AQMP LFA workshop held (Protea Hotel, Witbank)
10 November 2010	MSRG meeting to present the 2nd draft AQMP (Protea Hotel

	Witbank)
31 August 2011	MSRG meeting to workshop public comments (Nkangala District, Middleburg)
02 -04 Nov 2011	HPA AQMP capacity building session, (Nkangala District, Middleburg)

In terms of ambient air quality, the point of departure in developing any AQMP is to assess the state of air quality in the region of interest, as well as the incumbent capacity for air quality management. Collectively they allow for the identification and understanding of problems relating to air quality that inform the subsequent development of a management strategy to address these problems in the form of the AQMP. The baseline assessment therefore provides information on the status of air quality in the HPA and identifies the sources and conditions resulting in the air quality problems.

The baseline assessment for the HPA summarised the major issues to be addressed in the AQMP, specifically highlighting the geographical areas of concern within the HPA, where dedicated AQM interventions are to be focused. The constraints and developments in the abatement technology used and available, as well as the capacity of officials who will carry the majority of the responsibility for implementation of the AQMP have also been noted as part of the baseline for the AQMP. These issues were carried forward as gaps and priorities into the AQMP development process. The Logical Framework Approach (LFA) workshop, held from 3 – 4 June 2010 in Witbank, was a key milestone in the AQMP development process.

The LFA workshop scrutinised the air quality problems identified in the baseline report and developed problem trees, which outlined the cause and effect relationships relating to each air quality issue. These were converted into objective trees, outlining the desired outcome for each problem. Specific interventions were identified to reach the objective state. The LFA workshop was a stakeholder driven process and the outcomes of the workshop could be considered a true reflection of the concerns and issues raised by the MSRG. An overall objective for the HPA AQMP and the individual air quality issues were determined through group input. The workshop outcomes were taken into detailed strategy analysis and intervention development, and formed the initial draft of the AQMP.

The primary motivation of the AQMP for the HPA is to achieve and maintain compliance with the national ambient air quality standards across the HPA, using the Constitutional principle of progressive realisation of air quality improvements. The HPA AQMP also considers that AQM practices are aligned with legal and regulatory requirements, the on-going implementation of AQM activities are accommodated, and addresses the changing receiving environment. The AQMP for the HPA provides the framework for implementing departments and industry to include AQM in business planning to ensure effective implementation and monitoring.

The HPA AQMP has been drafted at a strategic level, indicating high-level tasks for responsible parties. The specific planning at an operational level, such as budgeting, human resource allocation, and detailed activity planning, has been excluded from the plan. This is to allow parties to tailor their implementation activities to their specific context, particularly organisational constraints, while still achieving the overall objective of the AQMP. The activities listed in the plan must be unpacked further by responsible parties into organisation-specific activity and intervention plans, and captured in the policy and strategic documents, such as business and investment plans, Integrated Development Plans (IDPs), and Environmental Implementation Plans (EIPs).

1.3 Overarching principles

The development of the HPA AQMP is guided by overarching principles detailed in key regulatory and policy documents. These include the principles outlined in the National Environmental Management Act (Act 107 of 1998). The SMART principles listed in the National Framework also apply to the planning process, as all objectives need to be specific, measurable, achievable, realistic and time-related.

Equity: Consideration of previously disadvantaged groups in the management of air quality is necessary. Gender and race variables should be incorporated into decision-making to mitigate disproportionate impacts on these groupings. Enhancing resource access to previously disadvantaged groups should also be promoted. In addition, consideration of these groupings in organisational structures and training is needed to address previous imbalances.

Participation: The participation of all interested and affected parties in environmental governance must be promoted, and all people must have the opportunity to develop the understanding, skills and capacity necessary for achieving equitable and effective participation, and participation by vulnerable and disadvantaged persons must be ensured. Broad consultation and the inclusion of the views of different sectors of society aid the development of robust, acceptable policy. Decisions must take into account the interests, needs and values of all interested and affected parties, and this includes recognising all forms of knowledge, including traditional.

Duty of care: Any person who harms the environment must take reasonable measures to avoid or minimise such harm, even if they have been legally authorised to do so.

Polluter pays: The costs of remedying pollution, environmental degradation and consequent adverse health effects and of preventing, controlling or minimising further pollution, environmental damage or adverse health effects must be paid for by those responsible for harming the environment.

Environmental justice: Environmental justice must be pursued so that adverse environmental impacts are not distributed in a manner that unfairly discriminates against any person, particularly vulnerable and disadvantaged persons.

Sustainability: The maintenance of the long-term well-being and capacity of economic, social and environmental systems.

Integration: Environmental management and by inference AQM must be integrated, acknowledging that all elements of the environment are linked and interrelated, and it must take into account the effects of decisions on all aspects of the environment and all people in the environment.

Transparency: Decisions relating to the management of air quality must be taken in an open and transparent manner, and access to information must be provided in accordance with the law. Where confidentiality is needed, the highest level of disclosure should be pursued.

Cooperative governance: All spheres of government and organs of state are required by law to co-operate by fostering friendly relations, assisting and supporting one another, informing one another and consulting one another on matters of common interest, and co-ordinating actions and legislation.

Effectiveness: Actions and decisions pertaining to the management of air quality should achieve set objectives in a manner that constitutes efficient use of resources, considering economic, social and environmental costs. A measure of effectiveness of activities should be included for each one or those grouped under objectives, where relevant. The use of indicators assists to measure progress, however, a defined measure is needed to assess whether activities are meeting the desired objective at a strategic level.

Research: Further improvement of interventions and innovation in abatement technology, as well as improved understanding and identification of air quality issues can be achieved through continued research initiatives in the HPA. It is necessary to promote research across the HPA in air quality and all related fields.

Best practicable environmental option: This approach considers the integrated spheres of the environment, i.e. land, water and air, in decision-making to facilitate the choice of option with least cost to the environment as a whole. It also includes consideration of economic costs in determining the most practical option.

1.4 Report structure

A general description of the HPA is presented in Chapter 2, including a description of the population distribution, the topography and land use, and the climatology and meteorology.Chapter 3 focuses on ambient air quality and the AQM capacity. It includes a discussion on emissions by sector and the resultant air quality status based on air quality monitoring data and dispersion modelling. Recent air pollution and health studies conducted in the HPA are reviewed and results are used to inform the baseline assessment. The incumbent AQM capacity at the respective levels of government is also reviewed in Chapter 3.

A review of current air pollution abatement technologies used in key industrial sectors in the HPA is presented in Chapter 4.

A summary of air quality problems in the HPA is presented in Chapter 5, according to areas where ambient air quality does not comply with standards, problem emission sectors or technologies, and AQMcapacity problems.

The overall objective, goals and objectives for the AQMP are presented in Chapter 6. Chapter 7 details the implementation plan to achieve the HPA AQMP overall objective. A separate implementation table is developed to meet each goal of the AQMP. Stakeholder roles and responsibilities are indicated. The monitoring, evaluation and review mechanisms for the AQMP are outlined in Chapter 8, indicating the methodology to use the indicators included in the implementation plan.

Supporting information such as the National Ambient Air Quality Standards and industry specific emission reduction plans are included as annexures.

2 GENERAL DESCRIPTION OF THE HPA

2.1 Topography and land use

The HPA forms part of South Africa's elevated inland plateau. The topography of the HPA is relatively flat or gently undulating. It slopes gently from elevations of about 1400 m in the northwest in the Delmas, Emalahleni and Steve Tshwete Local Municipality, to 1500 m in the central parts and to a little more than 1600 m in the east in the Msukaligwa Local Municipality, reaching 1800 m in the southeast in the Pixley ka Seme Local Municipality (Figure 2). The southern part of the HPA slopes to 1400 m into the Vaal River basin. The generally flat terrain is interspersed with relatively low koppies and rocky outcrops.

The HPA exists entirely in the Grassland Biome ecosystem (DEAT, 2005), but as with virtually all ecosystems globally, it has been modified or transformed by human activities. These include cultivation for commercial crops or subsistence agriculture; livestock; forestation for commercial timber production; the invasive spread of alien plants; urbanisation and settlements; the impoundment of rivers; mining; transportation and industrialisation (Macdonald, 1989).

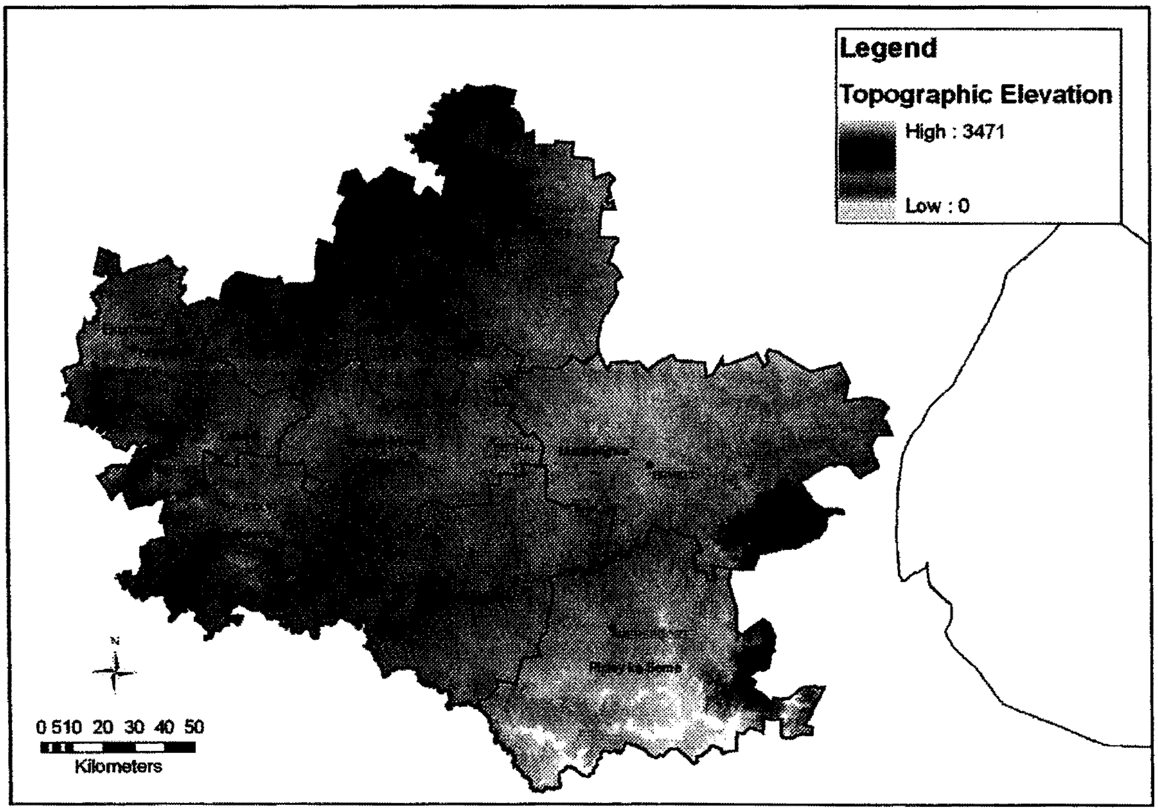


Figure 2: Schematic of the topography of the HPA

The land cover of the HPA is predominantly grassland and irrigated agricultural lands (Figure 3), comprising 60% and 27% of the total land cover respectively. Urban and build-up areas occur throughout the HPA and constitute 4% of the total land cover. This is however, dominated by Ekurhuleni, which is mostly urbanised. Industrial areas and mining constitute 1% and 2% of the total land cover in the HPA.

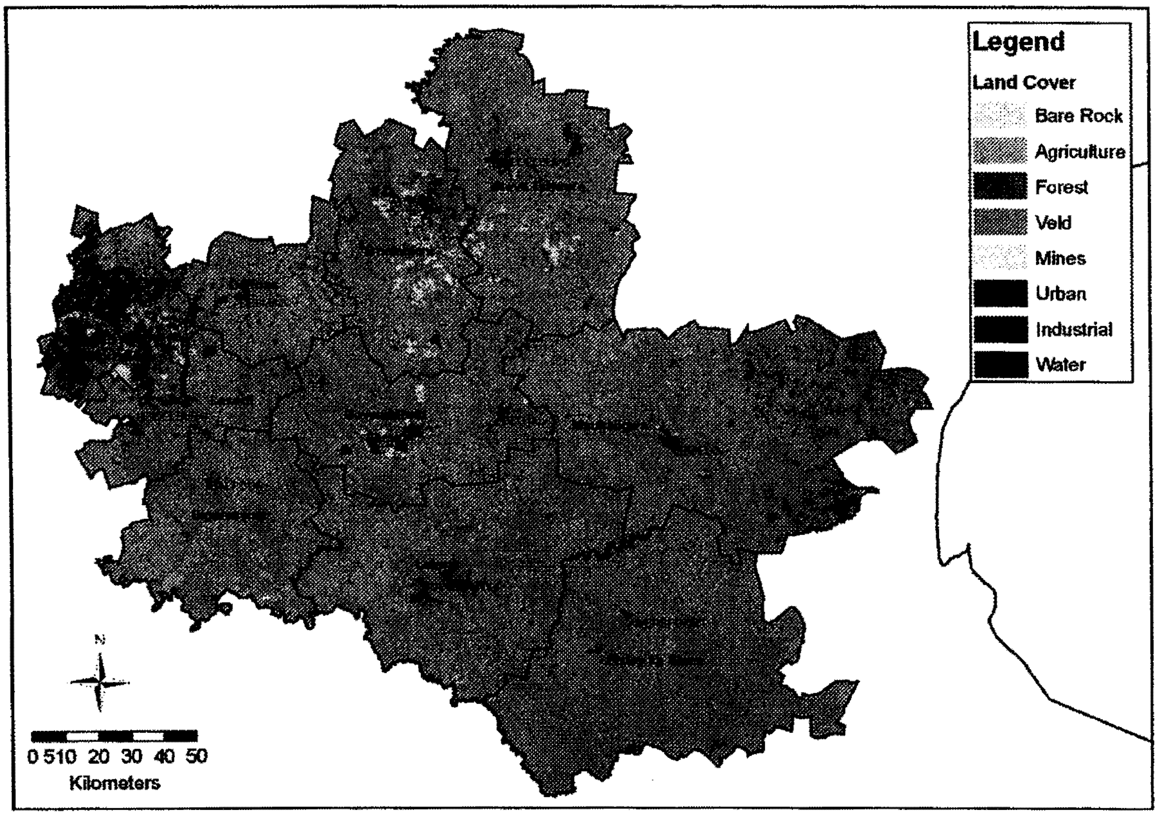


Figure 3: Land use distribution of the HPA

2.2 Population distribution

The total population of the HPA is an estimated 3 596 891 individuals according to Census 2001 data (StatsSA, 2001). Gauteng hosts the majority of individuals affected by the priority area declaration (71%), with Mpumalanga hosting the remaining 29%. The large population density within Gauteng, despite it constituting a relatively small proportion of the HPA, can be attributed to the Ekurhuleni Metropolitan Municipality. Ekurhuleni houses the majority of individuals within the HPA (69%, or 2 478 629 individuals), coupling high population density with a high-density industrial sector. Lesedi comparatively constitutes only 2% of the entire HPA population.

Within Mpumalanga, only Govan Mbeki (6%) and Emalahleni (8%) local municipalities have relatively significant populations, with Gert Sibande District Municipality hosting 15% of the total HPA population and Nkangala District Municipality, 14%. Within the HPA, 4% of individuals live within Steve Tshwete Local Municipality. All other local municipalities in Mpumalanga host a small proportion of the HPA population, with Msukaligwa, 3%, Lekwa, 3%, Pixley ka Seme, 2%, Delmas, 2%, and Dipalaseng, 1%.

With respect to population change, comparing data from the Census Household Survey 2007 (StatsSA, 2007) and Census 2001, shows that population growth was limited to the major urban municipalities in the HPA, with Emalahleni showing a significant influx of individuals (57% increase relative to 2001). Steve Tshwete and Govan Mbeki also recorded a high increase in population (28% and 21% respectively). This highlights the increasing rural to urban migration experienced in Mpumalanga as job seekers move to urban centres such as Witbank, Middelburg and Secunda to secure employment. Ekurhuleni comparatively experienced a marginal population increase of 10%. Msukaligwa also experienced positive population growth over the period (1%) indicating its significance as a secondary node in the province. All other municipalities experienced a net decrease in population over the period (Pixley ka Seme, -18%, Lekwa, -12%, Delmas, -10%, Lesedi, -10%, Dipaleseng, -2%). This further highlights the migration to urban centres for improved education, employment and service delivery prospects.

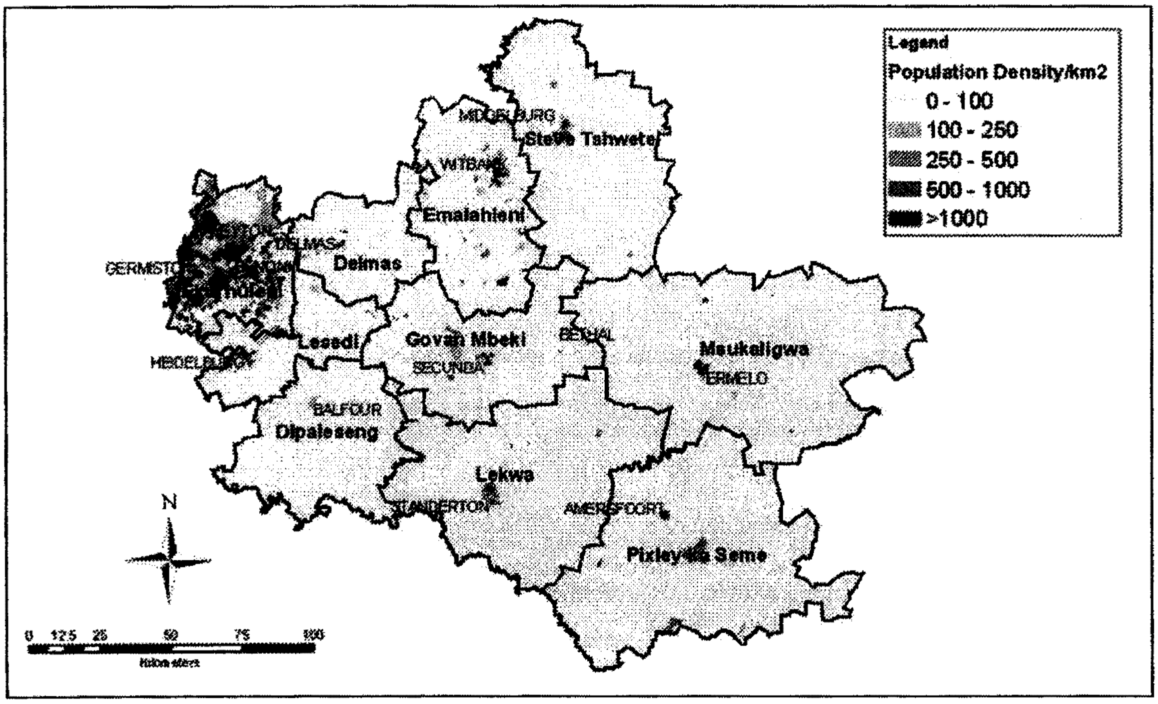


Figure 4: Population distribution of the HPA

2.3 Climatology and meteorology

The climatology of a particular place is controlled primarily by its latitude, which determines the amount of solar radiation that is received, its distance from the sea and the height above sea level. Secondary influences on climate are the general circulation of the atmosphere, the nature of the underlying surface and topography.

South Africa lies in the sub-tropical high-pressure belt, which causes the general circulation over the sub-continent to be generally anticyclonic above 700 hPa for most of the year. The HPA lies in temperate latitudes between 25^{0} 25' S and 27^{0} 31' S, and varies between 1500 and 1900 m above sea level. As a result, the HPA experiences a temperate climate with dry winters according to the Köppen Climate Classification system. Winters are mild and dry, but cold at night when frost may occur. Rain occurs in summer and temperatures are warm. The rain is mostly a consequence of the development of low-pressure troughs over the central plateau in summer and the dry winters are due to the dominant subtropical high pressure. The temperate temperatures are the consequence of relatively high altitude.

2.3.1 Rainfall and temperature

The average rainfall in the HPA varies from about 900 mm in the higher lying areas in the east to about 650 mm in the west. Rainfall is almost exclusively in the form of showers and thundershowers and occurs mainly in the summer from October to March, with the maximum in January. Winters are typically dry, but some rain does occur. The average monthly maximum and minimum temperatures and mean monthly rainfall at selected long-running South African Weather Service (SAWS) climatic stations in the HPA are shown in Figure 5.

2.3.2 Surface and near-surface winds

Wind has been monitored in the HPA by SAWS and as part of ambient air quality monitoring programmes by Eskom and Sasol for a number of years, and more recently by DEA and the Mpumalanga Department of Economic Development, Environment and Tourism (MDEDET) (Figure 6).

Numerous studies to characterise surface airflows have also been undertaken (e.g. Held, 1985; Tosen and Jury, 1986 and 1988; Pretorius *et al*, 1987; Held *et al*, 1990). Over the HPA, the mean daytime surface winds are predominantly north to northwesterly as a result of the prevalent anticyclonic circulation, with easterly winds being the next most frequent. In the winter, the frequency of southwesterly winds increases because of the passage of cyclonic westerly waves. Light topographically induced winds from the sector east to southeast are common at night. The so-called Escarpment Breeze that develops at night under weak pressure gradients is up to 1000 m deep and drains air away from the HPA area (Held, 1985; Held *et al*, 1990).

Annual surface wind speeds vary between 2 $m.s^{-1}$ and 4 $m.s^{-1}$, reaching speeds of 6 $m.s^{-1}$ in August and September. The variation of surface wind over the HPA is illustrated by the wind roses in Figure 7. The wind rose is a diagram that illustrates the frequency of wind speed and direction measurements in the 16 cardinal wind directions for a given period. Wind direction is indicated as the direction from where the wind blows (e.g. easterly winds blow from the east); the dashed circles indicate the frequency of occurrence of hourly wind in bands of 4%; the coloured bars indicate the wind speed classes.

Wind patterns vary across the HPA. A large percentage of northerly winds are observed at OR Tambo International Airport (ORTIA) in Ekurhuleni, with easterly and, to a lesser extent, westerly components in Witbank. Winds at Ermelo record in all components except southerly, which is likely to be the result of technical error; northerly and easterly components are significant as well. Monitoring at Amersfoort shows a significant percentage of calm southerly winds, with stronger winds from the west. Standerton shows strong east-west trajectories for winds. Monitoring at Club in Secunda displays significant wind activity in northwesterly and northeasterly directions. Monitoring at Grootvlei in Dipaleseng shows calm northeasterlies and stronger northwesterlies. The high proportion of easterly and westerly winds recorded at Lekwa is possibly due to incorrect averaging of recorded winds. Here westerly and northwesterly winds are likely to prevail.

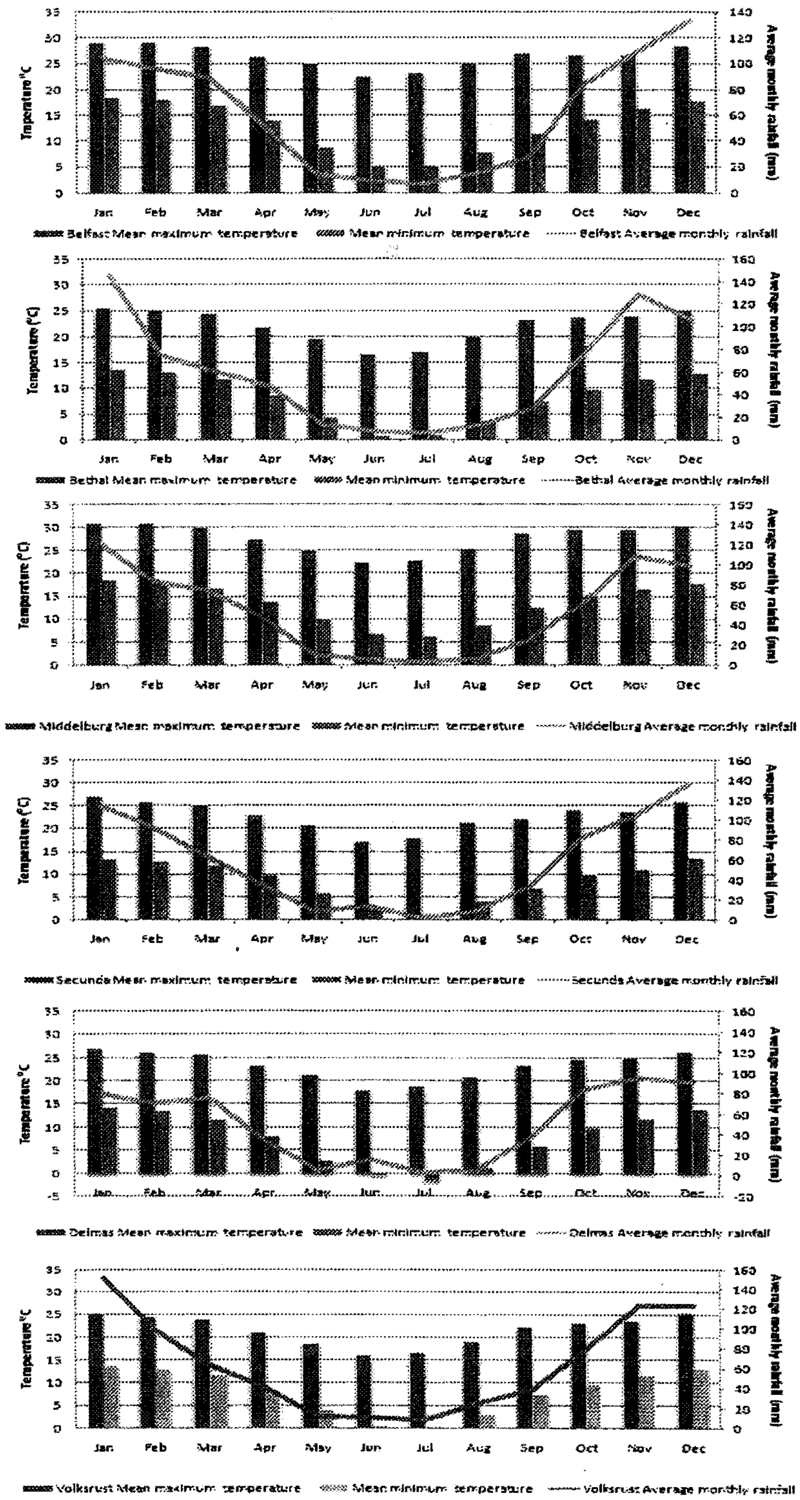


Figure 5: Average maximum and minimum temperatures and average monthly rainfall in the HPA (SAWS, 1998)

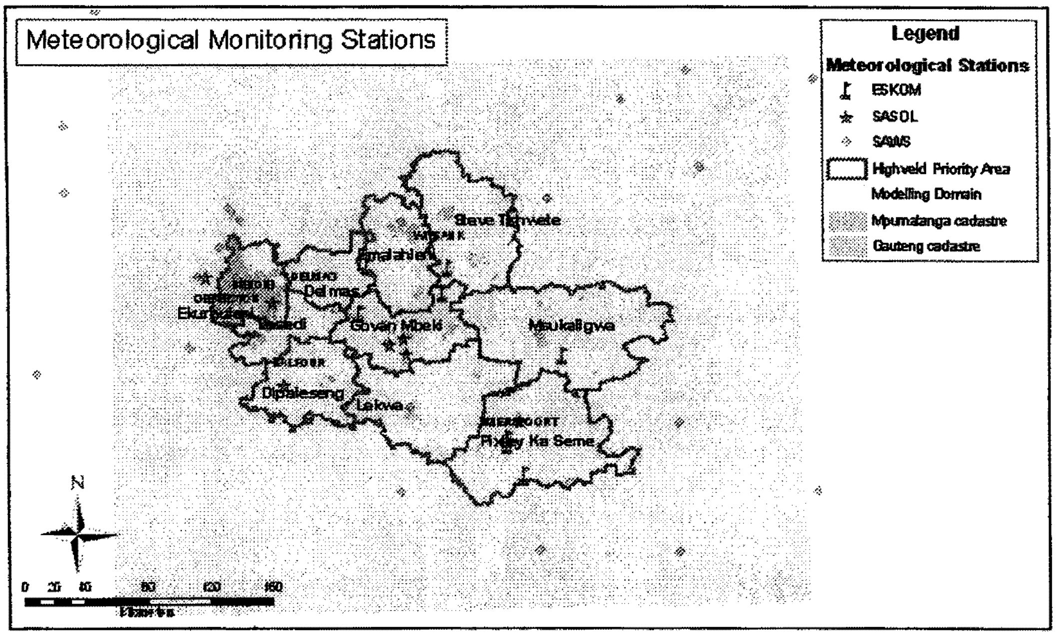


Figure 6: Location of meteorological stations in the HPA

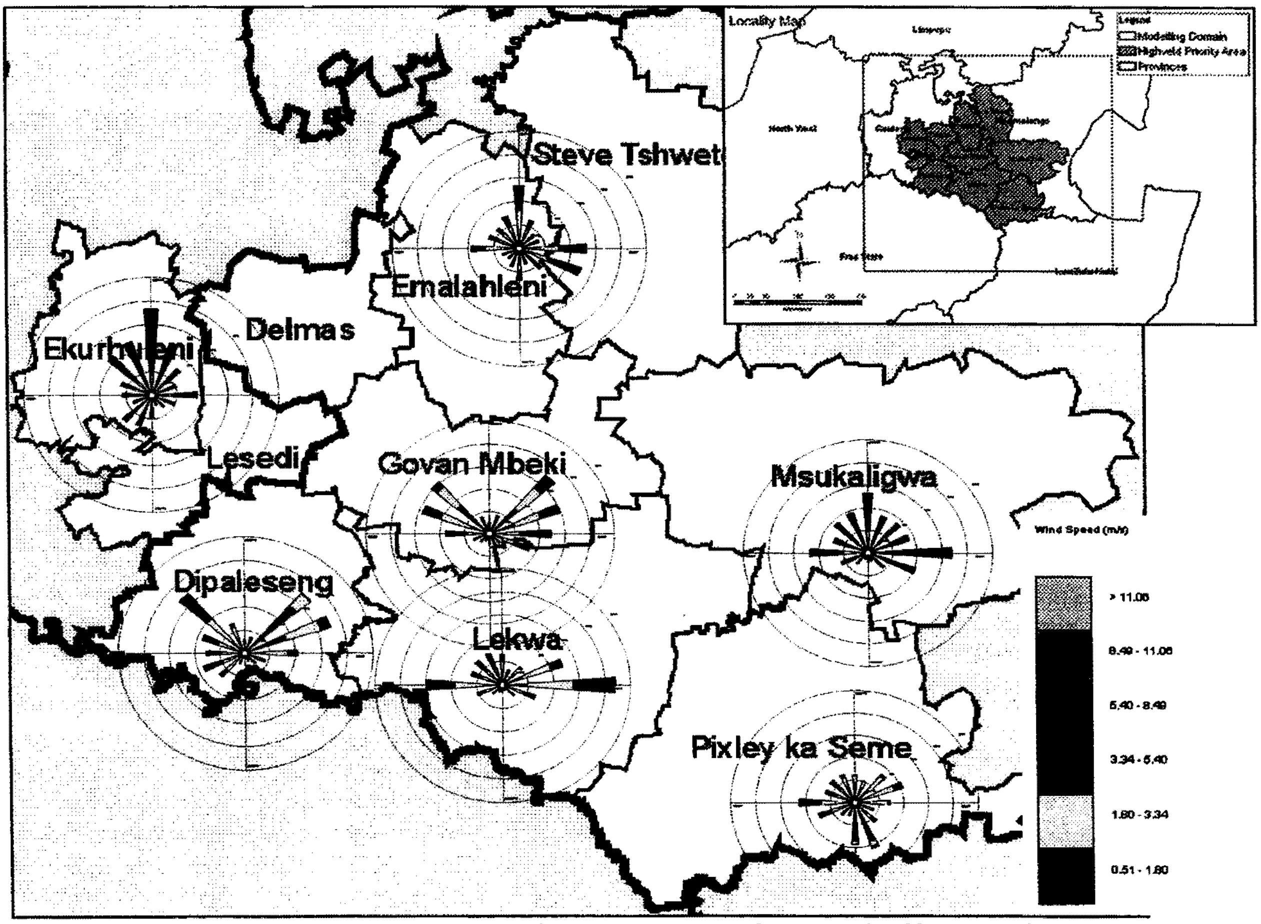


Figure 7: Annual wind roses at selected monitoring stations in the HPA for the period 2004 to 2007

Investigation of the dispersion potential of the Highveld region indentified the formation of a low-level wind maximum at night, known as a low-level jet (LLJ), under highly stable conditions and ranging in speed from 5 $m.s^{-1}$ to 15.5 $m.s^{-1}$ (von Gogh *et al*, 1982; Held, 1985; Jury and Tosen, 1987; Tosen and Jury, 1988). The south-north and east-west cross-sectional extent of the LLJ observed on 26 and 27 June 1986 in the vertical and horizontal is illustrated in Figure 8. Held *et al* (1990) suggest that the northern edge of the LLJ coincides with the topographical ridge just north of Middelburg and that it extends beyond the Vaal River basin to the south and to the escarpment in the east. Held and Hong (1989) showed the occurrence of a LLJ over the northeastern Free State, implying that the regional-scale LLJ extends beyond the western edge of the HPA.

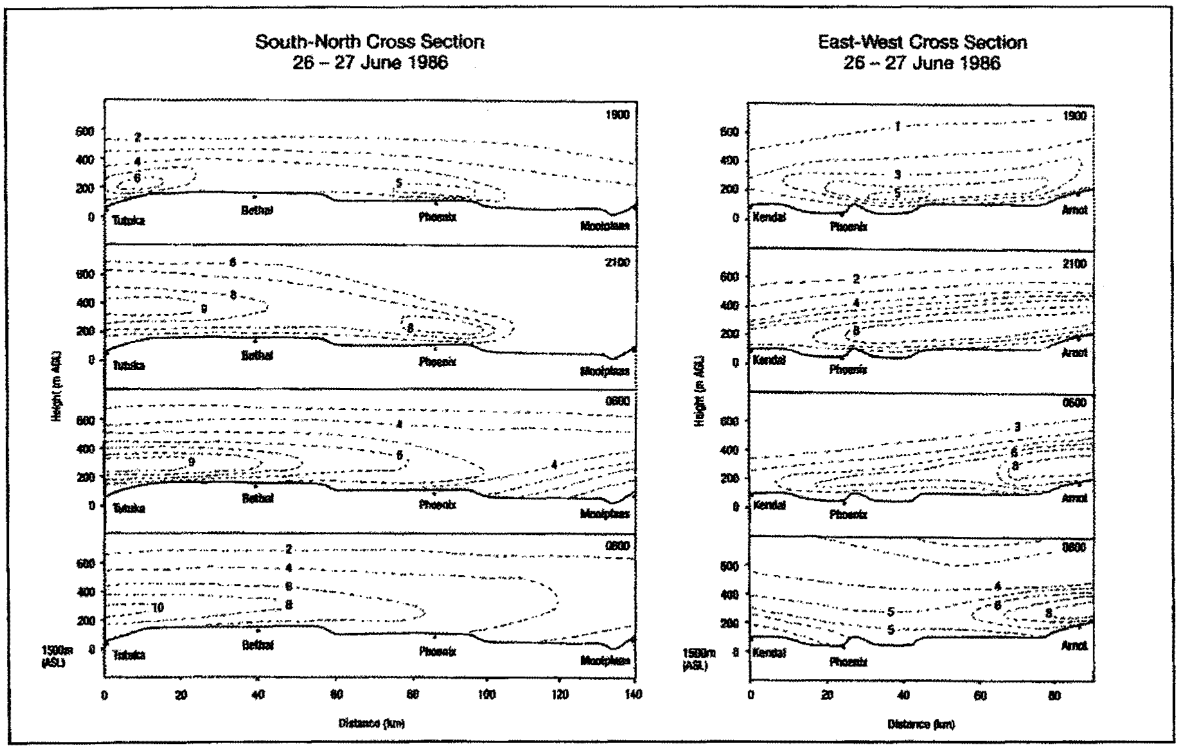


Figure 8: The south-north and east-west cross-sectional extent of the LLJ observed on 26 and 27 June 1986 in the horizontal and vertical with wind speeds in $m.s^{-1}$ (Held *et al*, 1990)

2.3.3 Atmospheric stability

The high frequency of anticyclonic circulation and associated subsidence in the upper air reaches a maximum in winter. The subsidence is conducive to the formation of elevated temperature inversions throughout the year with a frequency of 60% and winter base height of about 1300 and 2600 m above ground level (AGL) in summer (van Gogh *et al*, 1986).

Stable and clear conditions are ideal for the formation of surface temperature inversions at night. Tyson *et al* (1976) showed the winter inversions in the HPA region to vary in strength from 5 °C to 7 °C and in depth from 300 to 500 m AGL. Later, Pretorius *et al* (1986) and Tosen and Pearse (1987) showed the inversion to occur between 80 and 90% of winter nights, varying in strength from 3 °C to 11 °C and from 100 m to 400 m in depth. Inversions of more than 10 °C occur on more than 25% of winter nights. In summer, the surface inversions are weaker and seldom exceed 2 °C in strength (Pretorius *et al*, 1986). The maximum midday mixing depths vary between 1000 m and 2000 m AGL in winter and may exceed 2500 m in summer (Diab, 1975; Tosen and Pearse, 1987).

The presence of subsidence induced semi-permanent absolutely-stable layers at approximately 800 hPa (about 350 m AGL) and 500 hPa (about 3500 m AGL) were shown to extend over the southern African sub-continent (Cosijn and Tyson, 1996; Freiman and Tyson, 2000). These stable layers (Garstang *et al*, 1995) control the vertical transport of aerosols between the surface and the tropopause. Aerosols typically accumulate below the base of the respective layers and in turn, the layers promote transport of the aerosols at their respective levels. Garstang *et al* (1996) and Tyson *et al* (1996) showed trajectories to pass through different height levels, but become trapped between absolutely-stable layers.

2.3.4 Atmospheric transport in and out of the HPA

Considerable research effort has focused on the meteorological circulation responsible for the accumulation and recirculation of pollutants in the HPA region. Scheifinger (1993) developed a synoptic classification describing the relationship between air mass movement and surface sulphate concentrations. Westerly ventilation of the HPA region occurs mostly during winter with the passage of westerly waves across or south of the subcontinent. The westerly airflow over the HPA region is warm, dry and relatively free of pollutants as it originates from a source-free area (Scheifinger, 1993). The easterly ventilation originates with a strongly ridging (or budding) anticyclone up the east coast, resulting in an onshore flow and easterly winds over the HPA. Held *et al* (1994) showed the ridging anticyclone to result in a recirculation path that loops to the north of the HPA in winter (

Figure 9) and to the east and south of the HPA region in summer due to the seasonal north-south shift of the anticyclonic high-pressure belt.

Freiman and Piketh (2003) examined large-scale recirculation of air into and out of the HPA region and the frequency of transport from the HPA region that crosses into countries bordering South Africa. Four major transport pathways exist to the HPA region in the lower troposphere. The most frequently occurring transport mode is from the Atlantic Ocean, occurring 43% of times. Transport from the Indian Ocean (26%) together with transport from the African continent (25%), account for half of the transport to the HPA region. Regional-scale advection exclusively over southern Africa accounts for less than 10% of the transport. Air from the south and central Atlantic reaching the HPA region is likely to be free of industrial pollutants, while African transport may carry pollutants from central and southern Africa, particularly industrial pollutants from the Zambian copper-belt, from biomass burning in winter, and Aeolian dust.

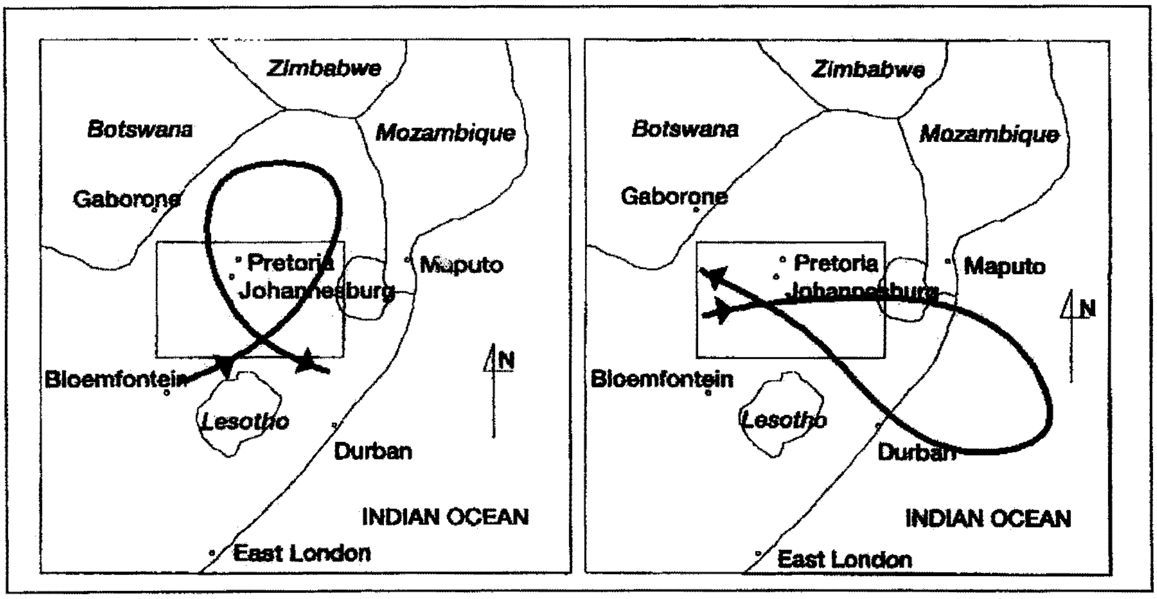


Figure 9: Characteristic wind paths during strong anticyclonic ridging in from May to June (left) and August to April (right) after Held *et al* (1994)

Significant seasonal variation exists in the transport of air to the HPA region (Table 3). Noteworthy is the high percentage of Indian Ocean transport (51%) in summer and by contrast, the high percentage of Atlantic transport (51%) in winter. The sub-continental scale recirculation does not vary much with season.

Table 3: Seasonal variation of transport types advecting air to the HPA region at 850 to 700 hPa, expressed as a percentage (Freiman and Piketh, 2003)

Season	Flow			
	Atlantic Ocean	Indian Ocean	African Continent	Recirculation
Summer	34	54	7	5
Autumn	46	16	27	11
Winter	51	10	33	6
Spring	39	26	30	5

Freiman and Piketh (2003) identified two main transport modes out of the HPA region, direct and re-circulated transport (Table 4). In the direct transport mode (45%), material is transported out of the HPA region with little decay in a westerly (to the Indian Ocean), easterly (to the Atlantic Ocean), northerly (to the south Indian Ocean, or southerly (equatorial Africa) transport mode. The second mode is re-circulated transportation where material re-circulates over the subcontinent towards the point of its origin, on a regional or sub-continental scale (33%). The overall re-circulating time ranges from 2 to 9 days, depending on the scale of the re-circulation.

Table 4: Variation of transport types advecting air from the HPA region at 850 to 700 hPa, expressed as a percentage, enclosing approximately 95% of trajectories studied (Freiman and Piketh, 2003)

	Direct Transport				Re-circulated Transport
	Atlantic Ocean	Central Indian Ocean	South Indian Ocean	African Continent	
Summer	21	27	9	7	30
Winter	7	49	3	9	36

Approximately 41% of all air transported from the HPA region affects countries bordering South Africa through either direct or re-circulated transport (Freiman and Piketh, 2003). Transport to Mozambique occurs more than 35% of the time, and more than 30% of the time to Botswana. Transport to Swaziland, Namibia and Zimbabwe is between 15% and 23% with less to other southern African countries (Figure 10).

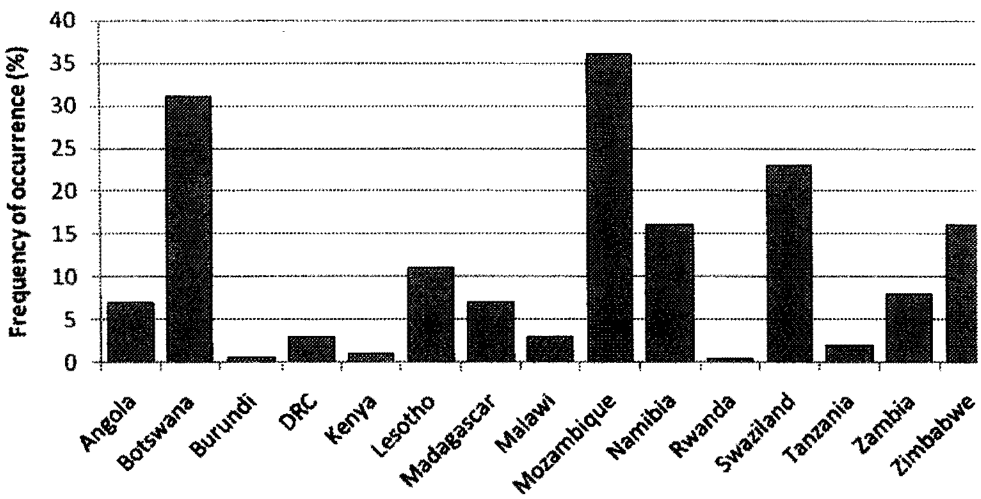


Figure 10: Percentage frequency with which the borders of each country are crossed by trajectories originating from the HPA region for 1990-1994 (Freiman and Piketh, 2003)

2.3.5 HPA meteorology and air quality

The predominant anticyclonic circulation over the HPA, particularly in winter, results in light winds, clear skies and the development of surface temperature inversions at night that persist well into the morning. The mechanisms to disperse pollutants that are released at or near ground level into this stable atmosphere are typically weak. Pollutants tend therefore to accumulate near their source or to travel under the light near-surface drainage winds. Relatively high ambient concentrations may occur especially at night and in the morning when the surface inversions are strongest. This meteorology is particularly relevant to low-level industrial stacks, domestic fuel burning, motor vehicles and burning coalmines and discard coal dumps.

During the day, surface warming induces the break-up of the surface inversion and promotes convection, which enhances the dispersion the nighttime pollution build-up. Convection, on the other hand, may bring emissions from taller stacks down to ground level, so-called fumigation, that result in episodes of high ambient pollutant concentrations.

Immediately above the surface inversion, the LLJ, a strong nocturnal wind system, provides an effective mechanism to transport pollutants from taller stacks away from their source. The LLJ occurs over the much of the HPA at night and is stronger and more persistent in winter.

Westerly flow into the HPA is associated with the introduction of clean, mostly maritime, air. Hence, ambient air quality improves with the passage of wintertime westerly waves over the HPA and ambient pollutant concentrations decrease. Convective summer showers and thundershowers wash pollutants out of the atmosphere on a relatively local scale, while widespread convective rain activity can reduce ambient pollutant concentrations on a larger scale.

Pollutants released in the HPA do not only affect the HPA. Easterly airflow associated with a ridging Indian Ocean Anticyclone results in recirculation over the subcontinent. Pollutants emitted in the HPA are recirculated at different spatial and temporal scales depending on the strength of the ridging anticyclone. The recirculation may be limited to the HPA for a few days only or for a number of days resulting in increases in ambient pollutant concentrations. Recirculation on larger spatial scales may transport pollutants emitted in the HPA well beyond its boundaries and into neighbouring municipalities and even across international borders.

3 AMBIENT AIR QUALITY

3.1 Introduction

The state of ambient air quality in the Highveld Priority Area has been the subject of investigation and monitoring for more than 30 years in step with the growing power generation industry, mining, and other industrial sectors such as the petrochemical and metallurgical sectors. Tyson *et al* (1988) drew attention to the high sulphur dioxide (SO_2) emission density of the Highveld industrial region and later, Held *et al* (1996) consolidated a significant body of research over the period 1988 to 1994 that described air quality with an initial investigation into the potential impacts of poor air quality. The state of air quality in the Highveld region is described in the Initial State of Air Report (DEAT, 2006) and by Scorgie *et al* (2004) in the Fund for Research into Industrial Development Growth and Equity (FRIDGE) study.

This description of the baseline state of ambient air quality in the HPA builds on this earlier work and focuses on the period from 2004. An inventory of emissions from industry, mining, transport, residential and biomass burning, and other sources is used to gain a deeper understanding of the characteristics of the different sources. Ambient air quality monitoring data from Eskom, Sasol, DEA and MDEDET are used together with dispersion modelling to describe ambient air quality relative to national ambient air quality standards. Collectively, these data provide insights into the sources that result in ambient air quality problems in the HPA.

3.2 Emission sources in the HPA

3.2.1 Introduction

The total annual emissions of fine particulate matter (PM_{10}) on the HPA is estimated at 279 630 tons, of which approximately half is attributed to particulate entrainment on mine haul roads**Error! Reference source not found.**. The emission of PM_{10} from the primary metallurgical industry accounts for 17% of the total emission, with 12% of the total from power generation. By contrast, power generation contributes 73% of the total estimated oxides of nitrogen (NO_x) emission of 978 781 tons per annum and 82% of the total estimated SO_2 emission of 1 633 655 tons per annum.

The emission inventory for industrial sources was relatively complete and included all industries on the HPA with scheduled processes in terms of the APPA. It is recognised that these sources comprise the major industrial sources, with non-registered sources being very small in comparison. In addition, specific methodologies were used for determining emissions from residential fuel burning, coal mining, transport, biomass burning and burning coal mines and smouldering coal dumps. Source categories where emissions could not determined were landfills, incinerators, waste water treatment works, tyre burning, biogenic sources, odour and agricultural dust. The issues relating to these emissions will be addressed through the implementation of the AQMP.

Table 5: Total emission of PM_{10}, NO_x and SO_2 from the different source types on the HPA (in tons per annum), and the percentage contribution for each source category

	PM10		NO_x		SO_2	
Source category	t/a	%	t/a	%	t/a	%
Ekurhuleni MM Industrial (incl Kelvin)	8 909	3	15 636	2	25,772	2
Mpumalanga Industrial	684	0	590	0	5,941	0
Clay Brick Manufacturing	9 708	3	-		9,963	1
Power Generation	34 373	12	716 719	73	1 337 521	82
Primary Metallurgical	46 805	17	4 416	0	39 582	2
Secondary Metallurgical	3 060	1	229	0	3 223	0
Petrochemical	8 246	3	148 434	15	190 172	12
Mine Haul Roads	135 766	49	-		-	
Motor vehicles	5 402	2	83 607	9	10 059	1
Household Fuel Burning	17 239	6	5 600	1	11 422	1
Biomass Burning	9 438	3	3 550	0	-	
TOTAL HPA	**279 630**	**100**	**978 781**	**100**	**1 633 655**	**101**

NB. SO_2 percentage contributions aggregate is greater than 100 due to rounding of numbers.

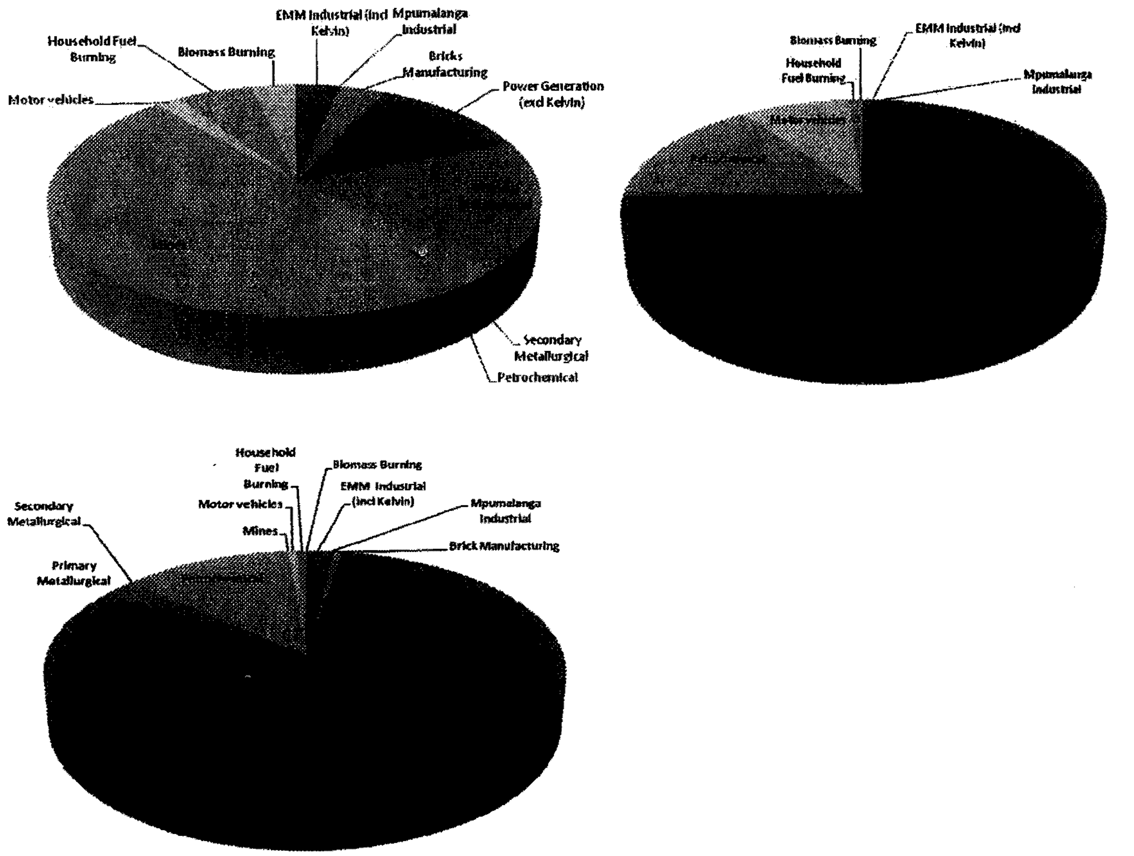


Figure 11: Relative contribution by the respective sectors to the total emission of PM_{10} (top left), NO_x (top right) and SO_2 (bottom left)

Each source category is discussed in detail in the following sections.

3.2.2 Industrial sectors

Industrial sources in total are by far the largest contributor of emissions in the HPA, accounting for 89% of PM_{10}, 90% of NO_x and 99% of SO_2.

Major industrial sources contributors were grouped into the following categories:

1. Power Generation
2. Coal Mining
3. Primary Metallurgical Operations
4. Secondary Metallurgical Operations
5. Brick Manufacturers
6. Petrochemical Industry
7. Ekurhuleni Industrial Sources (excluding the above)
8. Mpumalanga Industrial Sources (excluding the above)

The number of sources registered to operate scheduled processes under the Atmospheric Pollution Prevention Act; Act No. 45 of 1965 (APPA) shows a dominance of industrial processes in Ekurhuleni (Table 6). Other industrialised municipalities are Emalahleni, Steve Tshwete, Msukaligwa, and Govan Mbeki. This is consistent with the presentation of emission data, and further, ambient concentration data presented later.

Table 6: Number of operators registered under APPA per HPA municipality

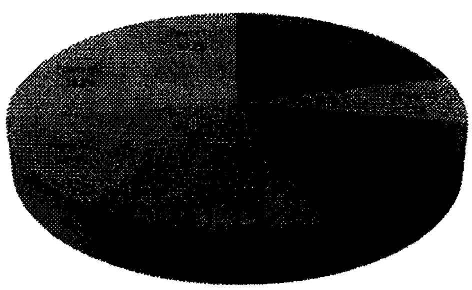
Municipality	No. of APPA registered operations
Delmas	6
Dipaleseng	3
Ekurhuleni	236
Emalahleni	36
Govan Mbeki	13
Lekwa	4
Lesedi	5
Msukaligwa	17
Pixley ka Seme	4
Steve Tshwete	22
Total	346

3.2.2.1 Power generation

Eskom generates approximately 95% of the electricity used in South Africa and relies on coal-fired power stations to produce approximately 92.5% of its electricity (http://www.eskom.co.za). Eskom operates 11 power stations in the HPA, with a combined nominal generating capacity of 30 075 MW. The estimation of emissions from operating power stations was based on information supplied directly by Eskom. The estimated emissions correlated closely to Eskom's reported emissions for power station operating in the years 2004 to 2006. Emissions from Camden, Grootvlei and Komati as used in this study are not as in 2004-2006, but are considered to be as when fully re-commissioned (Camden was only partially re-commissioned in 2004-2006, and Grootvlei and Komati were not emitting at all in 2004-2006). The individual power stations and their generation capacity are listed below and depicted in Figure 12.

Majuba	4 110 MW	Kendal	4 116 MW
Tutuka	3 654 MW	Duvha	3 600 MW
Matla	3 600 MW	Kriel	3 000 MW
Hendrina	1 995 MW	Arnot	2 280 MW
Grootvlei*	1 200 MW	Komati*	1 000 MW
Camden*	1 520 MW		

* Return to service power stations.



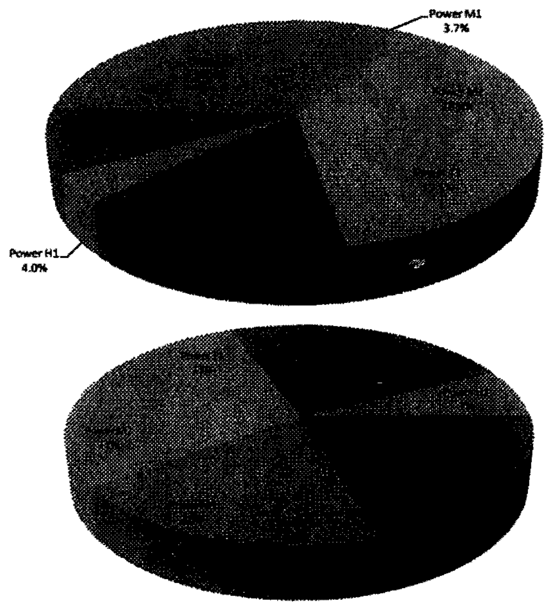


Figure 12: Relative contribution by power plants to the total power generation emissions of PM_{10} (top left), NO_x (top right) and SO_2 (bottom left)

3.2.2.2 Petrochemical sector

The petrochemical sector source inventory is dominated by Sasol's Secunda operations. Emissions from the Secunda operation were based on information provided to the DEA for the APPA registration certificate review process.

3.2.2.3 Primary metallurgical

Emissions for the primary metallurgical category were based largely on information from the APPA registration certificate review process and information supplied by the individual industries.

3.2.2.4 Secondary Metallurgical, Ekurhuleni Industries, and Mpumalanga Industries

This category of sources encompasses a wide variety of metallurgical processes other than pyrometallurgical processes, and industrial sources in the Ekurhuleni Metropolitan Municipality (MM) and in the district municipalities that comprise the HPA, some of which are scheduled processes in terms of the APPA. Various sources of information were used for estimation of emissions from these operations and these included:

- Information submitted directly by emitters
- DEA APPA registration certificate database
- Ekurhuleni MM emissions inventory

Where measured emissions data was available, this was used directly. Where measured data was not available, emissions were estimated using emissions factors from various sources, including the US-EPA AP42 database and the Australian NPI Emissions Estimation Technique Manual, but also from other research information reported from numerous other international sources. Raw material usage and production data applied to the emission factors were based on:

- Data requested from and supplied by the emitters
- Data extracted from APPA registration certificate database
- Company websites and published articles
- Information provided in the Ekurhuleni MM emissions inventory

Where data was still inadequate particularly with respect to stack parameters, extrapolation from the information available for similar sources was used.

3.2.2.5 Clay brick manufacturing

Various sources of information were used to estimate emissions from these operations, primarily:

- Information submitted directly by emitters
- DEA APPA registration certificate database

No measured emissions data was available hence emissions were estimated using emissions factors from various sources, including the US-EPA AP42 and the Australian NPI Emissions Estimation Technique Manual, as well as international literature resources. Raw material usage and production data applied to the emission factors were based on:

- Data requested from and supplied by the emitters
- Data extracted from APPA registration certificate database

Where data was still inadequate particularly with respect to kiln dimensions and stack parameters, extrapolation from the information available for similar sources was used to estimate the required data.

3.2.2.6 Opencast coal mining

The HPA contains a substantial number of coal mining operations extracting this resource through opencast and underground mining methods. Such operational mines have various activities that result in the entrainment/suspension of particulate matter, including but not limited to:

- The use of vehicles on unpaved and paved roads for transporting ore, personnel, waste rock etc.;
- Blasting;
- Overburden stripping;
- Ore and overburden handling;
- Crushing and screening of ore; and
- Wind entrainment from stockpiles.

According to Thompson and Visser (2001), "Dust, created through the mechanical disintegration of particulate matter, is a problem common to most surface mining operations". The broader environmental effects of dust have been reviewed by Amponsah-Dacosta (1997) who established an emission inventory for a South African coal strip mining operation. The emission inventory was based on a characterisation of open dust sources over a specific interval of time, to produce a dispersion model to enable predictions to be made concerning ambient pollution levels and the identification of major control areas. The analysis, conducted according to US EPA42 guidelines, found that 93.3% of the total emissions from the mine were attributable to dust generated from the mine haul roads (the next highest source is attributable to top soil handling as illustrated in Figure 13.

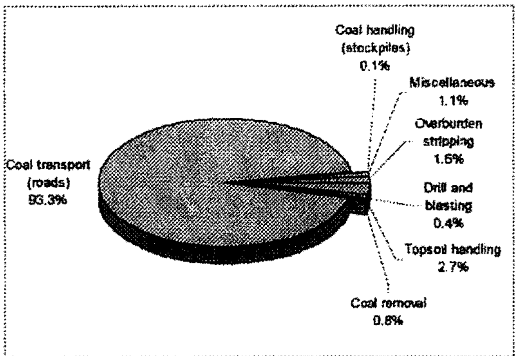


Figure 13: Percentage contributions to total dust emissions from typical South African strip mine (Visser & Thompson, 2001)

Although a high tonnage operation, the road network on the mine was similar to other such operations and it was concluded that emissions from the road network would be typical of most opencast coalmines, when calculated on a percentage of total emissions basis. The quantification of particulate emissions from coal mining was accordingly focused on the quantification of particulate emissions associated with major haul roads at opencast coal mining facilities. The estimations were undertaken using the US EPA's AP42 emissions factors for estimation of dust entrainment from vehicles on unpaved roads.

$$E = k\left(\frac{s}{12}\right)^{a} \cdot \left(\frac{W}{3}\right)^{b} \cdot 281.9$$

Where:

E	=	emission factor for particulates per vehicle kilometre travelled (g/VKT)
K	=	k, a, and b are empirical constants
S	=	silt content of road surface material (%);
W	=	mean vehicle weight (tonnes)

Mines and major haul roads were identified through the combined use of Geographic Information System (GIS) data and satellite imagery for the HPA. Mean vehicle masses were calculated based on haulage vehicle information supplied by various mines. Vehicle kilometres travelled for each mine in the inventory were calculated from GIS and satellite imagery-based haul road length quantification, in conjunction with run of mine, production and sales data for respective mines and information supplied by various mines where available. Road surface composition was based on data from measurements undertaken by the Safety In Mines Research Advisory Committee (SIMRAC, 2000) on haul roads at several surface mining operations.

3.2.2.7 Sources outside the HPA

Emissions from tall stacks outside the HPA were considered only as these have the potential to transport pollutants over relatively large distances, i.e. > 50 km. Conversely, emissions released nearer ground level influence air quality on a relatively local scale. Emission data directly from sources of tall stack emissions, within an approximate 50 km buffer area around the HPA border, were used.

3.2.3 Transport

3.2.3.1 Motor vehicles

One of the major contributors to air pollution, particularly in urban areas, is motor vehicle emissions, including NO_x, carbon monoxide (CO), PM_{10} and Volatile Organic Compounds (VOC's), including benzene (C_6H_6). Emissions arise during the different cycles of driving from start-up, during driving, evaporation from the engine and fuel line, and during re-fuelling. CO is a product of incomplete combustion and occurs when carbon in the fuel is only partially oxidised to carbon dioxide. NO_x is formed by the reaction of nitrogen and oxygen under high pressure and temperature conditions in the engine. SO_2 results from the sulphur in the fuel. Particulates originate from brake and clutch linings wear and from the fuel combustion processes, particularly from diesel engines. Emission from motor vehicles depends on the distance travelled, the speed of travel, the age of the vehicle, the fuel used and the emission abatement technology. Emissions can therefore differ from vehicle to vehicle.

Motor vehicle emissions are typically approximated for a fleet of vehicles by using emission factors that represent the characteristics of the vehicle fleet, the number of vehicles and the distances travelled. Air pollutant emission factors are representative values that attempt to relate the quantity of a pollutant released to the ambient air, with the activity associated with the release of that pollutant. These factors are usually expressed as the mass of pollutant divided by a unit mass, volume, distance, or duration of the activity emitting the pollutant (e.g., grams of particulate emitted per kilometre travelled). Wong and Dutkiewicz (1998) developed emission factors for exhaust emissions for typical South African vehicles in the Vehicle Emissions Project (VEP) for petrol vehicles (Table 7) and by Stone (2000) for light, medium and heavy diesel vehicles (Table 8).

Table 7: Emissions factors for petrol vehicles at the coast (Wong and Dutkiewicz, 1998)

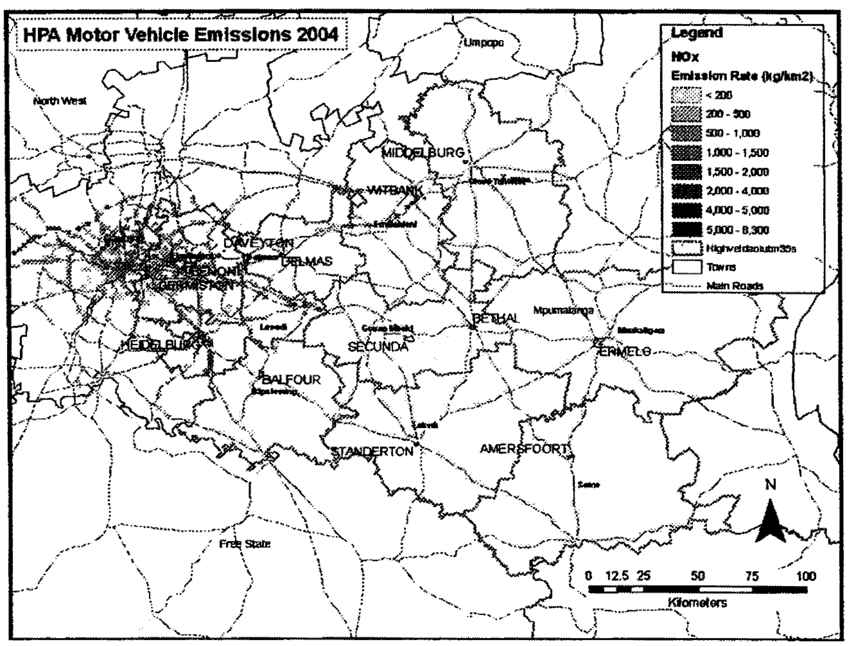
Pollutant	Emission factor (g/kg)
NO_x	2.84
CO	16.4
CO_2	213
SO_2	0.091
Total hydrocarbons	1.98
Methane	0.055
Benzene	0.036
1,3 Butadiene	0.022
Formaldehyde	0.0104
Acetaldehyde	0.0046

Total Aldehydes	0.015
Particulates	0.000

Table 8: Emissions factors for diesel vehicles at the coast (Stone, 2000)

Pollutant	LCV (g/kg)	M&HCV (g/kg)
NO_x	1.82	11.68
CO	1.13	3.54
CO_2	245	739
SO_2	0.796	1.54
Total hydrocarbons	0.2	1.01
Methane	0.007	0.088
Benzene	0.002	0.000
1,3 Butadiene	0.003	0.004
Formaldehyde	0.0102	0.016
Acetaldehyde	0.0109	0.010
Total Aldehydes	0.021	-
Particulates	0.293	0.64

Emissions from motor vehicles were estimated using the emission factors in Table 7 and Table 8, and vehicle kilometres travelled (VKT) in 1 km by 1 km grid blocks in the HPA. The VKT data was obtained from the CSIR's Sasol-Eskom funded project to determine the ozone forming potential of the Highveld. A spatial representation of the distribution of emissions of NO_x and PM_{10} from motor vehicle emissions on the HPA is provided in Figure 14. The majority of emissions of PM_{10}, NO_x and SO_2 from motor vehicles on the HPA occur in Ekurhuleni MM (Figure 15). Lesedi also features as a notable contributor, and the Mpumalanga municipalities make a significantly lower contribution to the total emission loading in relative terms.



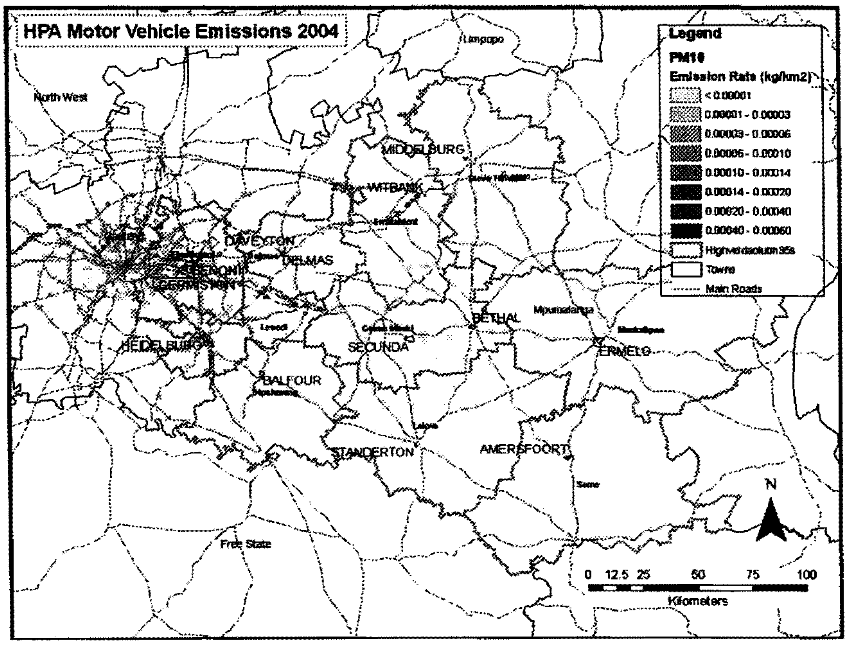


Figure 14 : Distribution of NO_x and PM_{10} from motor vehicle emissions on the HPA

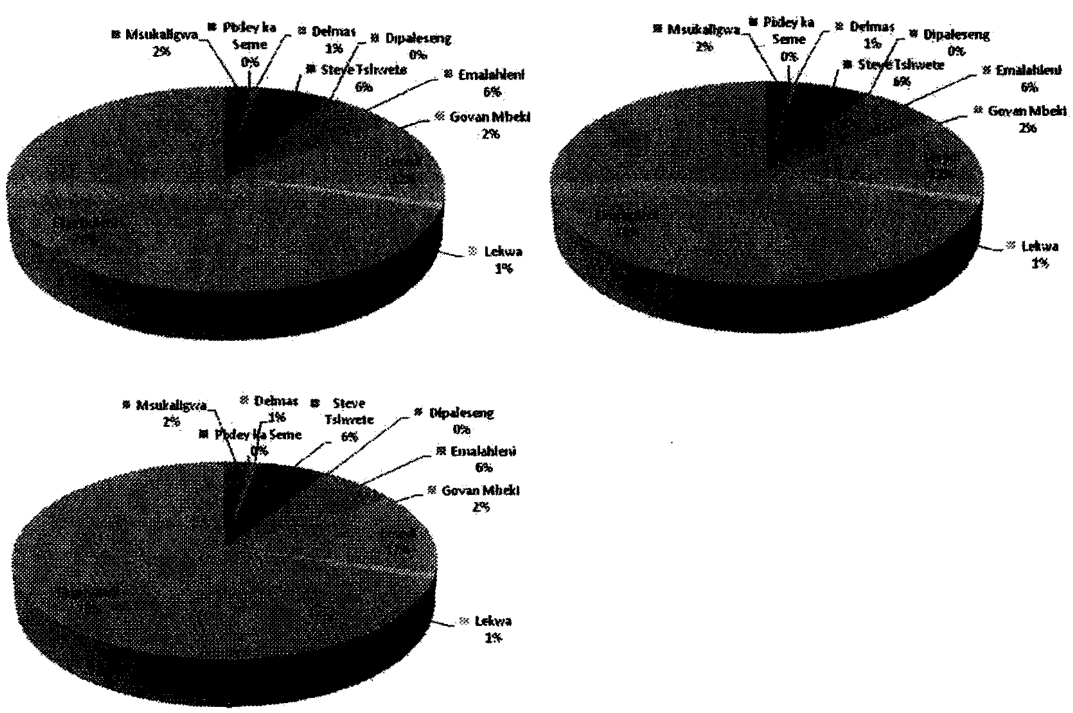


Figure 15: Relative contribution by Local Municipalities to the total vehicle emissions of PM_{10} (top left), NO_x (top right) and SO_2 (bottom left)

3.2.3.2 Airports

Airports are relatively small and localised sources in general, and emissions of air pollutants from airports result from a range of activities including the aircraft operations, ground support equipment, vehicular traffic at the airport's roadways, parking lot, electrical generators and fuel storage facilities. The main pollutants include CO, NO_x, SO_2, PM and hydrocarbons such as benzene, toluene, ethylbenzene and xylene. It is important to characterise the emissions from major airports when assessing air quality in a region.

The ORTIA in the Ekurhuleni MM is a major international and domestic airport, covering a significant area and including a number of different source types. A comprehensive emission inventory for ORTIA is presented in the specialist air quality assessment for the proposed new apron stands (Airshed, 2008) (

Table 9).

The vast majority of emissions are attributed to aircraft exhaust, followed by emissions from vehicles travelling to and from the airport. These emission data are used in this baseline assessment to assess the relative contribution of the activities at ORTIA to air quality on the HPA.

Table 9 : Summary of annual air pollutant emissions in tons per annum resulting from current operations at ORTIA (Airshed, 2008)

Pollution Group Source	CO	NO_x	SO_2	HC	Benzene	1,3 Butadiene	PM_{10}
Aircraft Exhaust	1941	1092	85.4	295	5.6	5.2	1.8
APU	30	22	0.0	2			0.0
Refuelling	0	0	0.0	6	0.1	0.0	0
GSE	22	61	1.0	6	0.1	0.1	3.8
GVS	33	6	0.3	4	1.4	0.1	3.1
Landside	183	26	1.0	66		0.2	12.4
Bulk Fuel Storage				25			
Spray Painting				1			
TOTAL	2210	1207	87.7	404.3	7.3	5.5	21.1

APU = auxiliary power unit
GSE = ground support equipment
GVS = ground support vehicles
Landside = passenger vehicles, including parking bays and transit

3.2.4 Domestic fuel burning

Domestic coal and wood combustion within informal settlements and rural areas has been identified through various studies to be, potentially, one of the greatest sources of airborne particulates and gaseous emissions to be inhaled in high concentration (i.e. before dispersion and fallout processes can ameliorate impact). Fuel used for domestic energy generation typically comprises of coal, wood, paraffin and Liquid Petroleum Gas (LPG), with animal dung and other waste materials used to a smaller extent. Electricity is used where available, but factors such as cultural traditions and affordability also play a role in the continuing use of other fuels. Combustion of coal and wood, and in some areas paraffin, remain the prevalent energy source for space heating and winter cooking in the townships and informal settlements of the HPA. Although many households are electrified, coal and wood continue to be used due to the cost associated with electricity as a heating energy carrier.

Domestic coal burning is a significant source of low-level fine particulate ($PM_{2.5}$ and PM_{10}) and contributes significantly to SO_2, CO, Total Organic Compounds and benzene emissions. Greenhouse gas emissions are also produced, including, but not limited to, carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Pollutants from the combustion of wood (including veld fires) include respirable particulates, nitrogen dioxide (NO_2), CO, polycyclic aromatic hydrocarbons, particulate benzo(a)pyrene and formaldehyde. Particulate emissions from wood burning within South Africa contain about 50% elemental carbon and about 50% condensed hydrocarbons (Terblanche *et al*, 1992).

A wide array of factors affect the extent of household fuel combustion, including population density and growth, the availability of electricity, household income, the degree of urbanisation, and the percentage of informal (unserviced) households. The following factors have been identified as variables that affect fuel choice and use:

- Average household income per capita;
- Distance to nearest coal mine, up to a distance of 300 km;
- Tree density with range, wood collection proportional to energy content of wood, and density of tree cover up to a distance of 80 km;
- Average winter temperature and average minimum winter temperature;
- Electrification;
- House type and construction as well as the extent of modification of Reconstruction and Development Programme (RDP) houses;
- Location and specific town culture; and
- Unit cost of paraffin, coal, wood and gas.

Due to the nature of household energy usage, residential fuel burning has a characteristic diurnal and seasonal signature. Periods of elevated residential fuel burning are in the early morning and evening, when space heating and cooking takes place. An increase in residential fuel burning may be expected as the demand for space heating and cooking increases with colder winters, but coal consumption levels do not reflect this and the winter consumption of wood and paraffin differ marginally (Pauw, 2009; Madunsi & Shackleton, 2007). It is notable that there is a significant lack of information pertaining to fuel types combusted, volumes of fuel used, diurnal and seasonal patterns of fuel usage, the combustion equipment used as well as the manner in which fuel is used within combustion equipment. This lack of information severely constrains the capability for accurate predictive quantification.

A GIS-based emissions quantification model was developed to be able to resolve spatially emissions for dispersion modelling. The emissions quantification model used the following inputs:

- Population statistics sourced from StatsSA Census 2001 and StatsSA Community Survey 2007,
- Energy use patterns sourced from StatsSA Census 2001 and corrected using surveys undertaken by the Nova Institute (personal communication Pauw, 2009)
- Fuel usage factors for coal, wood and paraffin (Afrane-Okese, 1998; Madunsi & Shackleton, 2007; personal communication Pauw, 2009).
- Emission factors (Table 10) were sourced/ derived as follows
  - for wood combustion for $PM_{2.5}$, PM_{10} and NO_x from the US EPA (1995);
  - for coal combustion an emission factor for total suspended particulates (TSP) reported by the CSIR (2004) is fractionated proportionally to $PM_{2.5}$ and PM_{10} fractions using the US EPA (1995), SO_2 is applied as reported by CSIR (2004);
  - The SO_2 emission factor for paraffin was derived from the S mass balance for Engen illuminating paraffin.

The Basa njengo Magogo (BnM) fire lighting method results in a significant reduction in particulate emissions (CSIR, 2004), however the assumption was made that it was not widely used during the 2004 to 2006 period evaluated for the baseline assessment.

Table 10: Emissions factors for household combustion of fuels (US-EPA AP42, CSIR 2001)

Fuel	$PM_{2.5}$	PM_{10}	SO_2	NO_X
Coal (g/kg)	12.01	12.91	9.91	4.55
Wood (g/kg)	16.089	17.3	0.2	1.3
Paraffin (g/l)	0.0012	0.1596	0.3991	1.5

Population statistics from Census 2001 and the 2007 mini census are used in the calculation of emissions (Table 11). The spatial distribution of PM_{10} emissions from domestic fuel burning and the relative volumes are illustrated in Figure 16.

Table 11: HPA Census 2001 GIS-based analysis of total annual emissions (in tons) due to household fuel combustion

Region	$PM_{2.5}$	PM_{10}	SO_2	CO	NO_X
Johannesburg	2 593	2 828	1 539	26 724	1 103
Vaal Triangle	1 367	1 479	847	14 347	486
HPA excl Ekurhuleni	7,426	4,699	2,353	-	74,459
Tshwane	2,211	2,398	1,085	21,884	743
Ekurhuleni	6,199	4,237	2,306	-	63,150
TOTAL	**19,796**	**15,641**	**8,131**	**62,956**	**139,943**

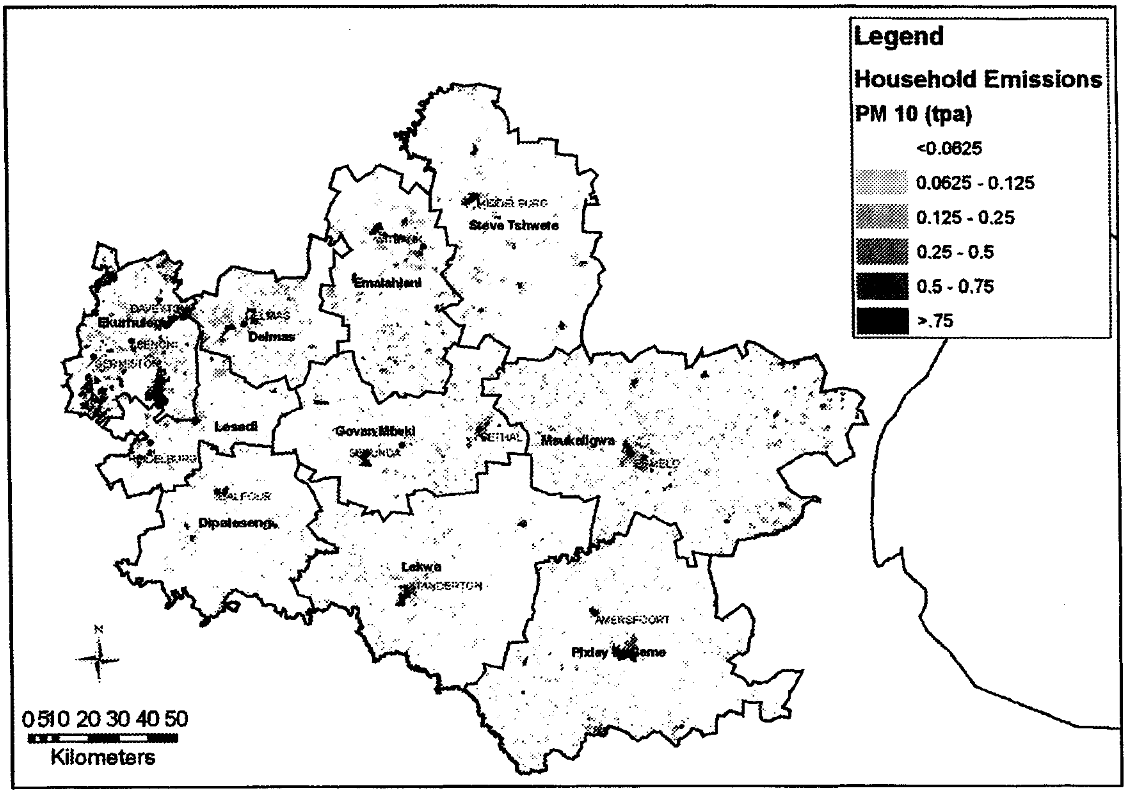


Figure 16: Annual PM_{10} emissions from domestic fuel use on the HPA

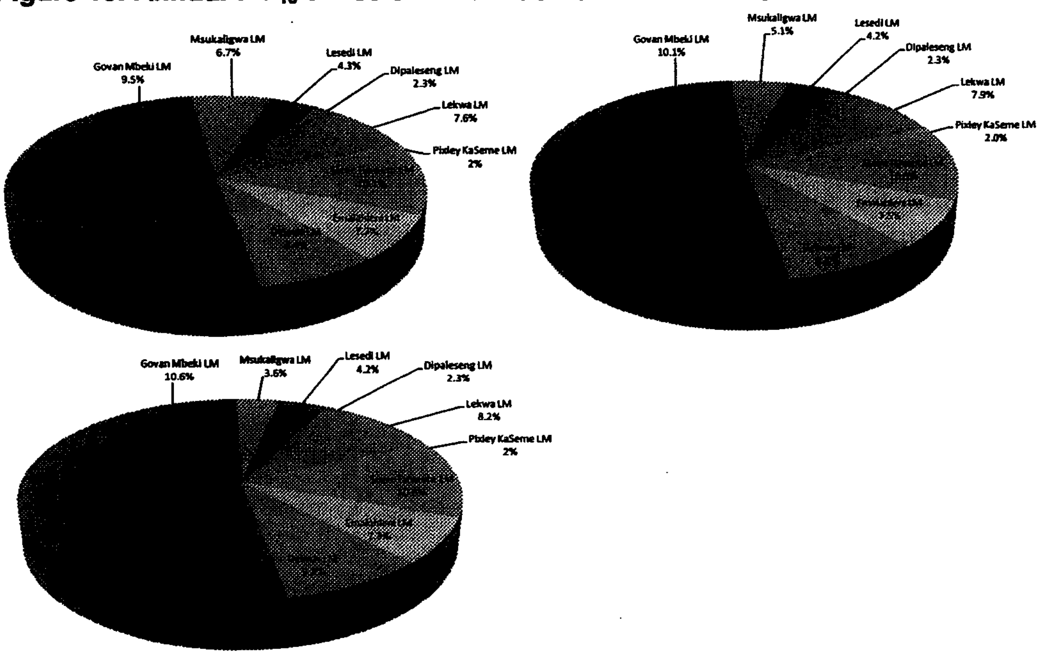


Figure 17: Relative contribution by District Municipality to the total domestic fuel burning emissions of PM_{10} (top left), NO_x (top right) and SO_2 (bottom left)

Factors such as population growth, reductions in household income levels, and an increase in number of informal (unserviced) households lead to an increase in volume of emissions from household fuel burning from 2001 to 2007 (Table 12).

Table 12: HPA 2007 mini-census GIS-based analysis of total annual emissions (in tons) due to household fuel combustion

Region	$PM_{2.5}$	PM_{10}	SO_2	CO	NO_X
Johannesburg	5 077	5 471	3 210	53 690	1 669
Vaal Triangle	3 413	3 675	2 420	37 284	1 190
HPA excl Ekurhuleni	9,402	10,124	6,636	102,559	3,270
Tshwane	2,695	2,911	1,178	26,120	749
Ekurhuleni	6,610	7,116	4,786	72,649	2,330
TOTAL	**27,196**	**29,296**	**18,230**	**292,303**	**9,208**

Significant notes regarding emissions from residential fires are the release close to ground level and the relatively low temperature of the fires. The low-level release implies that the pollutants are released into the stable surface inversion layer, where dispersion is inhibited and pollutants tend to accumulate close to the source. High ambient concentrations may result near the source under these conditions. The relatively low fire temperature implies that the combustion process is incomplete. The vast majority of particulate emissions from incomplete combustion are condensed organic products with a diameters equal to or less than 10 µm, .e.g. PM_{10} (US EPA AP-42). The high levels of organic compounds and CO emissions also result from incomplete combustion of the wood. Organic compounds include carcinogenic compounds such as dioxins, formaldehyde and polycyclic aromatic hydrocarbons (PAH) which have known negative impacts on human health.

In light of the wood usage rates in the HPA (StatsSA, 2001), the higher household wood fuel usage factors, as well as the increased emission factors associated with wood (as opposed to coal), the conclusions drawn from emissions estimates derived in this study ranks wood combustion as the single largest source of household particulate emissions. Wood emissions rank first, followed by coal with a slightly smaller contribution, and the implication is therefore that wood combustion is also a very significant contributor to the health impact associated with household air pollution. Although wood use is more prevalent in rural areas, it is noteworthy that large volumes are consumed in urban areas (StatsSA, 2001). The emissions derived in this study therefore highlight domestic wood use as a significant contributor to the health impact of air pollution on the HP A, followed by coal.

3.2.5 Biomass burning

Biomass burning includes the burning of evergreen and deciduous forests, woodlands, grasslands, and agricultural lands. Biomass burning is a key Earth system process, a major element of the terrestrial carbon cycle and a globally significant source of atmospheric trace gases and aerosols (Hao *et al*, 1990; Andreae and Merlet, 2001). Varying in size, location and timing, fires significantly modify land surface properties, influence atmospheric chemistry and air quality, and perturb the radiation budget (IPCC, 2001).

Africa is the single largest continental source of biomass burning emissions (Roberts *et al* 2008). Fire is prevalent throughout southern Africa and the Highveld. It is typically characterised by a prolonged winter dry season, preceded by summer periods with relatively fast rates of plant growth, leading to fuel accumulation that create conditions conducive to frequent fires. In southern Africa, most fires occur in the dry season, particularly July to September, when herbaceous vegetation is either dead (annual grasslands) or dormant, and when deciduous trees have shed their leaves, thereby contributing to an accumulation of dry and fine fuels that are easily combustible (Archibald *et al*, 2009).

Biomass burning results in the oxidation of organic plant material and is typified by being, to a significant extent, an incomplete combustion process (Cachier, 1992), with CO, CH_4 and NO_2 gases being emitted. Other pollutants associated with biomass burning are CO_2, non-methane hydrocarbons (NMHC), formaldehyde, NO_x ($NO + NO_2$), N_2O, SO_2 and particulates (TSP and PM_{10}). Emissions from biomass burning include a wide range of gaseous compounds and particles that contribute significantly to the tropospheric budgets on local, regional, and even global scales. The emission of CO, CH_4 and VOC affect the oxidation capacity of the troposphere by reacting with hydroxide (OH) radicals, and emissions of nitric oxide and VOC lead to the formation of ozone and other photo oxidants.

The fraction of the landscape that burns across the region varies because of the influence of weather conditions, the presence of ignition sources, and the amount, type, and arrangement of the available fuel (Archibald *et al*, 2009). The majority of fires on the HPA are thought to be anthropogenic and include veld fires, burning of grazing land and crop-residue.

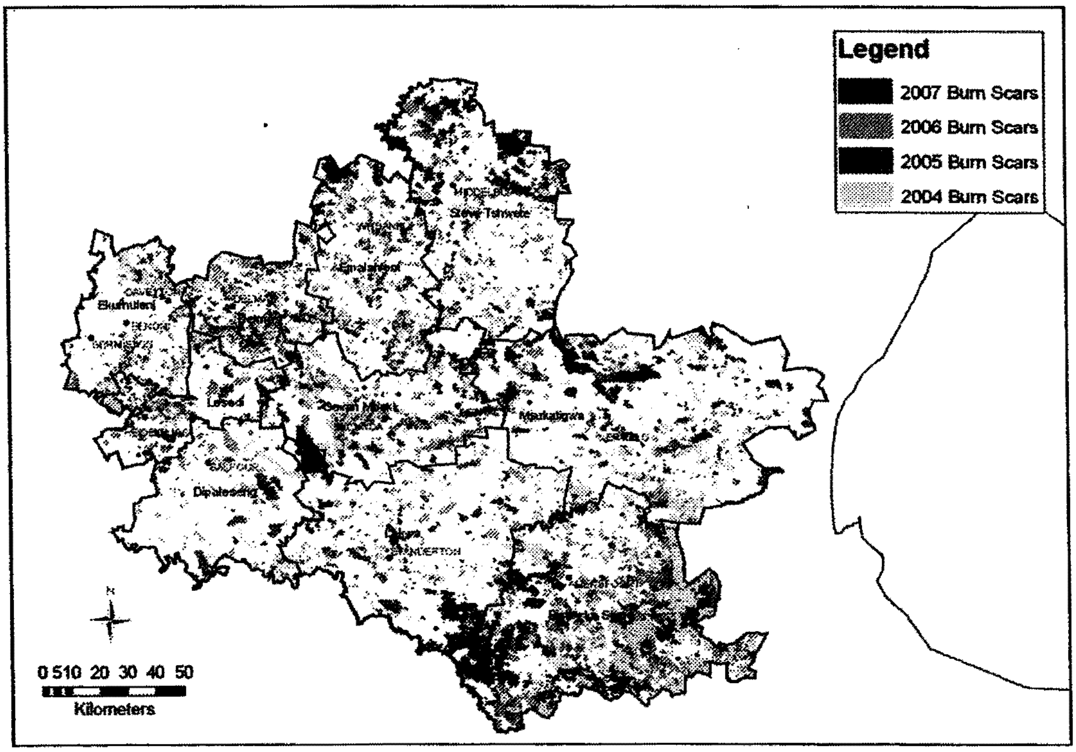


Figure 18 : Distribution of biomass burning within the HPA for 2004-2007

The emission of criteria pollutants from biomass fires is calculated by the general formula:

Emission = (Area burned) x (Fuel Load) x (Completeness of combustion) x (Emission Factor)

Any method for determination of emissions of criteria pollutants thus has to estimate the Area burned, the Fuel load and the Completeness of combustion and couple the resultant mass of fuel burned with an emission factor relating to the specific fuel type.

Biomass burning is accompanied by a wide variety of characteristic spectral signatures that can be detected by earth observation satellites. These include thermal radiation from actively burning fires, and the spectral reflectance and albedo changes induced by newly burned surfaces when compared to reference and surroundings. As such, it is ideal for monitoring using remote sensing techniques on earth observation satellites.

The NASA MODIS on the Terra and Aqua satellites has specific features for fire monitoring (Justice *et al*, 2002), (Kaufman *et al*, 1998). A bi-directional reflectance-model-based change detection approach is applied independently to each gridded MODIS pixel to take advantage of the spectral, temporal, and structural changes that characterise vegetation fire (Roy *et al*, 2005). The global MODIS Collection 5 burned area product (MCD45A1) is a monthly gridded 500 m product that describes the approximate day of burning derived by consideration of temporal changes in reflectance and not using the MODIS active fire product (Roy *et al*, 2005). The identification of the date of burning is constrained by the frequency and occurrence of missing observations, and to reflect this, the algorithm is run to report the burn date with an eight-day precision. MODIS burned-area products can be expected to capture 75% of the fire burnt area.

The determination of fuel load is a parameter with uncertainty and has been variously estimated from field data, satellite data, and Net Primary Production models with partitioning between fuel classes (Van Der Werf *et al*, 2003; Schultz *et al*, 2008). Completeness of combustion is a function of factors including the relative proportions of woody, grass, and leaf litter fuel, the fuel moisture, and the fire behaviour, which may be highly variable. For example, in African grasslands, Ward *et al* (1996) reported combustion completeness as approximately 0.15 and 0.85 for smouldering and flaming combustion respectively. Typically, emission factors are largely well determined from laboratory measurements, although their temporal dynamics as a function of fuel wetness is less certain (Hoffa *et al*, 1999; Korontzi *et al*, 2004)

Using MODIS 500 m fire scar data and the SA National Land Cover (2000), an advanced biomass burning emissions inventory based on "burnt land cover" was developed. Due to the role of soil fertility levels in biomass production, fuel load classes was derived from the SA National Land Cover (SANLC 2000) (49 classes) coupled to the soil fertility map comprised of 3 soil fertility classes(CSIR) – burnt fertility land cover class. This was in turn mapped to 22 fuel load classes using Intergovernmental Panel on Climate Change (IPPC) (IPCC 2001 Table 2.4 and 2.5) and South African Greenhouse Gas Inventory (SAGHGI) (DEAT 2008, 1998). For fuel combustion completeness factors, the IPCC Greenhouse Gas (GHG) Inventory Guideline 2006 (IPCC 2006) was adapted using the SANLC soil fertility classes. Emission factors were derived from IPCC, Ward *et al* (1996) and USEPA AP42, and presented in Appendix 5.

Table 13: Annual estimated emissions from biomass fires on HPA, in kilotonne/annum

Year	$PM_{2.5}$	PM_{10}	CO_2	CO	CH_4	N_2O	NO_X
2004	5.07	9.44	1566.76	73.64	2.54	0.20	3.55
2005	6.82	12.55	2076.20	98.15	3.41	0.26	4.69
2006	6.28	11.81	1967.06	92.01	3.16	0.25	4.46

NB. $NO_x = NO + NO_2$

3.2.6 Waste treatment and waste disposal

3.2.6.1 Landfill

Disposing of general municipal waste to landfill is common practice in the HPA. Currently, there are 26 municipal landfill sites in operation (Table 14). A significant number of private operators are found in the area, catering to the needs of the various mining, manufacturing and power generation industries. Unpermitted landfill operations are commonplace in the HPA, particularly in Mpumalanga (Gert Sibande DM, 2007, Nkangala DM, 2008). Accurate information on the number of landfill operations in the HPA could not be sourced for the area as a whole. Atmospheric emissions from general waste landfills, or landfill gas, are composed of a mixture of many different gases. By volume, landfill gas typically contains 45% to 60% methane and 40% to 60% CO_2. It also includes small amounts of nitrogen, oxygen, ammonia, sulfides, hydrogen, CO, and non-methane organic compounds (NMOCs) such as trichloroethylene, benzene, and vinyl chloride (Duffy, 2007).

Hazardous waste includes solvents, industrial wastes, and construction wastes such as asbestos. One private hazardous waste landfill site is operational in the HPA, in the Ekurhuleni MM, Holfontein, which is used by surrounding municipalities as well. The landfill is reported as accepting all types of hazardous waste, handling an average of 263 446 tonnes of waste per annum, with an average increase of less than 1% per annum (Ekurhuleni MM and GDACE, 2007). The Platkop landfill site accepts asbestos waste, in addition to general waste.

Table 14: Number of operational general and hazardous landfill sites in the HPA

	General waste	Hazardous waste
Ekurhuleni MM	5	1
Lesedi LM	1 illegal	
Gert Sibande DM	13	
Nkangala DM	6	

3.2.6.2 Incinerators

The incineration of waste is a Listed Activity in terms of the AQA (Category 8), that is facilities where general and hazardous waste including health care waste, crematoria, veterinary waste, used oil or sludge from the treatment of used oil are incinerated. The minimum emission standards are applicable only to facilities with a capacity of 10 kg of waste processed per hour or larger capacity. Pollutants released from waste incineration include SO_2, heavy metals, acid gases, dioxins and furans, which pose negative impacts on air quality and human health risk. Particulate emissions from incinerators may also contain heavy metals such as chromium and cadmium, which are suspected human carcinogens.

'Sandile.Kunene@sacu.int'; Saleem Rajah; Thesan Chellakooty; Vicky Ratsoana'Sandile.Kunene@sacu.int'; Saleem Rajah; Thesan Chellakooty; Vicky RatsoanaG.P.-S. 09/08 **Z95** (81/42603)

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There is a single permitted hazardous waste incinerator in the Ekurhuleni MM, at Olifantsfontein (Ekurhuleni MM and GDACE, 2007). The facility accepts most types of hazardous waste, including health care risk waste and mercury. A privately owned health care waste treatment facility has been established at Dunswart, with two further facilities planned at Dunswart and Wadeville.

3.2.6.3 Wastewater treatment works

The range of air emissions originating from wastewater treatment processes is highly dependent on the composition of the incoming effluent streams. The typical hazardous air pollutants emitted from wastewater treatment plants are benzene, toluene, xylenes, methylene chloride, ethyl benzene, chloroform, tetrachloroethylene and naphthalene (US EPA, 1995). Wastewater treatment plants are also associated with the emission of odorous compounds, the most common of which is hydrogen sulphide (H_2S). This pollutant is formed through the anaerobic bacterial reduction of sulphates and sulphur-containing organic compounds. The potential for emissions of VOCs during wastewater treatment is a cause for concern. Pollutants measured at local waste water treatment works have included H_2S, mercaptans, ammonia, formaldehyde, acetone, toluene, ethyl benzene, xylenes, perchloroethylene, butyric acid, propionic acid, valeric acid and acetic acid. Species which represent the most important odorants include H_2S, mercaptans, ammonium (NH_4), and the various fatty acids (butyric, propionic, valeric and acetic).

Fourty two wastewater treatment works are operating on a municipal basis in the HPA (Table 15). A large proportion is within the Ekurhuleni MM due to the large urban population. The major centres in Mpumalanga are also serviced with water-borne sanitation and wastewater treatment works. In addition, the rural and under-developed areas of Mpumalanga are formally serviced by a system of french drains, septic tanks and other sanitation means.

Table 15: Wastewater treatment works within the HPA

Waste water treatment works			
Ekurhuleni MM	17	Gert Sibande DM	17
Lesedi LM	3	Nkangala DM	5

3.2.7 Tyre burning

Tyre burning occurs in the HPA due to two primary reasons. Firstly, tyres are burnt for the retrieval of the scrap metal content, which is subsequently sold, therefore providing a source of income. Tyres are also burnt as an efficient energy source for heating, typically observed at bus stops and taxi ranks during winter. Dumping of tyres in vacant areas also occurs in the HPA as the safe disposal of tyres is problematic. Tyres disposed of in this fashion are frequently combusted during veld fire incidents.

The burning of tyres results in highly visible black smoke. Emissions from open tyre burning include the criteria pollutants PM, CO, SO_2, NO_x, and VOCs. They also include "non-criteria" hazardous air pollutants (HAPs), such as PAHs, dioxins, furans, hydrogen chloride, benzene, polychlorinated biphenyls (PCBs); and metals such as arsenic, cadmium, nickel, zinc, mercury, chromium, and vanadium. Both criteria and HAP emissions from an open tyre fire can represent significant acute (short-term) and chronic (long-term) health hazards to fire-fighters and nearby residents. Depending on the length and degree of exposure, these health effects could include irritation of the skin, eyes, and mucous membranes, respiratory effects, central nervous system depression, and cancer.

The Waste Tyre Regulation, which was promulgated in 2009 (Government Gazette No. 31901 vol. 524), came into effect on 30 June 2009. The regulations affect waste tyre producers, dealers, stockpile owners, landfill site owners and tyre recyclers with the intention to regulate the management of waste tyres. Although there is little information on tyre burning on the HPA, the enforcement of this regulation is likely to result in a reduction in the activity with a concomitant reduction in the related emission.

3.2.8 Biogenic emissions

Biogenic emissions are emissions from natural sources, such as plants and trees. The primary function of biogenic volatile organic compounds (BVOC) in plants is to protect them against biotic and abiotic stresses or to attract pollinators. The direct and indirect effects of BVOC emissions on atmospheric chemistry make understanding the sources of BVOCs important for AQM. As an example, approximately 90% of the annual global VOC emission budget of 1150 Tg C is attributed to biogenic sources mostly in the form of isoprene and monoterpenes, which contribute 44% and 11%, respectively (Guenther *et al*, 1995). BVOC emissions are functions of the species leaf mass, emission factors, temperature, and light conditions, and emission factors for BVOCs have been established for a limited number of southern African plant species and landscapes (Guenther, 1996; Harley *et al*, 2003; Otter *et al*, 2003). The initial estimate of the annual BVOC emission from southern Africa of 94.2 Tg C yr^{-1} (Guenther *et al*, 1995) compares favourably with the estimate of 80 Tg C yr^{-1} by Otter *et al* (2003), using vegetation maps and vegetation-specific emission factors. The natural vegetation on the HPA is dominantly grassland (Low and Rebelo, 1996), which are relatively low BVOC emitters (http://bai.acd.ucar.edu/Data/BVOC/index.shtml). Otter *et al* (2003) estimated the average summer isoprene emission to range from 0.01 to 0.24 (gCm^{-2} $month^{-1}$) with a very low winter emission due largely to the dormant vegetation.

3.2.9 Odour

Odour can be classified as offensive, pleasant, neutral or unpleasant. While offensive or unpleasant odours may not have direct health impacts, they have a negative impact on quality of life, resulting in numerous complaints to authorities. They are commonly associated with industries such as abattoirs, tanneries and fishmeal processing factories, and in the manufacture of H_2S. When odorants are released from tall stacks, the resultant effect may manifest on relatively large scales. Other sources of odour include chicken batteries and piggeries, landfill sites and wastewater treatment works, however, these are low-level emissions and their effect will be relatively local. The gasification of coal in the coal-to-liquid fuel industry is a major source of H_2S in Secunda, as are a number of other processes. It is emitted from tall stacks and may therefore be dispersed over significant distances. Long-range transport of H_2S from Secunda is known to impact as far as the City of Johannesburg (Pretorius *et al*, 1996).

3.2.10 Agricultural dust

Dryland agriculture in the HPA is extensive with amongst others, maize, sorghum, groundnuts and sunflowers being farmed. Clearing of veld and ploughing in preparation of fields for planting can generate significant amount of dust. The relative contribution of dust generated by agricutural activities to the ambient dust loading in the HPA are not quantified in this baseline assessment. However, the activities are of relatively short duration and the resultant effects are likely to be predominantly of a nuisance nature.

3.2.11 Burning coal mines and smoldering coal dumps

Many environmental consequences are associated with coal mining, including the exposure of the coal seam and allied minerals to air and moisture. This creates a chemical potential that results in the ignition of the coal through the processes of chemisorption, oxidation, and eventually spontaneous combustion of the coal (Stracher 2004, Sheail, 2005; Chatterjee 2006). Spontaneous combustion is a phenomenon that occurs during various phases of the coal mining process including mining (underground and opencast), waste disposal (waste dumps, and backfilling) as well as during transportation and storage (both in stockpiles and silos).

Once started, coal fires are difficult to extinguish and sometimes cannot be controlled. In addition to burning vast quantities of coal, the fires have an enormous negative impact on the local and global environments. Collieries in the Witbank coalfield have historically used board and pillar mining with typically low coal recovery ratios, leaving a significant amount of coal in pillars, and as floor and roof coal. When old workings are reopened, ingress of air can lead to spontaneous combustion (Pone *et al*, 2007). In the case of a subsurface coal fire, the required oxygen enters through cracks/fissures at the surface or mine shafts. However, the coal fire can cause subsidence as it voids the support (coal seam) beneath the overburden rock. This makes sufficient passage for air ingress, thus ensuring continued combustion.

Coal fires produce large quantities of air pollutants and greenhouse gases including CO, CH_4, SO_2 and NO_x. SO_2 and benzene, toluene, ethylbenzene and xylene (BTEX) concentrations have been shown to be elevated close to the source and to extend beyond the mine perimeter (Lodewijks, 2009). The formation of these compounds results from the thermal degradation during spontaneous combustion of biopolymers buried in the coal seams (Puttmann *et al*, 1991). Stracher *et al* (2005) stated that the exchange reaction between the gas, rocks, and solutions influences the chemistry of gas en route to the surface. The high concentration of CO and CO_2 detected in the samples are above the recommended world Health Organisation (WHO) guidelines and South African national standards, but sometimes occur in the Vaal Triangle (Pone *et al*, 2007).

South Africa started to export coal in the early 1970s. The export contracts required low ash material (<9% ash), and the South African industry started to wash the products in large quantities. The discard was dumped, and many dumps started burning due to spontaneous combustion. By the mid-1980s, Lloyd (2000) reported that the ambient SO_2 levels in present-day Mpumalanga had reached noxious levels in some regions. Studies soon showed that the primary source was the burning dumps, not power stations in the area. As a result, methods for constructing dumps were evolved which markedly reduced the chance of spontaneous combustion. Lloyd (2000) indicated that reasonable reserves of potentially useful discards have built up through engineered disposal site construction, which is still prone to spontaneous combustion if poorly maintained.

Putman *et al* (1991) suggested that the concentration of benzene, toluene and xylenes (BTX) transferred from the geosphere to the atmosphere/hydrosphere can be estimated to be about 45 g/t overburden for coals of the Witbank and Sasolburg rank, which is based on the approximation that about 10% of the material in spoil piles is coal. Using this transfer factor and a typical stripping ratio of 1:6 typical of opencast mining operating in the HPA (Buchan *et al*,1980), and assuming that 1% of the BTX arising from the mining operation is emitted to the atmosphere, 44 kt/a of BTX may be emitted from opencast coal mining activity in the HPA. This rate is higher when the material is subjected to self-heating and spontaneous combustion.

SO_2 emissions from smoldering coal dumps were estimated at more than 54 000 t/a in the Mpumalanga Province's 2001 State of Environment Report (DACE, 2001). The location of smoldering coal dumps and underground coal fires has not been established on the HPA for this baseline assessment, and their emission has not been updated and included in the HPA emissions inventory. The low release height of the emission result in relatively local effects, but concentrations may reach extreme levels due to the lack of dispersion potential. The nature of the impact will however be dependant on the duration of the combustion, volume of burning coal, local meteorology and relative location of sensitive receptors such as residential areas. The large volumes of coal mined and the quoted emission rates indicate that the resulting fires from spontaneous combustion are a very significant emitter of air pollutants on the Highveld. This source category will be included in the AQMP as an area for futher research and action to ameloriate the impacts.

3.3 Ambient air quality in the HPA

3.3.1 Introduction

The state of ambient air quality in the HPA is described using ambient monitoring data, dispersion modelling and the findings of research projects on the Highveld. The monitoring stations provide data at specific sites and while their spatial representativeness is limited, they are accredited and the ambient concentrations are considered accurate. By contrast, the modelled ambient concentrations cover the full extent of the HPA, they are estimates, and their representativeness is determined by the model parameterisation, but mostly by the accuracy and completeness of the respective meteorological and emission input data. An overview of ambient air quality monitoring on the HPA and the dispersion modelling are presented.

3.3.2 Ambient air quality monitoring

The comprehensive review of ambient air quality monitoring data in South Africa, presented in DEAT (2006), is used to provide a historical perspective on ambient air quality in the HPA. Data for the 3-year period 2004-2006 was provided by stakeholders conducting monitoring in the HPA, i.e. Eskom and Sasol. Data from monitoring stations recently installed by the DEA, MDEDET and Eskom are also included in the analysis. The more recent data falls outside of the period considered for emission characterisation, but despite the brevity of the monitoring records, they provide much-needed information on ambient concentrations in areas where data were previously not available. The relative locations of the monitoring sites within the HPA are presented in Figure 19. No ambient monitoring is undertaken in the Delmas and Lesedi Local Municipalities and ambient data was not available from Ekurhuleni MM. Priority pollutants were the parameters of interest in the monitoring record, viz. benzene, CO, NO_2, ozone (O_3), PM_{10}, and SO_2. Pollutants monitored at each site are detailed in Table 16. Information is also provided regarding the emission sectors that influence measurements at specific sites.

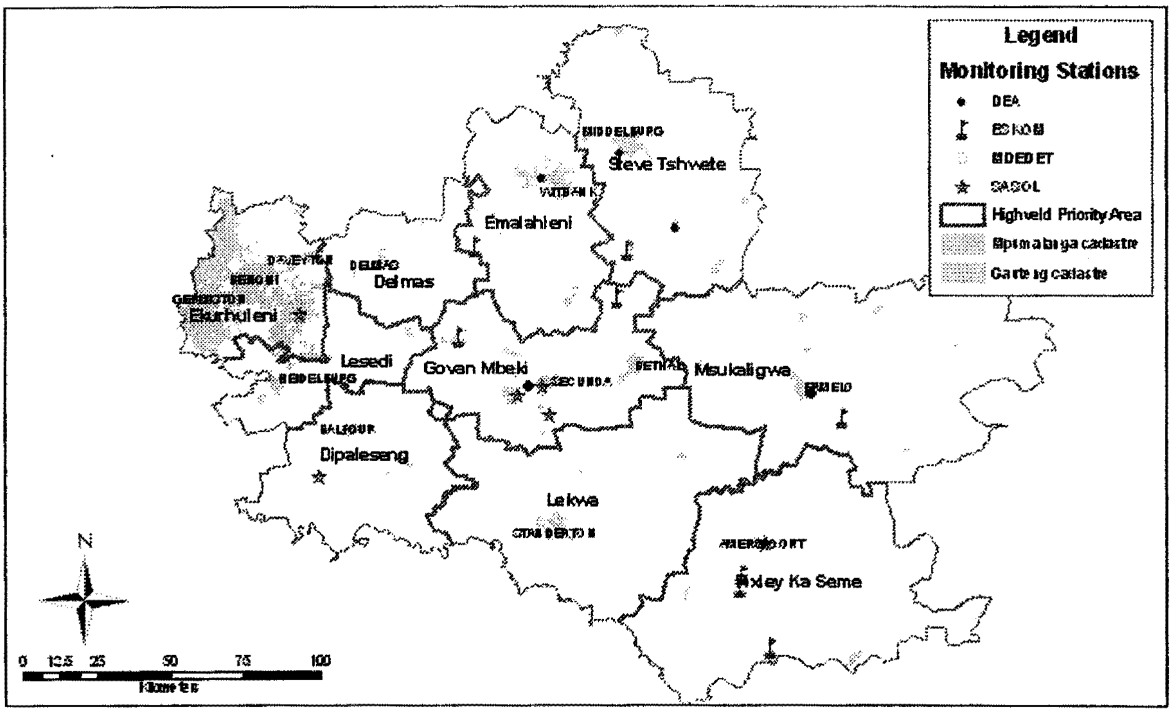


Figure 19: Location of ambient air quality monitoring sites in the HPA

Table 16: Monitoring sites with available data in the HPA

		Siting	NO_2	O_3	PM_{10}	SO_2
Emalahleni LM	Kendal 2	P	H, C	H, C		H, C
	Phola	RMPI	N		N	N
	Witbank	IR	N	N	N	N
	Witbank 2	RIT	N	N	N	N
Steve Tshwete LM	Columbus	I			H	
	Komati 2	PMTR			C	C
	Middelburg	I	N	N	N	N
	Middelburg 2	RI	N	N	N	N
	Hendrina	I	N	N	N	N
Govan Mbeki LM	Club	RI	H, C	H	C	H, C
	Langverwacht	RI	C		C	H, C
	Bosjesspruit	I				H, C
	Elandsfontein	PIM	H, C	H, C	C	H, C
	Leandra	RP				H, C

	eMbalenhle	IR	N	N	N	N
Msukaligwa LM	Camden	PRM	C	C	C	C
	Ermelo	R	N	N	N	N
Pixley Ka Seme LM	Amersfoort	I		H		
	Verkykkop	Reg	H, C	H, C	C	H, C
	Majuba 1	P				H, C
	Majuba 2	P				H
Lekwa LM	Standerton	RI	N	N	N	N
Dipaleseng LM	Balfour	RI	N	N	N	N

P –power generation impacts
I – industrial impacts
M – Mining impacts
H – historical data, 1994-2003
N – new data, 2008-2009
R – residential fuel burning impacts
T – transportation and traffic impacts
Reg – Regional-level impacts
C – HPA study data, 2004-2006

3.3.3 Dispersion modelling

Dispersion modelling was undertaken using the CALPUFF suite of models to estimate ambient concentrations of SO_2, NO_x and PM_{10} in the HPA for the 3-year period 2004 to 2006. The objective is to identify areas on the HPA where national ambient air quality standards are exceeded or may be exceeded. Three-years of monitored and modelled meteorological data were preprocessed as input to CALPUFF. A spatially resolved emission inventory was used to estimate the relative contribution of emission from different sectors. A process of summing provided the estimated combined effect of the different sectors on ambient concentrations. Details on the model set-up are provided in Appendix 4.

The following sectors were modelled independently:

- Power generation
- Petrochemical sector
- Primary metallurgical
- Non-ferroalloys
- Claybrick manufacturing
- Opencast coal mines
- Mpumalanga industries
- Industry in Ekurhuleni MM
- Transport (motor vehicles and ORTIA)
- Residential fuel burning
- Sources outside the HPA, but within 50 km of the HPA

Industrial sources were modelled as point and area sources and the emission rates were assumed to be constant over time. Mines and brickworks were modelled as area sources with constant emission rates. Motor vehicle emissions and residential fuel burning emissions were modelled as area sources with temporal profiles to account for the daily and seasonal variations that characterise these sources. Particulates are modelled as PM_{10}.

Dispersion modelling was not conducted for the following source categories:

- Biomass burning

- Biogenic emissions
- Burning coalmines and smoldering coal dumps
- Incinerators
- Tyre burning
- Wastewater treatment works
- Landfill sites, and
- Agricultural dust

Source apportionment was done within each of the hot spots to determine the relative contribution of modelled sectors to the total ambient pollutant loading of the hot spot. The contribution of each modelled sector was established for the entire hot spot using GIS and then calculated as a percentage of the total ambient pollutant concentration. These are represented as pie charts for each hot spot.

3.3.4 Comparison of model estimates and monitoring data

The index of agreement (IOA) is a measure of how well model predicted variations about the observed mean are represented. It provides a more consistent measure of model performance than the correlation coefficient and an IOA with a value greater than about 0.5 considered to be good (Hurley, 2000). Willmott (1981) was used to provide the IOA calculation methodology.

The performance of the CALPUFF model is evaluated by comparing modelled concentrations of SO_2 and PM_{10} from all industrial sources with the monitoring data for the period 2003 to 2006. The IOA for 1-hour and average 24-hour SO_2 concentrations and average 24-hour PM_{10} concentrations are provided in Table 17. The IOA for NO_2 was not evaluated, as its effects are more localised than SO_2 and PM_{10}.

Table 17: Comparative statistics between monitored data and model predictions

Sites	SO_2 1-hr	SO_2 24-hr	PM_{10} 24-hr	% hourly SO_2 predirediction	
				Under	Over
Camden	0.45	0.65	0.41	62	38
Elandsfontein	0.32	0.61	0.43	46	54
Kendal 2	0.20	0.40	0.39	70	30
Komati 2	0.39	[illegible]	0.43	70	30
Leandra	0.33	[illegible]	0.11	67	33
Majuba 1	0.23	[illegible]		62	38
Verkykkop	0.43	[illegible]	0.42	71	29
Bosjesspruit	0.24	[illegible]		37	63
Sasol Club	0.16	0.47	0.46	51	49
Langverwacht	0.44	0.20	0.41	61	39

For the 1-hour SO_2 predictions, CALPUFF performed best at Camden, Verkykkop and Langverwacht; otherwise, the IOA is relatively low. The generally low IOA is attributed mostly to variation in emissions that are not parameterised in the model, but will be captured by the monitoring stations.

The IOA improved significantly for the 24-hour SO_2 predictions, with an IOA of > 0.5 at eight of the 10 monitoring stations. The improvement is expected as the short- term fluctuations in emissions and meteorology are averaged and are therefore not as pronounced.

The number of occurences of hourly under and over predictions of SO_2 concentrations at the respective monitoring stations contributes to the understanding of the model results. The frequency of model underpredictions is considerably higher at all stations other than at Sasol Club, Elandsfontein and Langverwacht (Table 17). The greatest frequency of underprediction occurs at Kendal, Komati and Verkykkop. At the Sasol Club and Elandsfontein, the frequency of overprediction and underprediction are similar. Bosjesspruit is the only monitoring station where the model overpredicts.

The predicted PM_{10} concentrations do not compare as favourably with the monitored data. This is expected as residential fuel burning and mining contribute to the atmospheric loading of particulates and these have been excluded from the comparison. PM_{10} concentrations are therefore consistently underpredicted.

3.3.5 Ambient air quality standards

National ambient air quality standards were developed for South Africa by the DEA and published in 2009 (Table 18). Seven criteria pollutants are regulated. Transitional compliance periods with higher limit values have been included for PM_{10} and benzene.

The standards include a limit value, averaging period, permissible frequency of exceedance and date at which compliance is required. Regarding the permissible frequency of exceedance, it refers to the number of times the limit value can be exceeded without being recorded as an exceedance of the standard, e.g. the SO_2 24-hour limit value of 125 $\mu g/m^3$ can be exceeded four times in a calendar year while maintaining compliance with the standard. Further detail on pollutants and ambient standards are provided in Appendix 1.

Table 18: National ambient air quality standards in $\mu g/m^3$, with the permitted number of exceedances in brackets and compliance dates (DEAT, 2009)

Pollutant	Averaging period					Compliance date
	10-minute	1-hour	8-hour running mean	24-hour	1-year	
CO		30 000 (88)	10 000(11)			Immediate
SO_2	500 (526)	350 (88)		125 (4)	50 (0)	Immediate
NO_2		200 (88)			40 (0)	Immediate
Ozone			120 (11)			Immediate
Lead					0.5 (0)	Immediate
PM_{10}				120 (4)	50 (0)	Immediate
				75 (4)	40 (0)	1 January 2015
Benzene					10 (0)	Immediate
					5 (0)	1 January 2015

3.3.6 State of ambient air quality on the HPA

Most of the HPA experiences relatively good air quality, but there are nine extensive areas where ambient air quality standards for SO_2, NO_2, PM_{10} and O_3 are exceeded. These "hot spots" are illustrated in Figure 20 by the number of modelled exceedances of the 24-hour SO_2 and PM_{10} standards and the 1-hour NO_2 standard, and are confirmed by ambient monitoring data (Table 19). The air quality hot spots result from a combination of emissions from the different industrial sectors and residential fuel burning, with motor vehicle emissions, mining and cross-boundary transport of pollutants into the HPA adding to the base loading. The relative contribution of the different source categories to modelled ambient concentrations is presented for each of the hot spots in Sections 3.3.6.1 to 3.3.6.10. The cells comprising the hot spots are selected to illustrate the general contribution to ambient concentrations, rather than that of a single source or source category. A shortcoming of this approach is the inability to illustrate the relative contribution of emission sources that have a relatively limited spatial effect, e.g. mining, residential fuel burning and motor vehicles, where these sources will dominate.

The nine hot spot areas are:

- Emalahleni
- Kriel
- Steve Tshwete
- Ermelo
- Secunda
- Ekurhuleni
- Lekwa
- Balfour
- Delmas

Pixley ka Seme is discussed as a hotspot however, only exceedances of O_3 have been confirmed through monitoring and this is regarded as a regional-scale problem.

A transitional standard for PM_{10} has been published, which will be in effect until 2014, following which lower threshold values will apply. The current level is higher than limit values proposed previously, reducing the number of non-compliant sites for the annual and 24-hour standards. PM_{10} will still have to be managed at these sites to meet the reduced limit value in 2015, as particulate matter remains an issue across the HPA.

Available monitoring confirms that the areas of concern are in the vicinity of Witbank, Middelburg, Secunda, Ermelo, Standerton, Balfour, and Komati where exceedances of ambient SO_2, NO_2 and PM_{10} air quality standards occur (Table 19). Kendal 2 is a research station and is not indicative of ambient air quality in the general area. It has been strategically sited to measure impacts of emissions from Kendal power station under given meteorological conditions, The effects of poor dispersion conditions in the winter are evident throughout the monitoring record for all pollutants, resulting in greater frequency of exceedances of the standards. PM_{10} displays this seasonal trend most strikingly, showing a sharp contrast between wintertime peaks and summer minimum values at monitoring sites. Seasonal trends are clearly observed for O_3 in the monitoring record, as springtime peaks are easily identified. Monitoring data show CO and benzene to be within acceptable limits at the new sites. Trends in pollutant concentrations, based on current data, cannot be conclusively identified, marred in particular by poor data collection.

Table 19: Exceedances at HPA sites based on historic and new monitoring data

		NO_2 *1-hr (88)*	O_3 *8-hr (11)*	PM_{10} *24-hr (4)*	SO_2 *24-hr (4); 1-hr (88)*
Emalahleni LM	Kendal 2	1	**58**		**34; 343**
	Phola	0		3	7; 27
	Witbank	37	9	**9**	4; 51
	Witbank 2		**17**	**25**	1; 11
Steve Tshwete LM	Columbus				
	Komati 2			**26**	1; 14
	Hendrina	1	**22**	3	1; 2
	Middelburg	71	**60**	7	1; 4
	Middelburg 2		1	7	0; 1
Govan Mbeki LM	Club	1		0	0; 25
	Langverwacht	1		0	2; 78
	Bosjesspruit				2; 27
	Elandsfontein	0	**73**	3	4; 33
	Leandra				6; 114
	eMbalenhle	2	4	**39**	0; 1
Msukaligwa LM	Camden	0	**24**	1	0; 4
	Ermelo	1	**73**	**22**	**21**; 10
Pixley Ka Seme LM	Amersfoort				
	Majuba 1				4; 87
	Majuba 2				
	Verkykkop	0	**46**	0	1; 7
Lekwa	Standerton	4	10	**29**	1; 6
Dipaleseng	Balfour		**29**	**8**	0; 4

NB. - Row 1: The averaging period for the relevant pollutant's standard is represented below the pollutant and following, the permissible frequency of exceedance in brackets

- Stations in grey blocks represent new monitoring data for the period 2008-2009
- Exceedances in bold are greater than the permitted frequency in the standard for the monitoring period. The permitted frequency of exceedance varies according to period for which data is presented at each monitoring site, and for Eskom and Sasol stations must be assessed against a cumulative permitted frequency of exceedance for 3 years of data

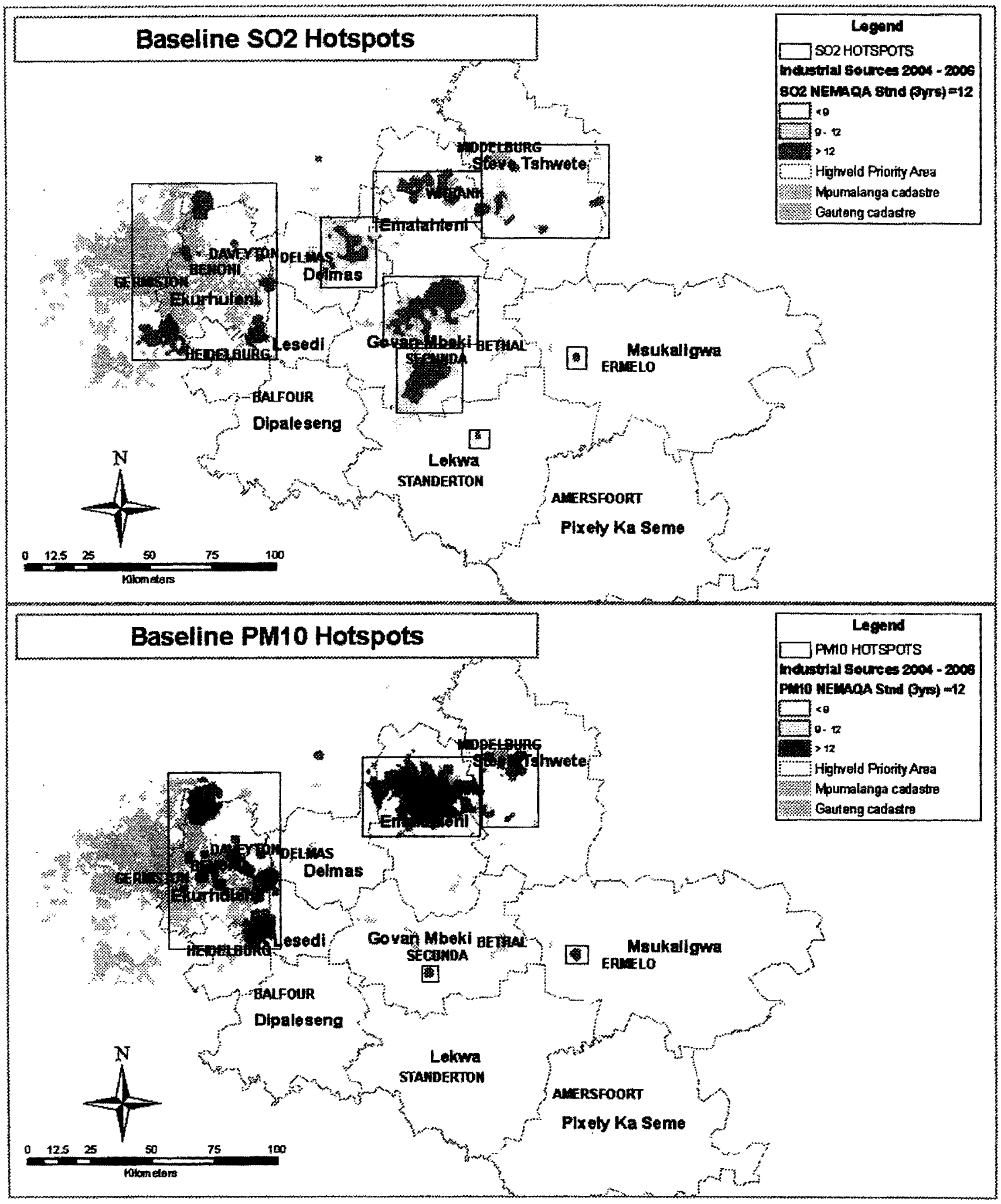


Figure 20: Modelled frequency of exceedance of 24-hour ambient SO_2 and PM_{10} standards in the HPA, indicating the modelled air quality Hot Spot areas

The regional extent of elevated O_3 concentration on the HPA was illustrated in the CAPIA project (Zunckel *et al*, 2004) showing concentrations to be consistently higher at Amersfoort than Bosjesspruit. Dominant northwesterly winds at these two sites indicate that the major source of O_3 precursors is the Secunda industrial complex. Elevated O_3 concentrations at Amersfoort are due to the site location 50 km downwind from the source area, allowing time for O_3 formation, as opposed to Bosjesspruit, which is 5 km away from the industrial complex. Hourly average O_3 concentrations show exceedances of the 80 μg/m^3 (40 ppb) threshold, aimed at crop protection, for a large portion of the day at Amersfoort. Hourly concentrations at Bosjesspruit approach this threshold at midday. Josipovic *et al* (2009) also showed the regional extent, with maximum concentrations for the Highveld in the Standerton area.

The estimated emission of total mercury (Hg) from power generation on the HPA is 21.6 tons Hg in 2009 (Scott, 2011). Mercury is considered a pollutant of concern, since South Africa is rated as the 6th largest emitter of mercury in the world (Leaner et al., 2009, Masekoameng, 2010). In South Africa, power generation accounts for approximately 75% of the total mercury emissions. The United Nations Environment Programme (UNEP) are currently in the process of developing a global legally binding instrument for mercury. As such, it is important to highlight the fact that mercury is a potential future pollutant of concern, with the Highveld power generation sector making a significant contribution to the national inventory.

Airborne sampling of BTEX indicated that toluene was predominant species and BTEX concentrations were generally higher over Johannesburg and Soweto than the eastern parts of Mpumalanga (van der Walt, 2008). This was attributed to traffic density, residential fuel burning and industrial sector contributions. Elevated BTEX concentrations were also detected over the forest area in the HPA, but could not be directly attributed to vegetation or biomass burning emissions in the area. The average benzene concentration over the HPA during the campaign was 4.6 μg/m^3. Results from in-plume sampling show significant BTEX concentrations in the plume of petrochemical industries in Secunda.

Power generation

Power stations are located across the central HPA. Their emissions are released well above the stable surface layer through tall stacks. The nighttime surface temperature inversion prevents the plumes from reaching ground level, with dispersion occurring above the inversion. During the day, particularly in summer, convection can bring the plumes to ground level when high concentrations may occur, so-called looping. The extreme buoyancy of the power station plumes have a significant effect on plume rise, resulting in maximum ground level concentrations a considerable distance from sources. Modelled exceedances of the ambient 1-hour and 24-hour SO_2 standards from power generation emissions occur across the central HPA, i.e. the southern parts of the Emalahleni LM and the northern parts of the Govan Mbeki LM, and close to the individual power plants at Matla, Kriel, Kendal, Hendrina, and Duvha (Figure 21).

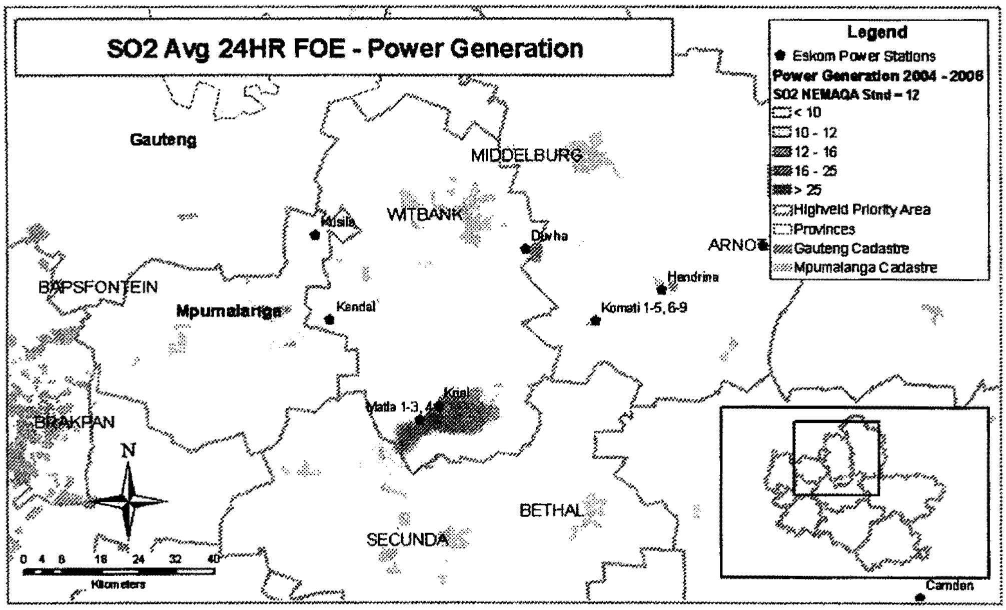


Figure 21: Modelled exceedances of ambient 24-hour SO_2 concentrations resulting from emissions from power generation

Petrochemical

The petrochemical industry is concentrated at Secunda. The major SO_2 emission is from tall stacks, resulting in relatively good dispersion above the surface layer. However, a number of exceedances of the SO_2 standards are predicted in the Secunda area, resulting from emissions from the petrochemical sector only. It is likely that these occur during during looping and fumigation when the plume is brought down to ground level. As may be expected, ambient SO_2 concentrations resulting from the emissions are highest at the source and decrease moving further away (Figure 22).

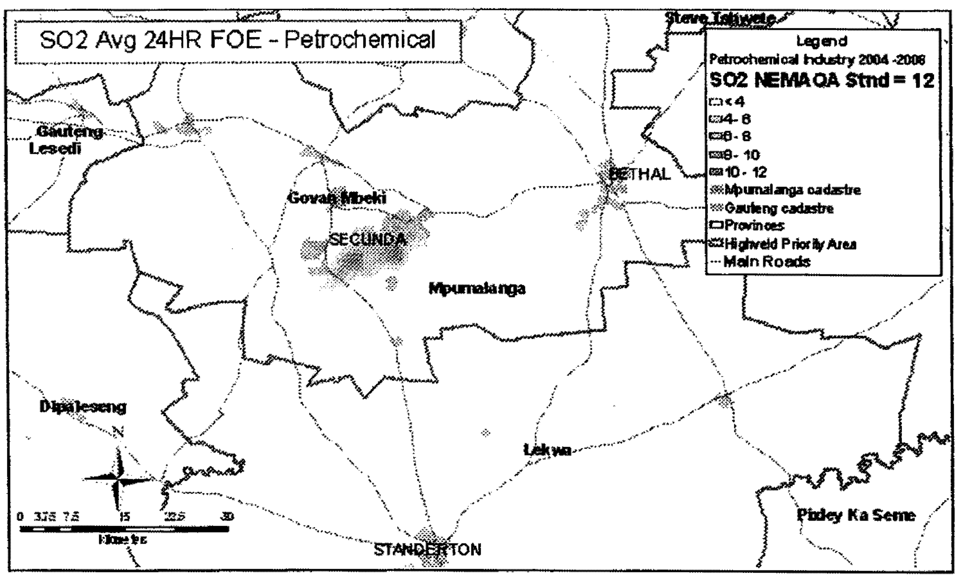


Figure 22: Modelled exceedances of ambient 24-hour SO_2 concentrations resulting from emissions from the petrochemical sector

Primary metallurgical and non-ferroalloy

Primary metallurgical production takes place in the Emalahleni and Steve Tshwete LMs. Emissions from this sector result in a number of predicted exceedances of the ambient PM_{10} standard as well as exceedances of the SO_2 standards (Figure 23). It may be expected that the effect of the emission would be limited to the vicinity of the sources as the stacks are relatively low, but this not so. Predicted exceedances of ambient standards extend over a relatively larger area due to the volume of the emission. By contrast, emissions from the non-ferroalloy industries, located in the Emalahleni LM, Steve Tshwete LM and Ekurhuleni MM, are released from relatively low stacks. This results in relatively limited dispersion and a localised effect in the ambient environment (Figure 24).

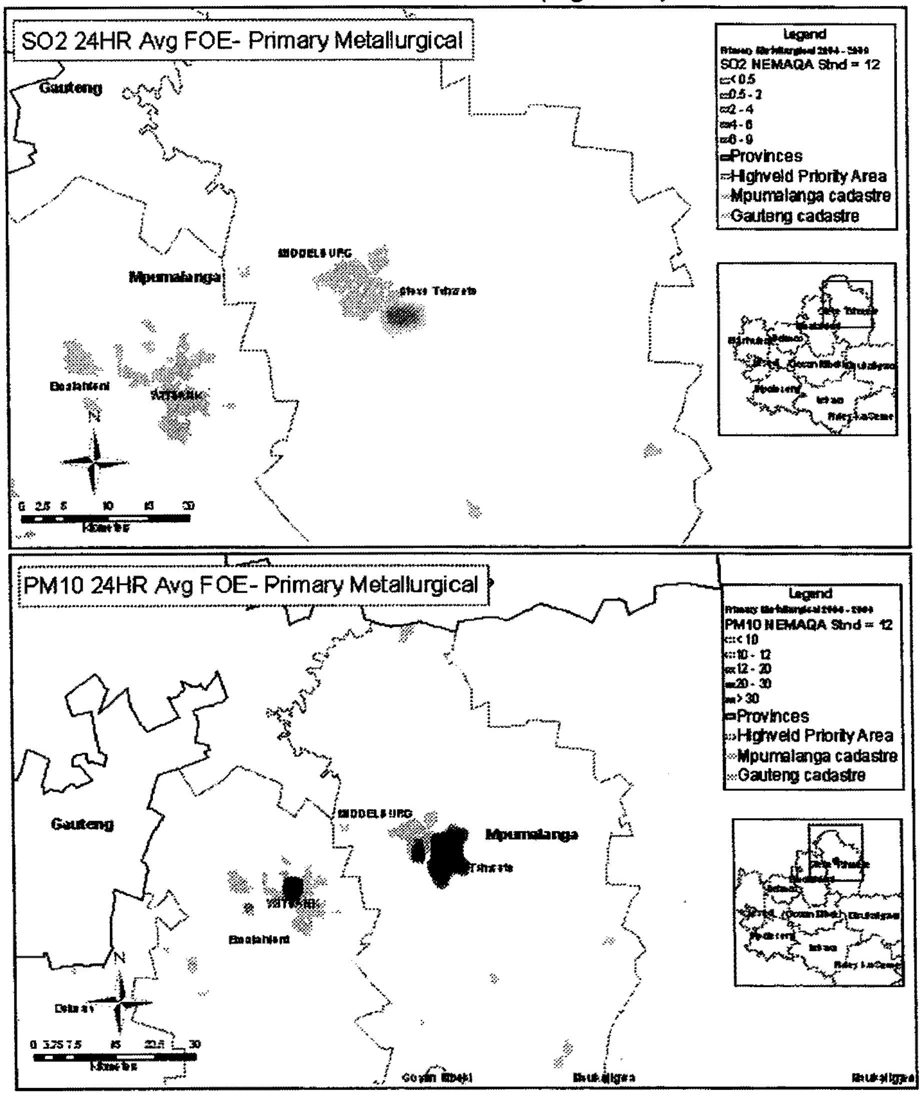


Figure 23: Modelled exceedances of ambient 24-hour SO_2 (top) and PM_{10} (bottom) concentrations resulting from emissions from primary metallurgical production

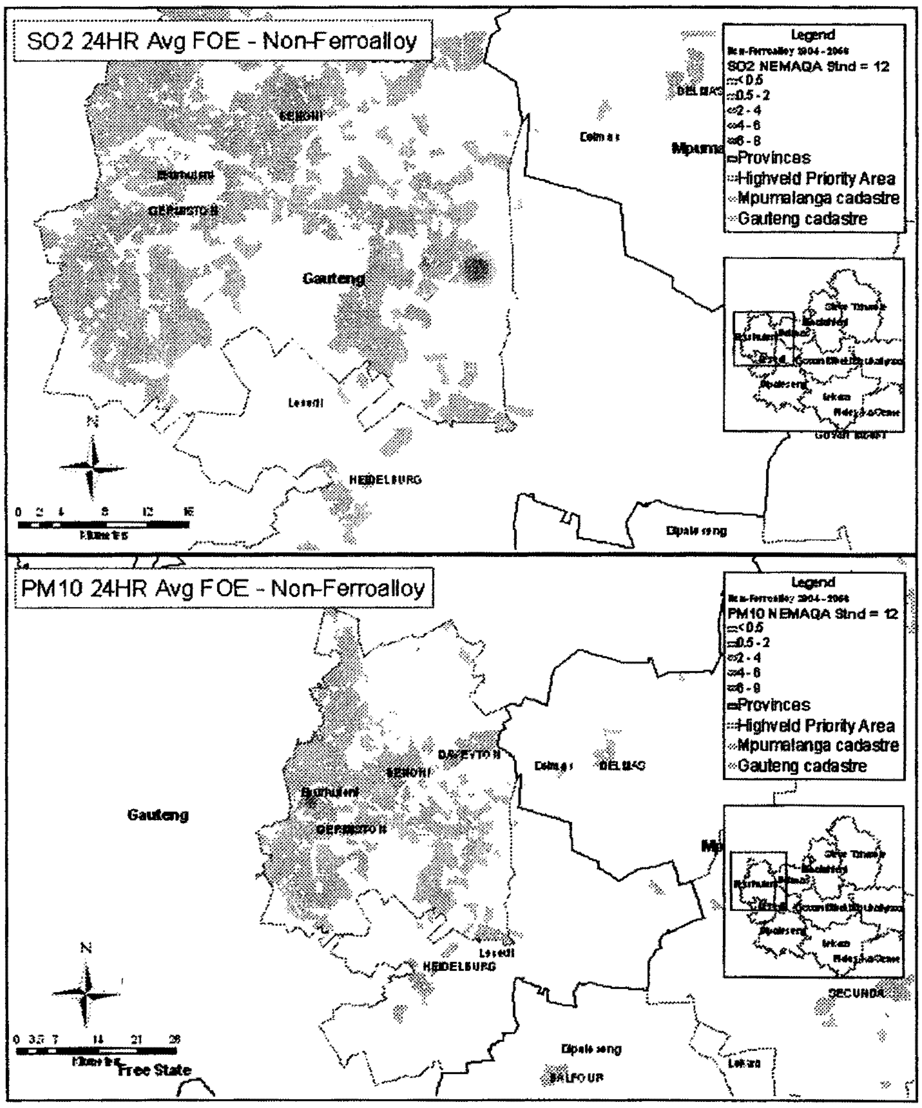


Figure 24: Modelled exceedances of ambient 24-hour SO_2 (top) and PM_{10} (bottom) concentrations resulting from emissions from non-ferroalloy production

Clay brick manufacturing

Brickworks using clamp kiln technology emit SO_2 and particulates near ground level, and compared with industrial emissions, the plume is relatively cool. The pollutants are therefore; released into the stable surface layer where dispersion is inhibited, particularly at night and in the winter. As a result of poor dispersion, the ambient concentrations are high at the source and the effect is generally limited to the surrounding area (Figure 25). In addition to the localised effect, PM_{10} and SO_2 emissions from brick works add to the baseline concentrations, particularly in Ekurhuleni.

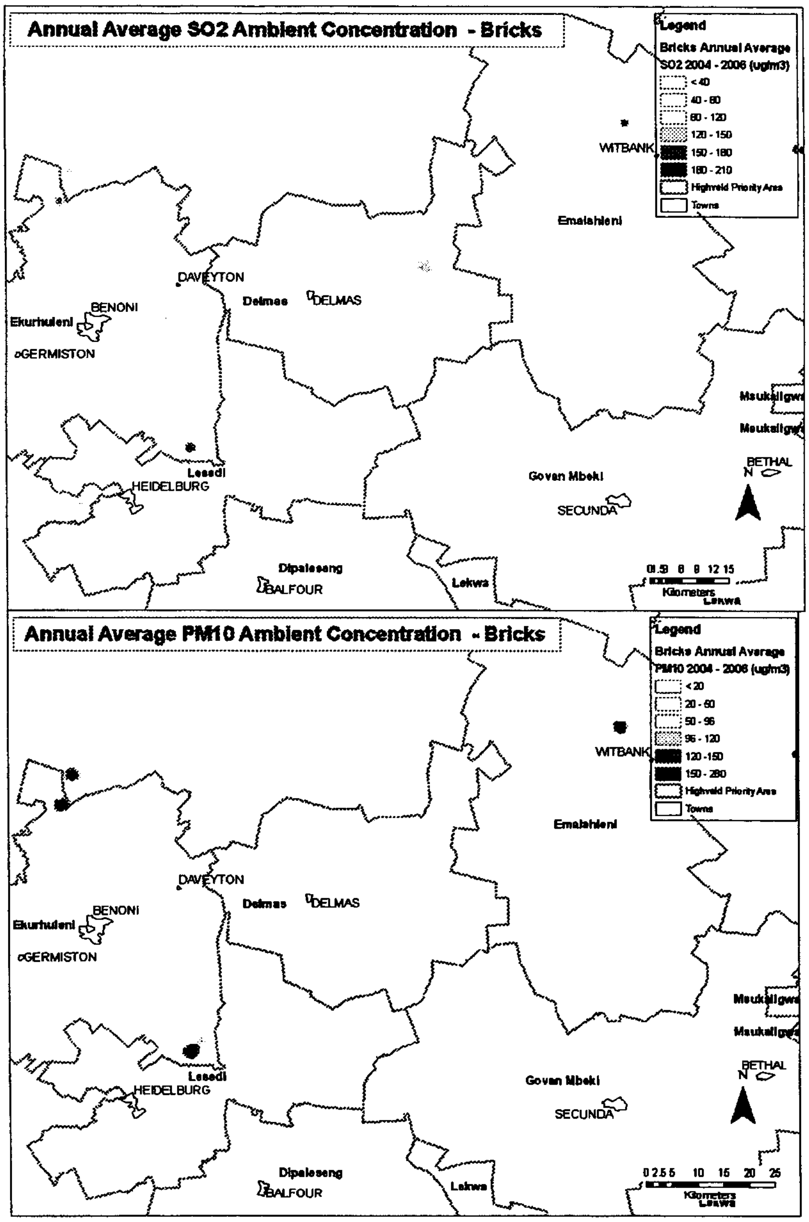


Figure 25: Modelled annual average SO_2 (top) and PM_{10} (bottom) concentrations resulting from emissions from brickworks on the HPA

Ekurhuleni industries

A significant number of industries in Ekurhuleni MM generally emit from low stacks and the individual emissions are relatively small by volume. Coupled with these factors, the stable near-ground conditions limit the dispersion of the pollutants and the effects are generally localised. However, the vast number of small sources has an additive effect on ambient concentrations in the Ekurhuleni MM (Figure 26).

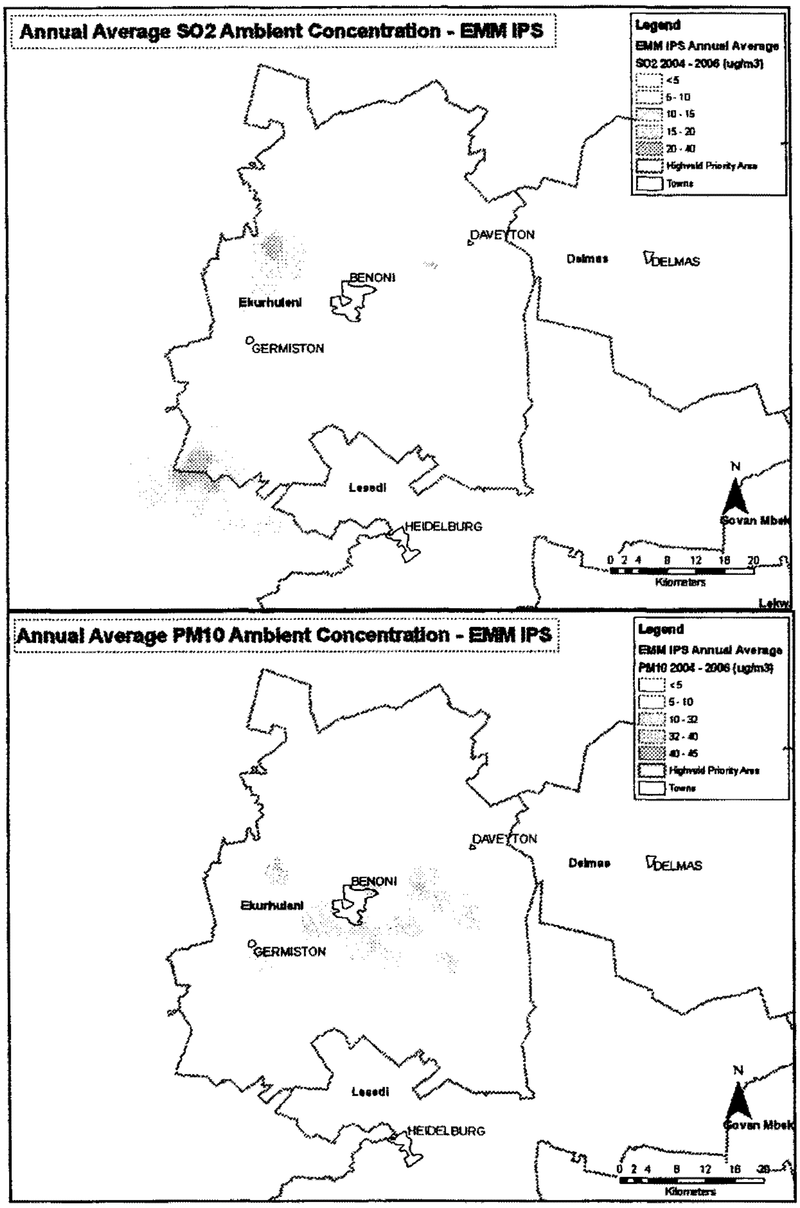


Figure 26: Modelled annual average SO_2 (top) and PM_{10} (bottom) concentrations resulting from industrial sources in the Ekurhuleni MM, excluding brickworks

Transport

Emissions from motor vehicles are also released very close to ground level and within the surface layer. With the inherently poor dispersion in this layer, the resultant effects on ambient air quality are generally limited to the immediate vicinity of the roadway (Figure 27). In Ekurhuleni, the density of the road network and the volume of motor vehicle traffic (Figure 15) results in a "spill over" and a cumulative effect beyond individual roadways. Predicted ambient concentrations are relatively low, but the emissions from motor vehicles add to the existing baseline concentrations, particularly in Ekurhuleni MM. The predicted effect of emissions at ORTIA is relatively small (Figure 28), but these also add to the ambient loading in Ekurhuleni MM.

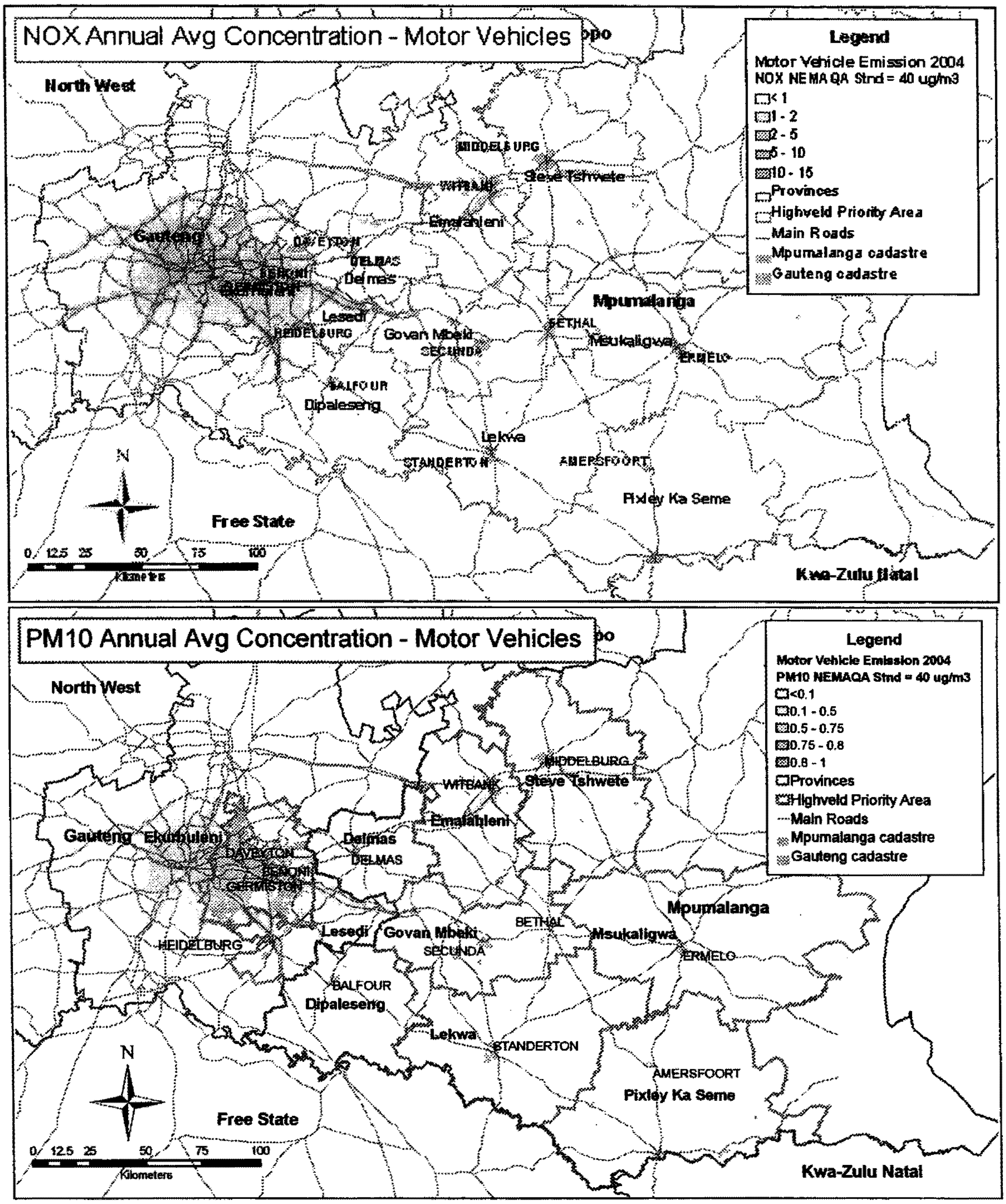


Figure 27: Modelled annual average NO_x (top) and PM_{10} (bottom) concentrations resulting from emissions from motor vehicles on the HPA

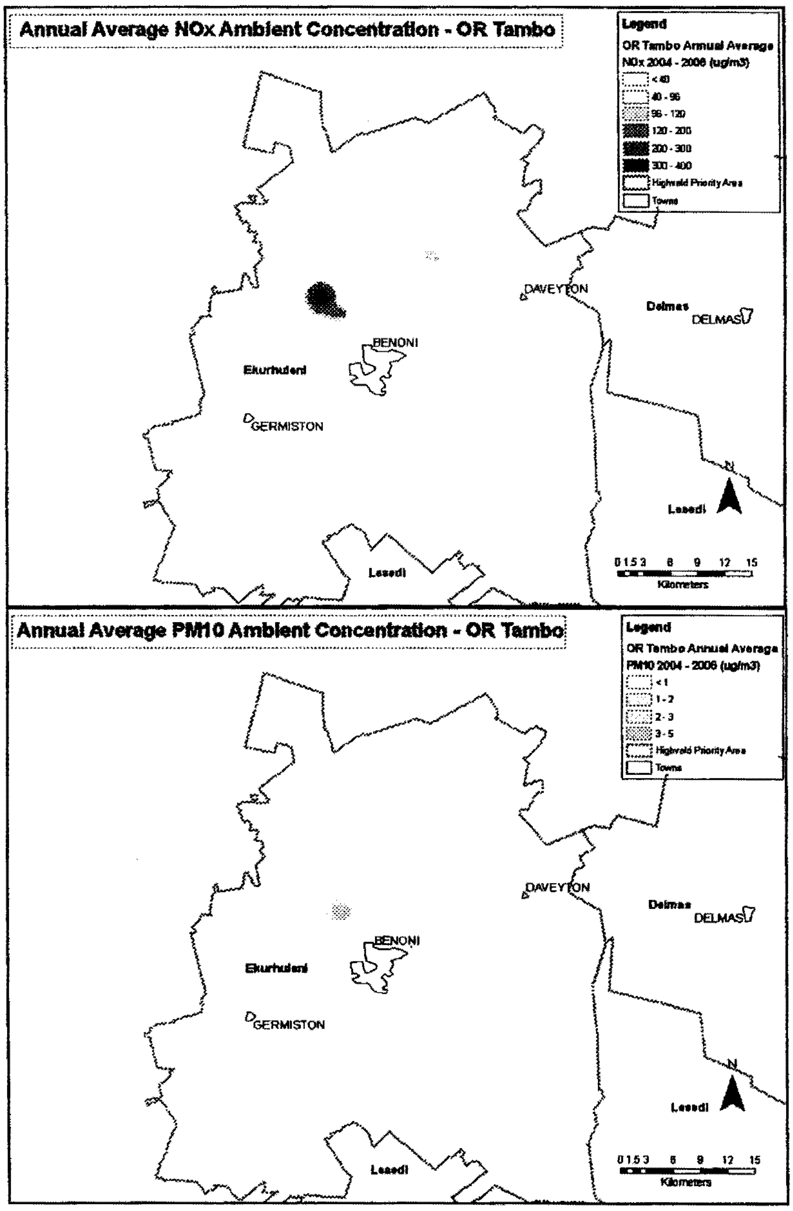


Figure 28: Modelled annual average NO_x (top) and PM_{10} (bottom) concentrations resulting from emissions from ORTIA

Opencast coal mining

The predicted effect of particulate emissions from opencast coal mining activities on ambient air quality is relatively limited, with the highest concentrations occurring immediately adjacent to the haul roads (Figure 29). In addition to the localised effect, particulate emissions from opencast mines add to the baseline particulate concentrations, particularly in Emalahleni LM and Steve Tshwete LM where opencast coal mining is concentrated.

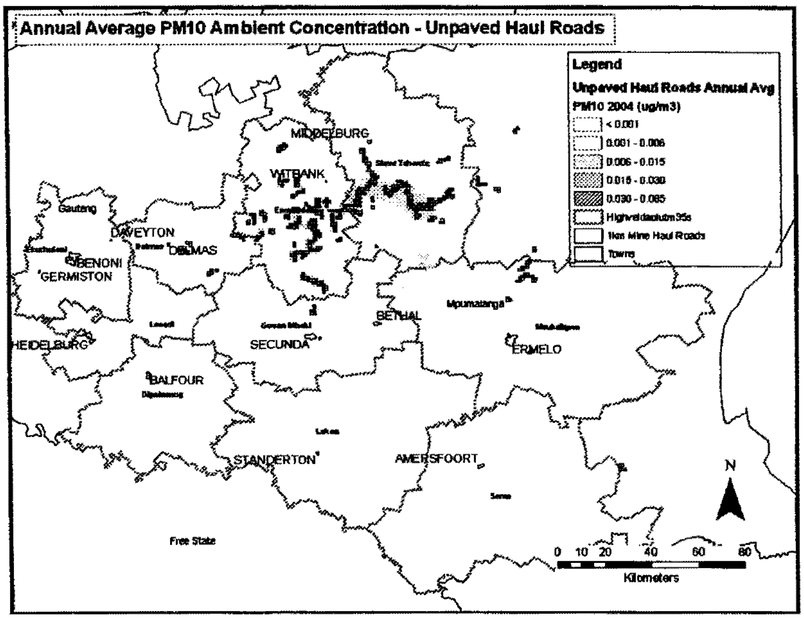


Figure 29: Modelled annual average PM_{10} concentrations resulting from opencast coalmines on the HPA

Residential fuel burning

The burning of coal and wood for heating and cooking in residential areas on the HPA, mostly in the early morning and evenings, results in the release of particulates and other pollutants into the stable surface layer. High concentrations occur in these areas, particularly where housing is dense. Due to poor dispersion, the spatial effect of these emissions on air quality is generally quite limited. However, the number of residential areas in the HPA where wood and coal are used is significant and the additive effect of these predicted emissions on air quality concentrations is significant, particularly in Lesedi, Ekurhuleni and Delmas (Figure 31). The effect is also significant in urbanised areas of Middelburg, Emalahleni, Secunda, Ermelo, Standerton, Balfour, and in the smaller towns.

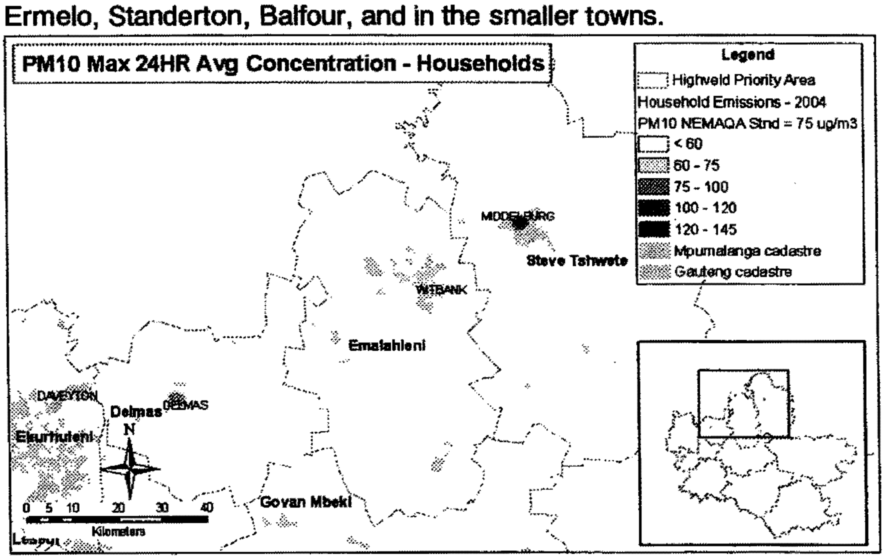


Figure 30: Modelled 24-hour average PM_{10} concentrations resulting from emissions from residential coal and wood combustion

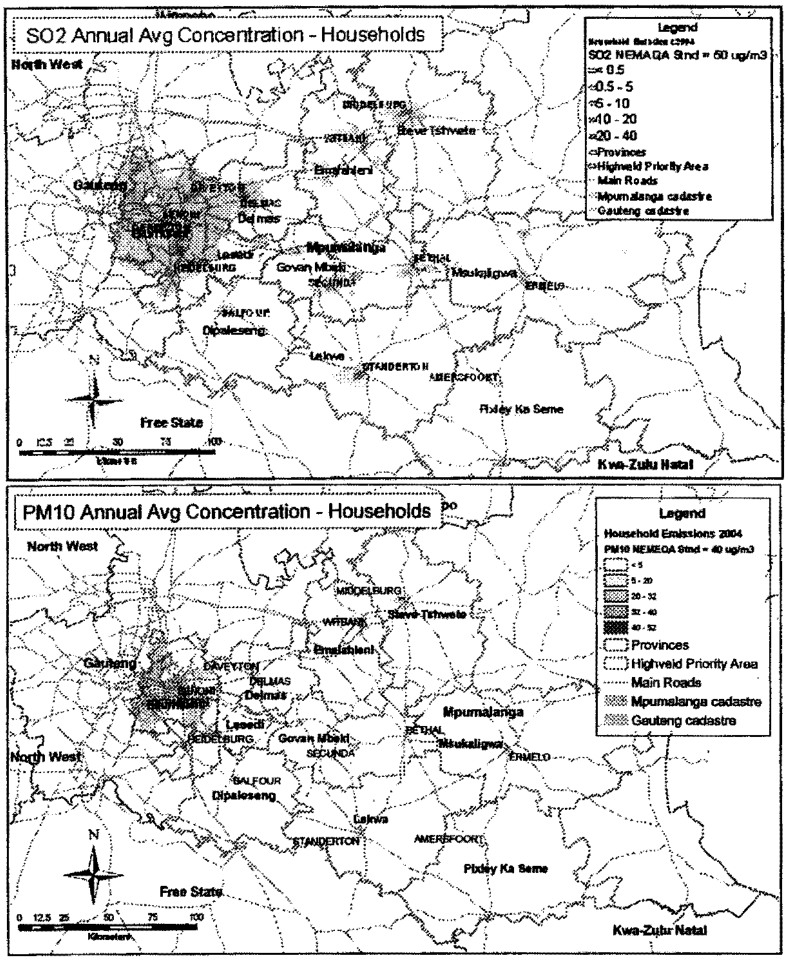


Figure 31: Modelled annual average SO_2 (top) and PM_{10} (bottom) concentrations resulting from emissions from residential coal and wood combustion

Biomass burning

Anthropogenically induced and naturally occurring biomass fires occur throughout the HPA at all times of the year, but the fire activity peaks in the dry winter months. The fires vary in size, location and duration, but result in the emission of CO, CH_4, NO_2, and particulates (TSP, PM_{10} and $PM_{2.5}$). Numerous minor gases, including CO, hydrocarbons, NO, NH_3 and SO_2 are produced as combustion products. The total annual emission of particulates is significant and exceeds 14 kton (Table 13). The relative impact of an individual fire on ambient air quality will depend on the size of the fire and duration of the burn. No model simulations were conducted in the HPA baseline assessment, but Carter (2009) showed that most impacts for a single fire occurred in close proximity to the fire. However, the vast number of fires that occur across the HPA on any given day will add to the regional air pollutant loading, particularly in winter.

Mpumalanga industries

The contribution of sources within Mpumalanga that are not captured in other categories was also modelled to determine ambient concentrations of SO_2, PM_{10} and NO_2. Model results show exceedances within the tolerance level of the 24-hr standard for SO_2 and PM_{10}. These are exclusively in the area to the west of Witbank. PM_{10} is elevated to a greater extent than SO_2. NO_2 model results show sources in Witbank, Secunda and Ermelo and surrounds, however, levels are low and do not approach the standard.

Sources outside the HPA

Emissions from tall stacks outside the HPA were considered only as these have the potential to transport pollutants over relatively large distances, i.e. > 50 km. Conversely, emissions released nearer ground level influence air quality on a relatively local scale. Sources outside the HPA, but within an approximate 50 km buffer of the HPA have been modelled to reflect transboundary impacts and their influence on ambient concentrations in the HPA. Predicted annual average SO_2 concentrations show import into Lesedi and Dipaleseng municipalities due to emissions from operations in the Vaal Triangle. These impacts are less pronounced for PM_{10}. NO_2 concentrations in Ekurhuleni are elevated as a result of atmospheric transport from the Vaal Triangle, highlighting the impacts of activities in the Vaal Triangle on a regional scale.

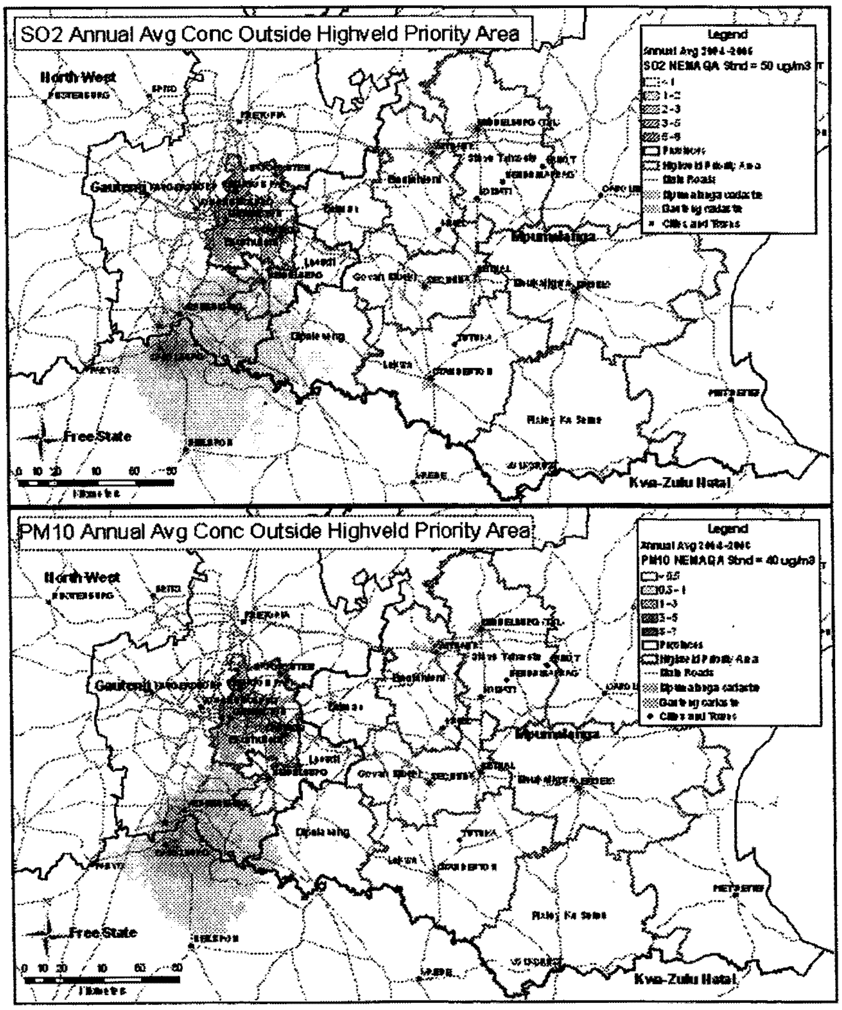


Figure 32: Modelled annual average SO_2 (top) and PM_{10} (bottom) concentrations resulting from emissions outside the HPA

3.3.6.1 Emalahleni Hot Spot

This hot spot is characterised by a significant number of modelled exceedances of the 1-hour SO_2 and NO_2 standards and of the 24-hour PM_{10} and SO_2 standards (Figure 20), with confirmation of the modelled exceedances provided by ambient monitoring at Phola and Witbank (Figure 33, Figure 34). These monitoring sites are influenced by residential fuel burning, as well as industries and power generation sources. The hot spot status is confirmed by frequent exceedances of the 8-hour ambient standard for ozone (Table 19).

The area of predicted PM_{10} non-compliance is extensive and stretches across the northern half of the Emalahleni LM and into the neighbouring Steve Tshwete LM. Areas of predicted SO_2 non-compliance occur in the eastern Witbank area and further westward adjacent to the N4. The greatest number of predicted exceedances of the 24-hour PM_{10} standard occurs further westward adjacent to the N4, extending towards the town of Emalahleni. Modelled ambient concentrations of NO_x and monitored NO_2 concentrations comply with the ambient standards, although measured exceedances of the 1-hour NO_2 standard occur. NO_x is an ozone precursor, and the ozone non-compliance at Kendal and Witbank is indicative of a regional scale phenomenon.

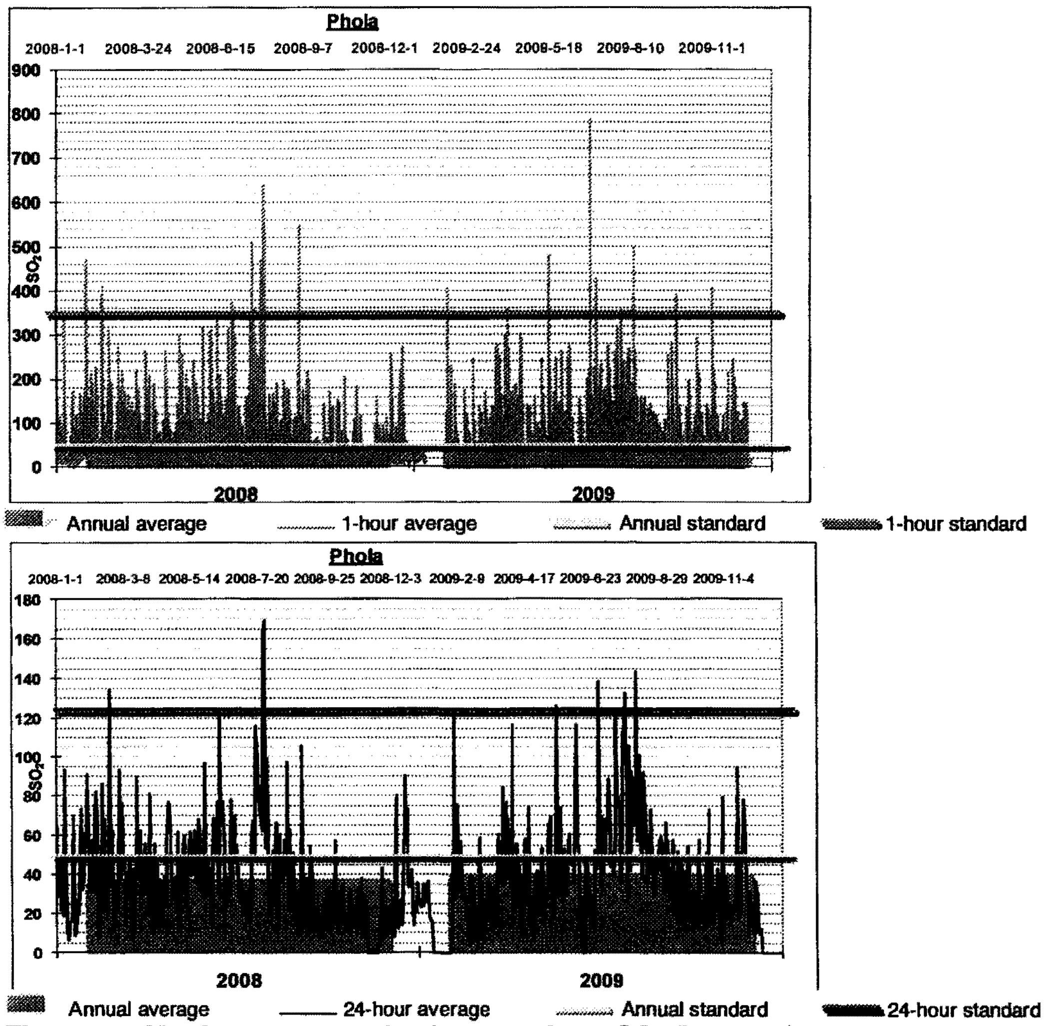


Figure 33: Monitored 1-hour (top) and 24-hour SO_2 (bottom) concentrations at Phola

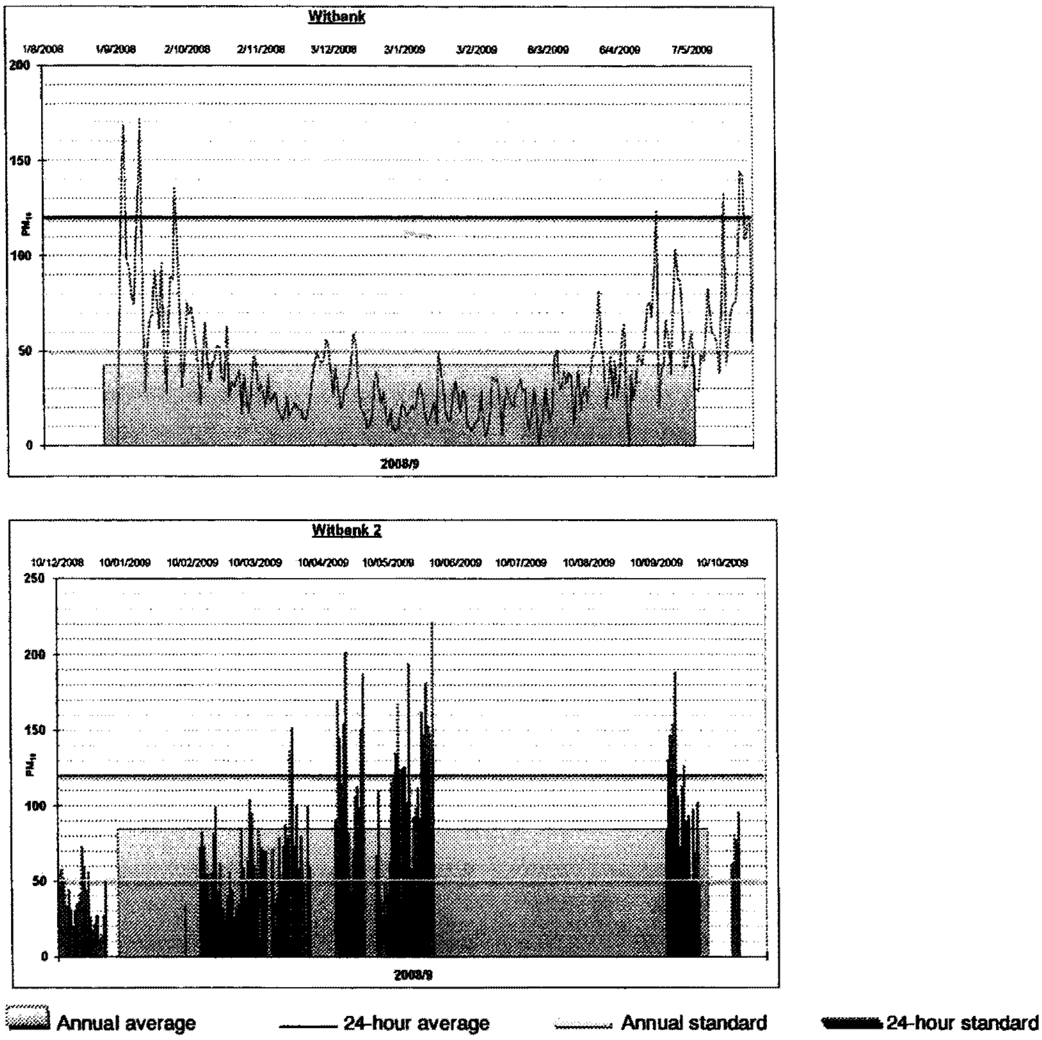


Figure 34: Monitored 24-hour PM_{10} concentrations at Witbank (top) and Witbank 2 (bottom)

Concentrations of SO_2 and PM_{10} at the DEA monitoring station in the KwaGuqa Township were plotted against wind direction to determine the relationship between significant source sectors in the surrounding areas (Figure 35 and Figure 36). The results show major contributions from the northwesterly direction, with secondary sources in the southeasterly and southwesterly directions. This is consistent with the large industrial area, Ferrobank, in the northwest, and various mining operations to the south. No clear relationship can be established between source sectors and pollutant concentrations for the Witbank site. It is apparent across seasons that PM_{10} sources exist in all vectors and no clear contributors can be isolated. This is indicative of the generally high particulate loading on the HPA.

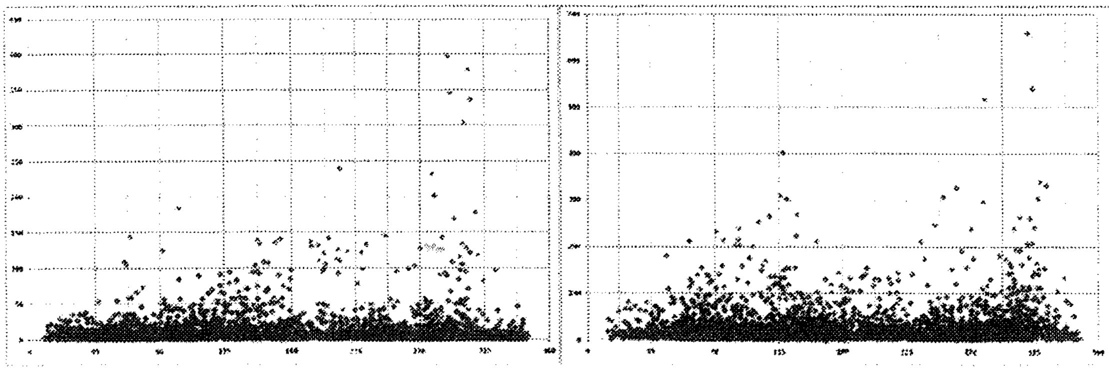


Figure 35: SO_2 Witbank January 2009, May 2009.
NB. Wind direction on x-axis, concentration on y-axis.

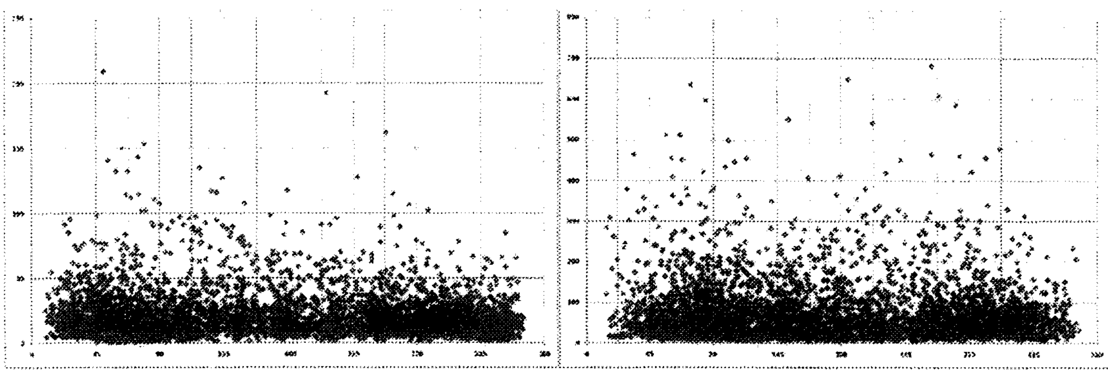


Figure 36: PM_{10} Witbank January 2009, May 2009
NB. Wind direction on x-axis, concentration on y-axis.

The state of air quality in the Emalahleni Hot Spot results from a combination of emissions from power generation, metallurgical manufacturing processes and residential fuel burning (Figure 37). The input of industries in the area dominates the source contribution, showing clearly that residential fuel burning, motor vehicles and coal mining are less significant in considering the total air quality loading for all pollutants.

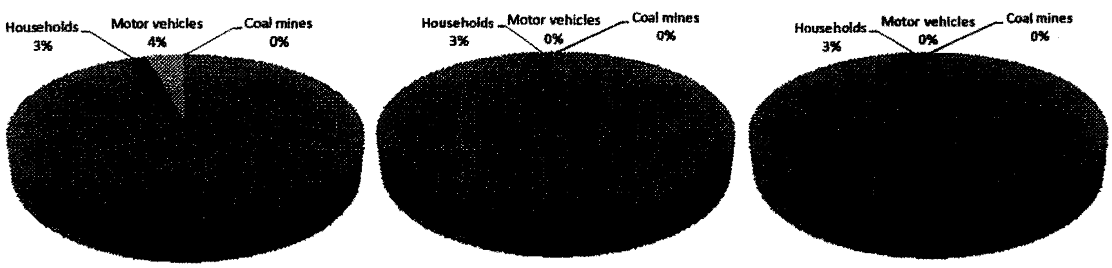


Figure 37: Contribution of different sources to ambient concentrations of NO_x (left), SO_2 (middle) and PM_{10} (right) in the Emalahleni Hot Spot

3.3.6.2 Kriel Hot Spot

The Kriel Hot Spot stretches across the southern part of the Emalahleni LM and into the Govan Mbeki LM, centred on the town of Kriel. It is characterised by modelled exceedances of the 1-hour SO_2 and NO_2 standards and the 24-hour SO_2 standard (Figure 20).

The modelled state of air quality in the Kriel Hot Spot results from a combination of emissions from power generation, residential fuel burning and motor vehicles (Figure 38). The contribution of industries in the area dominates the source contribution, showing clearly that residential fuel burning, motor vehicles and coal mining are less significant in considering the total air quality loading for all pollutants. Beyond their immediate area of influence, households make a nominal contribution to particulate matter concentrations and less, so, to ambient SO_2 levels and vehicles contribute a small percentage to NO_x concentrations.

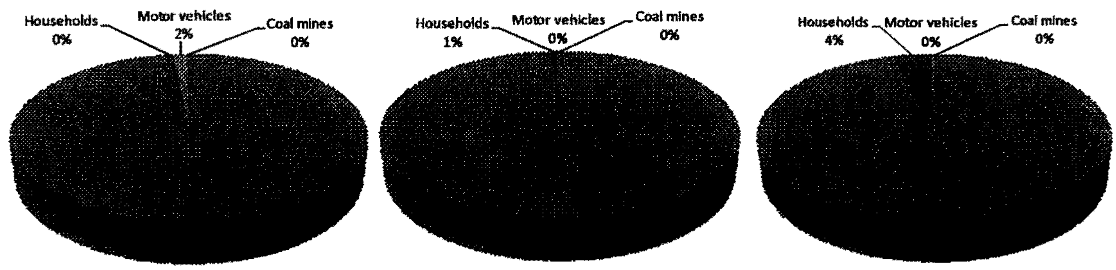


Figure 38: Contribution of different sources to ambient concentrations of NO_x (left), SO_2 (middle) and PM_{10} (right) in the Kriel Hot Spot

3.3.6.3 Steve Tshwete Hot Spot

This hot spot in the Steve Tshwete LM extends across the municipality from its border with Emalahleni to Arnot in the east. It has three main nodes of non-compliance with ambient standards. In the Middelburg node, both modelled 24-hour SO_2 and PM_{10} standards are frequently exceeded (Figure 20). Ambient monitoring at Middelburg, a site influenced by industrial sources, confirms the PM_{10} exceedances (Figure 39). The Komati-Hendrina node is located further south where the ambient SO_2 standard is exceeded by modelled concentrations. Ambient monitoring at Komati also indicates exceedances of the 24-hour ambient PM_{10} standard. The Komati site is influenced by various sectors, including power generation, mining, transport and residential fuel burning. Exceedances of the SO_2 standard predicted at the Arnot node in the extreme east of the municipality are fewer. Modelled ambient concentrations of NO_x and monitored NO_2 concentrations comply with the ambient standards, although monitored exceedances of the 1-hour NO_2 standard occur at Middelburg. These are attributed mostly to industrial emissions. The high ozone concentrations recorded at Hendrina and Middelburg (Figure 40) are indicative of the regional scale ozone phenomenon, forming as a result of NO_x and VOC being present.

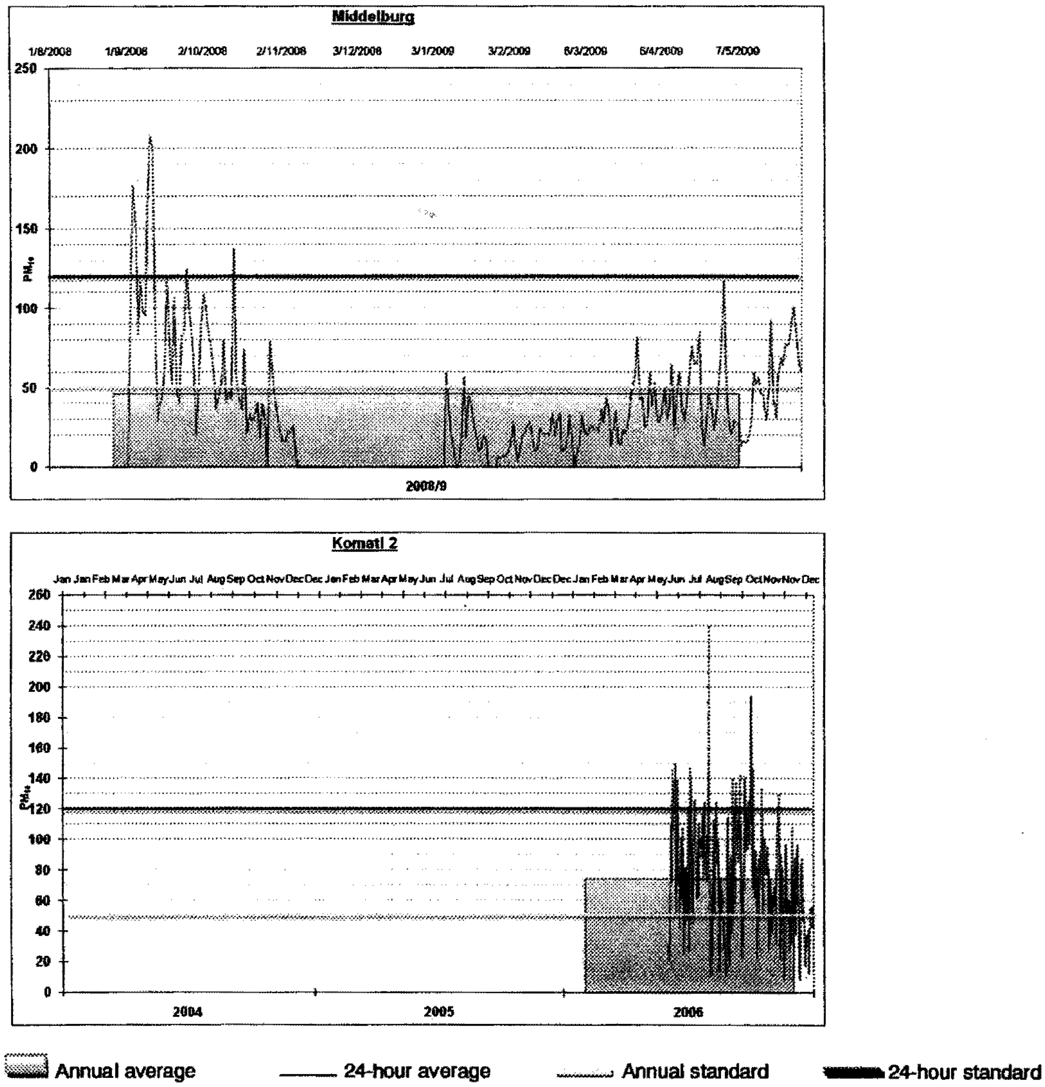
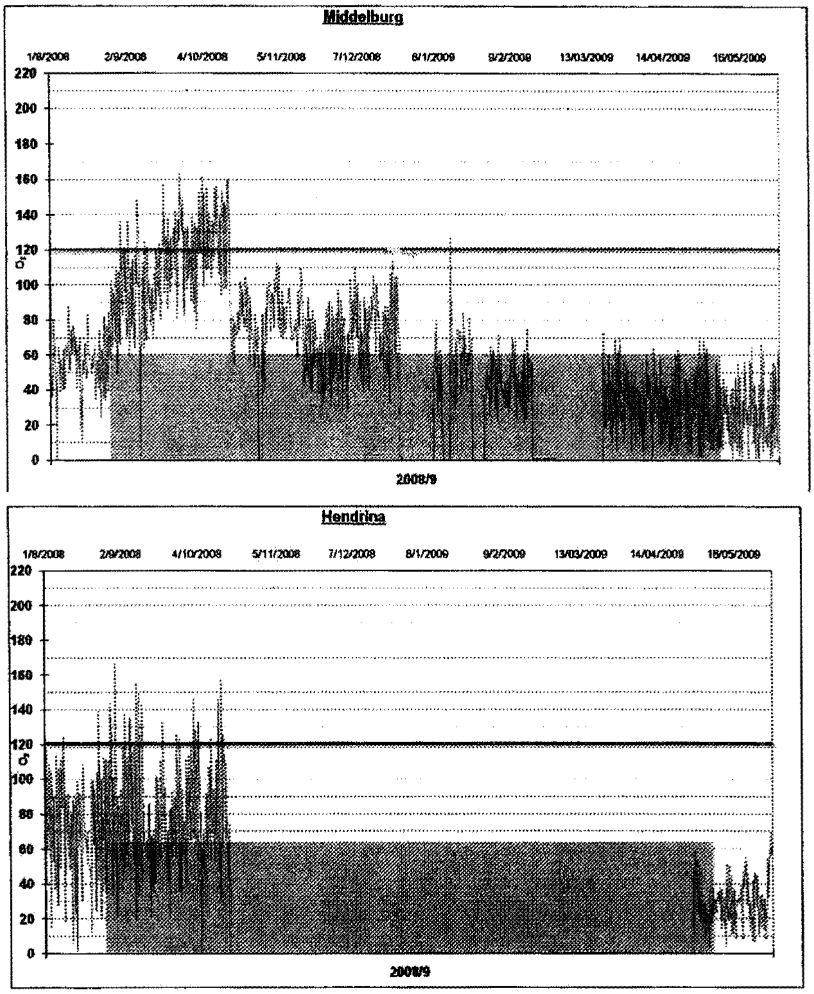


Figure 39: Monitored 24-hour PM_{10} concentrations at Middelburg (top) and Komati (bottom)



Annual average ——— 8-hour average 8-hour standard

Figure 40: Monitored 8-hour ozone concentrations at Middelburg (top) and Hendrina (bottom)

This hot spot is mostly attributed to emissions from the metallurgical industries and residential fuel burning (Figure 41). The contribution of industries in the area dominates the source contributions for all pollutants considered. In terms of PM_{10}, residential fuel burning does contribute a sizeable percentage to ambient concentrations.

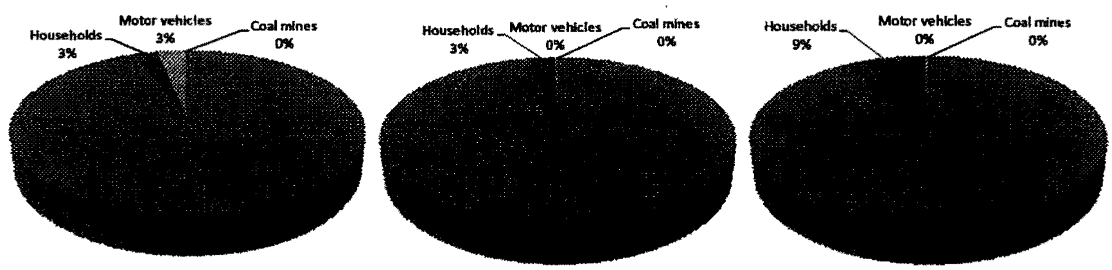
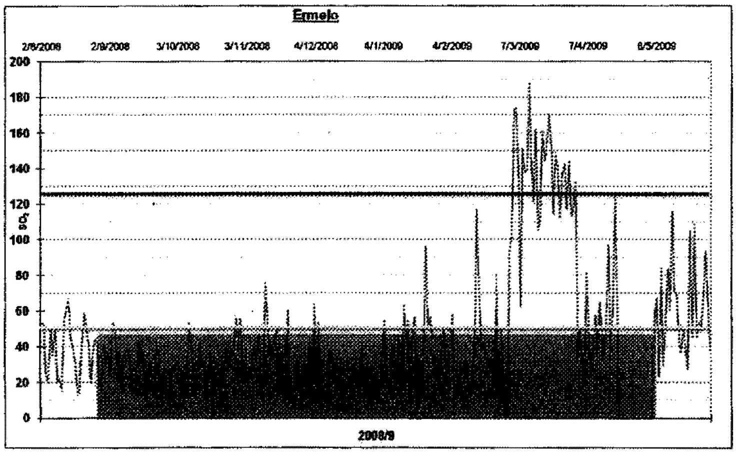


Figure 41: Contribution of different sources to ambient concentrations of NO_x (left), SO_2 (middle) and PM_{10} (right) in the Steve Tshwete Hot Spot

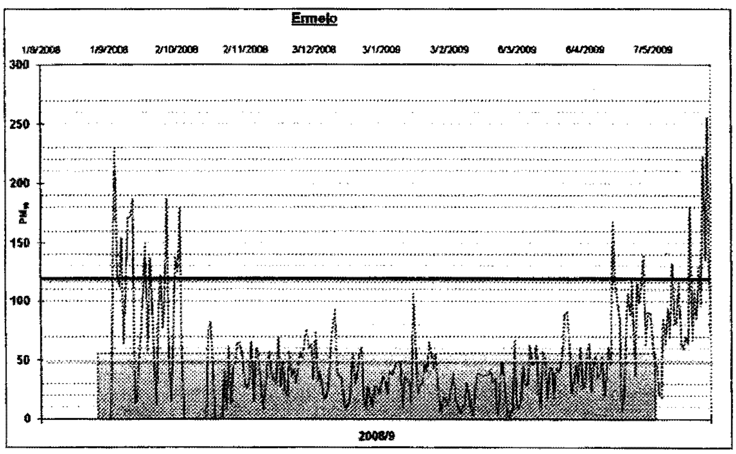
3.3.6.4 Ermelo Hot Spot

The Ermelo Hot Spot in the Msukaligwa LM is relatively small and is characterised by modelled exceedances of the 1-hour and 24-hour ambient SO_2 air quality standard (Figure 20). Exceedances of the SO_2 standard at the Ermelo monitoring station, which is largely influenced by residential fuel burning sources, support the model results (Figure 42). The monitored data are questionable for a period in March and should be viewed with caution for this period. 24-hour PM_{10} exceedances also occur at the monitoring station (Figure 43). Modelled ambient NO_x and monitored NO_2 concentrations are relatively low, but exceedances of the 8-hour O_3 standard are recorded at Camden and Ermelo (Figure 44). These stations are well removed from the main precursor source region providing the necessary time for ozone chemistry to be effective, resulting in higher ozone concentrations downwind of the source region.



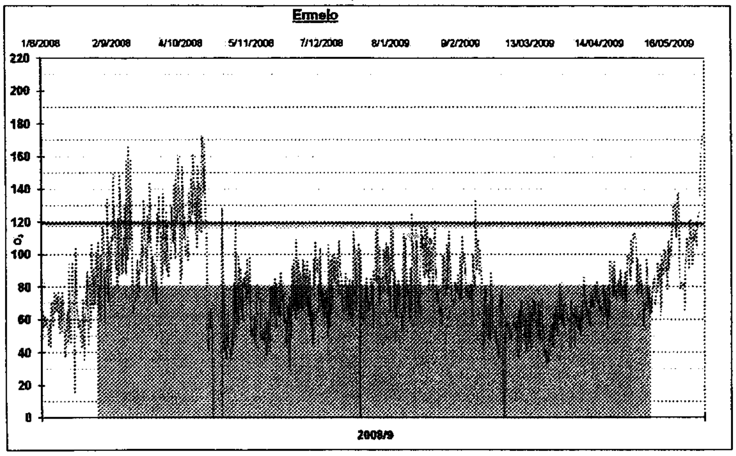
Annual average — 24-hour average — Annual standard — 24-hour standard

Figure 42: Monitored 24-hour SO_2 concentrations at Ermelo



Annual average — 24-hour average — Annual standard — 24-hour standard

Figure 43: Monitored 24-hour PM_{10} concentrations at Ermelo



Annual average ——— 8-hour average 8-hour standard

Figure 44: Monitored 8-hour ozone concentrations at Ermelo

Monitoring in Wesselton in Ermelo shows a contributing SO_2 source from the northeast and a more significant source in the northwest (Figure 45). A southeasterly component is also present. The peak in the northwest is consistent with transported pollutants, particularly from the Secunda area, while the northeast has a collection of smaller industrial and agricultural sources. Contributions from the town are more notable in the winter periods, as observed in the southeasterly direction.

Monitoring in Wesselton shows clear contributions to PM_{10} concentrations from the northeast and westerly directions (Figure 46), which is consistent with SO_2 observations. Respective sources are small-scale industry and agriculture in the northeast, with westerly contributions from the Sasol complex and industries based in Secunda.

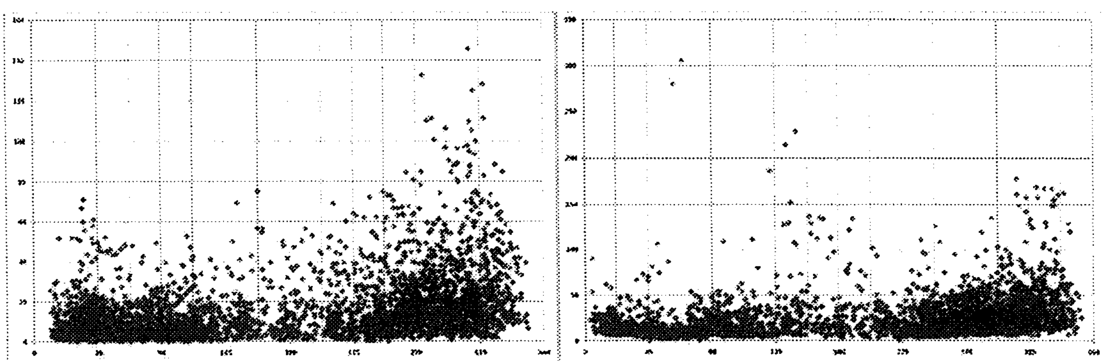


Figure 45: SO_2 Ermelo January 09, May 09.
NB. Wind direction on x-axis, concentration on y-axis.

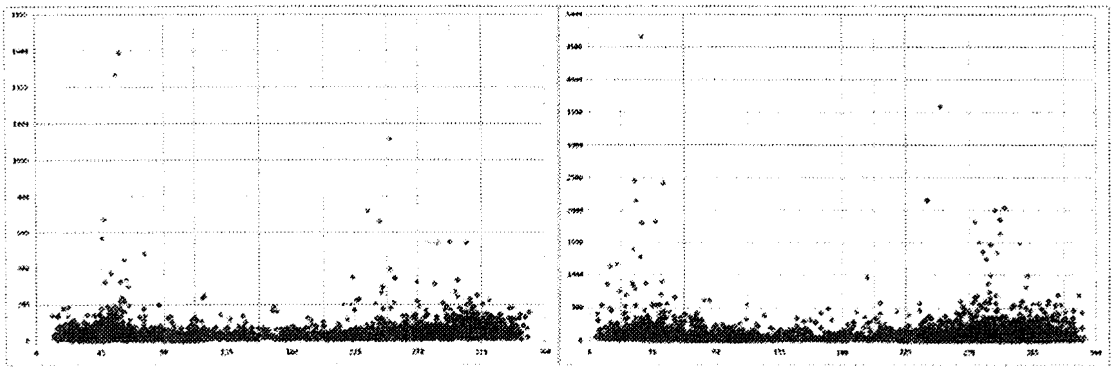


Figure 46: PM_{10} Ermelo January 09, May 09
NB. Wind direction on x-axis, concentration on y-axis.

The contribution of industries in the area dominates the source apportionment, showing clearly that residential fuel burning, motor vehicles and coal mining are far less significant in considering the total air quality loading for all pollutants (Figure 47).

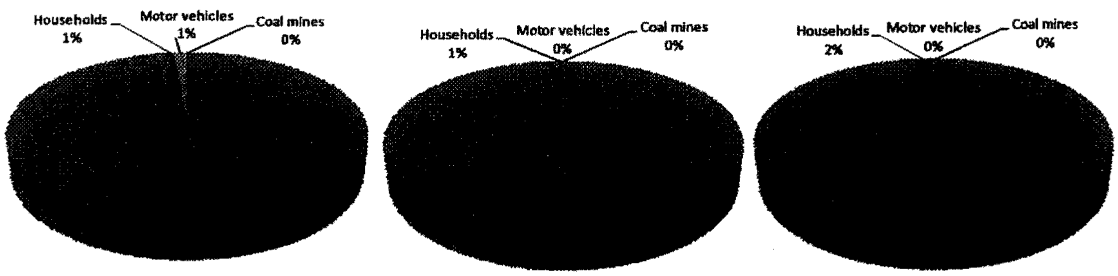
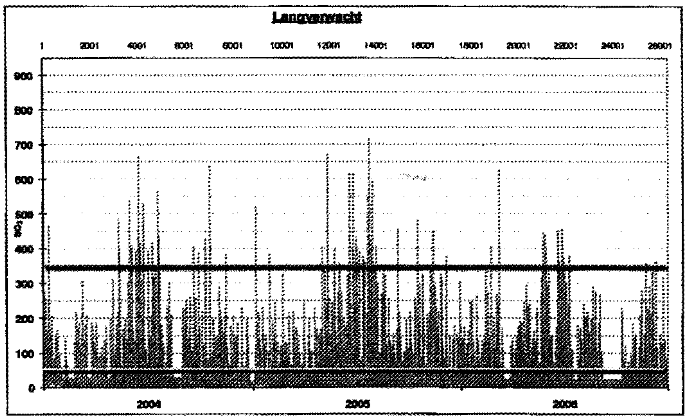


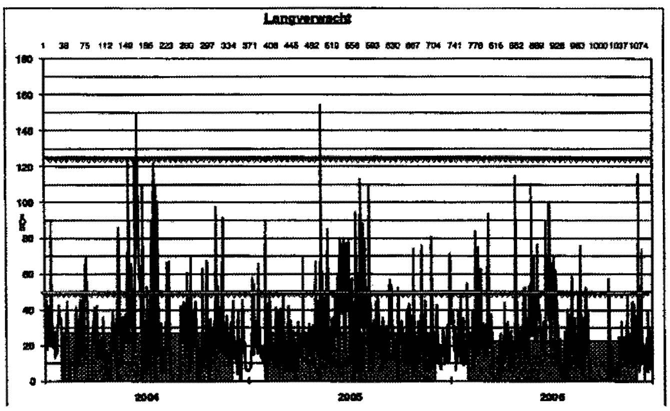
Figure 47: Contribution of different sources to ambient concentrations of NO_x (left), SO_2 (middle) and PM_{10} (right) in the Ermelo Hot Spot

3.3.6.5 Secunda Hot Spot

The Secunda Hot Spot in the Govan Mbeki LM is characterised by a number of modelled exceedances of the 1-hour and 24-hour ambient standard for SO_2 (Figure 21). Exceedances of the SO_2 standards are also recorded at the four monitoring stations in the Secunda, most notably Langverwacht and Bosjesspruit, but the frequency of exceedance is within the tolerance level (Figure 48, Figure 49). The frequency of exceedance of the 24-hour PM_{10} standard at the eMbalenhle site exceeds the tolerance (Figure 50). These stations are largely influenced by industrial and residential fuel burning sources. The Elandsfontein monitoring station in the municipality is ideally located on the HPA to provide representative regional ambient data and includes contributions from power generation, industrial and mining sectors. The frequent exceedance of the 8-hour O_3 standard at this monitoring station is further evidence of a regional scale ozone problem, resulting from NO_x and VOC chemistry.

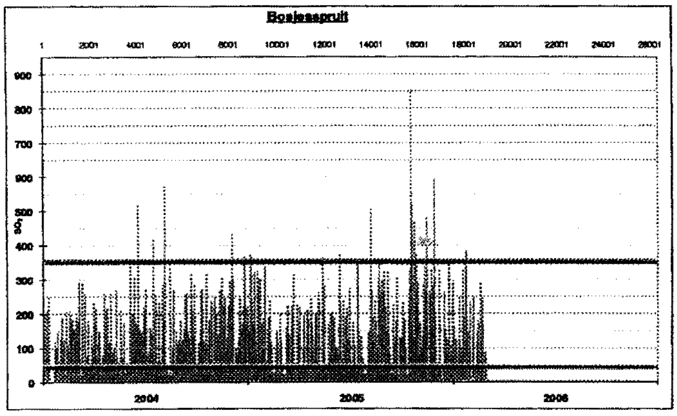


Annual average 1-hour average Annual standard 1-hour standard

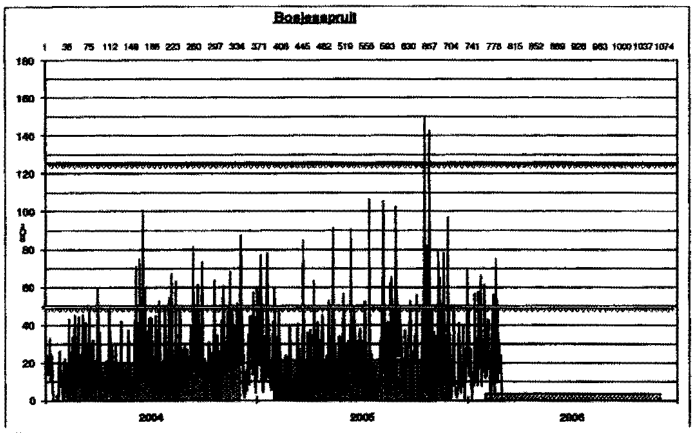


Annual average 24-hour average Annual standard 24-hour standard

Figure 48: Monitored ambient 1-hour (top) and 24-hour (bottom) SO_2 concentrations at Langverwacht

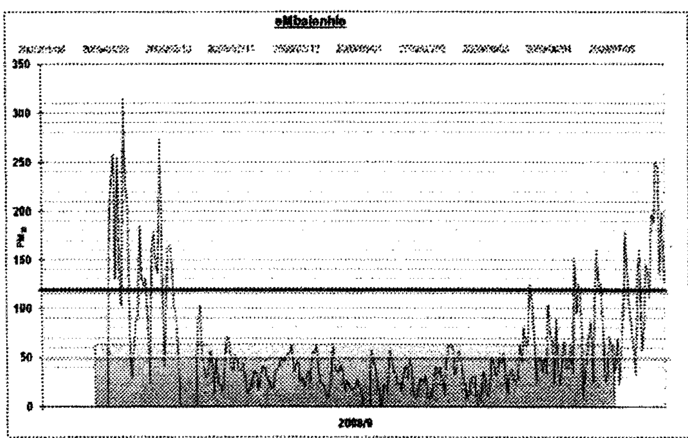


Annual average ——— 1-hour average ——— Annual standard ——— 1-hour standard



Annual average ——— 24-hour average ——— Annual standard ——— 24-hour standard

Figure 49: Monitored ambient 1-hour (top) and 24-hour (bottom) SO_2 concentrations at Bosjesspruit



Annual average ——— 24-hour average ——— Annual standard ——— 24-hour standard

Figure 50: Monitored ambient 24-hour PM_{10} concentrations at Secunda

Monitoring shows contributing sources to PM_{10} concentrations exist all around the site, however elevated levels are associated with westerly winds (Figure 51). The low-income areas surrounding the site contribute to PM_{10} levels, as well as the Sasol industrial complex to the east.

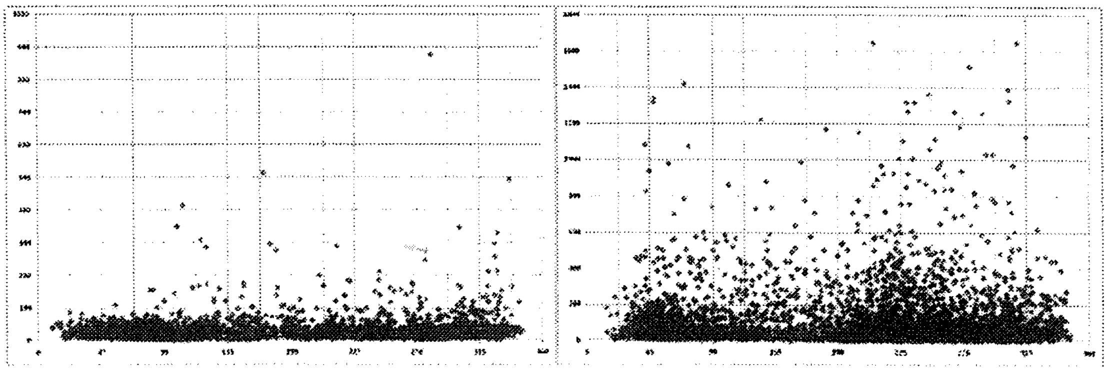


Figure 51: PM_{10} eMbalenhle January 09, May 09
NB. Wind direction on x-axis, concentration on y-axis.

This hot spot is mostly attributed to emissions from petrochemical processes and residential fuel burning (Figure 52). The contribution of industries in the area dominates the source apportionment, showing clearly that residential fuel burning, motor vehicles and coal mining are far less significant in considering the total air quality loading for all pollutants.

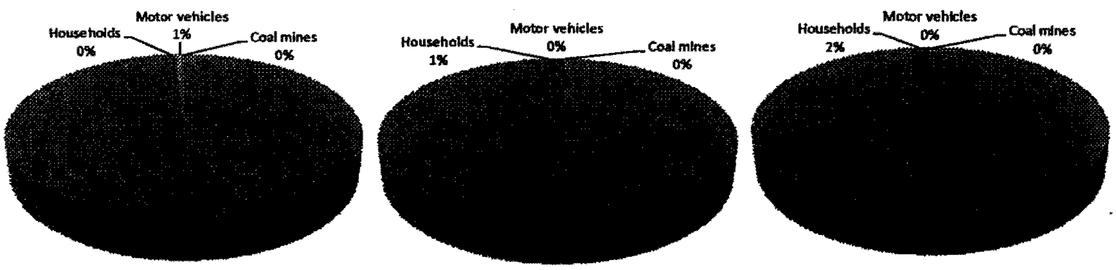


Figure 52: Contribution of different sources to ambient concentrations of NO_x (left), SO_2 (middle) and PM_{10} (right) in the Secunda Hot Spot

3.3.6.6 Ekurhuleni Hot Spot

Ekurhuleni MM has the highest population density on the HPA, and the greatest concentration of industries and motor vehicles. Air quality is generally poor throughout the municipality with frequent modelled exceedances of the 1-hour and 24-hour SO_2 concentrations and the 24-hour PM_{10} standards (Figure 20). The entire Ekurhuleni MM is regarded as an air quality hot spot, with a number of nodes of frequent modelled exceedance of the standards. There is unfortunately no reliable ambient monitoring data available in Ekurhuleni to support the model predictions.

The hot spot is characterised by predicted exceedances of both SO_2 and PM_{10} standards. The major source contribution in each of the nodes is from clay brick manufacturing. The contribution of industries in the area dominates the source apportionment, showing clearly that residential fuel burning, motor vehicles and coal mining carry less significance in considering the total air quality loading for all pollutants (Figure 53). Residential fuel burning makes a large contribution to ambient concentrations for all pollutants, due to the higher population density in the municipality. Motor vehicles contribute more significantly in this hot spot than all other hot spots to elevated NO_x concentrations.

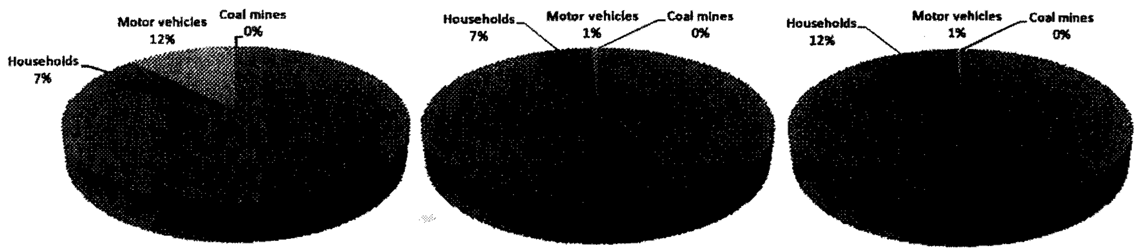


Figure 53: Contribution of different sources to ambient concentrations of NO_x (left), SO_2 (middle) and PM_{10} (right) in the different nodes in the Ekurhuleni Hot Spot

3.3.6.7 Lekwa Hot Spot

The Lekwa Hot Spot is characterised by two nodes with monitored and modeled exceedances of the 24-hour PM_{10} standard (Table 19, Figure 54). The Standerton node is attributed mostly to residential fuel burning, with some contribution from industrial sources. The modeled Tutuka node is relatively small and results mostly from power generation emissions.

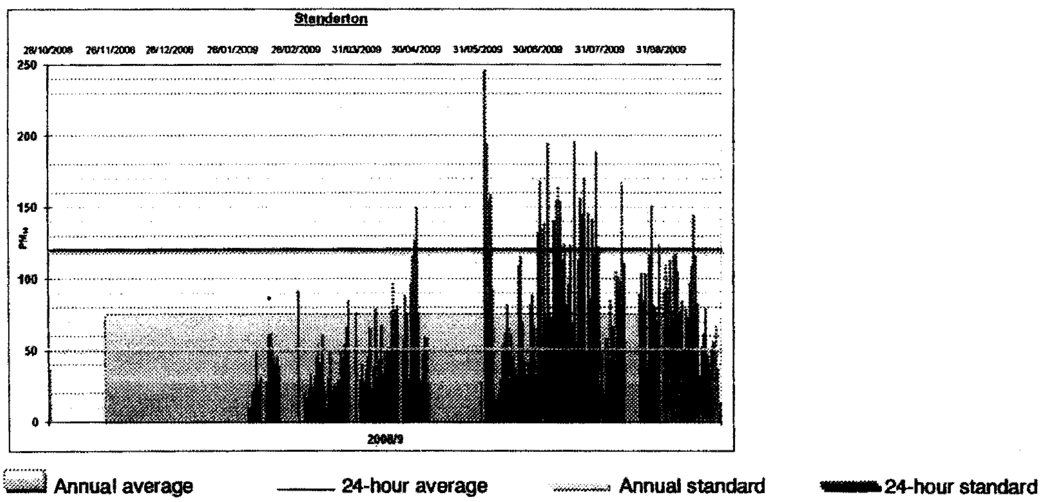
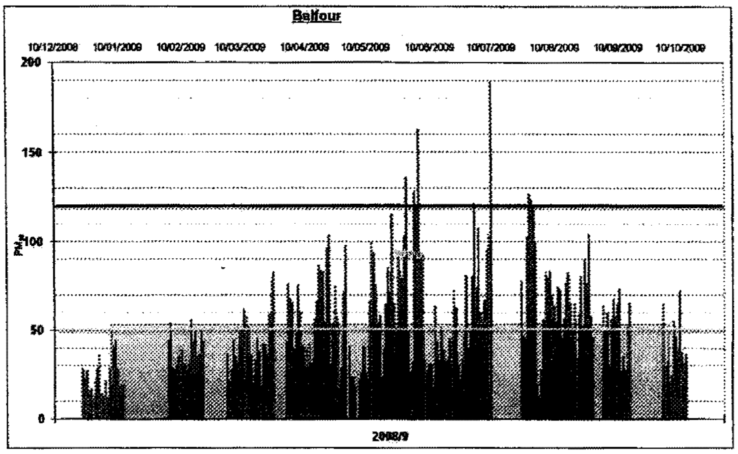


Figure 54: Monitored ambient 24-hour PM_{10} concentrations at Standerton

3.3.6.8 Balfour Hot Spot

The Balfour Hot Spot in the Dipaleseng LM is characterised by monitored exceedances of the 24-hour PM_{10} standard and the 8-hour ozone standard (Figure 55). Balfour is relatively distant from major industrial sources of PM_{10} and the observed exceedances are attributed mostly to residential fuel burning, with some contribution from industrial sources. The ozone exceedances are attributed to high ozone concentrations on a regional scale on the HPA.



Annual average ——— 24-hour average .... Annual standard ▬▬ 24-hour standard

Figure 55: Monitored ambient 24-hour PM_{10} concentrations at Balfour

3.3.6.9 Delmas Hot Spot

The Delmas hot spot is located in the northeastern parts of the LM, bordering on the Emalahleni LM. It is characterised by modelled exceedances of the 24-hr SO_2 standard. No ambient monitoring data is available in Delmas LM to confirm the model estimations.

The contribution by industries in the area dominates the source apportionment, showing clearly that residential fuel burning, motor vehicles and coal mining are less significant in considering the total air quality loading for all pollutants (Figure 56). Residential fuel burning makes a notable contribution to PM_{10} concentrations.

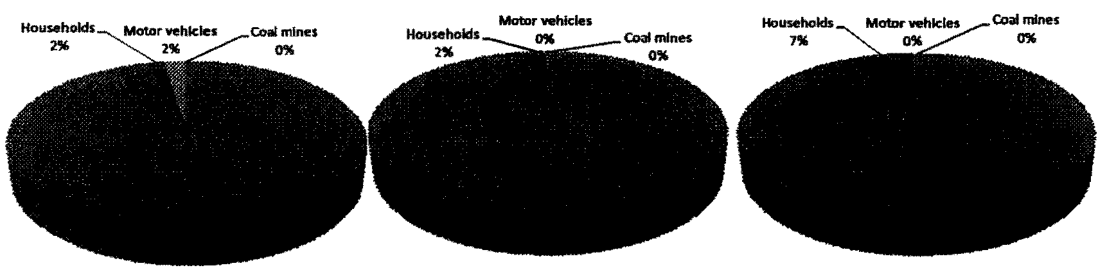


Figure 56: Contribution of different sources to ambient concentrations of NO_x (left), SO_2 (middle) and PM_{10} (right) in the Delmas Hot Spot

3.3.6.10 Pixley ka Seme Hot Spot

In Pixley ka Seme LM, exceedances of SO_2 limit values occur at the Majuba monitoring site. However, ambient air quality complies with the standard because the frequency of exceedance is within the tolerance limits.

Modelled ambient concentrations of NO_x are relatively low. Verkykkop is situated some 300 m above the surrounding terrain. Ozone concentrations typically increase with height above the surface and the high ozone concentrations recorded at this site (Table 19) provide a measure of ozone concentrations above the surface layer. They may also be an indication of the regional scale ozone problem on the HPA resulting from NO_x and VOC chemistry.

3.4 *Air Pollution and health in the HPA*

3.4.1 Health risk outcomes in the HPA

Health risk estimates that are directly relevant to the HPA were derived in 2002 for two major areas, viz. Mpumulanga Highveld and Johannesburg and Ekurhuleni (Scorgie *et al*, 2004). The latter therefore extends to a far greater population than considered in the extent of the HPA. The contributions from the various source activities in the country are also estimated (Scorgie *et al*, 2004).

Source contributions

Source sector contributions to the health risk estimates were estimated for Johannesburg and Ekurhuleni, and the Mpumalanga Highveld as conurbations. Respiratory hospital admissions were estimated to result primarily from domestic coal, followed by wood burning (56% and 21% respectively) in Johannesburg and Ekurhuleni. Similarly, for mortality outcomes, domestic coal and wood burning were identified to be significant contributors. Petrol and diesel vehicles were identified to be the overwhelming contributions to leukaemia cases. Power generation activities were estimated to be the primary driver for hospital admissions in Mpumalanga, with a 51% contribution, followed by the Sasol Secunda complex at 17%. Domestic coal burning also made a significant contribution (12%). Similarly, contributions were recorded for mortality outcomes as well. Domestic wood burning was the overwhelming contribution to leukaemia cases in the Mpumalanga Highveld, with vehicle emissions contributing very marginally. Point sources within the HPA with significant individual contributions are Highveld Steel and Vanadium and Sasol Secunda.

Exposure estimates

Some inference can be made on health risk and exposure of populations in the HPA based on the location of hot spots relative to human populations. Figure 57 highlights Ekurhuleni, Emalahleni, Steve Tshwete, and Secunda as 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 Ekurhuleni conurbation (over 34 000 cases) when compared to admissions in the Mpumalanga Highveld as a whole (over 8 600 cases). Similarly with all other health outcomes, with the exception of minor restricted activity days resulting from SO_2 exposure, where impacts were about three times greater in Mpumalanga. Mortality was estimated at 71 deaths for Johannesburg and Ekurhuleni, and 16 deaths for Mpumalanga, with unaccounted for impacts of NO_2 exposure. The significance of vehicle emissions was also seen in Johannesburg and Ekurhuleni in the high number of cases of leukaemia and lead exposure, which were primarily from vehicle exhaust. Comparatively, in Mpumalanga, no excessive lead exposure of children was recorded, although the estimates did not consider proposed lower lead standards in South Africa. In addition, the contribution of indoor air pollution, in particular from domestic fuel burning, was not estimated.

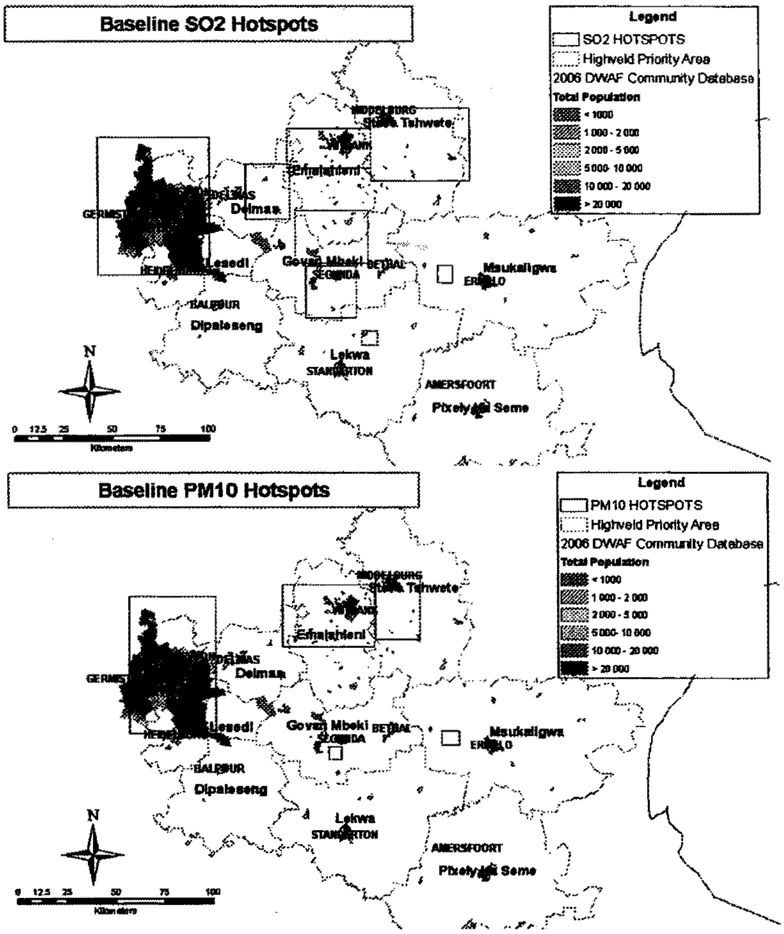


Figure 57: Location of HPA hot spots relative to human population

Table 20: Health impacts from combustion emissions in 2002 (Scorgie *et al*, 2004)

Health endpoint	Johannesburg and Ekurhuleni	Mpumalanga
Respiratory hospital admissions (due to PM_{10}, SO_2 and NO_2 exposures)	34 021	8 685
Cardiovascular hospital admissions (due to PM_{10} exposures)	262	34.5
Premature mortality (due to PM_{10} and SO_2 exposures)	71.5	16.8
Chronic bronchitis (due to PM_{10} exposures)	38 550	6 440
Restricted activity days (RAD, due to PM_{10} exposures)	238 326	31 542
Minor restricted activity days (MRAD, due to SO_2 exposures)	12 396 320	32 135 642
Leukaemia cases (due to 1.3 butadiene and benzene exposures)	67.4	6.4
Nasal carcinoma cases (due to formaldehyde exposures)	1.5	0.3
Number of children exposed to > 2µg/m^3 & hence to potential for IQ point reductions (lead exposure)	5 285	0

3.4.2 Mortality

Norman *et al* (2007a) estimated mortality arising from outdoor air pollution in major urban centres using PM_{10} and $PM_{2.5}$ concentrations. Three health outcomes were assessed, viz. mortality due to cardiopulmonary disease in adults aged 30 years and older, mortality due to lung cancer in adults aged 30 years and older, and mortality due to acute respiratory infections in infants and children (aged 0 – 4 years). Based on measured concentrations of PM_{10}, mortality outcomes were determined for *inter alia* Kempton Park in Ekurhuleni. The annual mean PM_{10} and estimated $PM_{2.5}$ concentrations used were 42.0 and 24.1 µg/m^3 respectively. Mortality outcomes calculated for South African urban areas estimated that air pollution caused 3.7% of total mortality from cardiopulmonary disease in adults aged 30 years and older, 5.1% of mortality attributable to cancers of the trachea, bronchus, and lung in adults, and 1.1% of mortality from acute respiratory infections in children under 5 years of age (Norman *et al*, 2007a). Further detail is included in Table 21.

Table 21: Burden of disease relating to mortality outcomes from outdoor air pollution (Norman *et al*, 2007a)

Related health outcomes	Attributable deaths (in individuals)	Attributable years of life lost (in years)
Lung cancer (adults 30+years)	350	3 604
Cardiopulmonary disease (adults 30+years)	4 222	36 423
Asthma	237	2 644
Acute respiratory infections (children 0-4 years)	65	2 193
Lower respiratory infections	64	21 44
Upper respiratory infections	1	45
Total	4 637	42 219
% of total burden	0.9	0.4

The largest contribution to the attributable burden was from cardiopulmonary disease, indicating the significance of air pollution impacts on the cardiovascular system including hypertension, heart disease, stroke, asthma and other respiratory diseases. In addition, the annual averages of PM concentrations determined in the study broadly demonstrate excessive risk levels for individuals residing in urban areas as health-based standards were exceeded. This relationship highlights the importance of health-based standards in AQM and continual monitoring of pollutant concentrations.

3.4.3 Chronic lung disease

Chronic lung disease includes largely chronic obstructive pulmonary disease (COPD) and asthma, with increasing prevalence in developing countries. These conditions place significant demands on health services and medication costs, with COPD listed as the fifth most common cause of death worldwide in 2001 (SADHS, 2003). In South Africa, respiratory disease, excluding tuberculosis, was ranked as the seventh most important cause of disability-adjusted life years in 2000, with asthma ranked as the 13th highest cause of death, and 18th highest cause of years of life lost in 2001 (SADHS, 2003). Asthma prevalence and mortality was also more closely linked in South Africa, indicating the need for better control and management of the disease.

The findings from the South African Demographic and Health Survey (SADHS) regarding COPD and asthma were based on self-reported symptoms and were presented with data for 1998 and 2003 for comparison purposes (Table 22). Asthmatic symptoms, as reported, showed a greater overall prevalence in women, although a contradictory change in prevalence was reported across genders from 1998 to 2003. An average prevalence showed that overall asthmatic conditions remained unchanged in South Africa. A decrease in chronic bronchitis symptoms was also noted, with further notes made on the influence of education and tobacco smoking. Abnormal peak flow was more prevalent in the 2003 survey, with some technical error recorded. Higher prevalence of abnormal peak flow was noted for women and for non-urban residents as well. Special note was made of the life-long impact of tuberculosis, as well as the need for a life-course consideration in the delivery of health services, where consistent care and medical and other needs are provided for from childhood to adulthood.

Table 22: Adult health indicators from SADHS 1998 and 2003 (SADHS, 2003)

Respiratory condition	**1998**		**2003**	
(% of adults 15+ years)	**Men**	**Women**	**Men**	**Women**
Symptoms of asthma	6.7	8.6	7.2	8.1
Symptoms associated with chronic bronchitis	2.3	2.8	2.3	2.0
Abnormal peak flow	4.0	4.1	7.9	10.9

3.4.4 Indoor air pollution and health

Indoor air quality is affected by outdoor ambient air quality issues through outside ventilation, such as windows and doors, as well as specific indoor sources, particularly domestic fuel burning. Exposure to indoor air pollution was associated with a number of health outcomes, including COPD, lung cancer, nasopharyngeal cancer, tuberculosis, cataracts, asthma, birth defects, and acute lower respiratory infections (ALRI) among children younger than 5 years (Norman *et al*, 2007b). ALRIs were the leading cause of death of children under 5 years worldwide, and similarly, fourth highest in South African children.

The total ALRI burden on children under 5 years was 24% in 2000, attributable to indoor air pollution from household fuel use (Norman *et al*, 2007b). Similarly for COPD, the female population experienced more than double the male attributable burden. Lung cancer burden was relatively minor from indoor air pollution as a result of household fuel use. Indoor air pollution from household fuel use was responsible for 2 489 deaths, or 0.5% of the total health burden on the individual, and resulted in the loss of 60 934 disability adjusted life years, or 0.4% of the total burden (Norman *et al*, 2007b). Details on burdens of disease and health outcomes are provided in Table 23.

The study also observed high mortality rates in African male and female populations, with the Coloured population showing far lower rates, with a minimal mortality rate in Indian and White populations. African females were at higher risk than males. In the study, mortality and life years lost were almost exclusively experienced in the African population. The ALRI burden contributed the greatest to the total burden of disease, indicating the significant impact on young children from indoor air pollution.

Table 23: Burden of disease relating to health outcomes from indoor air pollution (Norman *et al*, 2007b)

Outcome	Population attributable fraction (%)	Deaths (in individuals)	Disability adjusted life years (in years)
Acute lower respiratory infections (children 0-4 years)	23.7	1 428	48 579
Chronic obstructive pulmonary disease (adults 30+ years)	23.2	1 024	11 877
Lung cancer (adults 30+ years)	2.4	37	479
Total (% of total burden)		2 489 (0.5)	60 934 (0.4)

3.5 HPA ambient air quality management capacity

Capacity is an important element of implementing AQM, as the authorities are the main actors with regard to regulation and enforcement, as well as the planning of AQM actions. Capacity needs are differentiated into a number of individual areas, such as skills, human and financial resources, equipment, and working relationships. Within the HPA, the two provincial authorities, four districts or metropolitan municipalities, and nine local municipalities have completed capacity-related questionnaires. This information has been analysed and presented to aid in the defining the baseline capacity condition of HPA authorities and will inform the implementation of the AQMP.

Roles and responsibilities for the different spheres of government, as well as other stakeholders for AQM are outlined in the AQA, and are described in detail in the "logical implementation plan" developed to support the AQA, the National Framework for Air Quality Management in South Africa (DEAT, 2007). The National Framework further outlines principal, input and oversight responsibilities for the three spheres of government, which promotes cooperative governance. The primary roles and responsibilities for the respective spheres of government and the intergovernmental relationships for AQM are summarised in Table 24 for the seven areas of air quality governance. This is particularly relevant to consider in the assessment of capacity, as the development of capacity resources must be appropriate for the expected level of functioning.

Table 24: Primary roles and responsibilities for spheres of government in the seven areas of governance

AQA Governance Function	DEA	Provincial	Municipalities		
			Metro	District	Local
Functions relating to information management [1]	PR, O	PR, I, O	PR, I	PR, I	PR, I
Functions relating to problem identification and prioritisation[2]	PR	PR	I	I	I
Functions relating to strategy development[3]	PR, O	PR, O, I	PR, I	PR, I	PR, I
Functions relating to standard setting[4]	PR, O	PR, I, O	PR, I	PR, I	PR, I
Functions relating to policy and regulation development[5]	PR	PR, I	I	I	I
Functions relating to authorisations[6]	O	PR	PR	PR	I
Functions relating to compliance monitoring[7]	PR, O	PR, I, O	PR, I	PR, I	PR, I

Key: PR: Principal responsibility in relevant jurisdiction I: Input O: Oversight

1: Functions relating to information management refer to matters concerning ambient air quality and emissions monitoring, data quality control, storage and dissemination.

2: Functions relating to problem identification concern the identification of problem pollutants, activities or appliances, and the declaration of priority areas.

3: Functions relating to strategy development concern the development of air quality management plans and pollution prevention plans.

4: Functions relating to standard setting include among others the setting of emission standards and ambient air quality standards and standards for monitoring by different spheres of government.

5: Functions relating to policy and regulation development concern the development and promulgation of instruments necessary for the implementation and enforcement of air quality management plans.

6: Functions relating to authorisations concerns the emission licensing function.

7: Functions relating to compliance monitoring concern, among others, monitoring of compliance with emission and ambient air quality standards and compliance with AEL provisions.

3.5.1 Provincial

Air quality perceptions

According to the questionnaire responses, large industrial operations are problematic in the Mpumalanga area of the HPA. These include petrochemical, power generation, metal processing and brick manufacturing industries. There are 11 power stations in the HPA in Mpumalanga, with an additional station planned. Metal manufacturers in Emalahleni and Steve Tshwete municipalities, together with hydrocarbon processes (i.e. Sasol) in Govan Mbeki were listed specifically. Industries were identified as problematic in Gauteng, with no further detail provided on pollutants or sectors. Motor vehicles were also identified as problematic by MDEDET, as major freight movement for international import and export, as the transportation of raw and finished products was experienced. Five major national routes were listed, viz. the N2, N3, N4/N12, N11 and N17, as provincial links across these routes. Motor vehicles are an air quality issue in Gauteng as well, and Gauteng Department of Agriculture and Rural Development (GDARD) are in consultation with the Department of Transport (DoT) to address it. MDEDET listed residential fuel burning as comparable in impact to industrial emissions, as the technology, conditions and ventilation in which burning occurs result in high exposure levels. Low-grade coal is used for heating and cooking, and concerns have been raised around PM and mercury in fuels. GDARD is looking to address residential fuel burning problems by seeking partnerships and collaborative working.

Coal and metal ore mining are issues in Mpumalanga, particularly from suspended PM. Spontaneous combustion emissions from coal mines is a historical air quality issue, with Emalahleni being the most impacted area. Gauteng experienced air quality issues related to mines and quarries but did not provide further detail. Agricultural burning in Mpumalanga is limited to forestry plantations, which experience seasonal, spontaneous fires, particularly in Msukaligwa municipality. Agricultural burning is experienced in Gauteng as well, and is to be addressed through partnership and collaboration. Air quality issues have been raised around tyre burning, and unregulated tyre treading activities in the Highveld, and GDARD is consulting with the lead authority to address the issue. Complaints have been received on waste tyre burning at landfills. Other issues around landfill sites are the uncontrolled or spontaneous fires resulting from the combustion of methane gas. Other distinct issues raised by MDEDET are small-scale charcoal manufacturers operating in Mpumalanga, with little or no air pollution measures and non-compliance with Environmental Health and Safety regulations.

Table 25: Air quality issues as described by officials

	GDARD	MDEDET
Industries	✓	✓
Motor vehicles	✓	✓
Residential fuel burning	✓	✓
Mining/quarries	✓	✓
Agricultural burning	✓	✓
Tyre burning	✓	✓
Odour		
Dumping/landfill sites		✓
Other		✓

Capacity and practices

Air Quality Officer Appointment

MDEDET and GDARD have appointed an Air Quality Officer (AQO) to coordinate air quality matters at the provincial level, although the Gauteng nomination is still being processed.

Organisational structure

The AQM function is an integrated function under pollution control in MDEDET. Under a proposed organisational structure, AQM is intended to be placed in a separate unit. Similarly, AQM is not located as a separate function in GDARD, with air quality work divided evenly across the directorate.

Given the integrated function currently carried out by MDEDET, 20 to 40 percent of their time is dedicated to AQM activities. GDARD has indicated that AQM is a full-time occupation in the department; however, this is unlikely given the division of work across several areas of competence.

Capacity building

MDEDET and GDARD are both confident to implement the AQA, however require 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.

Provincial-local relationship

There are no planned service level agreements by MDEDET. GDARD is planning to enter into service level agreements with municipalities for the administration of the AEL function.

Regular meetings are held between MDEDET and national and municipal staff regarding air quality issues. The Provincial AQOF is part of this function, and the HPA AQOF is also used. GDARD holds regular meetings with municipalities through the AQOF.

Air quality fora with stakeholders also operate through the HPA. GDARD did not provide details of fora operating in Gauteng.

Budget allocation

MDEDET did not indicate a budget for AQM as it is performed as an integrated function, however, highlighted the allocation of a multi-year budget of R15 Million for the operation, processing and maintenance of the department's monitoring network. GDARD has a budget allocation of less than R500 000 for AQM.

Table 26: Capacity assessment

	GDARD	MDEDET
AQO appointment	✓	✓
AQM placement	EM	Other
Time allocation	Full time	20-40
Level of confidence for AQA implementation	Confident, extensive capacity building	Confident, extensive capacity building
Capacity building needs	Licensing	Monitoring; Modelling; Emission impact assessment; Emission inventory
Budget allocation	<R0.5 Million	

With regards to AQM practices, MDEDET only carries out inspections jointly with DEA or the Department of Health, and in response to complaints. MDEDET issues notices with reference to compliance with NEMA's (National Environmental Mnagement Act, Act No.107 of 1998) duty of care, remediation and incidents clauses, and Environmental Impact Assessment (EIA) environmental authorisation conditions. MDEDET investigates and records complaints. GDARD does not carry out industrial inspections, issue notices or manage a complaints register.

MDEDET carries out ambient air quality monitoring at four locations, viz. Witbank, Middelburg, Standerton and Balfour. DEA, Sasol and Eskom are also responsible for monitoring in the province. GDARD runs a number of stations in Gauteng; however, these have been partly operational for two years due to technical and budgetary constraints. MDEDET has not compiled an emission inventory, as most Scheduled Process industries in the province do not measure emissions, although a relatively complete list of the industries is available. The provincial emission inventory for Gauteng has been developed and includes inventories that have been completed for areas within the province. No regulation or by-law development has been done by MDEDET or GDARD. The Mpumalanga department is waiting for the circulation of the DEA model by-law for municipalities to adopt.

MDEDET intend to develop emission reduction initiatives when initial data collection through the monitoring network is available; none have been developed currently. Emission reduction initiatives for Gauteng are outlined in the AQMP for implementation. MDEDET has initiated informal discussions on licensing functions with district municipalities, with more interactions to follow to determine readiness. A questionnaire to the same effect has been distributed by DEA. GDARD has made progress in capacity development of officials responsible for licensing, although the officials are not currently dedicated solely to licensing functions. Air quality studies identified by MDEDET are the provincial State of Environment

Report 2003 and the Integrated Municipal Environmental Plan for Nkangala District Municipality. GDARD provided no details of air quality studies.

Table 27: AQM practices

	GDARD	MDEDET
Industry inspections		✓
Issuing of notices		✓
Complaints register		✓
Ambient AQ monitoring	✓	✓
Emission inventory	✓	
Regulation/by-law development		
Emission reduction initiatives	✓	
Processes to begin issuing AELs	✓	
AQ studies	✓	✓
Other		

AQMP status

MDEDET is planning to develop an AQMP, although terms of reference have been prepared, problems have been experienced in sourcing funding. The AQMP has been included in the department's 2009/10 Implementation Plan and Medium Term Strategic Framework. Currently, MDEDET is awaiting the finalisation of the HPA AQMP. The Gauteng AQMP is awaiting approval by the Department and provincial legislature, and has been incorporated into municipal IDPs.

Table 28: Status of AQMP development of provinces

	GDARD	MDEDET
No plans		
Planning		✓
Drafting		
Awaiting approval	✓	
In place		
Implementing		

3.5.2 Ekurhuleni Metro

Air quality perceptions

According to the questionnaire responses, industries are a high priority air quality issue, with the municipality hosting 210 Scheduled Process industries as per the DEA database, with 5000 – 6000 industries located in the metro, including non-regulated industries, as there is a permit backlog. Motor vehicles are also high priority, particularly diesel vehicles, with roadside testing being conducted two or three times a week. Petrol vehicles remain a challenge to address in the municipality. Residential fuel burning is also a high priority with demonstration projects for BnM being conducted in informal settlements for over six years.

Mining is a medium priority issue, with slime dams located on the East Rand in Springs, Benoni and Boksburg. A Department of Mineral Resources (DMR) forum had been set up to manage mining and environmental issues; however, it is since non-functional as the key driver has left the DMR. Agricultural burning is not significant, with limited seasonal burning of mielie fields experienced in Nigel and surrounds. Tyre burning is also of low significance, being sporadic in nature. Burning is motivated by scrap metal recovery, and in the winter, for heating. Odour complaints are received regarding industries and wastewater treatment works. Other issues raised by Ekurhuleni are aircraft emissions as the international airport in the metro is a major source of VOCs although no air quality complaints have been received. Two monitoring stations are located in the airport vicinity although no data sharing is practiced.

Table 29: Air quality issues as described by officials

	EMM
Industries	✓
Motor vehicles	✓
Residential fuel burning	✓
Mining/quarries	✓
Agricultural burning	✓
Tyre burning	✓
Odour	✓
Dumping/landfill sites	
Other	✓

Capacity and practices

AQO appointment

An AQO, responsible for coordinating AQM activities, has been appointed in the metro.

Organisational structure

AQM function is placed within the Environmental Health department of the municipal structure, where it is full time function.

Capacity building

The metro is confident for the implementation of the AQA, however, requires capacity building in some areas. These include monitoring, enforcement, licensing, dispersion modelling and process design.

Provincial-local relationship

Regarding regular meetings, quarterly meetings are held with GDARD and monthly reports are submitted as well. Air quality fora are independently held in the three regions of the metro, although plans are proposed to incorporate them into a single forum. The success of integration is uncertain at this point however.

Budget allocation

Ekurhuleni has indicated that a budget of R1 – 5 Million is provided for AQM functions.

Table 30: Capacity assessment

	EMM
AQO appointment	✓
AQM placement	EH
Time allocation	Full time
Level of confidence for AQA implementation	Confident, some capacity building
Capacity building needs	Monitoring; Enforcement; Licensing; Process design; Modelling
Budget allocation	R 1 – 5 Million

Concerning AQM practices, Ekurhuleni is still developing the industry inspection function, with boilers regulated through APPA eligible for inspection, i.e. boilers less than 10 tons. Issuing of notices is performed with respect to these small boilers. There is full implementation of a complaints recording system in the metro, with public call centres functioning. Some warnings are issued although no prosecutions have been made and compliance is encouraged through the fora. Complaints regarding listed activities are referred to DEA. Eight ambient air quality monitoring stations are operated by Ekurhuleni municipality, and an additional mobile station requiring meteorological measurements is located within industrial areas. Operational budget constraints exist currently, which have resulted in the stations being in different states of operation with limited data available. Further funding and planning is needed for the network to return to operational state.

An emission inventory has been compiled for the municipality, although only a 23% response rate was achieved on completed questionnaire submissions. Plans to complete the inventory are to follow, in order to improve the completeness and address contributions beyond the point sources currently captured. Regulation/by-law development is part of a process around the development of standards, through a DANIDA-funded project in which the municipality is involved. By-laws will follow standard development. Emission reduction initiatives, viz. diesel emission testing and BnM roll-out, have been implemented. Processes to begin issuing AELs are underway, with the municipality being involved with DEA in the licensing of a few industries, as a capacity building exercise.

Air quality studies in the municipality include the State of the Environment Report, with EIA involvement limited to interested and affected parties interaction linked to the AEL process. A note was made regarding industries waiting on AEL implementation before proceeding with industrial development and expansion, as current EIA's are largely limited to housing applications. Ekurhuleni has also purchased licences for EMIT and ADMS Urban models and plans for implementation are to follow.

Table 31: AQM practices

	EMM
Industry inspections	✓
Issuing of notices	✓
Complaints register	✓
Ambient AQ monitoring	✓
Emission inventory	✓
Regulation/by-law development	

Emission reduction initiatives	✓
Processes to begin issuing AELs	✓
AQ studies	✓
Other	✓

AQMP status

An AQMP has been prepared for Ekurhuleni, the only AQMP currently available in the HPA. A review of the plan, prepared in 2005, was planned for 2007; however, the municipality has decided to postpone pending outcomes of the HPA AQMP process.

Table 32: Status of AQMP development

	EMM
No plans	
Planning	
Drafting	
Awaiting approval	
In place	✓
Implementing	✓

The vision of the AQMP is the "attainment and maintenance of acceptable air quality for the benefit of present and future generations." The mission is to lead the protection and enhancement of the Metro's air quality through proactive and effective air quality management and sustainable development of the built environment and transportation systems within the Metro. To work in partnership with the community and stakeholders to ensure the air is healthy to breathe and does not impact significantly on the well-being of persons; and to reduce the potential for ecosystem damage from air pollution and to address global air quality problems.

The strategic objectives of the AQMP are:

- To achieve and sustain acceptable air quality levels throughout Ekurhuleni.
- To minimize the negative impacts of air pollution on health, well-being and the environment.
- To promote the reduction of greenhouse gases to support the council's climate change protection programme.
- To reduce the extent of ozone depleting substances in line with national and international requirements.

Specific objectives include:

- To promote cleaner production and continuous improvement in best practice as it pertains to air pollution prevention and minimization.
- To promote energy efficiency within all sectors including industrial, commercial, institutional, mining, transportation and domestic energy use.

3.5.3 Sedibeng district

Air quality perceptions

According to questionnaire responses, industries are an air quality issue in the Lesedi municipality of Sedibeng district. However, the district accorded it a medium priority, while officials from Lesedi rated it a high priority, particularly due to smoke and odours. Lesedi experiences air quality issues due to heavy vehicles travelling from Durban, with smoke and non-specified gas emissions. Residential fuel burning is a high priority in the local municipality, in the surrounding townships, with burning of coal, tyres and waste experienced. Mining and quarries are a low priority for Lesedi with problematic dust emissions identified. Agricultural burning is also a medium priority, with planned and spontaneous veld fires experienced. Tyre burning is a medium air quality priority, with smoke emissions listed. Farming activities are a high priority, particularly livestock such as cattle, chicken and pigs, and it can be inferred that it is largely an odour issue.

Table 33: Air quality issues as described by officials

	SDM	Les
Industries	✓	✓
Motor vehicles		✓
Residential fuel burning	✓	✓
Mining/quarries		✓
Agricultural burning		✓
Tyre burning	✓	✓
Odour		
Dumping/landfill sites		
Other		✓

Capacity and practices

AQO appointment

Sedibeng has an appointed AQO; however, Lesedi has had an individual nominated by the district municipality though not officially designated in terms of the AQA.

Organisational structure

Sedibeng handles AQM through the Environmental Management department. Lesedi has various functions related to AQM spread across 3 departments. In Lesedi, Environmental Health is responsible for assessing building plans, handling complaints and routine inspections, Environmental Management is located within the Development and Planning department, and handles land use plans and policy development.

Sedibeng conducts AQM as a full time function, and Lesedi dedicates a percentage of 0 – 20 of their time to AQM.

Capacity building

Both Sedibeng and Lesedi have indicated that they are confident to implement the AQA, however, require extensive capacity building. Sedibeng has expressed needs in monitoring, enforcement and licensing, whereas Lesedi requires broader initiatives in all areas of AQM.

District-local municipal relationship

Sedibeng District Municipality has a service level agreement in place regarding municipal health services and is looking to extend it to include AQM. Lesedi is not part of any service level agreement and is planning to develop an agreement.

Sedibeng is involved in regular meetings with local municipal, provincial and national staff and uses the municipal health services Intergovernmental Relations (IGR). A dedicated AQM IGR is planned. Lesedi is involved in regular meetings with the district municipality and national government, however has commented that feedback from local and national government to stakeholders is slow.

Sedibeng is involved in an air quality forum as part of the Vaal Triagle Airshed Priority Area (VTAPA), and Lesedi expects that a forum will be established as the process for the HPA develops.

Budget allocation
Both Sedibeng and Lesedi use a budget of R0.5 – 1 Million for carrying out AQM activities. The budget for Lesedi's activities is provided by Sedibeng District Municipality, which is an important note.

Table 34: Capacity assessment

	SDM	Les
AQO appointment	✓	
AQM placement	EM	EH/ EM/ Planning
Time allocation	Full time	0-20
Level of confidence for AQA implementation	Confident, extensive capacity building	Confident, extensive capacity building
Capacity building needs	Monitoring; Enforcement; Licensing	AQM
Budget allocation	R 0.5 – 1 Million	R 0.5 – 1 Million

With regards to AQM practices, both Sedibeng and Lesedi conduct industry inspections. Sedibeng District Municipality as the licensing authority intends to conduct compliance inspections reviewing licence conditions. Lesedi currently conducts routine inspections, as well as in response to complaints. Lesedi issues notices for education and awareness, and as part of legal action. Sedibeng's complaints register system is still to be developed at the district level; however, Lesedi does capture all complaints. Sedibeng is responsible for air quality monitoring at the district level, however no station operates in Lesedi Local Municipality.

An emission inventory is planned for Sedibeng when it embarks on an AQM planning exercise, while none is available currently. Regulation or by-law development has not been done in Sedibeng or Lesedi, with the local municipality regarding it as a district function. Emission reduction initiatives are achieved through notices and directives although no direct projects have been implemented by the local municipality. Sedibeng is undertaking a study to assess resource requirements to become an effective and efficient licensing authority. Air quality studies in the district are on general environmental issues, with the District Environmental Management Plan (EMP) and EIA involvement listed.

Table 35: AQM practices

	SDM	Les
Industry inspections	✓	✓
Issuing of notices		✓
Complaints register	✓	✓
Ambient AQ monitoring	✓	
Emission inventory		
Regulation/by-law development		
Emission reduction initiatives		✓
Processes to begin issuing AELs	✓	
AQ studies		✓
Other		

AQMP status

Sedibeng is planning an AQMP for its next financial year and the need for an AQMP has been captured in the district's IDP with funding being sourced. Lesedi has no plans for an AQMP, with its development expected as the HPA planning process unfolds.

Table 36: Status of AQMP development by municipalities

	SDM	Les
No plans		✓
Planning	✓	
Drafting		
Awaiting approval		
In place		
Implementing		

3.5.4 Gert Sibande district

Air quality perceptions

Within the district, industries are ranked as a high priority, with Dipalaseng and Lekwa confirming the ranking. The district municipality lists petrochemical industries specifically as significant sources. Govan Mbeki did not provide a ranking but listed the Sasol plant, mines and small industries as sources. Lekwa identified a power station in the municipality. Msukaligwa and Pixley ka Seme municipalities ranked industries as a low priority, with small industries and dry cleaning operations being respective local sources. The district municipality also ranked motor vehicles as a high priority, particularly coal trucks, which were reiterated by Govan Mbeki, Lekwa and Msukaligwa. Govan Mbeki also listed daily spray activity as a related source. Pixley ka Seme experienced air quality issues related to CO emissions from heavy vehicles. Residential fuel burning is also a high priority for the district, with coal burning and stoves listed as a source in Govan Mbeki, Lekwa, Msukaligwa and Pixley ka Seme. Wood is an additional fuel used in Lekwa, and general fossil fuels are used in Pixley ka Seme. Wesselton is mentioned specifically as a problem area in Msukaligwa.

Mining and quarries are regarded as a medium priority source across the district, and are associated with dust emissions. Gold and coal mining are significant activities in Govan Mbeki. Dipaleseng listed the power station as a source in this category, possibly alluding to the coal mining operations that support power generation activities. Lekwa also experienced deep mining. Agricultural burning is a medium priority for the district, related to grazing fields, fire breaks and forestry. Dipaleseng and Pixley ka Seme experienced agricultural burning, with spontaneous veld fires being problematic in Pixley ka Seme. Tyre burning is regarded as a low priority in the district, with Govan Mbeki experiencing incidents with burning at dumpsites, and Pixley ka Seme recording incidents with small quantities of tyres burnt at landfill sites. Odour is problematic at Govan Mbeki due to H_2S and Sasol Secunda Synfuels tar products, and at Lekwa from poultry abattoir and wastewater treatment works. The only additional issue raised was noise in Govan Mbeki.

Table 37: Air quality issues as described by officials

	GSDM	Gov	Dip	Lek	Msu	Pix
Industries	✓	✓	✓	✓	✓	✓
Motor vehicles	✓	✓	✓	✓	✓	✓
Residential fuel burning	✓	✓		✓	✓	✓
Mining/quarries	✓	✓	✓	✓		
Agricultural burning	✓		✓			✓
Tyre burning	✓	✓				✓
Odour		✓		✓		
Dumping/landfill sites	✓			✓		
Other		✓				

Capacity and practices

AQO appointment

An AQO has been appointed at the district level, and in Govan Mbeki, Lekwa and Msukaligwa Local Municipalities. Dipaleseng has no dedicated air quality personnel and the municipality is in the process of filling staff vacancies. Pixley ka Seme is preparing to transfer the municipal health service function to the district municipality, as they listed the appointment as not applicable.

Organisational structure

All municipalities have located AQM within the Environmental Health department, with the exception of Dipaleseng, which has placed the function with Environmental Management.

The majority of municipalities spend a significant portion of their time attending to AQM, including the district, with a 20 to 40% time allocation. Lekwa and Pixley ka Seme spent a percentage between 0 and 20 of their time on AQM.

Capacity building

Only the district municipality indicated they were fully confident for AQA implementation, with Govan Mbeki, Msukaligwa, and Pixley ka Seme requesting some capacity building in preparation for implementation. The district municipality expressed capacity-building needs for dispersion modelling and data analysis skills, Govan Mbeki with chemical and monitoring skills, Lekwa with monitoring and legal skills, including data analysis and operation, Msukaligwa for general AQM skills, and Pixley ka Seme with monitoring skills.

District-local municipal relationship

Msukaligwa was the only municipality with an existing service level agreement, although no further details were provided regarding the functions designated. Other municipalities are planning to develop these agreements: the district municipality intends to address monitoring, Govan Mbeki is planning to hand over the municipal health services to district, and Lekwa is planning to address monitoring using the mechanism. Dipaleseng indicated their intention to develop a service level agreement regarding the monitoring of polluters and enforcement actions, however further clarity is needed.

Regular meetings are held between district and local municipalities as indicated by all municipalities. The district municipality, Lekwa and Pixley ka Seme had regular meetings with provincial air quality personnel. Regular meetings with national air quality personnel are also held with the district municipality, Dipaleseng, Lekwa and Pixley ka Seme.

Gert Sibande was the only municipality to indicate to have an existing air quality forum within the district. Govan Mbeki used a community forum that addressed all issues, the Highveld Community Awareness Forum. Lekwa expressed the need for a district-local municipality forum.

Budget allocation

Gert Sibande was the only municipality to allocate a budget to perform the AQM function, which is less than R0.5 Million. Govan Mbeki indicated that proposals were included in the IDP for AQM funding; however, no funding is currently available.

Table 38: Capacity assessment

	GSDM	Gov	Dip	Lek	Msu	Pix
AQO appointment	✓	✓		✓	✓	
AQM placement	EH	EH	EM	EH	EH	EH
Time allocation	20-40	20-40	20-40	0-20	20-40	0-20
Level of confidence for AQA implementation	Fully confident	Confident, some capacity building		Not confident	Confident, some capacity building	Confident, some capacity building
Capacity building needs	Modelling	Chemical; Monitoring		Monitoring; Legal	AQM	Monitoring
Budget allocation	<R0.5 Million	None	None	None	None	None

Three municipalities carry out industry inspections, with Gert Sibande only addressing non-scheduled industries and Msukaligwa carrying out inspections on day-to-day operations. Pixley ka Seme used Environmental Health Practictioners (EHPs) to carry out industry inspections. Govan Mbeki held quarterly meetings with Sasol as opposed to inspections. Msukaligwa issued notices as part of the inspection process, with Pixley ka Seme also issuing notices. The level to which air quality was addressed during these activities is unclear. Complaints registers are functional at three municipalities. Gert Sibande indicated their register was part of a general register for different municipalities. Govan Mbeki stated their complaints were related to odour.

Gert Sibande DM has indicated that private sector and DEA monitoring networks are operational in the district. In Govan Mbeki, Sasol is conducting ambient monitoring, as well as one national government station. Dipaleseng also indicated that ambient monitoring was conducted in the municipality but did not provide further details on the responsible parties or air quality issues addressed. Emission inventory development was not underway in the district, with the district municipality indicating that the process is underway through the HPA AQMP development, and Govan Mbeki making unsuccessful attempts previously. Dipaleseng and Lekwa initiated the regulation and by-law development processes, with no added detail, and the district municipality indicated the plans for the two processes are underway. Govan Mbeki conducted emission reduction initiatives, specifically BnM projects, with the district municipality indicating they were being planned.

There is no progress on preparation for AEL processing and issuing by any municipality in the district. Air quality studies raised by Gert Sibande were an international project on climate change under the auspices of the University of Pretoria, Eskom, Sasol and European partners, and Govan Mbeki identified EIAs for expansion projects, however these were seen as inadequately addressing air quality issues.

Table 39: AQM practices

	GSDM	Gov	Dip	Lek	Msu	Pix
Industry inspections	✓				✓	✓
Issuing of notices					✓	✓
Complaints register	✓	✓				✓
Ambient AQ monitoring	✓	✓	✓			
Emission inventory						
Regulation/by-law development			✓	✓		
Emission reduction initiatives		✓				
Processes to begin issuing AELs						
AQ studies	✓	✓				
Other						

AQMP status

No municipality appears to have progressed significantly in AQMP development. Gert Sibande and Dipaleseng have stated that they are drafting an AQMP, although no progress is available. Gert Sibande has indicated that the district will only proceed with AQMP development following the publication of the HPA AQMP. Pixley ka Seme has also indicated that the municipality is planning an AQMP; however, given the status currently regarding transfer of personnel, it seems unlikely to develop further. Govan Mbeki, Lekwa and Msukaligwa have no plans for AQMP development at this stage. Msukaligwa and Pixley ka Seme plan to include the AQMP in their next IDP revision.

Table 40: Status of AQMP development by municipalities

	GSDM	Gov	Dip	Lek	Msu	Pix
No plans		✓		✓	✓	
Planning						✓
Drafting	✓		✓			
Awaiting approval						
In place						
Implementing						

3.5.5 Nkangala district

Air quality perceptions

Questionnaire responses show that major industries in the Nkangala area are the major source of emissions; these include Eskom, Columbus, Highveld Steel, Samancor, Rand Carbide, Vanchem, and Sasol. Industries were highly prioritised in all areas, with the exception of Delmas. Delmas experienced low priority air quality issues with regards to chicken rearing at broiler houses. Motor vehicles are a medium priority in the district, with the major issues being coal and freight haulage. Coal trucks are associated with dust and emissions, with freight vehicles using Emalahleni town to by-pass the tolling point. Vehicles with poor emission controls such as trucks and bakkies were also identified. Residential fuel burning varied between high and low priority across the municipalities in the district. It is particularly problematic in the winter, with smoke emissions from the primary fuel type, coal. The district municipality identified 5 settlements that are problematic in the winter, and a single settlement in the summer. Mining and quarries are an air quality issue in all municipalities, particularly as the result of opencast coal mining, with dust fallouts experienced. The district municipality raised mining as a high priority, with varying degrees of emphasis by the local municipalities.

Agricultural burning is raised as medium to low priority across the district, with Delmas experiencing no problems. Veld fires are most commonplace during and approaching the dry season, i.e. winter, with some field clearing in Steve Tshwete. The fire department in Steve Tshwete do run campaigns for farmer awareness. Tyre burning is also a medium to low priority across the district, with burning carried out informally, as part of illegal dumping practices of recyclers and tyre companies. Emalahleni and Steve Tshwete experience tyre burning mostly in winter and at night. Other issues raised; Delmas identified Kendal power station and other surrounding activities as a particular air quality issue; and Emalahleni identified incinerators and dry cleaners as problematic in a few areas. Incinerators are a challenge, with dry cleaners viewed as less serious although a need for constant monitoring is listed.

Table 41: Air quality issues as described by officials

	NDM	Del	Ema	Ste
Industries	✓	✓	✓	✓
Motor vehicles	✓	✓	✓	✓
Residential fuel burning	✓	✓	✓	✓
Mining/quarries	✓	✓	✓	✓
Agricultural burning	✓		✓	✓
Tyre burning	✓	✓	✓	✓
Odour				
Dumping/landfill sites				
Other		✓	✓	

Capacity and practices

AQO appointment

Nkangala District Municipality has not appointed an AQO, as well as Delmas, which is underway. Emalahleni and Steve Tshwete have appointed an AQO.

Organisational structure

At the district municipality, AQM function is placed within social services. Delmas has not set up a function, although it is likely to be Environmental Health. Emalahleni and Steve Tshwete have both located AQM within Environmental Health. Emalahleni's Environmental Health is located within the broader section of Environmental Management.

The district municipality, Delmas and Emalahleni Local Municipalities all dedicate a percentage between 0 and 20 to AQM, with Steve Tshwete allocating a higher percentage between 20 and 40.

Capacity building

All municipalities within the district are confident for the implementation of the AQA provisions, provided some capacity building is provided, with Emalahleni indicating that extensive capacity building is needed. Nkangala would like to clarify their organisational structure before further efforts in AQM can be undertaken. Delmas requires legal and general AQM capacity building. Emalahleni highlighted a large number of needs, including in monitoring, legal, AQM, enforcement, licensing, emission inventories, and Environmental Management Inspector (EMI) training. Steve Tshwete expressed capacity building needs in the areas of monitoring, licensing, emission inventory development, and general areas of AQM.

District-local municipal relationship

There are no service level agreements that have been determined, or are planned, in the district, with only Nkangala indicating their possibility.

Provincial-municipal coordination is high in the district, with all local municipalities indicating that regular meetings are held between themselves and MDEDET. The establishment of Provincial AQOF has contributed significantly to the high degree of interaction. Nkangala did not meet regularly with provincial or local authorities, and this is attributed to the lack of capacity and absence of environmental management. Delmas also recorded no specific personal interactions but broader engagement through the HPA project. National and municipal interactions are limited to Emalahleni and Steve Tshwete. Emalahleni uses the Provincial AQOF and MSRG, although regular meetings between directors are identified as a need. Steve Tshwete does enjoy regular meetings, together with a supervisor and provincial staff regarding air quality.

No other air quality fora are present in the district, with Steve Tshwete conducting an environmental management monthly meeting with communities.

Budget allocation

Both Nkangala and Delmas did not provide for an AQM budget. Emalahleni and Steve Tshwete have funding available of less than R0.5 Million.

Table 42: Capacity assessment

	NDM	Del	Ema	Ste
AQO appointment			✓	✓
AQM placement	Other		EH	EH
Time allocation	0-20	0-20	0-20	20-40
Level of confidence for AQA implementation	Confident, some capacity building	Confident, some capacity building	Confident, extensive capacity building	Confident, some capacity building
Capacity building needs	Organisational structure	Legal; AQM	Monitoring; Legal; AQM; Enforcement; Licensing; EMI training; Emission inventory	Monitoring; AQM; Licensing; Emission inventory
Budget allocation	None	None	<R0.5 Million	<R0.5 Million

Nkangala District Municipality does not conduct AQM practices due to issues of capacity and structure. All local municipalities conduct industry inspections to varying degrees. Delmas responds to community complaints on broiler houses related to odour, Steve Tshwete also reacts to complaints, whereas Emalahleni conducts inspections jointly with MDEDET. Emalahleni very seldom issues notices, while Steve Tshwete issues notices if no remediative action is taken by industries, such as dust emissions from mines. Emalahleni keeps a complaints register record, however Steve Tshwete follows up on company complaint registers with no record kept by the municipality. Both Emalahleni and Steve Tshwete conduct monitoring through a municipal station; the status of municipal monitoring is unclear due to funding and analysis constraints. Emalahleni and Steve Tshwete identified the need for by-law development although no processes are underway. BnM campaigns have been conducted in Emalahleni and Steve Tshwete, with Emalahleni also conducting health education and awareness as a component for emission reduction initiatives.

Air quality studies in Emalahleni include the APPA review process, with participation by the Environmental Management sections in EIAs, State of Environment reporting, and Integrated Environmental Management Plan development. Steve Tshwete listed the district State of Environment report and mining EIA reports.

Table 43: AQM practices

	NDM	Del	Ema	Ste
Industry inspections		✓	✓	✓
Issuing of notices			✓	✓
Complaints register			✓	✓
Ambient AQ monitoring			✓	✓
Emission inventory				
Regulation/by-law development				
Emission reduction initiatives			✓	✓
Processes to begin issuing AELs				
AQ studies			✓	✓
Other				

AQMP status

No municipality has taken steps to develop an AQMP, with most waiting to follow the development of the HPA AQMP. Delmas has indicated that they are in a planning phase, however, they are actively involved in the HPA AQMP development and plan to adapt the plan to suit the local municipality. Emalahleni felt similarly. Steve Tshwete expressed the need for a distinct air quality unit within the municipality.

Table 44: Status of AQMP development by municipalities

	NDM	Del	Ema	Ste
No plans	✓		✓	✓
Planning		✓		
Drafting				
Awaiting approval				
In place				
Implementing				

4 TECHNOLOGY REVIEW

4.1 Background

Section 21 (1) of the AQA provides for the Minister or the Member of Executive Council (MEC) to publish a list of activities which result in atmospheric emissions that the Minister or MEC reasonably believes have or may have a significant detrimental effect on the environment, including health, social conditions, economic conditions, ecological conditions or cultural heritage. A list published by the Minister applies nationally and a list published by the MEC applies to the relevant province only. Minimum emission standards in respect of a substance or mixture of substances resulting from a listed activity should be established, including:

i. the permissible amount, volume, emission rate or concentration of that substance or mixture of substances that may be emitted;
ii. the manner in which measurements of such emissions must be carried out.

In accordance, the final schedule for Section 21 of the AQA (DEA, 2010) was published on 31 March 2010. For the identified listed activities, the schedule provides minimum emission standards for existing and new plants for relevant pollutants in mg/Nm^3 at standard temperature and pressure, which is 25 °C, and 1 kilopascal (STP). Clarity on the manner in which the emission measurement should be carried out is also provided, with transitional and other special arrangements specific to each listed activity. The minimum emissions standards came into effect on 1 April 2010.

4.2 Sectors and technology

4.2.1 Typical abatement technology in use in the HPA

There are numerous sources of emission to atmosphere in the HPA. Each of these sources has unique characteristics; however, the sources can and have been broadly grouped in terms of the similarity of the processes undertaken. Similar sources generally tend to have similar, although not identical, emissions. Likewise, there are numerous methods available and in use for the prevention and abatement of atmospheric emissions. A brief description of commonly used abatement technologies is provided here.

4.2.1.1 Particulate abatement

Point emission sources are in many cases fitted with emissions extraction and abatement equipment. Particulate abatement for sources in the HPA can be achieved mainly by the installation of the following:

- Cyclone Separators
- Electrostatic Precipitators (ESPs)
- Fabric Filters
- Wet Scrubbers

Cyclone separators

Cyclone separators (commonly referred to as cyclones) remove particulates from laden gas streams using centrifugal forces. Typically, a particulate-laden gas enters tangentially near the top of the cyclone as depicted in Figure 58. The gas flow is forced into a downward spiral due to the cyclone's shape and the tangential entry. The centrifugal inertia of the particulates forces them to move outward and collide with the outer wall of the cyclone. The particulates then slide down to the bottom of the cyclone. The gas stream reverses near the bottom and spirals up in an inner spiral, which exits as a cleaned gas through a narrow tube at the top of the cyclone.

Cyclones are typically used as initial particulate removal equipment. They are generally inadequate for meeting particulate emissions limits but provide a cost effective, relatively maintenance-free means of effectively reducing particulate load in the gas stream, thus reducing the burden on downstream abatement equipment such as fabric filters and ESPs. The larger and denser the particulates in the gas stream, the more effective the cyclones. Collection efficiency decreases with decreasing particulate density and size.

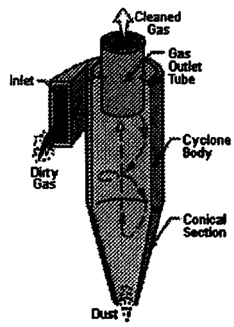


Figure 58: Typical Cyclone Separator (EPA, 2010)

Electrostatic precipitation

ESPs operate on principles of electrostatic attraction. The dust-laden gases pass through a chamber where the individual particles of dust are ionised as a result of a high voltage negative direct current (DC) field. The charged dust particles are removed from the gas stream onto the collecting electrodes. After being dislodged by intermittent blows on the electrodes - called rapping - the dust particles drop into dust hoppers situated below the electrodes.

The efficient operation of a precipitator depends largely on the resistivity of the ash. The resistivity in turn depends on the chemistry of the ash. High sulphur coals will tend to produce ash with lower resistivity and thus higher ESP efficiency and vice versa. The use of low sulphur coal can thus reduce ESP efficiency but this can be counteracted with flue gas conditioning (FGC). At present, the injection of sulphur tri-oxide (SO_3) is used to improve the surface conductivity of ash fed through ESPs. The sulphur injection rate should generally be low in comparison to the inherent sulphur from the coal.

ESPs are generally highly effective at removing particulate matter, including very small particulates. They are able to operate at high temperatures and handle high gas volumes with low operating costs. The main disadvantages of ESPs are the initial capital costs, the dependence on particulate resistivity, and the inability to handle explosive gases.

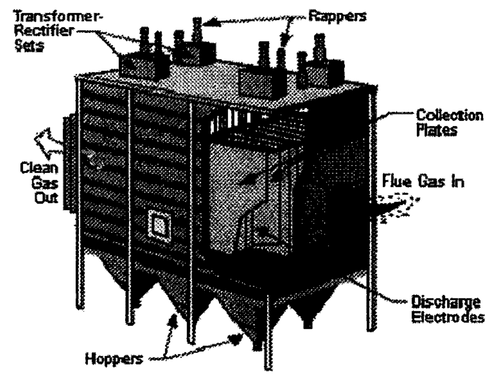


Figure 59: Conventional Electrostatic Precipitator (EPA, 2010)

Fabric filters

Fabric filters are a well-known and widely applied method for separating dry particulates from gas flow. The gas passes through a set of filter bags in parallel leaving particulates retained on the fabric, this layer of "dust" then further improves the filtration efficiency for small particulates. The bags are periodically cleaned (usually by pulses of compressed air) in order to drop the filter cake off the bag for collection in hoppers at the bottom of the filter.

Fabric filters are generally highly effective at removing particulate matter, including very small particulates. They can operate on a wide variety of dust types. The main disadvantages are susceptibility to corrosive gases, fire, moist gas streams and the temperature limitations of the bags.

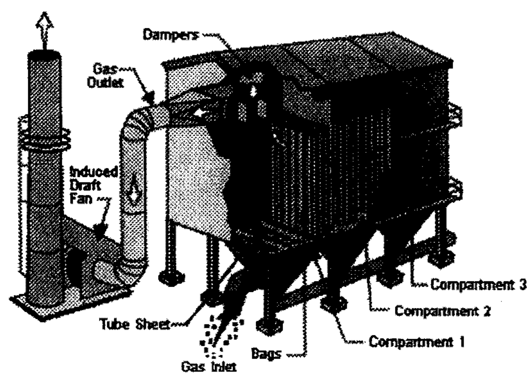


Figure 60: Fabric filter Plant (EPA, 2010)

Scrubbers

Scrubbers come in various forms and combinations of devices used for wet and dry abatement. Particulate scrubbers are generally wet collection devices. There are numerous forms of scrubbers; however, the main method of removal of particulates is through the entrapment of particulates in droplets (usually water droplets) and subsequent removal from the gas stream.

Scrubbers may have high efficiencies for a range of particle sizes and are generally suitable for moist, corrosive, and explosive gas streams. They have the disadvantage of producing effluent and being more maintenance intensive than fabric filters and ESPs.

4.2.1.2 SO_2 prevention and abatement

SO_2 emissions are generally associated with the combustion of coal, although other sources of SO_2 exist depending on the raw materials employed in certain processes. The rate of generation of SO_2 is dependant primarily on the sulphur content of the source. Sulphur content in coal depends on the source of the coal used. South Africa's coal reserves are mainly bituminous with a relatively high ash content (about 45%) and low sulphur content (about 1%) (DEAT, 2004). Coal is the most prolific source of fossil energy in South Africa, and is particularly abundant on the South African Highveld. It is thus a prime source of energy for industrial processes as well as for domestic thermal requirements.

SO_2 emissions are most effectively prevented through limiting sulphur input. SO_2 is a soluble acidic gas and there are various means of removing or reducing SO_2 from gas emission streams. The most commonly used means of reducing emissions is by absorption in scrubber water, or by dissolution and neutralisation in alkaline scrubber water. SO_2 may also be removed through dry scrubbing, or lime dosing.

4.2.1.3 NO_2 prevention and abatement

There are two main sources of oxides of nitrogen (NO_x):

1. Thermal NO_x
2. Fuel NO_x

Thermal NO_x is produced by the reaction of oxygen with nitrogen at high temperatures and typically originates from high temperature combustion processes. The rate of thermal NO_x formation depends on the temperature and residence time during which the reagents are exposed to high temperatures, in particular residence time in flames where temperatures can be as much as 2000°C. Thermal NO_x can thus be reduced by reducing flame temperatures and reducing oxygen availability in high temperature zones. This requires specially designed combustion equipment that employs numerous methods to reduce flame temperature, oxygen availability and residence time, including, but not limited to:

- Off-stoichiometric combustion;
- Low NO_x burners;
- Flue gas recirculation;
- Gas re-burning; or
- Water injection (or steam injection).

Fuel NO_x depends on the nitrogen content of the coal used. The rate of NO_x generation is governed largely by the availability of oxygen during combustion, and is less temperature-dependent than thermal NO_x formation.

NO_x emission levels can also be reduced through flue gas treatment (FGT), the primary means of which are wet absorption, dry sorption, catalytic and non-catalytic conversion.

4.2.2 Power generation

Eskom generates approximately 95% of the electricity used in South Africa and relies on coal-fired power stations to produce approximately 92.5% of its electricity (http://www.eskom.co.za). A summary of abatement equipment in place at the various units is presented in Table 45. The tall stacks at power stations, coupled with high buoyancy plumes, aid dispersion and reduce ground-level concentrations in proximity to power stations. Under stable conditions, the plume is generally released above the surface temperature inversion, while during convective conditions, the plume dilution occurs throughout a considerably deeper atmospheric layer.

Table 45: Power generation abatement equipment

Power station	Capacity (MW)	Stack height (m)	Particulate technology	Notes
Majuba	4110	220	Fabric Filter	
Kendal	4116	275	ESP (+FGC)	
Tutuka	3654	275	ESP	
Duvha	3600	300	Units 1-3: Fabric Filter Units 4-6: ESP (+FGC)	
Matla	3600	275 & 213	ESP (+FGC)	
Kriel	3000	213	ESP (+FGC)	
Hendrina	1995	155	Fabric Filter	
Arnot	2280	195	Fabric Filter	
Grootvlei	1200	152	3 Fabric Filter + 3 ESP (+FGC)	Return to service
Komati	1000	220	ESP (+FGC)	Return to service
Camden	1520	155	Fabric Filter	Return to service
Kusile	4800	220	Fabric Filter	Future

4.2.2.1 Fuel

Energy content is a key consideration in the cost of coal. Higher calorific value coal generally fetches higher prices and has a higher export demand while low calorific value coal generally has high ash content. Sulphur content is also a consideration due to the environmental restrictions for sulphur emissions in many parts of the world.

Power stations are generally fired with relatively low-grade coal, thermal value ranging from 12Mj/kg (megajoules per kilogram) to 25Mj/kg (Table 46). Export quality coal generally starts at about 25Mj/kg. (http://www.miningmx.com/news/energy/913174.htm).

The use of low-grade coal in coal-fired power stations requires large quantities of coal being used as fuel source resulting in relatively higher gaseous and particulate emissions. Large coal stockpiles, and significant amounts of ash generated for disposal, are also a source of fugitive particulate entrainment.

Table 46: Eskom fuel quality and quantity (http://www.eskom.co.za/enviroreport01/resource.htm)

	2000	1999	1998	1997	1996
Coal mined, kt	90 740	91 157	92 252	88 695	81 225
Coal burnt, kt	92 289	88 470	87 225	90 169	85 401
Average CV MJ/kg	19.50	19.53	19.84	19.68	19.83
Average ash content, %	28.6	28.5	29.1	28.4	27.8
Average sulphur content, %	0.90	0.96	0.93	0.94	0.97

4.2.2.2 Particulate abatement

Eskom power stations are all fitted with PM emissions abatement equipment. These are either fabric filters or ESPs. At all Eskom's power stations except for one, the performance of electrostatic precipitators is enhanced with flue gas conditioning plants.

4.2.2.3 SO_2 abatement

Acid gas prevention and abatement

None of the currently operating power stations has flue gas desulphurisation (FGD) technology installed. There are various means of removing SO_2 from flue gases. Eskom has committed to installing flue gas desulphurisation at the Kusile station. This will be the first coal-fired power station in South Africa to have FGD installed.

4.2.2.4 NO_x abatement

The prevention of NO_x formation is largely dependent on the combustion process dynamics (primarily flame temperature and residence time) and the nitrogen content of the coal used. Boiler configuration is of importance and typically, tangentially-fired boilers deliver lower NO_x emissions than wall-fired boilers, primarily due to operating temperatures. It is not clear to what extent such technologies are in use at power generation plants in the HPA.

4.2.3 Petrochemical industry

Petrochemical industry within the HPA is dominated by coal to liquids production. Various processes are operated, the key sources of emissions are:

- Electricity generation;
- Gasification;
- Waste gas flaring; and
- Fugitive emissions from various processes and material piles.

4.2.3.1 Electricity generation

The petrochemical industry requires vast amounts of electricity to drive its internal processes; it is thus cost effective to generate power onsite. This is a achieved by on-site fired boilers, where pulverised coal is burned in order to produce electricity in much the same manner as other coal fired power stations in the HPA. Other fuel sources such as natural gas and products from internal production facilities may also be used.

These boilers are the most significant source of PM_{10}, NO_2 and SO_2, generated in the same manner as for coal fired power stations, with the same technologies applied.

4.2.3.2 Gasification

Sasol, specifically, has the technology to produce liquid and gas fuels from low-grade ore and operates mines that supply its operations. The traditional production units are Lurgi fixed bed gasifiers (NTIS, 1980) and more recently; moving-bed 3-phase reactors have been introduced for better production and efficiency. Ash from the gasification chambers is quenched in water, in the process releasing ash particulates with the steam evolved from the quenching process.

4.2.3.3 Flaring

Flares are employed for disposing of waste gases from the plant processes and process upsets. The high flame temperature and excess air introduced through turbulent mixing in the flare flame is expected to generate significant thermal NO_x.

4.2.4 Primary metallurgical

South Africa has significant metallurgical ore resources, and is a significant global contributor in many sectors of the ferroalloy industry, and related industrial chemicals industries. The "primary metallurgical group", in this study, encompasses pyrometallurgical processes and vanadium chemicals producers in the HPA, in the main:

- Ferrochrome producers;
- Ferrovanadium producers;
- Ferromanganese producers;
- Iron and steel producers;
- Vanadium chemicals producers; and
- Ferrosilicon producers.

In all cases, production involves the application of pyrometallurgical processes for the winning of primary, intermediate and/or final products from ore. The primary energy sources for these processes are:

- Coal;
- Natural gas; and/or
- Electricity.

In many instances, coal also provides the fundamental reagent (carbon) required for reduction of raw materials to yield ferroalloys.

Emissions associated with these operations typically include the three primary atmospheric pollutants covered in the HPA AQMP (i.e. PM, NO_2, and SO_2), however the full suite of pollutants depends on the nature of the processes undertaken as well as the nature of the raw materials and products. Pollutants of potential significance may include:

- CO;

- Particulates containing heavy metals in various states of oxidation depending on the source; and/or
- Organic and inorganic volatile and semi-volatile emissions.

Key emission sources include:

- Kilns (gas fired, and coal fired);
- Electrode arc furnaces; and/or
- Blast oxygen furnaces.

Other sources of potential significance include:

- Material stockpiles;
- Vehicle entrainment on unpaved roads; and
- Slag and other bulk waste heaps.

Fugitive emissions from operational procedures such as oxygen lancing and tapping may also be significant.

4.2.4.1 Particulate abatement

Key emission sources are in most, if not all, cases fitted with emissions extraction and abatement equipment. Particulate abatement is achieved mainly by:

- ESPs;
- Fabric filters;
- Wet scrubbers; and/or
- Cyclone separators.

Cyclone separators

Cyclone separators are mostly used as pre-cursors to the other three systems. In some cases, only cyclones are used for cleaning gas streams laden with relatively large particles.

ESPs and fabric filters

ESP and fabric filters are used in instances where flue gases are not explosive. ESPs have the advantage of being able to operate at higher temperatures; however, bagfilters are not dependent on the resistivity of the particulates they capture.

Wet scrubbers

Operations such as closed electrode arc furnaces produce significant amounts CO. CO is highly flammable and can be explosive. Generally, wet scrubbers are used for particulate removal in these instances. The clean gas is then flared.

Fugitive emissions

Fugitive emissions are often not captured or efforts to capture these emissions are not very effective. Dust entrainment from unpaved roads is in some cases reduced by application of water or chemical palliatives.

4.2.4.2 SO_2 prevention and abatement

SO_2 abatement is achieved as a secondary benefit of the use of wet scrubbers for closed furnace and other off-gases. In some cases, the use of low sulphur coal may reduce SO_2 emissions.

4.2.4.3 NO_2 prevention and abatement

Conversion of open furnaces to closed and semi-closed furnaces at some facilities is expected to reduce the availability excess oxygen required for formation of both thermal and fuel NO_x. However, thermal NO_x is subsequently generated in clean gas flares.

4.2.5 Clay brick manufacturing

The brick manufacturing process has six general phases, namely:

1. Mining and storage of raw materials,
2. Preparing raw materials by sizing and screening,
3. Forming the brick,
4. Drying,
5. Firing and cooling in a furnace, and
6. De-hacking and storing finished products (The Brick Industry Association, 2006).

The firing process is the most significant source of atmospheric pollutant emissions. Significant quantities of fossil fuels are burned to generate heat for brick curing. A combination of fuels may be used, including coal, natural gas, sawdust, and used oil.
A variety of kiln types exist, the most commonly used technologies in South Africa are:

Clamp Kiln: this is an old brick manufacturing technology and is the most commonly used kiln in the developing world. Generally built with four brick walls like a room, then green bricks are stacked inside. Clamp kilns are fuel inefficient and produce significant emissions of particulate matter and CO from incomplete combustion. Pollutant emissions are uncontrolled.
Tunnel Kiln: this technology is common in developed countries. Since their invention, tunnel kilns have now become highly automated and are for high-volume brick production. Bricks move mechanically through a long stationary fire zone. These kilns have the benefit of being able to exhaust emission through flue stacks, and thus can be fitted with abatement equipment.

Clamp kilns are not fitted with abatement equipment. Tunnel kilns are in some instances fitted with cyclones and/or fabric filters.

The wide-scale use of coal leads to significant SO_2 emissions, however no SO_2 abatement is in use. Both thermal and fuel NO_x may be generated, however the low temperatures and lack of excess oxygen imply that NO_x generation is low.

4.2.6 Secondary metallurgical sources and other industrial sources

These categories encompass a wide variety of processes, some of which are scheduled processes in terms Schedule 2 of APPA. A wide variety of pollutants is emitted from these sources, including the three key pollutants of interest (PM_{10}, SO_2 and NO_2). SO_2 emissions are primarily associated with, but not limited to, the combustion of coal. Emissions of NO_2 are generally associated with, but not limited to, combustion processes.

Various technologies are applied for the abatement of particulate matter. In the main, these are:

- (ESPs;
- Fabric filters;
- Scrubbers; and/or
- Cyclone separators.

Abatement for SO_2 and NO_2 is rare, however in cases where scrubbers are used there is the benefit of absorption of SO_2 and NO_2.

4.2.7 Opencast coal mining

Opencast mining is widely employed for the economical extraction of coal deposits close to surface in the HPA. The key atmospheric pollutant emitted from these operations is PM. There are various sources of PM emissions including, but not limited to, the following:

- The use of vehicles on unpaved and paved roads for transporting ore, personnel, waste rock etc.;
- Blasting;
- Overburden stripping;
- Ore and overburden handling;
- Crushing and screening of ore; and
- Wind entrainment from stockpiles.

It has been noted previously that the primary contributor to PM is from unpaved mine haul roads. The force of the wheels of a vehicle that travels on an unpaved road surface causes pulverisation of surface material. Particles are lifted and dropped from the rolling wheels, and the road surface is exposed to strong air currents in turbulent shear with the surface. The turbulent wake behind the vehicle continues to act on the road surface after the vehicle has passed (US EPA, 1995).

The rate of PM entrainment is largely dependent on the characteristics of the wearing course material, the mass and number of vehicles travelling and, to an extent, the speed at which these vehicles travel on the roads. Mines apply various means of reducing haul road-related PM emissions through the application of palliative measures. These include:

- Application of chemical palliatives;
- Applying vehicle speed constraints;
- Providing a tightly-bound wearing course material;
- Armouring the surface (placing a thin layer of higher quality wearing course on the existing material or turning this into the top 50mm of material);
- Good maintenance practices; and/or
- Regular light watering of the road.

The degree to which these methods are applied varies across mines. Under typical summer conditions, for a water-based spray suppression system with a large rear-dump truck running on a well-built and maintained haul road, re-watering is required at approximately 30-minute intervals to maintain a dust defect that at no time exceeds a score of two. Under winter conditions, the re-application interval extends to approximately 50 minutes (Thompson & Visser, 2000). This approach therefore requires dedicated resources and management but can be effective if undertaken correctly and is considered a relatively cheap option.

The palliation achieved using chemical palliatives can significantly reduce dust emissions from mine haul roads. All palliatives (with infrequent watering) share one common failing as compared with frequent water-spray systems. This is the inability to prevent material spillage from being entrained. In mines where spillage cannot be effectively controlled, watering or removal of spillage by sweepers/vacuum in combination with a dust palliative may prove to be more effective for dust control.

Poor wearing course materials generally cannot be improved to deliver adequate performance solely through the addition of a dust palliative, and this may be a significant factor in inhibiting dust suppression in some cases.

4.3 Summary

There are numerous emission sources each with unique emission characteristics. However, many similarities in the physical and chemical processes that generate these pollutants exist, and in the prevention and abatement technologies that may be applied.

In general, it is noted that:

- Significant emphasis is employed in controlling particulate emissions from point sources, and a variety of abatement means are applied.
- The management of fugitive or non-point sources of particulate emissions is less vigorously applied and in many cases, non-point emissions are uncontrolled.
- Point source particulate emissions are also regulated for scheduled processes to a larger extent than non-point sources. This is a contributing factor to the lack of non-point source emissions management.

- Prevention and/or control measures for SO_2 and NO_2 emissions are not commonly employed, although various practicable technologies and means exist for preventing and/or controlling these pollutant emissions.
- Regulation of scheduled processes has, in the past, placed a more significant focus on particulate emissions and this is also a contributing factor to the lack of SO_2 and NO_2 emissions management.

5 HPA AIR QUALITY PROBLEM DESCRIPTION

5.1 Ambient air quality problem areas

Exceedances of ambient air quality standards present situations where potential impacts on human health can occur. Ambient monitoring and dispersion modelling have identified nine areas on the HPA where ambient concentrations of PM_{10}, SO_2 or NO_2 exceed, or predicted to exceed, the ambient standards. Pixley ka Seme is discussed as a hotspot however, only exceedances of O_3 have been confirmed through monitoring and this is regarded as a regional-scale problem. Exposure may be high where these exceedances coincide with populated areas and the risks to human health may be significant.

The air quality hot spots on the HPA are summarised in Table 47 with an indication of the pollutants of concern.

Table 47: HPA air quality hot spots

Hot Spot	PM_{10}	SO_2	NO_2
Emalahleni	✓	✓	
Kriel		✓	
Steve Tshwete	✓	✓	✓
Ermelo	✓	✓	
Secunda	✓	✓	✓
Ekurhuleni	✓	✓	
Lekwa	✓	✓	
Balfour	✓		
Delmas		✓	

It is important to note that all residential areas where wood and coal are combusted experience high concentrations of particulates and CO, particularly those that are densely populated. Here, exposure can be particularly high. Due to the relatively local scale of their air pollution problem, they may not fall directly into one of the identified hot spot areas in Table 47. They are equally as important in terms of AQM and are discussed further in paragraph 3.2.4.

High ambient ozone concentrations are a regional-scale problem with the 8-hour ambient standard frequently exceeded over much of the HPA. Ozone is not a source-specific pollutant, but its formation depends on the ideal ratios of NO_x and VOC, together with incident ultra-violet radiation from the sun. Both NO_x and VOC are emitted by different sources on the HPA.

5.2 *Abatement technology problems*

Table 48: Summary of technology challenges and developments in key sectors in the HPA

	Challenges	Developments
Industrial sources	• Management of fugitive and non-point sources • SO_2 and NO_2 emission management and control • Environmental and technical constraints on abatement choices	• Listed Activity minimum emission standards and AEL conditions may begin to address current shortcomings in abatement
Clay brick manufacturing	• Poor uptake of Tunnel kiln technology • Lack of abatement on clamp kilns, particularly of PM and CO emissions	• Tunnel kiln technology is promoted in new, regulated operations
Opencast coal mining	• Control of PM from mine haul roads	• Water spraying is a cheap and effective means of control, which needs to be consistently applied across mines in the HPA
Domestic fuel burning	• Poor uptake of technology due to economic circumstances • Pace of settlement growth	• Rollout of awareness and technology promotion activities is increasing
Motor vehicle emissions	• Slow infiltration of new technology vehicles • Growth in vehicle parc • Diffuse VOC emissions from filling stations and fuel storage facilities	• Vehicle emission standards continue to improve • Drive towards cleaner fuels and low emission vehicles is increasing • Vapour recovery units can address re-fuelling emissions

5.3 *Air quality management capacity*

Table 49: Summary of capacity challenges in the HPA

AQ management aspect	Level of capacity
Human resources and skills	2 municipalities are not confident to implement the AQA 5 municipalities have not made AQO appointments 12 municipalities and both provincial departments have identified capacity building needs, ranging from technical to legal to general AQM training and assistance
Monitoring	6 municipalities indicated that no ambient air quality monitoring takes place Existing monitoring initiatives are not integrated, there is no standardised monitoring, reporting and quality control approach No in-house technical skills for maintenance and operation of stations
Emission inventory	12 municipalities and 1 provincial department have undertaken an emission inventory exercise The HPA project has produced a relatively comprehensive emission inventory, this needs to be completed and maintained
AEL preparation	2 district municipalities and 1 provincial department have not initiated steps to prepare for the delegation of the AEL function with the repeal of the APPA

6 AQMP OVERALL OBJECTIVE AND GOALS

The overall objective for the HPA AQMP has been developed through multi-stakeholder interactions and is informed by policy and developments in AQM in South Africa. The overall objective is:

Ambient air quality in the HPA complies with all national ambient air quality standards

The overall objective is intended to guide government, communities and other stakeholders and frame the implementation of the AQMP. It echoes the regulatory standing given to the priority area declaration and recognises the importance of air quality as a significant measure in an area with this status.

Seven goals of the AQMP each address different aspects of meeting the overall objective, these are:

Goal 1: By 2015, optimise organisational capacity in government to efficiently and effectively maintain, monitor and enforce compliance with ambient air quality standards

In achieving the goal, it is necessary to focus on institutional arrangements, resource availability, cooperation and collaboration as well as maximisation of regulatory and management tools. Capacity development in the AQMP is addressed holistically, looking at the necessary structures, systems, skills, incentives, inter-relationships and strategy.

Goal 2: By 2020, industries equitably reduce emissions to achieve compliance with ambient air quality standards and dust fallout limit values

The goal will be achieved through a combination of emission determination and reduction, technological improvement, improved resource allocation and information provision. The use of regulatory tools and best practice principles is also provided for. Political and social awareness, alternative energy and energy efficiency, fugitive dust emissions and greenhouse gas emission reduction are also promoted as aspects towards achieving the goal. The maintenance of vehicles and equipment on sites and industrial plants are addressed, and spontaneous combustion is addressed as a contribution from the industrial mining sector.

Goal 3: By 2020, air quality in all low-income settlements is in full compliance with ambient air quality standards

Effective interventions, research, awareness raising and education are major aspects in achieving the goal. Technological improvements are also critical, together with addressing the social and economic drivers of poor environmental practices.

Goal 4: By 2020, all vehicles comply with the requirements of the National Vehicle Emission Strategy

To achieve the goal, the focus is on the implementation of the National Vehicle Emission Strategy, as it will provide direction on emission reduction, technological improvement, and a conducive regulatory environment. Emission testing is recognised as a major driver for current reductions in vehicle emissions, which can be instituted by provincial and local authorities.

Goal 5: By 2020, a measurable increase in awareness and knowledge of air quality exists

Achieving the goal is linked to access to information, resources, improving governance and authorities' capacity, and promoting air quality issues amongst stakeholders.

Goal 6: By 2020, biomass burning and agricultural emissions will be 30% less than current

Management and regulatory tools are keys to achieving the goal, together with improved individual practices such as reduction of polluting inputs, awareness of unsuitable conditions and use of control measures.

Goal 7: By 2020, emissions from waste management are 40% less than current

In achieving the goal, it is necessary to improve waste processing, promote best practice principles and technological improvements, as well as address planning and delivery shortcomings, and improve regulatory control of all aspects of waste management.

7 AQMP IMPLEMENTATION PLAN

7.1 Stakeholder roles and responsibilities

The responsibilities of the authorities functioning in the HPA are listed in the AQA and are further elaborated upon in the National Framework.

The regulated roles and responsibilities of the HPA authorities have been used an input into the implementation plan for the AQMP. These are described further in Section 3.5. Roles and responsibilities of other spheres of government are described in the AQA and National Framework for AQM. The roles and responsibilities of other stakeholders in the HPA are clearly outlined, and education and awareness roles are suggested, as well as the adoption of good environmental practices. Reference to industries in the implementation plan is broad and all encompassing, including listed and smaller non-listed activities, as well as municipal-, provincial- and state-operated entities.

Several platforms for inter-governmental, as well as other stakeholder, cooperation and collaboration exist in the HPA. Examples of these groups are listed in Table 50. These groups can constitute part of the membership of the AQMP Working Groups, assist in implementation of the AQMP, and communicate progress on implementation. The available mechanisms can be maximised to ensure the implementation of the AQMP.

Table 50: Air quality groups operating in the HPA

Name	Membership
HPA Multi-Stakeholder Reference Group	All interested and affected parties in the HPA
Ekurhuleni Environmental Forum	Business, industry and authorities in Ekurhuleni
GDARD AQM and Climate Change Multi-Stakeholder Forum	Authorities in Gauteng
Highveld branch of National Association for Clean Air (NACA)	Industry and authorities in Mpumalanga
Mpumalanga Air Quality Officers' Forum	Provincial Air Quality Officer, Air Quality Officers from each local and district municipality, DEA
Gert Sibande District Air Quality Officers' Forum	District and Local municipality AQO's
Nkangala District Environmental Forum	MDEDET, district and local authorities

7.2 Implementation plan

It is important to note that the effectiveness of the implementation plan presented here has not been tested, therefore, a final implementation plan will be developed as a starting point of the implementation process.

Timeframes: Short-term (1-2 years); Medium-term (3-5 years); Long-term (>5 years)
Responsibilities: P = Principal; I = Input; O = Oversight

1. By 2015, organisational capacity in government is optimised to efficiently and effectively maintain, monitor and enforce compliance with ambient air quality standards

Objectives	Activities	Timeframe	Responsibility	Indicator
1) Goals and objectives of HPA AQMP are implemented through respective business plans	Use HPA AQMP to inform business planning for air quality function	Short, On-going	P – DEA, MDEDET, GDARD, Municipalities	• Business plans include HPA AQMP goal and objectives • HPA AQMP incorporated within IDP/ EIPs • Council resolution passed adopting municipal AQMPs
	Draft municipal-level AQMP case study using HPA implementation plan	Short	P – DEA I - MDEDET, GDARD, Municipalities	
	Adopt HPA AQMP as part of IDPs and EIPs	Short	P - MDEDET, GDARD, Municipalities	
2) Air quality function is assigned to the most appropriate section of municipalities and provinces	Consultation between local, district and provincial authorities to identify the most appropriate sphere for AQM function on behalf of each municipality	Short	P – MDEDET, GDARD, affected municipalities	• AQM function allocation or delegation made for every municipality • Functional analysis conducted and assignment made
	Create database of AQM functional analyses conducted	Short	P – DEA I – Provincial environmental authorities, Municipalities	
	Conduct functional analysis or Section 77/78 Municipal Systems Act analysis to determine suitable section/department for AQM and assign function accordingly	Short	P – MDEDET, GDARD, affected municipalities O – MDEDET, GDARD, DEA	
3) Institutional arrangements accommodate AQM function	Revise organograms to create air quality structure and designation, where needed	Short	P – affected municipalities	• AQO appointed • AQM responsibilities

Objectives	Activities	Timeframe	Responsibility	Indicator
	Optimise air quality resource availability	Short	P – affected municipalities	allocated to personnel • Staff appointed to fill AQM posts in organogram • AQM scarce skills retention policy developed
	Fill AQM posts with appropriately skilled staff	Short	P – affected municipalities	
	Develop/ revise retention policies to retain scarce AQM skills	Short	P – MDEDET, GDARD, Municipalities	
4) Cooperative governance and collaboration occurs between well- and poorly- skilled AQM sections	Establish statutory inter-governmental cooperation mechanism to harmonise AQM decision making (under IGRFA) e.g. joint licensing tribunal	Short, On-going	P – DEA, MDEDET, GDARD, Municipalities	• Cooperation mechanism established and regular meetings held • Forum established and regular meetings held • Reports made to HPA Standing Committee
	Provide guidance and assistance in AQM to provincial and local authorities	Short, On-going	P – DEA, MDEDET, GDARD, municipalities	
	Establish inter-governmental forum to coordinate air quality governance in the HPA and reporting mechanism for the Standing Committee	Short, On-going	P – MDEDET, GDARD O – DEA I – Municipalities	
5) Personnel are equipped to perform AQM function and use AQM tools effectively	Cooperatively develop training guideline document to identify skills training needs for AQM	Short	P - DEA I - MDEDET, GDARD, Municipalities	• Training guideline developed • Skills gap analysis conducted • Skills development plans implemented • Standard courses used for training • Consultation with tertiary and other training institutions to develop standard and specialised AQM courses • AQM research needs
	Conduct AQM skills gap analysis to identify areas of capacity development for assigned sections/departments	Short	P – MDEDET, GDARD, Municipalities	
	Develop skills development plans to address identified gaps	Short	P – MDEDET, GDARD, Municipalities	
	Implement skills development plans	Short, On-going	P – MDEDET, GDARD, Municipalities	

Objectives	Activities	Timeframe	Responsibility	Indicator
	Engage with tertiary institutions to offer standardised, accredited AQM courses (undergraduate and post-graduate level) and other training institutions to offer specialised accredited AQM training short courses	Short, On-going	P – DEA I - MDEDET, GDARD, Municipalities	identified and communicated
	Coordinate officials' schedules to enable attendance of courses	Short, On-going	P – DEA, MDEDET, GDARD, Municipalities	
	Engage with NACA on sponsorship of AQM capacity development	Short	P – DEA I - MDEDET, GDARD, Municipalities	
	Determine areas of research needed in AQM and communicate to relevant research institutions	Short	P- DEA I - MDEDET, GDARD, Municipalities, Research institutions	
6) Financial resources are available for air quality governance	Develop AQM implementation plan and budget to give effect to adopted HPA AQMP and include in IDP/ EIP	Short	P – MDEDET, GDARD, Municipalities	• AQM implementation plan and budget developed and included in IDP/ EIP • Consultation meetings held with D-COGTA and SALGA
	Engage with D-COGTA and SALGA to address specific financial and performance management needs of priority areas	Short	P – DEA, Municipalities	
7) All AELAs and AQOs have extensive practical experience in air quality governance	Responsible personnel undergo AEL training	Short	P - AELAs	• AEL training completed • AEL system established • APPA Registration Certificates converted to AELs • Air quality noted in EIA process • Industrial plant comply with AEL conditions
	AEL system is established by AELAs	Short	P - AELAs I - DEA	
	Convert APPA Registration Certificates to AELs	Short – medium	P - AELAs I - DEA	
	Contribute to EIA decision-making and environmental authorisations through commenting on air quality impact assessments	Short, On-going	P – MDEDET, GDARD, Municipalities	

Objectives	Activities	Timeframe	Responsibility	Indicator
	Conduct regular inspections to monitor plant performance and compliance	Short, On-going	P – MDEDET, GDARD, Municipalities I - DEA	• Emission reporting regulation published • Emission reports received and processed regularly • Mechanism developed for recognition of good performance • Presentations made and discussion held on AQM activities
	Develop and publish emission reporting regulation for reporting to authorities	Short	P – DEA I – MDEDET, GDARD	
	Enforce emission reporting regulation	Short, On-going	P - AELAs	
	Acknowledge good performance/compliance e.g. annual awards	Medium, On-going	P - MDEDET, GDARD I – DEA, Municipalities	
	Carry out enforcement action on all non-compliant incidences	Short, On-going	P - AELAs I – Other non-AELA municipalities	
	Use established inter-governmental governance forum as an experience-sharing platform	Short, On-going	P – MDEDET, GDARD, Municipalities I/O - DEA	
8) Development planning in the HPA recognises the objectives of the AQMP	Include air quality in environmental decision-making tools for land use planning	Short, On-going	P – MDEDET, GDARD, Municipalities	• Air quality criteria are included in planning decision-making and discussed in policy • Status quo case study prepared
	Align and integrate municipal and provincial AQMPs and other environmental planning tools with the IDP/ EIP in the HPA	Short, On-going	P – MDEDET, GDARD, Municipalities	
	Draft status quo assessment case study for use in AQMPs and other planning tools	Short	P – DEA I - MDEDET, GDARD, Municipalities	

Objectives	Activities	Timeframe	Responsibility	Indicator
	Develop HPA pilot for national AQMP support programme	Short	P - DEA	
9) Use of air quality management tools such as ambient monitoring, emission inventories, dispersion modelling, etc. are optimised and expanded	Develop monitoring station purchase and operation guideline, including capacity development activities	Short	P – DEA, I - MDEDET, GDARD, EMM	• Improved data availability at stations • Publicly available data has undergone quality assurance and control and is up-to-date • Annual monitoring and emission reports are available • Annual reports are presented at Air Quality Governance Lekgotla • Updated HPA emission database is available • Emission database is 80 % complete • Scenario modelling is carried out for HPA
	Conduct quality control and assurance on all data to assist compliance monitoring	Short, On-going	P – DEA, MDEDET, GDARD, EMM	
	Upload monitoring data to SAAQIS routinely	Short, On-going	P – DEA, MDEDET, GDARD, EMM	
	Compile annual reports on monitored data, for technical and AQM purposes	Short, On-going	P – DEA, MDEDET, GDARD, EMM	
	Improve HPA emission database to make it current and representative	Short	P – DEA I – MDEDET, GDARD, Municipalities	
	Maintain the database to ensure it remains current and representative	Short, On-going	P – DEA I – MDEDET, GDARD, Municipalities	
	Compile annual reports on emissions data, for technical and AQM purposes	Short, On-going	P – DEA I - MDEDET, GDARD, Municipalities, Industries	
	Configure HPA dispersion model	Short	P – DEA I – Industries	
	Use HPA dispersion model to assist planning and decision making	Short, On-going	P – DEA I – MDEDET, GDARD, Municipalities	

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Objectives	Activities	Timeframe	Responsibility	Indicator
10) Progress on the implementation of the HPA AQMP is monitored	Establish a Standing Committee with governance stakeholders to assess and report on progress with the HPA AQMP implementation	Short, On-going	P – DEA I – MDEDET, GDARD, Municipalities	• Standing Committee established and operational • Progress reports on AQMP implementation available
	Develop progress reports regularly	Short, On-going	P – DEA, MDEDET, GDARD, Municipalities	

2. By 2020, industrial emissions are equitably reduced to achieve compliance with ambient air quality standards and dust fallout limit values

Objectives	Activities	Timeframe	Responsibility	Indicator
1) Emissions are quantified from all sources	Establish and maintain a site emission inventory that includes all point and diffuse sources for all significant pollutants	Short, On-going	P - Industries	• Site emission inventories completed • Emission reports available
	Submit emission inventory report as per emission reporting regulation	Short, On-going	P - Industries O - AELAs	
2) Gaseous and particulate emissions are reduced	Determine equitable emission reduction for specific industries: • Identify significant emitters in HPA • Submit AIR's using a regulated modelling approach • Determine equitable emission reduction using AIR submissions and industrial action plans (Appendix 6) • Issue AELs with emission reduction requirements and industrial action plan commitments	Short	P – DEA, AELAs, Industries I – Other non-AELA municipalities	• AELs issued with emission reductions • Emission reduction measures implemented by industries • Maintenance plans implemented • Reduced disruptions to plant operations
	Develop and implement maintenance plan for each plant	Short	P – Industries	
	Schedule and conduct repairs to coincide with plant offline times	On-going	P – Industries	
	Incorporate equipment changes into maintenance schedule	On-going	P – Industries	
	Operate plants with minimum disruption e.g. back-up plan for energy consumption/ generation	Short, On-going	P – Industries	
3) Fugitive emissions are minimised	Develop fugitive emission management plan	Short	P – Industries I - DEA, AELAs	• Fugitive emission management plan developed and implemented • Reduction in fugitive emissions
	Implement appropriate interventions e.g. LDAR programme	Short, On-goin	P – Industries O - DEA, AELAs	

Objectives	Activities	Timeframe	Responsibility	Indicator
4) Emissions from dust-generating activities are reduced	Develop and implement dust reduction programmes in line with industry best practice, considering technology and management interventions	Short, On-going	P – Industries O - DEA, AELAs	• Dust reduction programme implemented • Fleet maintenance carried out • Alternate haulage and waste management investigated
	Investigate feasibility of using alternative means for haulage e.g. conveyer, rail	Medium	P – Industries	
	Plan and carry out regular fleet maintenance	Short, On-going	P – Industries	
	Investigate opportunities to market waste as raw material inputs to other industries e.g. discard coal	Medium	P – Industries	
5) Greenhouse gas emissions are reduced	Include greenhouse gas emissions in site emission inventory	Short	P – Industries	• Site greenhouse gas emission inventories compiled • Energy efficiency plans implemented
	Develop and implement a site energy efficiency plan	Short	P – Industries I - DEA, MDEDET, GDARD, Municipalities	
	Consider climate change implications in AQM decision-making	Short, On-going	P – Industries	
	Investigate opportunities for co-generation e.g. off-gas as an energy source	Short – Medium	P – Industries	
	Investigate feasibility of renewable energy	Short – Medium	P – Industries	
6) Incidences of spontaneous combustion are reduced	Promote research needs regarding spontaneous combustion	Short	P – DEA I - MDEDET, GDARD, Municipalities	• Research needs communicated • Consultation with DMR on abandoned mines • Reduced incidences of spontaneous combustion
	Communicate the need to determine abandoned mine ownership to facilitate rehabilitation and/or closure	Short	P – DEA	
	Promote the need for compliance monitoring of abandoned mines	Short	P – DEA	

Objectives	Activities	Timeframe	Responsibility	Indicator
	Implement and enforce discard dump management regulations	Short	P – DEA	
	Improve supply and demand forecasting to reduce coal stockpile size and limit coal stockpile retention time	Medium	P – Industries	
7) Abatement technology is appropriate and operational	Install and/or maintain appropriate air pollution abatement technology compliant with requirements of AEL and achieving Section 21 emission standards	Short – Long	P – Industries	• Air pollution abatement technology installed • Equipment operated optimally • Individual technology benchmarks completed
	Train operators to ensure optimal operation of abatement equipment	On-going	P – Industries	
	Promote individual benchmarking of abatement technology	Medium	P - DEA	
	Motivate for and undertake research to improve abatement technology and reduce retrofitting costs	Medium	P – DEA, Industries, Research institutions	
8) Industrial AQM decision making is robust and well-informed, with necessary information available	Establish sector information sharing fora	Short	P – Industries	• Sector fora established • Sector best practice guidelines available • Benchmarking promoted
	Compile best practice documents for the sectors	Short – Medium	P – DEA I - AELAs	
	Conduct international benchmarking within the sectors	Medium	P – Industries O – DEA	
	Make sector emission performance information available for company benchmarking	Medium	P – DEA I – Industries	
	Make best practice information available on SAAQIS	Medium	P - DEA	
9) Clean technologies and processes are implemented	Incorporate cleaner technology considerations into AEL	Short	P - AELAs I - DEA	• AEL includes clean technology recommendations • Clean technology feasibility studies conducted
	Investigate feasibility of introducing clean technologies on plant-specific basis	Medium	P – Industries	
	Implement feasible technology options on plant-specific basis	Medium – Long	P – Industries	

Objectives	Activities	Timeframe	Responsibility	Indicator
	Investigate regulatory mechanisms to facilitate introduction of new technology	Medium	P – DEA, MDEDET, GDARD	• Clean technology options implemented
	Investigate feasibility of switching to clean fuels at times of poor dispersion	Medium	P – Industries	
	Investigate alternative design and process options to improve plume dispersion	Medium	P – Industries	
	Implement feasible alternative design and process options	Medium - Long	P – Industries	
10) Adequate resources are available for AQM in industry	Revise organograms to create air quality structure and designation, where needed	Short	P – Industries	• AQM personnel designated • Abatement and measurement financial planning complete
	Optimise environmental management resource availability to accommodate air quality function	Short	P – Industries	
	Fill AQM posts with appropriately skilled staff, where needed	Short	P – Industries	
	Input into financial planning to implement emission abatement and measurement requirements of AEL and Section 21 emission standards	Short	P – Industries	
	Investigate the possible use of offset programmes to reduce financial investments	Medium	P – Industries I - DEA, AELAs	
11) Ambient air quality standard and dust fallout limit value exceedances as a result of industrial emissions are assessed	Conduct ambient air quality monitoring in accordance with AEL requirements	Short, On-going	P – Industries O - AELAs I – DEA	• Ambient air quality and dust fallout monitoring carried out • Monitoring results reported and available on SAAQIS • AIRs updated to include monitoring results
	Conduct dust fallout monitoring in accordance with legislative requirements, and consider advances in monitoring technology	Short, On-going	P – Industries O - AELAs I – DEA	
	Report ambient monitoring results, to relevant AQO and publish on SAAQIS	Short, On-going	P – Industries O – DEA, AELAs	
	Update AIR submissions	Short, On-going	P – Industries O – DEA, AELAs	

Objectives	Activities	Timeframe	Responsibility	Indicator
12) A line of communication exists between industry and communities	Conduct quarterly consultative community meetings	Short, On-going	P – Industries	• Quarterly meetings held between industry and communities

3. By 2020, air quality in all low income settlements is in full compliance with ambient air quality standards

Objectives	Activities	Timeframe	Responsibility	Indicator
1) Implementation of the strategy for dense low income settlements	Promote the objectives of the strategy in dense low income settlements on the HPA	Medium, On-going	P – MDEDET, GDARD I – DEA, Municipalities	• Planning of dense low income settlements considers the objectives of the strategy
2) Clean fuels and technology are used that are affordable and easily available	Coordinate BnM rollout in HPA PM_{10} "hot spot" settlements	Short, On-going	P – MDEDET, GDARD I – DEA, Municipalities, DoE, Industries	• BnM demonstrations held across HPA • Mechanisms to provide clean energy are investigated
	Communicate the air quality benefits of subsidy provision for clean combustion technology (stoves) and clean fuels (anthracite coal, gas) to implementing stakeholders	Short, On-going	P – DEA I – MDEDET, GDARD, Municipalities	
	Motivate for other regulatory and financial mechanisms to improve affordability of clean energy	Short, On-going	P – DEA I – MDEDET, GDARD, Municipalities	
	Communicate the benefit of accessing CDM funding for fuel switching projects in HPA	Short, On-going	P – DEA I – MDEDET, GDARD, Municipalities	
3) Service delivery to low income residential areas is improved	Communicate the air quality benefits of improved service delivery to relevant departments, particularly: • Electrification • Road surfacing • Refuse removal • Greening	Short, On-going	P – DEA, MDEDET, GDARD, Municipalities	• Benefits of service provision are understood in relevant departments • Electrification program is revised to address identified air quality hot spots as priority
	Participate in development of prioritisation methodology for electricity provision	Short	P – DEA, MDEDET, GDARD, Municipalities	
	Engage Eskom to electrify areas of poor air quality in hot spots as a priority	Short, On-going	P – DEA, MDEDET, GDARD	

4) Adequate scientific, health and economic information is available on domestic fuel burning and air quality	Identify and communicate research needs to research institutions and organisations to motivate research on domestic fuel use, particularly emission reduction measures	Short, On-going	P – DEA I – MDEDET, GDARD, Municipalities	• Research on domestic fuel burning and related topics conducted • Research outcomes on domestic fuel burning and related topics available on SAAQIS
	Develop linkage between HPA website and SAAQIS database of available information	Short, On-going	P – DEA I - MDEDET, GDARD, Municipalities, Research institutions, Industries	
5) Low-income and informal households are energy efficient	Participate in the revision of low cost housing design principles	Short	P – DEA, DoHousing, MDEDET, GDARD, Municipalities	• Low cost housing design principles consider energy efficiency
	Communicate the air quality benefits of large-scale subsidised solar water heating and other energy efficient fittings	Short	P – DEA	
	Communicate the benefit of accessing CDM funding for energy efficiency projects in HPA	Short	P – DEA	
6) Social upliftment and development has air quality benefits	Promote air quality-related corporate social investment in low income communities in hot spot areas	Short, On-going	P – DEA, MDEDET, GDARD, Municipalities	• Corporate investment occurs in low income communities in hot spot areas

4. By 2020, all vehicles comply with the requirements of the National Vehicle Emission Strategy

Objectives	Activities	Timeframe	Responsibility	Indicator
1) Regulations for motor vehicle emission reduction is in place	Implement requirements of the national vehicle emission strategy	Short - Medium	P – DEA, DoT, DoE	• National vehicle emission strategy implemented
2) Emission testing capacity is extended	Develop emission testing regulation	Short	P – relevant municipalities	• Emission testing regulated and implemented • Emission testing report compiled
	Acquire emission testing equipment	Short	P – relevant municipalities	
	Conduct training programme for testing personnel	Short	P – relevant municipalities I – MDEDET, GDARD, EMM, Other municipalities with testing function	
	Conduct regular inspections	Short, On-going	P - relevant municipalities	
	Compile report on emission testing activities and effectiveness	Short, On-going	P - relevant municipalities	

5. By 2020, a measurable increase in awareness and knowledge of air quality exists

Objectives	Activities	Timeframe	Responsibility	Indicator
1) Air quality information is easily accessible to all stakeholders	Simplify technical reports and management plans for public consumption	Short, On-going	P – DEA, MDEDET, GDARD, Municipalities	• Air quality information is available in hard copy and electronic formats • Air quality information is available in official languages • Simplified technical information is available
	Disseminate information in areas accessible to all stakeholders (e.g. community libraries in the HPA)	On-going	P – DEA, MDEDET, GDARD, Municipalities	
	Use media to share information on air quality	Short, On-going	P – DEA, MDEDET, GDARD, Municipalities	
	Use organisations' websites for distribution of information	Short, On-going	P – DEA, MDEDET, GDARD, Municipalities	
	Develop educational material on air quality impacts in relevant official languages aimed at individuals, communities and government officials	Short	P - DEA	
2) Air quality information is communicated to all stakeholders	Conduct educational campaigns within all HPA communities	Short, On-going	P – MDEDET, GDARD, Municipalities	• Educational campaigns conducted across HPA • Stakeholder fora established • Training and awareness-raising courses held for community leaders and councillors • Air quality criteria considered in development planning policy and initiatives • Use of fire danger index promoted • Reduction in incidents of burning (controlled and uncontrolled)
	Conduct educational awareness programmes at schools which host monitoring stations	Short, On-going	P – DEA, MDEDET, EMM	
	Establish a community forum/fora (NGOs, CBOs and FBOs) to address stakeholder education, awareness and capacity building	Short	P – MDEDET, GDARD, Municipalities	
	Organise seminars, workshops and training courses for community leaders and councillors on air quality issues	Short	P – DEA, MDEDET, GDARD, Municipalities	
	Conduct air quality awareness raising activities accompanied by elected officials	Short	P – DEA, MDEDET, GDARD, Municipalities	
	Increase awareness of development planners to consider air quality criteria in planning decision-making	Short	P – MDEDET, GDARD, Municipalities	

	Conduct awareness-raising activities and educational programmes on correct use of fire and vegetation management	Short, On-going	P – DEA, DoA, MDEDET, GDARD, Municipalities	
	Publicise the existing fire danger index as part of AQM	Short	P – MDEDET, GDARD, Municipalities	
	Promote the "Follow the smoke" campaign	Short	P – DEA I - MDEDET, GDARD, Municipalities	
3) Research is considerate of stakeholders in the area of study	Consult communities, local leaders, community organisations etc as part of research process	Short, On-going	P – Research institutions	• Community knowledge is included in air quality studies
	Incorporate indigenous information/ knowledge into air quality studies	Short, On-going	P – MDEDET, GDARD, Municipalities, Research institutions	
4) Opportunities for public participation and involvement in air quality decision-making are readily available	Use stakeholder fora to provide communication platform to communities	Short, On-going	P – Municipalities	• Community communication platform established • Community are able to access AQM officials in emergencies
	Publish contact details of relevant AQOs in communities	Short	P – Municipalities	
	Investigate feasibility of establishing a toll free number for air quality incidents for the HPA	Short	P – DEA, MDEDET, GDARD	

6. By 2020, biomass burning and agricultural emissions will be 30% less than current

Objectives	Activities	Timeframe	Responsibility	Indicator
1) Emissions from biomass burning and agricultural activities on the HPA are quantified	Develop emission estimate for biomass burning (natural and controlled)	Short	P – DEA I – DoA, DoAFF	• Current emission estimate available for biomass burning and agriculture
	Maintain information on fires on HPA using AFIS and other resources	On-going	P – DEA	
	Develop emission estimate for agriculture: • Pesticides • Odour-related pollutants • Dust	Short	P – DEA I – DoA, GDARD	
2) Management alternatives to burning are available	Promote grass cutting and baling in agricultural, protected and road reserve areas, to be used as a resource e.g. fodder, compost, smokeless fuel	Short, On-going	P – DEA, DoA, DoT I – MDEDET, GDARD	• Reduction in burning in agricultural, protected and road reserve areas
	Motivate for research on veld management practices/ strategies for alternatives to burning and on the relationship between fire and environmental factors	Short	P – DEA, DoA	
3) Legal requirements discourage vegetation burning	Optimise the use of existing regulatory tools to prevent agricultural burning in poor conditions	Short	P – DEA, DoA	• Regulation restricting burning is promulgated
	Motivate for specific conditions for creating fire breaks in Veld and Forest Fires Act	Short – Medium	P – DEA, DoAFF	
	Motivate for regulation of burning in sensitive ecosystems and surrounding areas	Medium	P – DEA, DoA, DoAFF	
4) Dust entrainment, odour, and pesticide emissions are reduced	Cooperatively investigate the feasibility of the development and publication of weather forecasts for optimum ploughing time and spraying of pesticides	Short	P – DEA, SAWS, DoA	Feasibility report prepared on agricultural forecast available

7. By 2020, emissions from waste management are 40% less than current

Objectives	Activities	Timeframe	Responsibility	Indicator
1) Emissions from waste management activities on the HPA are quantified	Develop and maintain emission estimate for landfills, waste water treatment works and incinerators	Short	P – DEA	• Emission estimates available for waste management facilities • Greenhouse gas emission estimates available
	Include Greenhouse gas emissions in emission inventory	Short	P – DEA	
2) Management of waste processing sites considers air pollutant and greenhouse gas emission reductions	Develop emission reduction plan for all process and fugitive sources	On-going	P – Operating Entities O – DEA, AELAs	• Emission reduction plans developed and implemented
	Implement emission reduction and maintenance plan for all emission sources resulting from waste management activities	Short, On-going	P – Operating Entities O – DEA, AELAs	
	Investigate feasibility of methane extraction for energy generation	Short – Medium	P - Operating Entities	
	Promote the use of best available technology in waste management	Medium	P – DEA, MDEDET, GDARD, Municipalities	
3) Emissions from burning of waste are reduced	Motivate for regular collection of waste from skips	Short	P – Municipalities	• Waste burning is regulated
	Apply/ develop regulatory tools to control waste burning	Short – Medium	P - MDEDET, GDARD, Municipalities I – DEA	
	Motivate for enforcement action on incidences of waste burning	Short – Medium	P - MDEDET, GDARD, Municipalities	

7.3 Co-benefits from projects by other governance stakeholders

As part of the AQMP development, work by stakeholders not directly related to air quality but having co-benefits for improved air quality in the HPA has been included. The projects listed are under development, have been implemented, or are proposed following consultation, and possible collaboration.

Table 51: Collaborative working and support projects

Implementing agent	Project
Department of Health	• Implementation of the guideline on indoor air pollution • Cooperatively develop healthcare admission methodology to include air pollution exposure parameters
Department of Transport	• Motivate for the inclusion of emission testing as part of roadworthiness certification
Department of Energy	• Revision of fuel specifications as part of National Vehicle Emissions Strategy
Department of Energy, Eskom	• Develop promotional material and tools to inform energy efficient and alternative energy choices
Department of Education	• Promote revision of school curriculum to include AQM • Distribute DEA air quality educational material to educators in the HPA • Promote AQM as a career path at schools and tertiary institutions
Department of Justice	• Motivate for stricter enforcement action through prosecution and stiff penalties for arson offenders
Department of Agriculture	• Promote research on improving farming techniques and good agricultural practices e.g. minimum tillage, application of pesticides • Promote best practice for the conversion of animal waste to manure and fertiliser
Department of Water Affairs and DEA	• Compile best practice documents for the waste management sector • Develop promotional material on air quality benefits of household waste minimisation

8 Monitoring, evaluation and review

8.1 Monitoring

Monitoring the progress of the implementation of the AQMP is a key factor in maintaining momentum for the rollout of interventions and provides a means to update key stakeholders. Working groups are the preferred mechanism for monitoring, as they are the primary means for initiation of implementation. The outcomes of the meetings will be taken forward into the annual evaluation exercise.

Responsibility	DEA, Working Groups
Method	Progress meeting/Level of completion of interventions
Timeframe	6 months

8.2 Evaluation

On-going evaluation is an essential element of AQMP implementation as it allows for a thorough assessment of the AQMP, including the shortcomings and strengths evident in implementation. Evaluation is an internal mechanism to measure the performance of the AQMP implementation. Annual evaluation of the AQMP will be conducted as a minimum timeframe and is ideally incorporated into the annual performance review mechanisms existing in the HPA authorities.

AQMP evaluation is divided into two sections, which comprises an internal evaluation of the final AQMP, and an on-going evaluation, which addresses implementation outcomes. This component is regarded as a limited peer review mechanism, as the MSRG has technical and management background in AQM and is able to refine the content of the AQMP. An evaluation checklist is provided in DEA's AQMP Manual, which deals with all aspects of the AQMP that require assessment. The checklist includes details on the general document and process, as well as specific information on the performance of interventions.

Indicators are an easily interpreted and meaningful method of communicating progress on implementation. These have been developed for the activities specified in the AQMP implementation plan. These are ideally incorporated into the annual reports necessary to be submitted to the Minister by the Priority Area management team, as indicated in Section 17 of the AQA. These reports, together with the regular progress reports proposed in the implementation, will be incorporated into the National AQO's Annual Report, which is submitted to the Minister as well, and available to all stakeholders.

8.3 Review

AQMP review comprises internal and external review components, and addresses further developments in the science as well as management of air quality. The purpose of the HPA AQMP review will be to assess the contents of the plan, including institutional and strategic arrangements put in place for the plan implementation, assess progress on interventions implementation, re-look into the AQMP baseline assessment, and determine the current air quality status through analysis of current monitoring data and emission inventory. The plan review will further investigate current and future economic realities and provide recommendations to further strengthen intervention implementation.

With regards to the formal review of the AQMP and the implementation, a review period of every *five years* is recommended in the DEA Manual. The definition of the review period is subject to funding and political cycles, as well as implementation outcomes.

The process of five-yearly review is anticipated to be initiated through an internal review mechanism and incorporate the annual evaluation exercise, effectively assessing the five-year performance of the AQMP and examining the successes and failures of implementation. An evaluation of the current organisational and air quality setting is necessary to complete the evaluation portion of the review. Following the comprehensive evaluation, goals and objectives are amended as needed and activities updated. The internal revision is communicated to stakeholders through a limited public participation process, followed by a further iteration and publication.

Responsibility	DEA, Working Groups, MSRG
Method	Compilation of annual evaluations
Timeframe	5 year

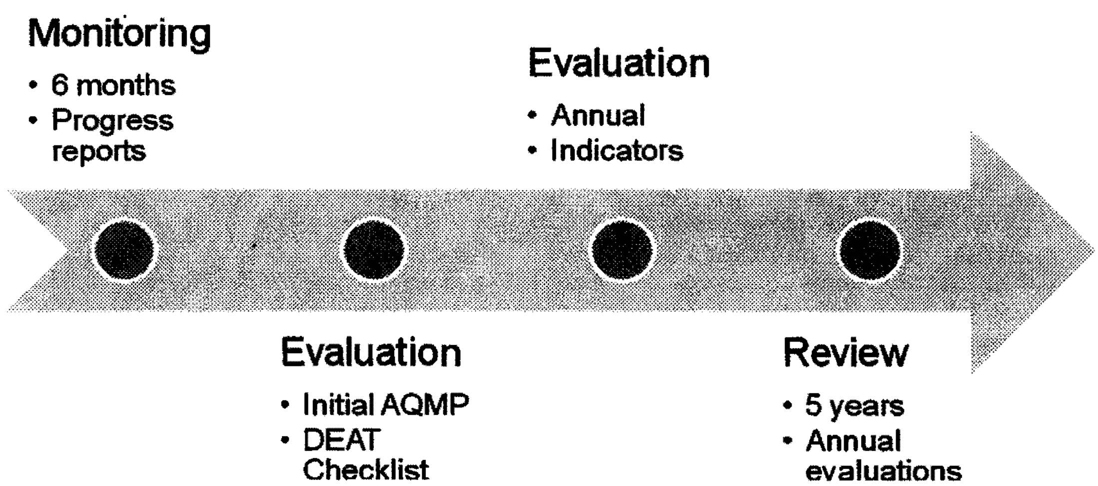

Figure 61: Timeframes for monitoring, evaluation and review of the AQMP

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ACRONYMS

$\mu g/m^3$	micrograms per cubic metre
µm	micrometres
ACGIH	American Conference of Government Industrial Hygienists
AEL	Atmospheric Emission Licence
AELAs	Atmospheric Emission Licence Authorities
AGL	Above ground level
AIR	Atmospheric Impact Report
ALRI	Acute lower respiratory infection
APPA	Atmospheric Pollution Prevention Act
AQA	National Environmental Management: Air Quality Act
AQM	Air Quality Management
AQMP	Air Quality Management Plan
AQO	Air Quality Officer
AQOF	Air Quality Officers Forum
AQUA	Aqua (EOS PM-1) is a multi-national NASA scientific research satellite in orbit around the Earth, studying the precipitation, evaporation, and cycling of water. It is the second major component of the Earth Observing System (EOS) following on Terra (launched 1999)
ATSDR	American Toxic Substances and Disease Registry
BnM	Base njengo Magogo
BTEX	Benzene, toluene, ethylbenzene and xylene
BTX	Benzene, toluene and xylenes
BVOCs	Biogenic Volatile Organic Compounds
C_6H_6	Benzene
CH_4	Methane
CAPCO	Chief Air Pollution Control Officer
CBD	Central Business District
CBOs	Community Based Organisations
CDM	Clean Development Mechanism
CO	Carbon monoxide
CO_2	Carbon dioxide
COPD	Chronic obstructive pulmonary disease
DC	Direct Currect
D-COGTA	Department OF Cooperative Governance and Traditional Affairs
DEA	Department of Environmental Affairs
DEAT	Department of Environmental Affairs and Tourism
DM	District Municipality
DMR	Department of Mineral Resources

DoA	Department of Agriculture
DoAFF	Department of Agriculture, Forestry and Fisheries
DoE	Department of Energy
DoHealth	Department of Health
DoHousing	Department of Housing
DoT	Department of Transport
EHP	Environmental Health Practitioner
EIP	Environmental Implementation Plan
EIA	Environmental Impact Assessment
EMM	Ekurhuleni Metropolitan Municipality
EMI	Environmental Management Inspector
EMP	Environmental Management Plan
EMS	Environmental Management System
EPA	Environmental Protection Agency
ESP	Electrostatic Precipitators
FBOs	Faith-based Organisations
FGC	Flue gas conditioning
FGD	Flue gas desulphurisation
FGT	Flue gas treatment
FRIDGE	Fund for Research into Industrial Development Growth and Equity
g/kg	grams per kilogram
GDACE	Gauteng Department of Agriculture, Conservation and Environment
GDARD	Gauteng Department of Agriculture and Rural Development
GHG	Greenhouse gas
GIS	Geographic Information System
H_2S	Hydrogen sulphide
HAPs	Hazardous air pollutants
Hg	Mercury
HPA	Highveld Priority Area
IDP	Integrated Development Plan
IGRFA	Intergovernmental Relations Framework Act (Act No.13 of 2005)
IGR	Intergovernmental Relations
IOA	Index of agreement
IPCC	Intergovernmental Panel on Climate Change
IQ	Intelligence quotient
KPI	Key Performance Indicator
LED	Local Economic Development
LFA	Logical Framework Approach
LLJ	Low-level jet
LM	Local municipality

LPG	Liquid Petroleum Gas
MDEDET	Mpumalanga Department of Economic Development, Environment and Tourism
MEC	Member of Executive Council
MHS	Municipal Health Services
MM	Metropolitan Municipality
MODIS	Moderate-resolution Imaging Spectroradiometer is a scientific instrument launched into Earth orbit by NASA in 1999 on board the Terra Satellite, and in 2002 on board the Aqua (EOS PM) Satellite MRL minimum risk level
MoU	Memorandum of Understanding
MRAD	Minor restricted activity days
MSRG	Multi-Stakeholder Reference Group
MW	MegaWatt
NACA	National Association for Clean Air
NASA	US National Aeronautical and Space Administration
NAQO	National Air Quality Officer
NEMA	National Environmental Management Act, Act No. 107 of 1998
NGOs	Non-Governmental Organisations
NH_4	Ammonium
NMHC	Non-methane hydrocarbons
NMOC	Non-methane organic compounds
NO	Nitrous oxide
NO_2	Nitrogen dioxide
N_2O	Nitrous oxide
NO_x	Oxides of nitrogen
NPI	National Pollutant Inventory
O_3	Ozone
OH	Hydroxide radicals
ORTIA	OR Tambo International Airport
PAH	Polycyclic aromatic hydrocarbons
PAQMP	Priority Air Quality Management Plan
Pb	Lead
PCBs	Polychlorinated biphenyls
PM	Particulate matter
PM_{10}	Particulate matter of aerodynamic diameter less than 10 micrometres
$PM_{2.5}$	Particulate matter of aerodynamic diameter less than 2.5 micrometres
ppb	parts per billion
ppm	parts per million
PSC	Project steering committee
RAD	Restricted activity days
RDP	Reconstruction and Development Programme

SAAQIS	South African Air Quality Information System
SADHS	South African Demographic and Health Survey
SAGHGI	South African Greenhouse Gas Inventory
SALGA	South African Local Governmemt Association
SANLC	South African National Land Cover
SANRAL	South African National Roads Agency
SAPIA	South African Petroleum Industry Association
SAWS	South African Weather Service
SLA	Service Level Agreement
SO_2	Sulphur dioxide
SO_3	Sulphur tri-oxide
SOER	State of Environment Report
STP	Standard temperature and pressure, which is 25°C and 1 kilopascal
t/a	Tons per annum
TERRA	Terra (EOS AM-1) is a multi-national NASA scientific research satellite in a sun-synchronous orbit around the Earth. It is the flagship of the Earth Observing System (EOS).
TSP	Total suspended particulates
US-EPA AP42	Compilation of Emission Factors produced by the US EPA Emission Factor and Inventory Group.
VEP	Vehicle Emissions Project
VKT	Vehicle kilometres travelled
VOC	Volatile organic compounds
VTAPA	Vaal Triangle Airshed Priority Area
WHO	World Health Organisation

GLOSSARY OF TERMS

1. **Ambient air:** Outdoor air in the troposphere, excluding work places. According the National Environmental Management Act, (Act no.39 of 2004) **"ambient air"** excludes air regulated by the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993).
2. **Averaging Period:** A period of time over which an average value is determined.
3. **Limit values:** a numerical value associated with a unit of measurement and averaging period that forms the basis of the standard.
4. **Frequency of exceedance:** A frequency (number/time) related to a limit value representing the tolerated exceedance of that limit value, i.e. if exceedances of limit value are within the tolerances, and then there is still compliance with the standard.
5. **Standard:** A standard may have many components that define it as a "standard". These components may include some or all of the following; Limit values, averaging periods, frequency of exceedances, and compliance dates.
6. **Interim Levels**: These levels represent the timeframes for compliance with the standards.
7. **Compliance date**: A date when compliance with the standard is required. This provides a transitional period that allows activities to be undertaken to ensure compliance date.
8. **Morbidity:** The incidence rate, or the prevalence of a disease or medical condition
9. **Mortality**: Mortality rate of a condition is the proportion of people dying during a given time interval
10. **Exposure:** An event that occurs when there is contact a human and a contaminant of a specific concentration in the environment for an interval of time (Ott, 1995)

APPENDIX 1: AMBIENT AIR QUALITY STANDARDS

The effects of air pollutants on human health occur in a number of ways with short-term, or acute effects, and chronic, or long-term, effects. Different groups of people are affected differently, depending on their level of sensitivity with the elderly and young children being more susceptible. The factor that links the concentration of an air pollutant to an observed health effect is the level and the duration of the exposure to that particular air pollutant.

Short-term effects include irritation to the eyes, nose and throat and the upper respiratory system, headaches, nausea and allergic reactions. Short-term exposure can aggravate existing health problems such as asthma and emphysema. Long-term effects include chronic respiratory disease, lung cancer, heart disease and damage to the nervous and renal systems.

Criteria pollutants occur ubiquitously in urban and industrial environments. Their effects on human health and the environment are well documented (e.g. WHO, 1999, 2000, 2005). South Africa has national ambient air quality standards for the priority pollutants (DEAT, 2009). These are formulated in line with internationally accepted norms and standards and local data, and specifically developed for the protection of human health. Future revisions to the standards are expected to include the protection of vegetation and ecosystems.

The criteria pollutants in South Africa are:

- Carbon monoxide (CO)
- Nitrogen dioxide (NO_2)
- Sulphur dioxide (SO_2)
- Ozone (O_3)
- Particulate matter (PM_{10})
- Lead (Pb)
- Benzene (C_6H_6)

Other air pollutants monitored in the HPA for which no national ambient standards exist are:

- Volatile organic compounds (VOCs), with toluene, xylene and ethylbenzene discussed; and
- Hydrogen sulphide (H_2S).

Other pollutants are also characterised for general information and due to global interest. These are:

- Total suspended particulates (TSP);
- Mercury (Hg);
- Dioxins and furans;
- Methane (CH_4); and
- Carbon dioxide (CO_2).

1. Carbon monoxide (CO)

Sources

CO is a product of incomplete combustion of fossil fuels. It is predominantly formed in internal combustion engines of motor vehicles, but the combustion of any carbon-based material can release CO. Chemical reactions in the atmosphere may also lead to the formation of CO by the oxidation of other carbon-based gases such as methane. Decomposition of organic material within soils can also result in the release of CO.

Health and environmental effects

When inhaled, CO enters the blood stream by crossing the alveolar, capillary and placental membranes. In the bloodstream, approximately 80-90% of absorbed CO binds with haemoglobin to form carboxyhaemoglobin. The haemoglobin affinity for CO is approximately 200-250 times higher than that of oxygen. Carboxyhaemoglobin reduces the oxygen carrying capacity of the blood and reduces the release of oxygen from haemoglobin, which leads to tissue hypoxia. This may lead to reversible, short lived neurological effects and sometimes delayed severe neurological effects that may include impaired coordination, vision problems, reduced vigilance and cognitive ability, reduced manual dexterity, and difficulty in performing complex tasks (WHO, 1999).

People with existing heart conditions such as angina, clogged arteries, or congestive heart failure are particularly sensitive. In these cases, CO may induce chest pain and lead to the development of other cardiovascular effects such as myocardial infarction, and cardiovascular mortality (WHO, 1999).

Ambient standards

Table 52: National ambient standard for CO (DEAT, 2009)

Averaging period	Limit value (mg/m^3)	Number of permissible exceedances per annum
1 hour	30	88
8-hour running average calculated on hourly averages	10	11

2. Sulphur dioxide (SO_2)

Sources

Dominant sources of SO_2 include fossil fuel combustion from industry and power plants. SO_2 is emitted when coal is burnt for energy. The combustion of oil also results in high SO_2 emissions. Domestic coal or kerosene burning can thus also result in the release of SO_2. Motor vehicles also emit SO_2, in particular diesel vehicles due to the higher sulphur content of diesel fuel. Mining processes where smelting of mineral ores occurs can also result in the production of SO_2 as metals usually exist as sulphides within the ore.

Health and environmental effects

On inhalation, most SO_2 only penetrates as far as the nose and throat, with minimal amounts reaching the lungs, unless the person is breathing heavily, breathing only through the mouth, or if the concentration of SO_2 is high (CCINFO, 1998). The acute response to SO_2 is rapid, within 10 minutes in asthmatics (WHO, 2005). Effects such as a reduction in lung function, an increase in airway resistance, wheezing and shortness of breath, are enhanced by

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exercise that increases the volume of air inspired, as it allows SO_2 to penetrate further into the respiratory tract (WHO, 1999).

SO_2 reacts with cell moisture in the respiratory system to form sulphuric acid. This can lead to impaired cell function and effects such as coughing, broncho-constriction, exacerbation of asthma and reduced lung function.

SO_2 has the potential to form sulphurous acid or slowly form sulphuric acid in the atmosphere via oxidation by the hydroxyl radical. The sulphuric acid may then dissolve in water droplets and fall as precipitation. This may decrease the pH of rain water, altering any balance within ecosystems and can be damaging to man-made structures.

Ambient standards

Table 53 : National ambient standard for SO_2 (DEAT, 2009)

Averaging period	Limit value ($\mu g/m^3$)	Number of permissible exceedances per annum
10 minutes	500	526
1 hour	350	88
24 hour	125	4
1 year	50	0

3. Nitrogen dioxide (NO_2)

Sources

NO_2 and nitric oxide (NO) are formed simultaneously in combustion processes and other high temperature operations such as metallurgical furnaces, blast furnaces, plasma furnaces, and kilns. NO_x is a term commonly used to refer to the combination of NO and NO_2. NO_x can also be released from nitric acid plants and other types of industrial processes involving the generation and/or use of nitric acid. NO_x also forms naturally by denitrification by anaerobic bacteria in soils and plants. Lightning is a source of NO_x during the discharge and the rapid cooling of air after the electric discharge.

Health and environmental effects

The route of exposure to NO_2 is inhalation and the seriousness of the effects depend more on the concentration than the length of exposure. The site of deposition for NO_2 is the distal lung where NO_2 reacts with moisture in the fluids of the respiratory tract to form nitrous and nitric acids (WHO, 1997). About 80 to 90% of inhaled nitrogen dioxide is absorbed through the lungs (CCINFO, 1998). Nitrogen dioxide (present in the blood as the nitrite ion) oxidises unsaturated membrane lipids and proteins, which then results in the loss of control of cell permeability. Nitrogen dioxide caused decrements in lung function, particularly increased airway resistance. People with chronic respiratory problems and people who work or exercise outside will be more at risk to NO_2 exposure (EAE, 2006). People with a vitamin C deficiency may be more at risk, as vitamin C inhibits the oxidation reactions of NO_2 in the body (WHO, 1997).

NO_x also reacts with water in the atmosphere and can contribute to the formation acid rain. It is an important pre-cursor in the formation of ozone. NO_x is a key ingredient in atmospheric photochemistry and the formation of secondary pollutants such as ozone and smog.

Ambient standards

Table 54: Ambient standard for NO_2 (DEAT, 2009)

Averaging period	Limit value (µg/m³)	Number of permissible exceedances per annum
1 hour	200	88
1 year	40	0

4. Ozone (O_3)

Sources

Ozone occurs naturally in the lower stratosphere as the ozone layer, which protects the earth from shortwave ultraviolet radiation. Near the surface of the earth however, ozone is a secondary pollutant and is a major constituent of photochemical smog.

The formation of ozone relies on the availability of NO_x, hydrocarbons and sunlight. It cannot be directly related to any particular source, but it is rather associated with the sources of its precursor gases (NO_x and hydrocarbons). Ozone may also reach the lower troposphere from the stratosphere with deep convective storms or with deep frontal systems.

Health and environmental effects

Ozone is a very reactive gas and is a strong oxidant. Ozone mainly affects the respiratory system. Short-term ozone exposure leads to the development of airways irritation and inflammation leading to a decrease in lung function. Associated symptoms include wheezing, coughing, pain when taking a deep breath and breathing difficulties during exercise or outdoor activities (WHO, 1999). Prolonged exposure to ozone leads to a reduction in lung function in children (WHO, 2003). It also leads to morphological changes in the lung and permanent lung damage (WHO, 1999). People with existing respiratory illnesses and those who are involved in outdoor activities are most at risk to ozone exposure.

Ambient standards

Table 55: Ambient standard for O_3 (DEAT, 2009)

Averaging period	Limit value (µg/m³)	Number of permissible exceedances per annum
8-hour running average calculated on hourly averages	120	11

5. Lead (Pb)

Sources

Lead is a metal that occurs naturally in the environment. It is used as an anti-knocking agent in gasoline, in the manufacture of paints, solders, piping and in the manufacture of batteries.

Lead has a low boiling point and as such is vaporised easily during combustion processes and can then condense onto the surface of fine particles. It can be present in the atmosphere in a solid form (lead phosphate, lead chloride, or lead bromide) or in a gaseous form as alkyl lead that has evaporated from petrol.

Lead emissions are predominantly anthropogenic; the sources include the combustion of leaded fuels, mining of lead, and smelting, solid waste disposal, use of lead based paints, solders, and lead piping. Natural sources include windblown dust and volcanoes.

Health and environmental effects

Nearly all-environmental exposure to lead is in the form of inorganic compounds. Lead occurs in particulate form in the environment. The public may be exposed through inhalation of contaminated air and ingestion of contaminated food (including acid food in lead ceramic ware), water and soil. Hand-mouth contact is the main route of exposure for children.

Inhaled lead particles may be absorbed into the blood stream. Ingested lead is deposited into the gastrointestinal tract where absorption takes place. Children absorb more and excrete less of the absorbed lead than adults. The absorbed lead is transported to various body organs and tissues through blood. The half-life of lead in human blood is 28 to 36 days, but lead accumulates in the bones and teeth where it can stay for decades and be released again (ATSDR, 1999). The organs mostly affected by lead are the developing nervous system, the haematological (blood) system and the cardiovascular system (ATSDR, 2006).

Ambient standards

Table 56: Ambient standard for Pb (DEAT, 2009)

Averaging period	Limit value ($\mu g/m^3$)	Number of permissible exceedances per annum
1 year	0.5	0

6. Particulates

Sources

Particulate matter is a broad term used to describe the fine particles found in the atmosphere, including soil dust, dirt, soot, smoke, pollen, ash, aerosols and liquid droplets. The most distinguishing characteristic of PM is the particle size and the chemical composition. Particle size has the greatest influence on the behaviour of PM in the atmosphere with smaller particles tending to have longer residence times than larger ones. PM is categorised, according to particle size, into TSP, PM_{10} and $PM_{2.5}$.

Total suspended particulates (TSP) consist of all sizes of particles suspended within the air smaller than 100 micrometres (µm). TSP is useful for understanding nuisance effects of PM, e.g. settling on houses, deposition on and discolouration of buildings, and reduction in visibility.

PM_{10} describes all particulate matter in the atmosphere with a diameter equal to or less than 10 µm. Sometimes referred to simply as coarse particles, they are generally emitted from motor vehicles (primarily those using diesel engines), factory and utility smokestacks, construction sites, tilled fields, unpaved roads, stone crushing, and burning of wood. Natural sources include sea spray, windblown dust and volcanoes. Coarse particles tend to have relatively short residence times as they settle out rapidly and PM_{10} is generally found relatively close to the source except in strong winds.

$PM_{2.5}$ describes all particulate matter in the atmosphere with a diameter equal or less than 2.5 µm. They are often called fine particles, and are mostly related to combustion (motor vehicles, smelting, incinerators), rather than mechanical processes as is the case with PM_{10}. $PM_{2.5}$ may be suspended in the atmosphere for long periods and can be transported over large distances.

Fine particles can form in the atmosphere in three ways: when particles form from the gas phase, when gas molecules aggregate or cluster together without the aid of an existing surface to form a new particle, or from reactions of gases to form vapours that nucleate to form particles.

Health and environmental effects

Particulate matter may contain both organic and inorganic pollutants. The extent to which particulates are considered harmful depends on their chemical composition and size, e.g. particulates emitted from diesel vehicle exhausts mainly contain unburned fuel oil and hydrocarbons that are known to be carcinogenic. Very fine particulates pose the greatest health risk as they can penetrate deep into the lung, as opposed to larger particles that may be filtered out through the airways' natural mechanisms.

In normal nasal breathing, particles larger than 10 µm are typically removed from the air stream as it passes through the nose and upper respiratory airways, and particles between 3 µm and 10 µm are be deposited on the mucociliary escalator in the upper airways. Only particles in the range of 1 µm to 2 µm penetrate deeper where deposition in the alveoli of the lung can occur (WHO, 2003).

Coarse particles (PM_{10} to $PM_{2.5}$) can accumulate in the respiratory system and aggravate health problems such as asthma. $PM_{2.5}$ which can penetrate deeply into the lungs, are more likely to contribute to the health effects (e.g. premature mortality and hospital admissions) than coarse (WHO, 2003).

People with existing health conditions such as cardiovascular disease and asthmatics, as well as the elderly and children, are more at risk to the inhalation of particulates than normal healthy people (Pope, 2000; Zanobetti *et al.*, 2000).

Ambient standards

There is no national air quality ambient standard for TSP. Error! Reference source not ound. presents the national ambient air quality standard for PM_{10}, and Table 58 the proposed national ambient standard for $PM_{2.5}$.

Table 57: National ambient standards for PM_{10} (DEAT, 2009)

Averaging period	Limit value (µg/m³)	Number of permissible exceedances per annum	Compliance date
24 hour	120	4	Immediate to 31 Dec 2014
24 hour	75	4	1 January 2015
1 year	50	0	Immediate to 31 Dec 2014
1 year	40	0	1 January 2015

Table 58: Proposed national ambient standard for $PM_{2.5}$ (DEA, 2011a)

Averaging period	Limit value (µg/m³)	Number of permissible exceedances per annum	Compliance date
24 hour	65	0	Immediate to 31 Dec 2015
24 hour	40	0	1 Jan 2016 to 31 Dec 2029
24 hour	25	0	1 January 2030
1 year	25	0	Immediate to 31 Dec 2015
1 year	20	0	1 Jan 2016 to 31 Dec 2029
1 year	15	0	1 January 2030

There is no national ambient air quality standard for ***dust deposition***. A proposed regulation under Section 32 of the AQA provides for a two-band scale to evaluate dust deposition (DEA, 2011) (Table 59), with further conditions regarding operation and monitoring.

Table 59: Bands of dust deposition evaluation rates (DEA, 2011b)

Band number	Band description label	Dust-fall rate (*D*) (mg m^{-2} day^{-1}, 30-day average)
1	Residential/ Light commercial	$D < 600$
2	Other areas	$D \leq 1\ 200$

7. Benzene (C_6H_6)

Sources

Benzene is a colourless liquid with a sweet odour. It evaporates into the air very quickly and dissolves slightly in water. It is highly flammable and is formed from both natural processes and human activities.

Benzene is also a natural part of crude oil, petrol and other liquid fuels. Industries use benzene to make other chemicals, which are used to make plastics, resins, and nylon and synthetic fibres. Benzene is also used to make some types of rubbers, lubricants, dyes, detergents, drugs, and pesticides. Natural sources include volcanoes and forest fires.

Health and environmental effects

After exposure to benzene, several factors determine whether harmful health effects will occur, as well as the type and severity of such health effects. These factors include the amount of benzene to which an individual is exposed and the length of time of the exposure.

For example, brief exposure (5–10 minutes) to very high levels of benzene (14 000 – 28 000 µg/m^3) can result in death (ATSDR, 2007). Lower levels (980 - 4 200 µg/m^3) can cause drowsiness, dizziness, rapid heart rate, headaches, tremors, confusion, and unconsciousness. In most cases, people will stop feeling these effects when they are no longer exposed and begin to breathe fresh air.

People who inhale benzene for long periods may experience harmful effects in the tissues that form blood cells, especially the bone marrow. These effects can disrupt normal blood production and cause a decrease in important blood components. A decrease in red blood cells can lead to anaemia. Excessive exposure to benzene can be harmful to the immune system, increasing the chance for infection and perhaps lowering the body's defence against cancer. Both the International Agency for Cancer Research and the Environmental Protection Agency (EPA) have determined that benzene is carcinogenic to humans as long-term exposure to benzene can cause leukaemia, a cancer of the blood-forming organs.

Ambient standards

Table 60: Ambient standards for benzene (DEAT, 2009)

Averaging period	Limit value (µg/m^3)	Number of permissible exceedances per annum	Compliance date
1 year	10	0	Immediate to 31 Dec 2014
1 Year	5	0	January 2015

8. Hydrogen sulphide (H_2S)

Sources

Anthropogenic sources of H_2S include pulp and paper manufacturing, coke ovens, sewage plants, landfills and oil refineries. Natural sources include volcanoes, decomposition of organic matter and bacterial reduction of sulphates in anaerobic conditions.

Health and environmental effects

H_2S is a flammable gas that carries an offensive odour, similar to that of a rotten egg. It is oxidised in the atmosphere to form SO_2, thereby increasing SO_2 levels.

H_2S is highly toxic. It is considered a broad-spectrum poison, meaning that it can poison several different systems in the body, although the nervous system is most affected. Breathing H_2S may paralyze the olfactory nerve making it impossible to smell the gas after an initial strong exposure.

Ambient guidelines

There is no national ambient air quality standard for H_2S. The U.S. Department of Health and Human Service's Agency for Toxic Substances and Disease Registry (ATSDR, 2008) has set the acute minimum risk level (MRL) for acute exposure to H_2S at 70 ppb (98 µg/m^3). The MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse non-cancer health effects over a specified duration of exposure. The odour threshold for H_2S is 8 ppb (11 µg/m^3).

8. Toluene ($C_6H_5CH_3$)

Sources

Toulene is a colourless, flammable liquid with an odour threshold of 1000 µg/m^3 (ACGIH, 2001). It is primarily used as part of a mixture to improve the octane rating of petrol. Toluene is also used to produce benzene, as well as a solvent in paints, coatings, adhesives, inks and cleaning agents. Naturally occurring toluene is found in crude oil and the tolu tree. It is regarded as the most prevalent hydrocarbon. Toluene is a common indoor air pollutant and indoor sources include household products, wood fires and tobacco smoke.

Health and environmental effects

Toluene exposure is primarily through air. The main effect of toluene is on the central nervous system and is related to the concentration the individual is exposed to. At approximately 50 ppm, slight drowsiness and headaches have been reported, and upper respiratory irritation has occurred between 50 and 100 ppm (CCINFO, 1998). Above 100 ppm, fatigue and dizziness have been reported, over 200 ppm, mild nausea, and above 500 ppm, mental confusion (CCINFO, 1998).

Chronic exposure to toluene at concentrations of 30 – 50 ppm in the occupational environment showed central nervous system effects. Increased incidence of hearing loss, changes in visual-evoked brainstem potential and colour vision impairment were also observed.

Ambient guidelines

There is no national ambient air quality standard for toluene. The WHO non-cancer 30 minute guideline value is 1000 µg/m^3, based on odour annoyance (WHO, 2000). The WHO weekly average guideline value is 260 µg/m^3, based on observed occupational effects (WHO, 2000).

9. Xylene (C_8H_{10})

Sources

Xylene is a colourless, flammable liquid with an aromatic odour. It is used in the production of ethyl benzene in solvents, and in paints and coatings. Natural sources of xylene include coal tar, petroleum, and forest fire emissions. Xylene is a common emission from vehicle tailpipes.

Health and environmental effects

Acute exposure to xylene at concentrations of 50 ppm and higher have resulted in irritation of the eyes, skin and mucous membranes, impaired respiratory function, and mild central nervous system effects, including headache and dizziness (ATSDR, 2007). Exposure at 700 ppm has caused vomiting and nausea (CCINFO, 1998). The lowest published lethal dose for xylene is 10 000 ppm for a six hour exposure. Chronic occupational exposure to mixed xylene at 14 ppm may cause mild central nervous system effects, such as headache, fatigue and dizziness, as well as nose and throat irritation at levels reaching 14 ppm. It is not carcinogenic.

Ambient guidelines

There is no national ambient air quality standard for xylene. The WHO ambient air guidelines for xylene are 4800 µg/m³ for 24 hours and 870 µg/m³ as an annual value (WHO, 2000). The odour threshold for xylene is between 0.07 and 40 ppm (ACGIH, 2001).

10. Ethylbenzene (C_8H_{10})

Sources

Ethylbenzene is a colourless, flammable liquid with an aromatic odour and is primarily used in the manufacture of styrene, which supports polystyrene production. It is also used as a solvent for resins and is a minor component of petrol, due to its natural occurrence in coal tar and petroleum.

Health and environmental effects

Ethylbenzene undergoes chemical transformation in the atmosphere. Respiratory effects have not been observed at concentrations of 55 ppm for 15 minutes, however short-lived irritation was observed at 200 ppm (ACGIH, 2001). Lacrimation and irritation of the eyes and throat were observed at 1000 ppm. Throat irritation and chest constriction were reported at 2000 ppm. Dizziness with vertigo, and worsening of previous symptoms were observed at increased exposure of 5000 ppm (ATSDR, 2007).

Chronic exposure did not show toxicity at low levels, and conflicting results on the effects on blood were reported. It is not classified as a human carcinogen, however the American Conference of Governmental Industrial Hygienists (ACGIH) confirms ethylbenzene as an animal carcinogen.

Ambient guidelines

There is no national ambient air quality standard for ethylbenzene. The WHO annual average guideline value is 22 000 µg/m³. The odour threshold for ethylbenzene is 10 000 µg/m³.

11. Mercury (Hg)

Sources

Mercury is a naturally occurring metal and is typically a shiny metallic liquid at room temperature. If heated, it is a colourless, odourless gas. Mercury is used in the production of chlorine gas and caustic soda, and is found in thermometers, dental fillings and batteries (ATSDR, 2007). Mercury salts also have cosmetic and medicinal uses. Sources of mercury include ore mining activities, coal and waste combustion, and manufacturing plants. Natural sources are volcanoes and natural deposits.

Health and environmental effects

Mercury has central nervous system effects, and high levels of exposure can result in permanent brain and renal damage. Effects on brain functioning include irritability, shyness, tremors, changes in vision or hearing, and memory problems. Acute exposures at high concentrations may cause lung damage, nausea, vomiting, diarrhoea, increases in blood pressure or heart rate, skin rashes and eye irritation. Two forms of mercury, mercuric chloride and methyl mercury, are identified as possible human carcinogens based on animal carcinogenicity.

Ambient guidelines

There is no South African ambient air quality standard for mercury. The WHO annual average guideline value is 1 $\mu g/m^3$ for inorganic mercury vapour (WHO, 2000).

12. Dioxins and Furans

Sources

Dioxins and furans are the common terms given to a family of compounds such as 2,3,7,8 tetrachlorodibenzo-p-dioxin (2,3,7,8 TCDD). Emissions to the atmosphere are through chlorination processes at waste and water treatment plants, pulp and paper mills, and incineration processes. They can be produced as part of manufacture of organic chemicals.

Health and environmental effects

They have characteristics of persistence in the atmosphere, allowing them to be transported over long distances, and are easily taken up in food sources by deposition and bioaccumulation. Food is the primary exposure pathway, with minimal exposure through drinking water and inhalation (ATSDR, 1999; WHO, 2000). The most common effect of high exposure to 2,3,7,8 TCDD is chloracne, which is a serious skin disease that produces severe acne-like lesions on the face and upper body. Other effects include skin rashes, discolouration, excessive body hair, possible liver damage, glucose metabolism alterations, and hormonal level changes (ATSDR, 1999). 2,3,7,8 TCDD is recognised as a human carcinogen.

Ambient guidelines

There is no national ambient air quality standard for 2,3,7,8 TCDD or similar compound. The US EPA has set limits for concentrations of 2,3,7,8, TCDD in drinking water (ATSDR, 1999) and the WHO recommends minimum emissions to the atmosphere to reduce deposition and uptake into the food chain (WHO, 2000).

14. Methane (CH_4)

Sources

Methane is a colourless, flammable gas, and is odourless in its natural form. The mixture with other hydrocarbons and organic sulphur compounds give methane its characteristic odour. Methane is used in the manufacture of methanol, formaldehyde, and carbon tetrachloride. Naturally occurring methane is produced by anaerobic decomposition of organic matter and in the digestive system of ruminant animals such as cattle. Anthropogenic sources are fossil fuel combustion, domestic sewage, biofuel use and biomass burning.

Health and environmental effects

Methane acts as a simple asphyxiant by displacing the oxygen in air (CCOHS, 2006). No other adverse health effects have been reported. Methane is the third most important greenhouse gas after H_2O vapor and carbon dioxide (CO_2) and has a Global Warming Potential (GWP) 25 times that of CO_2 on a 100 – year timescale (IPCC, 2007).

Ambient guidelines

There is no national, or other internationally recognised, ambient air quality standard for methane.

15. Carbon dioxide (CO_2)

Sources

Carbon dioxide (CO_2) is a colourless gas that is denser than air. It exists in significant concentrations naturally, emitted by volcanoes, chemical reactions of carbonaceous rocks, and vegetative respiration at night. Anthropogenic source contributions have increased markedly since the Industrial Revolution, particularly from fossil fuel combustion, hydrogen and ammonia production, and limestone-containing processes. Fire extinguishers, carbonated drinks and various areas of the food industry also produce CO_2 emissions.

Health and environmental effects

CO_2 is not very reactive and forms a weak acid on dissolution in water. Inhalation of the gas at high concentrations results in a sour taste and stinging sensation in the nose and throat. No adverse effects were observed for acute exposures at concentrations below 20 000 ppm, or 2% of air, however, respiratory function and excitation effects, followed by depression of the central nervous system can result from exposure to higher concentrations (CCOHS, 1997).

CO_2 can displace oxygen in the air at high concentration, and the effects of oxygen deficiency can be coupled with CO_2 toxicity. CO_2 exposure to concentrations between 3.3 to 5.4% of air for 15 minutes showed increased depth of breathing. Exposure to 7.5% resulted in a feeling of inability to breathe, increased pulse rate, headache, dizziness, sweating, restlessness, disorientation, and visual distortion (CCOHS, 1997). Exposure to 6.5 or 7.5% for 20 minutes decreased mental performance, longer term exposure at these concentrations resulted in irritability and discomfort. Brief occupational exposure at very high concentrations showed retina damage, light sensitivity, abnormal eye movement, visual field constriction and blind spot enlargement (CCOHS, 1997). Concentrations greater than 10% have caused impaired hearing, vomiting, breathing difficulty, and loss of consciousness within 15 minutes of exposure. Acute exposure to 30% results in unconsciousness and convulsions, and deaths at higher concentrations (CCOHS, 1997).

Occupational long term exposure of submarine occupants showed flushing of skin, fall in blood pressure, decreased oxygen consumption, impaired circulation, and impaired attentiveness. Adaptation to some effects of chronic exposure has been reported.

CO_2 is also the most significant greenhouse gas, and increased atmospheric concentrations are responsible for global warming and the resultant climate change impacts.

Ambient guidelines

There is no national or internationally recognised ambient air quality standard for CO_2. As part of global agreements to address global warming and climate change impacts, targets have been set for countries to reduce CO_2 emissions significantly.

APPENDIX 2: POLICY REVIEW

The review of national policies are presented by keypoints, provincial policies are separated into policy content summaries and AQMP considerations with significant content highlighted, and local policies are presented in tabular format with keypoints on air quality issues and related themes.

1 National

South Africa Environment Outlook – Atmosphere, 2007 (NSOER)
Air quality: Ambient air quality is a concern in industrial and mining areas, and areas with busy traffic routes. Indoor air quality is a concern in household-fuel-burning areas. Wood is the primary fuel in fuel-burning areas at the coast, including Cape Town *Pollutant issues*: These are identified as elevated PM_{10} concentrations at all sites, fine particulates at fuel-burning residential areas and few short-term exceedances of SO_2, traffic sites recorded short-term NO_2 and wide-spread benzene exceedances, elevated PM_{10}, SO_2, NO_2, and benzene was recorded at industry-related sites, H_2S exceedances were recorded at petrochemical operations and waste water treatment works *Industries of concern*: These include petrochemical, chemical, and mineral processing industries, as well as pulp and paper, metallurgy, textile manufacturing, and brick, cement and refractory manufacturers *Source sectors*: Significant contributors to atmospheric emissions are electricity generation, industrial and commercial activities, transport, waste treatment and disposal, residential, mining, agricultural, and tyre-burning, wildfires and fugitive dust *Energy:* Electricity generation sector emissions are expected to increase concomitant with the national household electrification drive and increased industrial consumption. • No predicted increases in particulate matter concentrations due to emission control measures • Iron and steel industries are the highest consumers of coal and energy amongst the industrial sub-sectors, using generated electricity, coke-oven gas, coking coal and fuel oil. Other significant consumers are chemical, petro-chemical, food and tobacco, pulp and paper, and non-metallurgical in the industrial sub-sectors • Household fuel burning has persisted despite large-scale electrification projects, with fuel source contributions as electricity (62%), biomass (14%), paraffin (12%), coal (8%), and liquefied petroleum gas and candles (2% each). Decreased emissions are expected as a result of lower population growth rates and on-going electrification *Vehicles:* Growth in vehicle activity rates have been recorded in cities such as Cape Town, with increases in number of single-occupancy vehicles, cars per capita, and average length of trips. Recommended measures to address vehicle emissions are the specification of Euro technology for tailpipe emissions and fuel specifications changes to reduce sulphur, lead, benzene and aromatic content *Air Quality Management:* New air quality legislation is also discussed, including air quality management planning by local authorities, air quality limit revision, sector-specific air quality controls, and vehicle emissions *Air quality and climate change*: CO_2 concentrations have been shown to be increasing by 0.6% per annum in South Africa, with impacts predicted as greater incidences of flooding and droughts, and **more frequent temperature inversions**, which exacerbate air pollution

episodes. **Increased ozone** levels, due to higher temperatures, are also expected, resulting in respiratory disease increases. **Longer lasting peaks of ozone** are predicted for urban areas during the day.
Emerging sources and pollutants: Significant emerging emission sources include **filling stations, landfill gas emissions, spontaneous combustion from coal discard dumps and opencast mines, waste water treatment works, tyre burning emissions**, and **fugitive releases from commercial agriculture**. Emerging priority pollutants include **persistent organic pollutants, finer particulate fractions such as $PM_{2.5}$**, and **indoor air pollutants** such as formaldehyde and radon
Going forward: critical areas in management are **regulation development**, **capacity building**, **air quality management system development**, and **methodology standardisation**. Four key areas of change are listed as necessary: **significant improvements to implementation and enforcement**, **an increase and consistency in the monitoring of information and increased accessibility**, **capacity building of local government**, and **fostering an attitude of joint responsibility for sustainable development**. Local government capacity is needed in the area of strategic environmental assessment, which incorporates environmental objectives into land use planning, and highlights the appointment of **community development workers** and their role in **environmental awareness and education**

National Land Transport Strategic Framework 2006-2011, 2006 (NLTSF)

Principles and projects: These include the prioritisation of public transport over private, encouraging the development of transport plans, regulation of road, rail and bus modes, and improving coordination and implementation of transport structures.
Strategy components: the integration of planning and economic development with transport functions, a countrywide road network that supports development, regulatory controls for cross-border transport, a balance of freight transport across road, rail and pipeline modes, rural access planning, coordination and delivery of inter-provincial transport, safety, transport needs of the disabled, promotion of and provision for non-motorised transport, consideration of tourism interests, promotion of inter-modalism and integration, conflict resolution mechanisms, key performance indicators, and funding
Environmental impacts: These are recognised as air pollution and visual impact of outdoor advertising, and are coupled with a statement to minimise impacts in design
Travel demand measures: These are proposed for implementation as a means of reducing vehicle numbers on-road
Initiatives:

- A National Rail Passenger Plan will be developed, where priority corridors will be identified cooperatively, assessed for feasibility, and incorporated into Regional Rail Plans, and accompanied by action plans and business plans for implementation
- The upgrading of infrastructure that prioritises public transport on existing roads will be favoured, and together with other measures, will be funded by the Public Transport Infrastructure and Systems Fund
- The transport sector is to be included in the Urban Renewal Strategy aimed at restructuring urban areas to improve sustainability
- A National Freight Logistics Strategy aims to align fully the sector with economic and industrial development demands and pressures, and promote the viability of road and rail modes. A freight transport information system, freight corridors and modal integration will

be developed and promoted. Environmental impacts of freight transport will be managed by focusing on externality recovery, heavy vehicle management, and dangerous goods regulation enforcement

Air Quality Management: Air pollution will be minimised by incorporating **travel demand management** and **public transport promotion measures** into transport plans, and government promotion of **efficient technologies and fuels** and emission reduction through **environmental standards review** and **effective roadworthiness testing**. Coordination of transport and environmental functions will be achieved through promotion of the Department of Transport's **Environmental Implementation Plan** and awareness-raising through measures such as **EIAs**

Integrated Energy Plan for the Republic of South Africa, 2003 (IEP)

Conclusions:

- Continued dominance of **coal** as a primary energy source
- Need for diversification of energy sources in the country, motivated by energy security
- Environmental objectives and regional development considerations
- Sustained **energy efficiency** measures
- Commitment to **renewable energy** in the order of 10 000 GWh by 2012
- Investigations into the technical and financial feasibility of nuclear energy
- Natural gas is also considered, including anchor customers acting as catalysts for introduction of supply in regions, although limited reserves inhibit competitiveness with coal
- Expansion of **oil and gas exploration** is also proposed. Oil refinery expansion is promoted over greenfields development and importation of shortfall, and growing the demand for diesel
- Synthetic liquid fuels are encouraged as feasible at high load factors, more so than increasing refinery capacity, and requires further investigation
- Electricity generation will be coal-based as the least-cost option for the planning horizon although hydro, nuclear and natural gas potential exists
- Universal access to energy raises demand concerns and rural commercial energy supply issues, with linkages to IDP processes needed
- In plant operations, higher load factors are promoted to rest spare capacity and the matching of supply and demand

Other findings: The IEP does not indicate a shortage in energy or water resources over the planning horizon. Various governance interventions have been proposed as part of the IEP, including development of policy and regulatory instruments

Review of the World Energy Outlook: Energy demand is expected to rise fastest in developing countries, with **transportation** use outstripping other sectors, as well **coal production** increases expected to come from countries with poor resource investments previously, such as South Africa, China, India and North and Latin America

Integrated Household Clean Energy Strategy, Prospectus, 2003 (IHCES)

Components: The IHCES incorporates the top-down ignition method of fire-lighting (Base Njengo Magogo, BnM), manufacture and distribution of low-smoke fuels, housing design, and cleaner fuels and stoves

Purpose: The strategy is intended to provide for the phase-out of coal as an energy source, and the fuel switch of communities to electricity

BnM method: It has been subject to laboratory-scale investigation, as well as pilot demonstrations, and is now in full rollout in numerous townships in Highveld. The **rollout of the BnM technique** has received support from numerous parties and is to be coordinated by national government ***Low-smoke fuels***: These fuels contribute significantly to reducing air pollution however incur higher production costs. Methods of providing support to improve their economic feasibility for poorer households will be explored in the second phase of the IHCES *Housing insulation*: It provides significant benefits in reduction of fuel used, and suitable and affordable materials will be investigated

A Framework for Considering Market-based Instruments to Support Environmental Fiscal Reform in South Africa, 2006
Content: Current and possible future intervention methods using market-based instruments, Criteria for the development of instruments, and a process for considering options *Fund hypothecation*: A case for soft earmarking of funds for preferred uses is possible *Proposals*: • Current reforms for environmentally-related taxes and charges in the transport and waste sector are the general fuel levy, vehicle customs and excise duties, provincial vehicle licence fees, product-specific taxes, deposit refund systems, disposal taxes, and differential tariffs for disposal services are recommended for revision with environmental outcomes • New environmentally-related taxes in the electricity and waste water sectors, where environmental issues can be integrated into reforms to the electricity distribution industry and waste water discharge charge system • Reform of non-environmentally-related taxes with negative environmental impacts, including incentives for land conversion from conservation purposes, and VAT zero-rating for farming inputs such as pesticides, and illuminating paraffin. Changes to property rates are also considered to incentivise conservation and land management practices • Five broad categories of incentive mechanisms for improving environmental outcomes are environmental funds, partial or soft earmarking of environmentally-related tax revenues, rehabilitation funds/guarantees, accelerated depreciation allowances, and review of specific tax provisions

2 Provincial

Mpumalanga State of Environment Report, 2003
Air quality issues: greenhouse gases, visibility (sawdust, fires, burning), pollen, vehicle emissions, dirt toads, domestic coal use, coal-fired electricity, respiratory health problems, odours, ambient particulate concentration, asbestos, coal dumps, abandoned mines, industrial and other emissions *Household energy use*: 60% electricity, 20% candles for lighting, 20% wood for cooking and heating, 10% paraffin for cooking and heating *Electricity generation*: 70% of South Africa's supply, PM decreasing since 1999 *Ambient SO_2*: monitoring by Eskom and Sasol, below WHO values with 1 station recording 24-hour exceedances for 2% of recording during May to October 2002

Ambient particulates: monitoring by Eskom (PM_{10}) and Sasol ($PM_{2.5}$), PM_{10} exceedances at some stations, mainly **Leandra and Kendal, Sasol Langerwacht** station 20% readings above US EPA $PM_{2.5}$ standard
Respiratory clinic admissions: no information from clinics, infections in children <5 years more common in winter and polluted areas, highest cases in Ehlanzeni district
Governance: greater capacity for environmental education than environmental management, large industries have voluntarily implemented environmental management systems
Provincial response to air quality: air quality monitoring initiatives, National Electrification Programme

Gauteng State of Environment Report, 2004

Air quality issues: high **particulate** concentrations in low-income areas, high air pollution levels – household coal use, heavy industrial areas, main traffic routes, exacerbates respiratory illness

- Main management needs – province-wide ambient **monitoring** network, emission **inventory**
- Motor vehicles: largest number in SA, increased fuel sales, recognised as the major air quality issue in Gauteng
- **Mine dumps**: major source of dust, especially in late winter and early spring, completion of reclamation in Springs and far East Rand expected in 2 years (2006), dumps in West Rand are problematic
- Household fuel use: source apportionment in Soweto – **70%** contribution to PM, in Vaal – 36.5% average, 65% in winter
- **Veld fires**: prevalent during autumn, winter and early spring
- Monitoring: Esther Park (residential and industrial) - higher concentrations than Alexandra; domestic coal burning - great influence on PM concentrations; **3 Ekurhuleni sites** – Springs Old Boys Club (NO_2, PM_{10}, $PM_{2.5}$, CO, Pb, O_3, Benzene), Leondale (SO_2, NO_2, NO_x, O_3, PM_{10}), Esther Park proposed (SO_2, NO, NO_2, NO_x, NH_3, PM_{10})
- Climate change: largest sources - transport and manufacturing

Mpumalanga Provincial Growth and Development Strategy 2004-2014

Main sectors: manufacturing, mining, electricity and community service, with manufacturing focusing on refined petroleum, chemical and rubber products, mining primarily for coal and gold, mineral resources such as chrome, asbestos, magnesite, iron-ore, vanadium, limestone, dolomite, silica, construction materials, manganese
Industrial growth sectors: stainless steel, agri-processing, wood products, chemical and chemical products, agri-products, tourism
Industrial locations: in Gert Sibande - Secunda, Trichardt, Evander, petrochemical- linked industry, in Nkangala – power stations around coal areas
Waste: largest producer of hazardous waste by province, dominated by fertiliser manufacturing
Air pollution: dominated by **energy** sector, 8 power stations in province, particulates, SO_2 and NO_x problematic
Environmental management: revision to structure planned with goal to have 90% compliance with national and international legislation and policy by 2014

3 Local

Ekurhuleni State of Environment Report, 2004
Energy: households use coal for heating (19%) and paraffin for cooking (26%) ***Lower respiratory infections***: 2725 cases in children < 5 years, in first quarter of 2003, general incidence rate is 13 per 1000 people *Strategic priorities*: environmental education, inequality and poverty (including service delivery and spatial planning), HIV/AIDS, crime and unemployment, tourism *Air quality*: • Sources and % contribution – **heavy industry** (20), power station, mines (dumps, 9), waste sites, transport (7), veld fires (3), **domestic fuel burning** (60) • Pollutants – PM including iron, copper, lead, and chrome oxides, NO_x, CO, CO_2, SO_2, dioxins, formaldehyde, and phenols • Industries - 327 Scheduled processesregistered in Ekurhuleni in 1995, **8000 industries** in 20 industrial areas in seven activity nodes, light industry significant for GHG • **Vehicle** emission considered as most significant **regional** source, particularly in urban areas, road, rail and air network support high traffic levels • Domestic fuel use – 60% pollution load in winter, most important environmental health-related issue, especially in low-income areas, high household use of coal for cooking and heating • Industrial SO_2 – Boksburg North and Springs problematic in 1990's, South African guidelines require revision to identify problem areas adequately • Residential smoke – soiling index higher in industrial and low income residential areas, decrease in CBDs, elevated PM concentrations measured, particularly in winter • Mine dump emissions – mercury, cyanide, sulphur compounds, other heavy metals, α-quartz (leads to silicosis) • Respiratory disease – no causal link established in Ekurhuleni, incidence in first quarter of 2003 – northern, 13, southern, 12, eastern, 14 per 1000 children • Strategic priorities –electrification and alternate energy sources for low income areas, improved air quality monitoring and standards enforcement, AQMP and by-law development, quantification of transport emission impacts • **Monitoring** – Airkem forum, since 1991, Kelvin power station, Esther Park, Edenvale Reservoir, Ivory Park, Tembisa; Springs Air Quality Forum, since 2003; smoke and SO_2, Alberton, Bedfordview, Benoni (active), Boksburg (active), Brakpan, Germiston, Kempton Park, Springs; GDACE to initiate 2 stations in Leondale/Wadeville and Springs *Transport*: travel to work by private (53%) and taxis (28%) *Agriculture*: ploughing produces dust emissions, regional impact, occurs in late winter and early spring *Mining*: mined resources – gold, coal, silver, dolomite, clay, sand, and rock, mostly in southern and eastern regions, radon gas and dust are concerns from mine dumps

Nkangala State of Environment, 2006
Air quality: • Monitoring – fragmented, stations in Witbank (2 - Apolcom, LM) and Middelburg (2 - LM, Columbus Steel/BHP Billiton), dust fallout by LM at Middelburg Townlands Colliery, **SO_2, NO_2, PM** (fallout, PM_{10}) measured, exceedances of SO_2 and PM_{10}, data quality and availability issues

- AQMP – no plan or strategy in place, management is ad-hoc
- Sources – coal-fired power plants, industries, mining activities, domestic fuel burning, motor vehicles, crop spraying with pesticides raised by stakeholders
- **Odours** – produced by industries (leather tanning and abattoirs) and domestic practices (pit latrines, animal carcasses, domestic livestock); complaints – Delmas maximum 5/month domestic-related, Emalahleni maximum 5/month tyre/refuse burning, scheduled processes odour complaints referred to DEAT, Steve Tshwete average 1/month domestic-related
- Scheduled processes – examples in DM – metal and alloys, chemical, coke ovens, power plants, brickworks, textile
- **Capacity** – all LMs have an individual for air quality, Steve Tshwete budget for 1 additional person and monitoring station, has air quality budget; officials work in general environmental, not air quality specialists, Emalahleni looking for external funding for station
- Fines: Emalahleni given to non-compliant owners for domestic-related incidents – burning of tyres/refuse
- Recommendations: data analysis training, improved reporting form for respiratory illnesses, increased renewable energy, energy efficiency awareness

Household fuel use: Delmas – coal dominant for cooking and heating, Emalahleni – coal dominant for heating, Steve Tshwete – wood for heating

Energy efficiency: education on building design principles needed, reduces heating costs

Funding: DM has lowest total operating and per capita **budget** of DMs in Mpumalanga

Environmental management: Delmas requires urgent intervention to improve function

Ekurhuleni State of Energy, 2005

Climate change: baseline assessment for climate change and energy strategy development; landfill gas assessment for energy provision

Energy demand, 2003: transport, 41%, industry and construction, 36%, households, 14%; manufacturing is largest demand sector for electricity

Energy efficiency measures: scaled domestic electricity tariff, landfill management system, municipal building energy metering and other measures to come, demand side management measures – building passive solar design, solar home systems, residential load control

Audit: electricity and water needs of customers being undertaken

Energy carrier: liquid fuels 49%, electricity 38%, pipeline gas 10%

Household coal use: 30% or 44 800 tonnes consumed

Air quality and climate change impacts: household consumption of fossil fuels and vehicle traffic are most significant factors, PM from coal boilers, SO_2, benzene and lead emissions from these activities

Recommendations: automated energy balance for electricity management; environmental – integrated environment and energy programme for climate change strategy, metro to link transport activities to provincial developments, focused data collection on diesel vs petrol statistics, monitoring of PM and greenhouse gases; liquid fuels – diesel vs petrol consumption and energy efficiency incentives, **vehicle survey**

Ekurhuleni Growth and Development Strategy 2025, 2005

Environmental management: upgrading to be done in old mining and industrial areas

Core economic triangle: Kempton Park, Germiston, Boksburg, and Benoni CBDs

Air pollution: **monitoring system** to be in place by 2010
Mining: **mine dumps/slime dams** to be recovered or rehabilitated by 2025 to bring about environmental improvements in mining belt
Healthcare: outcomes include 50% reduction in maternal and child < 5 **mortality rates** by 2015, and bringing environmental pollution levels in line with internationally accepted standards by 2015

Ekurhuleni Integrated Transport Plan, 2006-2011

***Core** economic areas*: 4 areas the focus of transport planning, ORTIA, central activity belt – Germiston, Boksburg, Benoni, Alrode-Wadeville corridor, far East activity belt
Other goals: corridor development, sustainable public transport, modal integration, environmental protection/enhancement
Environmental objectives: **improve public transport**, construction guidelines, sustainable strategies, minimise infrastructure impacts, **non-motorised transport** in planning
Rail: national competence with devolution to lower transport authorities, **1,4 million** passengers/day with Johannesburg (Park) and **Germiston stations** busiest (16%), **priority corridor** focus – 4 in Ekurhuleni in National Rail Plan – Olifantsfontein/Tembisa-Germiston, Daveyton-Germiston, Kwesine/Katlehong-Germiston, Springs-Dunswart, proposed extensions – Daveyton-Etwatwa, Angelo-Knights, Kwesine-Zonkesizwe, Tembisa loop
Airports/airfields: ORTIA, Rand Airport Germiston, Brakpan Airfield, Springs Airfield, Petit Airfield at Putfontein, Bapsfontein Airfield (two fields – one normal and a separate one for microlights), Fly Inn Airpark near Bapsfontein, Fincham Airfield at Nigel, Daveyton Airfield (now closed), Dunnottar Airfield, Microland Flight Park near Bapsfontein
Spatial pattern: central, east-west oriented mining and industrial activity belt, residential developments around activity belt, and rural/agricultural areas to NE and central to south
Historically disadvantaged communities: 4 complexes – Tembisa, Katorus, Kwatsaduza, Daveyton-Etwatwa
Second order road network: five main N-S and 3 E-W priority desire lines
Transport modelling: road congestion to increase preference for rail, densification around rail stations, 2010 – 64% growth from 2001, VKT 80% increase, peak congestion – North R21, N3 Alberton-Edenvale, R59 between M7-N12, Olifantsfontein/Modderfontein Road sections, Allandale Road, Andrew Mapheto Drive near Tembisa
Vehicle emission factors calculated in transport model

Scenario	Network	NO_x g/km	SO_2 g/km	CO g/km	HC g/km
2001	2001	769	13	1	153
2010	2001	995	16	1	192
2010	2010	964	16	1	191
2025 S1	2010+	1155	19	2	229
2025 S2	2010+	1179	20	2	233
2025 S3	2010+	1140	19	2	226

***High occupancy vehicle** lanes*: Tembisa-Kempton Park, Vosloorus-Boksburg, Daveyton-Benoni, Katlehong-Germiston, R23
***Park and ride** facilities*: 3 planned, Rhodesfield station Gautrain, Brakpan station, 2^{nd} priority – Kempton Park station
Class 3 roads: network of minor/activity arterials proposed
Other strategies: travel demand management and **intelligent transport system** proposed for long-term implementation

APPENDIX 3: IDP REVIEW

IDPs are presented on an individual municipality basis. Discussion of IDPs is also separated into air quality and other relevant issues.

Ekurhuleni MM
Air quality: • AQMP prepared in 2005 • BnM – households reached used as performance indicator • Sources – household fuel burning, industrial and commercial fuel burning, vehicle exhaust emissions, ORTIA, unrehabilitated tailings and impoundments, large industries • Priority areas identified in vicinity of sources, also CBD and residential areas transected by highways, on-ramps and main feeder roads
Other: • Main towns – Alberton, Benoni, Boksburg, Brakpan, Edenvale/Lethabong, Germiston, Kempton Park/Tembisa, Nigel, Springs; Main activities – manufacturing • GDS guidelines – intensive agriculture, small-scale mining, transport and logistics, manufacturing beneficiation • Industry – largest concentration of industries in SA and Africa, industrial areas – Isando, Spartan, Jet Park, Germiston, Anderbolt, Benoni South, Wadeville, Alrode, Vulcania, New Era, Nuffield, Vorsterkroon and Pretoriusstad which is part of industrial revitalisation strategy • Transport – N12, N17, N3, R21, R26, ORTIA, Rand Airport, railway hub in Germiston, projects – Wadeville-Alrode industrial corridor, City Deep Container terminal, Gautrain rapid rail link, ORTIA IDZ, priority expansion – PWV 15, PWV 13, PWV 14, R21, N12, secondary roads – 6 north-south and 3 east-west desire lines • SANRAL Gauteng Freeway Improvement Scheme – upgrade N12, N17, N3, construct PWV14, Intelligent Transport System rollout, overload control centre development • Residential development - 8 precincts, Olifantsfontein/Clayville, Esselenpark/ Kaalfontein, Pomona/Benoni North, north of Daveyton, KwaThema-Duduza, Tsakane West, Boksburg South, Katorus South • Infill development areas – disused mining land in Germiston, central Boksburg, east Benoni, northwest and west of Springs CBD • Mining – Reiger Park, east Benoni, east Springs, Kwatsaduza
Sedibeng DM
Air quality issues: • Indoor and industrial air pollution recognised as some causes of poor environmental health in district • No statistical data is readily available on air pollution levels to quantify impacts • Monitoring - District has 2 stations – Emfuleni, Midvaal • AQM Strategy – recognition of VTAPA and development of plan together with municipalities • Capacity – lack of capacity to perform AQM adequately, listed as specialist function • AQA implementation – assistance from National Government regarded as essential, burden seen as on DM and Metro's to implement in jurisdiction • AQM challenges –monitoring and data analysis, SLA renewal, future of MHS, health by-law development for district, district-wide resource provision; others - AQA

implementation, DM air quality unit establishment, AQMP development • BnM rollout also planned for 4 years • EHS - DM function but performed by LM's as requested and funded by DM, includes air pollution, 5 EHPs employed in Lesedi • Contradiction of DM and LM – AQA contradicts the EHS function by giving powers & functions to the LM and licensing to DM
Other: • EMS - DM to encourage uptake of ISO 14000 by large industries, improved environmental reporting and industry regulation needed by DACE, DM and LM's encouraged to adopt an EMS
Lesedi LM
Air quality: • Environmental health services - rendered by LM's in the district by SLA, includes industrial emission control and complaints investigation • Sources – informal settlements due to residential fuel burning using coal and paraffin, industrial area particularly BAT and Escort, slimes dams
Other: • Main centres – Heidelberg/Ratanda, Devon/Impumelelo; main activity – agriculture • Main industries – British American Tobacco Cigarette Manufacturing Plant, Escort Meat Processing Plant, small industries – Heidelberg. Also light industries and commercial operations operating illegally from small holdings – Vischkuil, Endicott, Hallgate • Transport - N3 and N17 pass through district • Mining – previous activity, major slime dams adjacent to N17 Vischkuil/Endicott area, smaller slime dams at old Witwatersrand/Nigel gold mine, commercial coal mining possibility in future as extensive reserves in LM • Quarries – building sand, S/SW Lesedi; shale/brickclay, NE Ratanda, Rensburg, N Vischkuil; refractory/fireclay, E Heidelberg; stone aggregate, adjacent old Witwatersrand Nigel Gold Mine • Informal settlements – around Ratanda and Impumelelo, Alra Park, KwaZenzele
Gert Sibande DM
Air quality: • Monitoring – network to be established for DM using Sasol and DALA funding • AQMP proposed, with support from other departments • MHS – Section 78 assessment to be done to determine mechanism to deliver services, proposed as shared service
Other: • LED – study to maximise potential – Dipaleseng, Govan Mbeki, Msukaligwa – mining, agric and manufacturing, Lekwa and Pixley ka Seme – tourism, agriculture • Transport – N17, N11 development corridors
Govan Mbeki LM
Air quality: • Strategies – compile AQMP, compliance with standards, source inspections, awareness campaigns, monitoring data analysis, involvement in EIA processes and monitoring development's use of best practice
Other: • Main towns – Secunda, Bethal • Transport – N17 passes through, major rail link between Gauteng and Richards Bay

• Landuse and activities – major landuse is commercial agriculture, main activity is petrochemical sector with SASOL as key industry, also coal and gold mining
Dipaleseng LM
Air quality: • Sources - Coal stoves, Siyathemba, Nthorwane, informal settlements and townships, smoke pollution from wood, coal fires, no data available on pollution, limited industrial pollution • Environmental health priority – inadequate health and environmental services
Other: • Main towns – Balfour, Greylingstad, also Grootvlei; main activity – agriculture • Transport – N3, N2, R23 • Abattoir in Balfour • Power generation and coal mining were significant economic activities prior to closure, Grootvlei power station scheduled for re-opening due to electricity crisis • Industrial area – proposed for Grootvlei
Lekwa LM
Air quality: • Air pollution monitoring and control to be addressed through Integrated EMP • Monitoring network to be set up for DM, with funding set aside, and website needed
Other: • Main town: Standerton • Projects – broiler house, poultry abattoir planned • Industries – agriculture main activity, 2 coal mines Thuthukani
Msukaligwa LM
Air quality: • Need for AQMP sector plan identified and budget expressed, Council resolution not made
Other: • Main town – Ermelo, main activity – agriculture • Transport – N2, N11, N17 pass through municipality
Pixley ka Seme LM
Air quality: • Development and implementation of pollution control strategies included in priorities
Other: • Main town – Volksrust • Energy – main lighting is electricity, followed by candles, paraffin and gas • Transport – main inter-regional transport routes, N11 passes through
Nkangala DM
Air quality: • MHS - rendered by LM and provincial DoHealth, capacity constraints at DM, Section 78 investigation underway and outcomes may result in MoU/SLA development between LM and DM, MHS by-law development and implementation a district challenge, implementation of MHS function planned by DM, with budget allocation • Environmental management – development of AQMP and district licensing function implementation planned, DM AQMP development part of HPA process
Other: • Main towns – Middelburg, Emalahleni; others, Belfast, Machadodorp, Delmas

• Main activities – manufacturing, mining, power generation, chrome and coal deposits, high agricultural potential • Transport – N4, N12, N11, rail corridor proposed, truck port/logistics hub project, Delmas cargo airport planned • Industrial areas – Steve Tshwete - Columbus Steel, Emalahleni - Highveld Steel • Energy – Bravo station, new 4800MW, online 2012 – 2015/6, Komati station upgrade, trial ethanol plant planned
Delmas LM
Air quality:
Other: • Main town – Delmas, main activities – agriculture, mining (coal, silica) • Transport – N12 • Informal settlements – 7 • Dirty fuels – high coal usage for cooking and heating, 80%
Emahlaleni LM
Air quality: • Air pollution identified as major impact from opencast coal mining activities, expected to be addressed through IEMP development • Budget set aside for purchase of monitoring equipment
Other: • Main town – Emalahleni/Witbank, main activities – manufacturing, mining, agriculture • Transport – N4, N12, rail network, internationally linked, 2 major projects planned, logistics hub, multi-modal facility • Energy – 4 power stations, Kendal, Matla, Duvha, Ga-Nala, extensive coal reserves, Eskom capacity expansion and coal mine development • Industrial areas – 9 • Mining – coal, 6 abandoned combusting mines • Manufacturing – metals, metal products, machinery and equipment sub-sector, including Highveld Steel, major strength sub-sectors – other non-metallic products glass, cement, ceramic; radio, tv, instrument, watches, clocks; transport equipment • Airport – Emalahleni aerodrome planned in Klarinet development • Informal settlements – Blesboklaagte/Klarinet, Enkanini, Duvha, Van Dyksdrift
Steve Tshwete LM
Air quality: • Air pollution is key institutional challenge • Threat in SWOT analysis - environmental hazards and impacts include pollution • Strategic goal is service delivery, includes AQM • Health and environment priority – implementation of monitoring strategy for air pollution, and other media, implementation and enforcement of regulations, by-laws and standards, community awareness/participation to be conducted, KPI – monitoring sample numbers • Budget allocation made for air pollution reduction by health department • AQO nominated to monitor and coordinate air quality in LM • Monitoring station and dust analyser purchased with operating budget, 2nd station planned • Environmental management meetings held with DALA, DoHealth, private sector - Samancor, Columbus Steel, community organisations

Other:

- Main town – Middelburg, main activities – agriculture, mining, steel manufacturing, power generation
- Informal settlements – Newtown, Kwazamokuhle, Uitkyk, Rondebosch (Vaalbank)
- Energy – 73% of rural households not electrified, Arnot power station
- Transport – multi-modal transport facility planned for Middelburg CBD
- Veld fires – raised as priority municipal issue, strategy is firebreak management

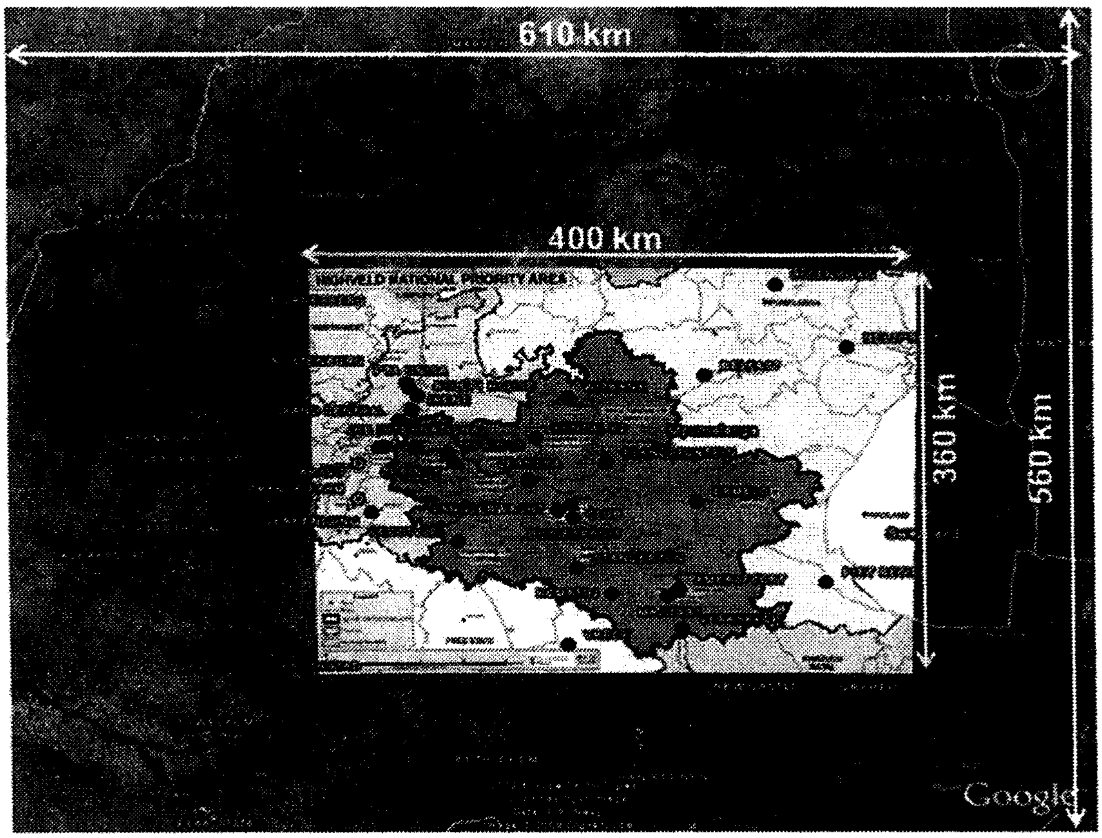
APPENDIX 4: MODELLING APPROACH

Methodology

The modelling objective is to use dispersion modelling to understanding areas of ambient air quality concern on the HPA at a regional scale

Modelling domain

The modelling domain for the Highveld has an extent of 400 km (west to east) by 360 km (north to south), covering an area of 144 000 km^2 and is centred on 26°30'00"S; 29°30'00"E (close to the town of Bethal). The domain includes a 50 km buffer on either side of the HPA boundary. The top of the domain was set at 5 km.



Extent of the two modeling domains

Data

Data used for the dispersion modelling include measured and modelled hourly average meteorological data (wind speed, wind direction, temperature, relative humidity, pressure, rainfall, sunshine) for the period 2004-2006 from 29 stations in the modelling domain.

Modelled surface and upper air wind fields are generated at 44 locations using the Australian CSIRO meteorological processor, The Air Pollution Model (TAPM) (www.dar.csiro.au/tapm).

TAPM has been extensively verified in Australia and other international locations. TAPM data, together with the measured data provide comprehensive surface and upper air data coverage of the study area.

Prognostic meteorological model - TAPM

The meteorological component of TAPM is an incompressible, non-hydrostatic, primitive equation model with terrain following vertical coordinates for three-dimensional simulations (Hurley *et al*, 2001; 2002). The model solves the momentum equations for horizontal wind components, the incompressible continuity equation for vertical velocity, the scalar equations for potential temperature and specific humidity of water vapour, cloud and rainwater. The synoptic scale pressure gradient is represented explicitly in the horizontal momentum equations as a function of the synoptic wind, which is input to TAPM. TAPM includes parameterisation for vegetative canopy, soil and radiative fluxes.

TAPM is configured with two nested grids for the modelling domain. The outer grid consists of 80 X 80 horizontal grid points at a spacing of 10 km followed by a second, inner 80 X 80 grid at 5 km spacing. Thirty vertical levels are modelled in each nest.

In both model runs, TAPM was run in data assimilation mode in which the observed hourly winds at 10 m (above ground) from the respective observation stations are input into the model. In data assimilation mode, TAPM uses the wind speed and direction observations to nudge the predicted solution towards the observations. Each monitoring station is set with a varying radius of influence ranging from 5-20 km, depending on the surrounding topography and proximity of other monitoring stations. Observed winds are set to influence level one, which is the lowest model level (10 m) and corresponds to the measurement height of the observations. Application of the data assimilation approach for TAPM runs on the west and east coast of South Africa resulted in an enhancement of modelled data (Raghunandan *et al.*, 2009)

Modelled surface and upper air data was extracted at regular intervals on the TAPM output grids. Modelled surface data was not used if monitored data was available within a 5 km radius of a modelled station. All modelled upper air data was used as input to CALMET.

Meteorological model - CALMET

CALMET is a meteorological model which includes a wind field generator containing objective analysis and parameterised treatments of slope flows, terrain effects and terrain blocking effects. This meteorological pre-processor produces gridded fields of wind components, air temperature, relative humidity, mixing height and other micro-meteorological variables for input into the CALPUFF dispersion model.

The CALMET pre-processor requires hourly data in terms of wind speed, wind direction, temperature, cloud amount, ceiling height, relative humidity, surface pressure, sea surface temperature; and temperature and wind data from upper air soundings. A combination of measured and modelled surface data was processed into a CALMET-ready format for the modelling domain.

CALMET requires geophysical data including gridded fields of terrain elevations and land use categories. This data was accessed from geophysical databases for the inner domain at a 2 km resolution. The topography of the HPA is relatively simple and the main features are well resolved.

The CALPUFF model

CALPUFF is a multi-layer, multi-species non-steady state puff dispersion model, which can simulate the effects of time- and space-varying meteorological conditions on pollutant transport, transformation and removal. CALPUFF uses the three-dimensional meteorological fields developed by CALMET.

CALPUFF contains algorithms for near-source effects such as building downwash, partial plume penetration, sub-grid scale interactions as well as longer-range effects such as pollutant removal, chemical transformation, vertical wind shear and coastal interaction effects.

The model employs dispersion equations based on a Gaussian distribution of pollutants across the puff. The model takes into account the complex arrangement of emissions from stacks, represented as point sources, and from potline roof ventilators, represented as low-level buoyant line sources. As with any mathematical environmental model, the CALPUFF model represents a simplification of the many complex processes involved in determining the outcome, in this case ground level concentrations of pollutants.

Emission scenarios

Separate model runs were done for the following emission sectors:

- Power generation
- Petrochemical sector
- Primary metallurgical
- Non-ferroalloys
- Brickworks Other
- Opencast coal mines
- Mpumalanga industries
- Industry in Ekurhuleni Metropolitan Municipality
- Transport (motor vehicles and ORTIA)
- Residential fuel burning
- Sources outside the HPA, but within 50 km of the HPA
- Biomass fires

Industrial sources were modelled as point and area sources and the emission rates were assumed to be constant over time. Mines and brickworks were modelled as area sources with constant emission rates. Motor vehicle emissions and residential fuel burning emissions were modelled as area sources with temporal profiles to account for the daily and seasonal variations that characterise these sources. Particulates are modelled as PM_{10}.

APPENDIX 5: EMISSION FACTORS FOR BIOMASS BURNING

		Emission Factor(mg/kg)				
SANLC Code	**SA National Land Cover Class**	PM25	PM10	CO	NOX	CO2
0	No data entered (assumed to be grass)	4.95	10.00	76.80	3.90	1699.00
1	Forest (indigenous)	11.00	12.00	107.00	3.00	1569.00
2	Woodland	11.00	12.00	107.00	3.00	1699.00
3	Thicket, Bushland, Bush Clumps, High Fynbos	11.00	12.00	107.00	3.00	1699.00
4	Shrubland and Low Fynbos	11.00	12.00	107.00	3.00	1569.00
5	Herbland	4.95	10.00	76.80	3.90	1699.00
6	Natural Grassland	4.95	10.00	76.80	3.90	1699.00
7	Planted Grassland	4.95	10.00	76.80	3.90	1699.00
8	Forest Plantations (Eucalyptus spp)	11.00	12.00	107.00	3.00	1569.00
9	Forest Plantations (Pine spp)	11.00	12.00	107.00	3.00	1569.00
10	Forest Plantations (Acacia spp)	11.00	12.00	107.00	3.00	1569.00
11	Forest Plantations (Other / mixed spp)	11.00	12.00	107.00	3.00	1569.00
12	Forest Plantations (clearfelled)	11.00	12.00	107.00	3.00	1569.00
13	Waterbodies (assumed to be grass/wetland)	4.95	10.00	76.80	3.90	1699.00
14	Wetlands	4.95	10.00	76.80	3.90	1699.00
15	Bare Rock and Soil (natural)	4.95	10.00	76.80	3.90	1699.00
16	Bare Rock and Soil (erosion : dongas / gullies)	4.95	10.00	76.80	3.90	1699.00
17	Bare Rock and Soil (erosion : sheet)	4.95	10.00	76.80	3.90	1699.00
18	Degraded Forest & Woodland	4.95	10.00	76.80	3.90	1699.00
19	Degraded Thicket, Bushland, etc	4.95	10.00	76.80	3.90	1699.00
20	Degraded Shrubland and Low Fynbos	4.95	10.00	76.80	3.90	1699.00
21	Degraded Herbland	4.95	10.00	76.80	3.90	1699.00
22	Degraded Unimproved (natural) Grassland	4.95	10.00	76.80	3.90	1699.00
23	Cultivated, permanent, commercial, irrigated	4.95	10.00	76.80	3.90	1699.00
24	Cultivated, permanent, commercial, dryland	4.95	10.00	76.80	3.90	1699.00
25	Cultivated, permanent, commercial, sugarcane	4.95	10.00	76.80	3.90	1699.00
26	Cultivated, temporary, commercial, irrigated	4.95	10.00	76.80	3.90	1699.00
27	Cultivated, temporary, commercial, dryland	4.95	10.00	76.80	3.90	1699.00
28	Cultivated, temporary, subsistence, dryland	4.95	10.00	76.80	3.90	1699.00
29	Cultivated, temporary, subsistence, irrigated	4.95	10.00	76.80	3.90	1699.00
30	Urban / Built-up	4.95	10.00	76.80	3.90	1699.00
31	Urban / Built-up (rural cluster)	4.95	10.00	76.80	3.90	1699.00
32	Urban / Built-up (residential, formal suburbs)	4.95	10.00	76.80	3.90	1699.00
33	Urban / Built-up (residential, flatland)	4.95	10.00	76.80	3.90	1699.00
34	Urban / Built-up (residential, mixed)	4.95	10.00	76.80	3.90	1699.00
35	Urban / Built-up (residential, hostels)	4.95	10.00	76.80	3.90	1699.00
36	Urban / Built-up (residential, formal township)	4.95	10.00	76.80	3.90	1699.00
37	Urban / Built-up (residential, informal township	4.95	10.00	76.80	3.90	1699.00
38	Urban / Built-up (residential, informal squatter)	4.95	10.00	76.80	3.90	1699.00
39	Urban / Built-up (smallholdings, woodland/ lot)	4.95	10.00	76.80	3.90	1699.00
40	Urban / Built-up (smallholdings, thicket, bushland)	4.95	10.00	76.80	3.90	1699.00
41	Urban / Built-up (smallholdings, shrubland)	4.95	10.00	76.80	3.90	1699.00
42	Urban / Built-up (smallholdings, grassland)	4.95	10.00	76.80	3.90	1699.00
43	Urban / Built-up, (commercial, mercantile)	4.95	10.00	76.80	3.90	1699.00
44	Urban / Built-up, (commercial, education, health,)	4.95	10.00	76.80	3.90	1699.00
45	Urban / Built-up, (industrial / transport : heavy)	4.95	10.00	76.80	3.90	1699.00
46	Urban / Built-up, (industrial / transport : light	4.95	10.00	76.80	3.90	1699.00

	47	Mines & Quarries (underground / subsurface)	4.95	10.00	76.80	3.90	1699.00
	48	Mines & Quarries (surface-based mining)	4.95	10.00	76.80	3.90	1699.00
	49	Mines & Quarries (mine tailings, waste dumps)	4.95	10.00	76.80	3.90	1699.00

APPENDIX 6: INDUSTRIAL INTERVENTION PLANS

Emission reduction plans were requested by DEA from industries operating in the HPA, indicating the air quality improvements that would be undertaken as part of fulfilling the "duty of care"principle.

A list of all industries included in the initial HPA emission inventory, which informed the baseline assessment, is provided below. Industries that have provided emission reduction plans are indicated and the plans are included here for public information. Through the imoplementation of the AQMP, industry-specific emission reductions will be determined for significant emitters together with the respective AELAs. The plans included here will serve to inform this process and will be finalised accordingly.

Industry Name	Submitted Plan
A.B.Brickworks	
A.F. Pillman Tractors (Pty) Ltd	
Abrasive Grit Corporation	
Active Alloys & Metals Cc	
Active Foundry	
Actonville Hospital	
African Bitumen Emulsions	
African Char	
African Oxygen Limited -Germiston	
Afrisol (Pty) Ltd	
Afro East Galvanizers	
Afrox Ltd- Leondale	
Air Liquide Southern Africa	
Air Products South Africa (Pty) Ltd	
Alu-Bronze Alloys (Metlite Alloys)	
Aluminium Castings	
Aluminium Chemicals	
Aluminium Granulated Products(Pty)Ltd	
American Iron & Brass Foundry (Pty) Ltd	
Anso Aluminium (Wispeco (Pty) Ltd)	
Ao Chemicals (Pty) Ltd	
Apollo Brick (Purchased Eagle Brick And Tile)	
Apollo Bricks (Pty) Ltd	
Aquachlor (Pty) Ltd	
Arch Water Products	
Armco Superlite (Pty) Ltd	

Arnot Power Station	Y
Associated Power & Light (Pty) Ltd	
Atlas Copco Serococ (Pty) Ltd	
Autoindustrial Foundry	
Automa Multi Styrene	
Avbob Crematorium	
Aztec Metals (Pty) Ltd	
Bagat Carbide	
Bandag Southern Africa	
Bank Stene	
Barend J Van Der Merwe Stene (EMDS) BPK	
Basil Read (Pty) Ltd	
Bayer (Pty) Ltd	
Bell Metals	
Benoni Municipality	
Bernice Samuel Hospital	
Bethal Hospital	
Bethal Stene	
Bishop Metals.Cc	
Black Top Asphalters	
Black Top Surfaces	
Blesbok Stene	
Blue Circle Cement	
Boart Longyear	
Boksburg Foundry	
Boksburg Galvanizing	
Brass Extruders (Copalcor)	
Brick & Clay (Nigel)	
Brickfab (Edms) Bpk	
Brikor Limited (Olifantsfontein)	Y (Bronkhorstspruit)
Briti (Pty) Ltd	
Brollo Africa (Pty) Ltd	
Bulpan Steenmakery	
Busby Saw Mills (Pty) Ltd	
Caltex Oil Sa (Pty) Ltd - Alrode	
Canlin (Pty) Ltd	
Cape Lime (Tvl) Limited - Benoni	
Carborundum Universal Sa (Pty) Ltd	
Castrol South Africa (Pty) Ltd	
Cemlock Gauteng (Pty) Ltd	
Central Engineering Works (Pty)Ltd	
Char Technology (Pty) Ltd	
Chargold Pty Ltd	
Chemetall	

Chemserve System (Pty) Ltd	
Clyde Brickfields	
Cobra Watertech	
Colas North (Pty) Limited	
Columbus Stainless Steel	Y
Concor Ltd - Roads Surfacing Division	
Consol (Germiston)	
Consol Glass (Olifantsfontein)	
Consol Limited	
Consolidated Galvanising Service (Pty) Ltd	
Consolidated Galvanising Services (Pty) Ltd (Alpha Hot Dip Galvanisers)	
Cord Chemicals (Pty) Ltd	
Corobrik Middlewit Factory	
Corobrik Transvaal (Daggafontein)	
Corobrik Transvaal Witbank	
Corrobrik	
Craigan (Pty) Ltd	
Crown Bronze Cc	
Crown Cast (Pty) Ltd	
D B Thermal (Pty) Ltd	
David Brown Gear Industries (Pty) Ltd	
Distell (Pty) Ltd	
Doves Crematorium	
Dow Agro Sciences Southern Africa (Pty) Ltd	
Duvha Power Station	Y
E14 Everite Ltd	
E15 Exarro Zincor Base Metals	Y
Early Bird Farm	
East Brick Company (Pty) Ltd	
Eastern Gauteng Services Council	
Eclipse Foundry	
Effek Kleisteen Vervaardigers (Edms) Bpk	
Elgin Refractories Springs Ltd	
Elmacast	
Elsie Ballot Hospital	
Embalenhle Community Hospital	
Ermelo Hospital	
Ermelo Steengroewe	
Etac Rubber Linings (Pty) Ltd	
Falcon Smelters (Pty) Ltd	
Federal Mogul Large Bearing (Pty) Ltd	
Fedgas (Pty) Ltd (Alberton)	
Ferro Industrial Products	
Ferrometals	Y

Ffs Refiners (Mpumalanga)	
Ffs Refiners (Pty) Ltd (Kempton Park)	
First National Battery	
Flembar Alloys Cc	
Fluidex Engineering (Pty) Ltd (Stationary Plant)	
Foundary And Engineering Supplies	
Foundry And Precision Castings Cc	
Foundry Pattern Engineering Equipment (Pty) Ltd	
Fry's Metals (Germiston)	
Future Alloys (Pty)Ltd	
G Parkin Transport	
Galva Force (Pty) Ltd	
Galv-Spin Galvanizers	
Gayatri Paper	
Gea Aircooled Systems (Pty) Ltd	
Geduld Brickworks	
Girlock (Sa) (Pty) Ltd	
Glacier Bearings	
Global Sawmills (Pty) Ltd - Jessievale Mill	
Goedehoop Collery Springbok	
Goedehoop Colliery	y
Goedehoop Colliery Goedehoop	
Gravelotte Mines (Pty) Ltd	
Griffiths And Inglis (Pty) Ltd	
Grifo Foundry Cc	
Groves (Pty) Ltd	
Gsg Foundry (Pty) Ltd	
Gypsum Industries Limited	
H02 Hannitan Leather	
Haggie Wire & Strand	
Hendrina Power Station	Y
Henkel Surface Technologies	
Hi Tech Galavanizers (Pty) Ltd	
Hi-Carb Solutions	
High Duty Castings Cc	
Highveld Hospital Anglo	
Higjhveld Steel & Vanadium	Y
Hl & H Mining Timber (Pty) Ltd	
Hl&H Mining Timber - White Rivert Mill	
Hl&L Mining Timber (Graskop Meule)	
Hoeveld Stene (EDMS) BPK	
Holcim (Sa) (Pty) Ltd	
Holfontein Steenwerke (Edms) Bpk	
Hulamin Extrusions	

Hume-Monowed Corrosion Protection (Pty)Ltd	
Huttenes-Albertus Falchem (Sa) (Pty) Ltd	
Impala Platinum Limited	
Impala Platinum Ltd Springs	Y
Industrial Distillers And Refiners (Pty) Ltd	
Industrial Iron And Steel Works (Pty) Ltd	
Investchem (Pty) Ltd	
Jay-Bee Castings Cc.	
Johannesburg Drum Reconditioning	
Johannesburg Foundry	
Johnson Matthey (Pty) Ltd	
Kayalami Bricks	
Kellogg Company Of South Africa	
Kelvin Power Station	
Kendal Power Station	Y
Khutala Colliery	
Kimberley-Clark South Africa Enstra	
Kolbenco (Pty) Ltd	
Kriel Power Station	Y
Kromdraai Stene - Witbank	
Lead Processing International (Pty) Ltd	
Leslie Gold Mines	
Lever Brothers(Pty) Ltd-Boksburg	
Lianru Galvanisers	
Lianru Galvanisers Cc-NIgel	
Lodge Metals Cc	
Loot Pretorius	
Louis Cox Foundry (Pty) Ltd (Denville Foundries)	
Lusafrica Founders	
M & N Sawmills (Pty) Ltd - Lothair Mill	
M L Projects	
M.R Zinc Cc	
Majuba Power Station	Y
Maksal Tube (Pty) Ltd	
Malleable Castings (Pty) Ltd	
Mariavale Bricks (Pty) Ltd	
Matla Power Station	Y
Mc Kechnie Brothers South Africa (Pty) Ltd	
Mccain FOODS	
MCP Containers & Drum Reconditioners Cc	
Metalco (Pty) Ltd	
Middelburg Ferrochrome & Technochrome	Y
Middelburg Steen Groewe	
Mill & Industrial Services (Pty) Ltd	

Miracle Manufacturing	
Mondi Packaging Sa	
Much Asphalt	
Multi Construction Chemicals (Pty) Ltd	
Murray & Roberts Civils (Pty) Ltd	
Mustang Precision Castings (Pty) Ltd	
N Fdie Casting (Pty) Ltd	
Nampak Bevcan	
Nampak Corrugated	
National Asphalt (Pty) Ltd	
National Solder Co.	
Ncp Chloorchem	
Ncp Transvaal (Isegen)	
Nestle Ice-Cream	
New Century Bricks cc	
Nf Die Casting	
Nf Die Casting (Pty) Ltd	
Nigel Brick & Clay (Pty) Ltd	
Nigelchem CC	
Olifantsfontein Brickworks	
Owens Corning	
Ozalid Sa (Pty) Ltd	
Ozz Foundry	
P.G Sealant & Mastic	
P.G. Bison (Pty) Ltd (Boksburg)	
Pilkington Flat Glass (Sa) (Pty)Ltd	Y
Pine Sawmills Bpk	
Plaaskem (Pty) Ltd	
Plant Protection (Pty) Ltd	
Prima Industrial Holdings	
Profile Timbers	
Prorand JV	
Protea Asphalt (Pty) Ltd (No.10 Plant)	
Protea Asphalt (Pty)Ltd	
Protea Chemical Developments (Pty) Ltd	Y
Pro-Tech Galvanisers (Pty) Ltd	
Quick Pack Cc	
Rand Carbide	Y
Rand Refinery Limited	
Rcl Non- Ferrous Foundry	
Rechem Industries (Pty) Ltd	
Rely Precision Castings	
Remote Electrical Insulation (Pty) Ltd	
RINGROLLERS (Division Of DCD Dorbyl)	

Roadmix SA (PTY) LTD	
Robor Tube	
Rolfes	
S & B Patterns & Founders (Pty) Ltd	
S.A. Breweries Ltd	
Sa Copper Alloys-Benoni-Aberdeen Rd.	
Saint-Gobain Isover South Africa (Pty) Ltd	
Salcast (Pty) Ltd	
Sappi Enstra	
Sasol	Y
Sasol Oil (Pty) Ltd - Alberton	
Sasol Secunda	Y
Sasol Smx-Witbank	
Scaw Metals	Y
Seitz Technology (Pty) Ltd	
Seton South Africa	
Shell Sa (Pty) Ltd	
Smith Wheels (Pty) Ltd	
South African Airways (Pty) Ltd	
Spangle Galvanizers (Previously Afro East Galvanizers)	
Spotless Drums Reconditioners	
Standard Foundry	
Standerton Hospital	
Stove Mecca	
Tarmac Roadstone S.A (Pty) Ltd	
Techmet Cc	
Technical Manufacturers And Distributors (Pty) Ltd	
Telcast Engineering Works (Pty) Ltd	
Tembisa Hospital	
Thermal Ceramics	
Thermopower Process Technologies(Pty) Ltd	
Thomas Foundry	
Thor Foundry (Pty) Ltd	
Timberline CC	
Tinning&Galvanising Industries (Pty) Ltd	
Tongaat Hulett Starch	
Total South Africa(Pty) Ltd - Alrode	
Town Council Boksburg	
Transalloys	Y
Transvaal Galvanisers	
Tri Cast Forming	
Tutuka Power Station	Y
Ultra High Pressure Units (Pty) Ltd	
Univa (Pty) Ltd	

Universal Metal Holdings	
Van Lenrob Eiendomme (EDMS) BPK Quality Bricks	
Vanchem Vanadium Products	Y
Vereeniging Refactories	
Verre Oos-Rand Hospitaal	
Vestcast (Pty) Ltd	
Vesuvius South Africa (Pty) Ltd	
Vula Bricks (Pty) Ltd	
Wade-Chem (Pty) Ltd	
Wam Metals (Pty) Ltd	
Waste Product Utilisation	
Wastetech (Pty) Ltd	
Waste-Tech (Pty) Ltd (Rietfontein)	
Western Platinum Refinery	
Wilgard Patterns (Pty) Ltd	
William Wingale Holdings	
Windsor Metals (Pty) Ltd	
Windsor Metals (Pty) Ltd - Springs	
Witbank Brickworks (Pty) Ltd Clamp Kiln	
Witbank Brickworks (Pty) Ltd H-Type Kiln	
Zealous Pressure Castings (Pty) Ltd	
Zimco Aluminium Company	Y
Zinc Compounds & Chemicals (Pty) Ltd	
Zinc Corporation Of SA (Pty) Ltd	
Zincall (Pty) Ltd (Precious Metal Recoveries)	
Zinchem (Pty) Ltd	
Omnia	Y
Xstrata Coal SA	Y

Company Name:	BRIKOR LIMITED – BRONKHORSTSPRUIT		
Location:	ZITHOBENI, BRONKHORSTSPRUIT		
AQA S.21 Sector:	CATEGORY 5: MINRAL PROCESSING, STORING AND HANDLING AS PER GOVERNMENT GAZETTE No. 33064		
AQA S.21 Sub-sector:	SUBCATERGORY 5.2: CLAMP KILNS FOR BRICK PRODUCTION		
Intervention Title:	IMPROVEMENT OF AIR QUALITY		
Intervention Type:	1. MORE FREQUENT WATERING OF ROADS 2. RAW MATERIAL MIDFICATION INVESTIGATION		
Problem Statement			
POSSIBLE PROBLEMS ARE: 1. DUST FALLOUT AND 2. SULPHUR DIOXIDE			
Intervention			
1. WATER CART TO BE USED MORE FREQUENTLY TO SUPRESS DUST (SHORT TERM – NOW TO 2012) 2. INVESTIGATE DIFFERENT FUEL TYPES (LONG TERM 2015 – 2020) 3. IMPROVE SULPHUR DIOXIDE MONITORING			
Current Status:	OPERATING		
Expected Start:	OPERATING	Expected Commissioning:	2010 - 2012

Current Emissions:	1. DUST FALLOUT – 474.21 TO 2623.67 mg.m^2.day. 2. SULPHUR DIOXIDE – UNTESTED, MONITORING TO BE INTRODUCED	Expected Emission Reductions:	1. DUST LEVELS ARE EXPECTED TO DROP TO LOWER LIMIT OF +/- 100 mg.m^2.day. (SHORT TERM NOW – 2012) 2. ANTHRACITIC COAL, LOW SULPHUR COAL OR GAS COULD BE INVESTIGATED PROVIDED IT IS ECONOMICALLY VIABLE (LONG TERM – 2015 – 2020) 3. TO BE DETERMINED
Estimated Fixed Cost:	1 WATER CART – R10 000.00 P/A 2. FUEL TYPE INVESTIGATION – R5K 3. SULPHUR TESTING – R3 000.00 P/A	Estimated Running Cost:	1. WATER CART – R10 000.00 P/A 2. FUEL SUBSITUTION TO ANTHRACITE – R4,3M P/A 3. SULPHURE DIOXIDE MONITORING – R3 000.00 P/A
Significance			
THE SIGNIFICANCE OF IMPROVED INTERVENTION TO REDUCE ANY NEGATIVE ATMOSPHERIC IMPACT WILL HAVE AN IMMEDIATE IMPROVEMENT WITHIN 1 KM RADIUS. A CUMULATIVE IMPROVEMENT WILL BE SIGNICANT ON 10 KM RADIUS AND PRIORITY AREA-WIDE AIR QUALITY IF ALL POLUTERS PARTICIPATE.			
Measurement, Reporting and Verification			
1. THREE MONTH RUNNING AVERAGE NOT TO EXCEED LIMIT VALUE FOR ADJACENT LAND USE ACCORDING TO DUST FALLOUT STANDARDS PROMULGATED IN TERMS OF SECTION 32 OF NEM: AQA, 2004 (ACT 39 OF 2004), IN EIGHT PRINCIPAL WIND DIRECTIONS 2. TWELVE MONTH RUNNING AVERAGE NOT TO EXCEED LIMIT VALUE AS PER GN 1210 OF 24 DECEMBER 2009. PASSIVE DIFUSIVE MEASUREMENT APPROVED BY THE LICENSING AUTHORITY CARRIED OUT MONTHLY.			

Company Name:	Columbus Stainless		
Location:	Off Hendrina Road, Middelburg		
AQA S.21 Sector:	Metallurgical Industry		
AQA S.21 Sub-sector:	Electric Arc Fumace and Steel Making		
Intervention Title:	Ambient Air Quality Monitoring Station		
Intervention Type:	Measurement of ambient air quality at the Columbus site.		
Problem Statement			
The impact of Columbus emissions on ambient air quality needs to be known to correctly identify what interventions are required.			
Intervention			
Upgrading of existing ambient air quality station and re-location to already determined appropriate monitoring site.			
Current Status:	Existing monitoring station unreliable and incorrectly located		
Expected Start:	4th Quarter 2010	Expected Commissioning:	1st Quarter 2011
Current Emissions:	Not applicable	Expected Emission Reductions:	Not applicable
Estimated Fixed Cost:	R1m	Estimated Running Cost:	R200k p.a.

Significance
This monitoring station will measure air quality in the local area of Columbus.
Measurement, Reporting and Verification
Air quality in terms of PM10, SO_2 and NO_x will be measured together with meteorological parameters. Reporting is done on a monthly basis and the station is run to SANAS accreditation standards.

Company Name:	Columbus Stainless		
Location:	Off Hendrina Road, Middelburg		
AQA S.21 Sector:	Metallurgical Industry		
AQA S.21 Sub-sector:	Electric Arc Furnace and Steel Making		
Intervention Title:	Dust Fall Out Monitoring		
Intervention Type:	Measurement of dust fall out at the Columbus site.		
Problem Statement			
The ambient air quality impact associated with particularly non point source fugitive particulate emissions.			
Intervention			
Measure the impacts as described in the problem statement.			
Current Status:	About to be implemented		
Expected Start:	September 2010	Expected Commissioning:	September 2010
Current Emissions:	Not applicable	Expected Emission Reductions:	Not applicable
Estimated Fixed Cost:	R30k	Estimated Running Cost:	R100k p.a.
Significance			
This monitoring programme will quantify impacts of fugitive dust emissions and improvements stemming from any interventions made.			
Measurement, Reporting and Verification			
Dust fall out will be measured on a monthly basis and reported monthly. The programme will be done in accordance with the appropriate SANS standard.			

Company Name:	Columbus Stainless
Location:	Off Hendrina Road, Middelburg
AQA S.21 Sector:	Metallurgical Industry
AQA S.21 Sub-sector:	Electric Arc Furnace and Steel Making
Intervention Title:	Stack emission monitoring
Intervention Type:	Measurement of emissions associated with stacks at the Columbus site.

Problem Statement

It is necessary to quantify emissions at Columbus to both compare with allowed emissions and to be enable to estimate impacts on ambient air quality.

Intervention

Periodic stack emission monitoring is to be undertaken.

Current Status:	Current monitoring programme to commence in October 2010.		
Expected Start:	October 2010	Expected Commissioning:	October 2010
Current Emissions:	Not applicable	Expected Emission Reductions:	Not applicable
Estimated Fixed Cost:	Not applicable	Estimated Running Cost:	R0.5m p.a.

Significance

This monitoring will allow for comparison with allowable emission limits and hence give a determination of the efficacy of pollution control equipment. These results will also be used as input to dispersion modelling to determine ambient air impacts.

Measurement, Reporting and Verification

Periodic monitoring will be done every six months and reported on. Measurement will be done to appropriate standard.

Company Name:	Columbus Stainless
Location:	Off Hendrina Road, Middelburg
AQA S.21 Sector:	Metallurgical Industry
AQA S.21 Sub-sector:	Electric Arc Furnace and Steel Making
Intervention Title:	Dispersion modelling
Intervention Type:	Dispersion modelling will be used as a tool to access ambient air quality impacts of Columbus emissions.

Problem Statement

It is necessary to be able to access the impacts of Columbus emissions on ambient air quality.

Intervention

Columbus should be able to do its own air dispersion modelling and train personnel accordingly.

Current Status:	Capability still to be costed and applied for.

Expected Start:	2nd Quarter 2011	Expected Commissioning:	2nd Quarter 2011
Current Emissions:	Not applicable	Expected Emission Reductions:	Not applicable
Estimated Fixed Cost:	R50k	Estimated Running Cost:	R50k p.a.
Significance			
Dispersion modelling will allow impacts of site emission to be determined.			
Measurement, Reporting and Verification			
Not applicable			

Company Name:	Columbus Stainless
Location:	Off Hendrina Road, Middelburg
AQA S.21 Sector:	Metallurgical Industry
AQA S.21 Sub-sector:	Electric Arc Furnace and Steel Making
Intervention Title:	Lime charging extraction system
Intervention Type:	Install air pollution control equipment.

Problem Statement			
Charging of lime to the charging basket results in fugitive dust during this material handling process.			
Intervention			
Install air pollution control equipment to capture and filter the fugitive dust.			
Current Status:	Capital to be applied for		
Expected Start:	2011	Expected Commissioning:	2011
Current Emissions:	Fugitive emissions not quantified	Expected Emission Reductions:	Not quantified
Estimated Fixed Cost:	R5m	Estimated Running Cost:	R200k p.a.
Significance			
Although a relatively low source of emissions, is a nuisance problem in the immediate vicinity.			
Measurement, Reporting and Verification			
This source may contribute to general suspended dust in the area and may show in the dust fall out monitoring conducted monthly and reported monthly. Dust fall out monitoring to SANS standards.			

Company Name:	Columbus Stainless
Location:	Off Hendrina Road, Middelburg
AQA S.21 Sector:	Metallurgical Industry
AQA S.21 Sub-sector:	Electric Arc Furnace and Steel Making
Intervention Title:	Liquid Ferro Chrome Transfer

Intervention Type:	Addition of liquid ferrochrome to the AOD at Columbus will reduce electrical consumption associated with melting of this material.		
Problem Statement			
Liquid ferrochrome provides an opportunity to reduce electrical consumption associated with melting operations at the Steel Plant.			
Intervention			
Provide for liquid ferrochrome transfer between Columbus and the ferrochrome supplier located next door to the Columbus operation.			
Current Status:	In the process of being implemented.		
Expected Start:	Has been started but the system needs to be expanded.	Expected Commissioning:	On going
Current Emissions:	Scope 2 CO_2 emissions of the order of 300 000tpm	Expected Emission Reductions:	On site emission not effected. Project results in lower electricity consumption.
Estimated Fixed Cost:	R10m	Estimated Running Cost:	R1m p.a.
Significance			
Lower electricity consumption will lower GHG emissions by generator.			
Measurement, Reporting and Verification			
Reductions will be associated with improved electricity consumption which is measured and reported on monthly.			

Company Name:	Columbus Stainless		
Location:	Off Hendrina Road, Middelburg		
AQA S.21 Sector:	Metallurgical Industry		
AQA S.21 Sub-sector:	Electric Arc Furnace and Steel Making		
Intervention Title:	Dust suppression at slag handling facility.		
Intervention Type:	Improved fugitive emission controls in this area need to be identified.		
Problem Statement			
Fugitive dust emissions associated with material storage and material handling in this area are problematic.			
Intervention			
Possible interventions to limit these emissions need to be identified.			
Current Status:	Investigation needs to be initiated.		
Expected Start:	Quarter 1 2011	Expected Commissioning:	Quarter 1 2012
Current Emissions:	Not quantified but considered significant	Expected Emission Reductions:	Still to be assessed
Estimated Fixed Cost:	Still to be assessed	Estimated Running Cost:	Still to be assessed
Significance			
Although emissions in this area impact the immediate vicinity primarily and these emissions have not been quantified, visually it is apparent that these emissions are significant.			

Measurement, Reporting and Verification
Dust fall out monitoring in the area is to be undertaken on a monthly basis and reported monthly. Monitoring per SANS standards.

Company Name:	Columbus Stainless
Location:	Off Hendrina Road, Middelburg
AQA S.21 Sector:	Metallurgical Industry
AQA S.21 Sub-sector:	Electric Arc Furnace and Steel Making
Intervention Title:	Scanacon system for NO_x abatement
Intervention Type:	Installation of Scanacon system will reduce NO_x levels of fees to De-NO_x plants.

Problem Statement
On occasions the NO_x levels in the feed to the De-NO_x plants exceeds the treatment capability of these plants, leading to emissions exceeding limits on these plants.

Intervention
The Scanacon system allows for improved waste acid recovery particularly nitric acid. Less waste acid results in lower NO_x emissions in the process.

Current Status:			
Expected Start:	Already installed	Expected Commissioning:	Currently commissioned
Current Emissions:	Frequency of exceedance has already dropped.	Expected Emission Reductions:	Exceedance levels have dropped from ± 20% to less than 5%.
Estimated Fixed Cost:	R12m	Estimated Running Cost:	R1m p.a.

Significance
This system has already led to improved frequency of exceedance conditions.

Measurement, Reporting and Verification
The emissions from the De-NO_x plant in question are measured continuously and reported on a daily basis. The NOx analyser is calibrated daily.

Company Name:	Columbus Stainless
Location:	Off Hendrina Road, Middelburg
AQA S.21 Sector:	Metallurgical Industry
AQA S.21 Sub-sector:	Electric Arc Furnace and Steel Making
Intervention Title:	Dust suppression on site gravel roads.
Intervention Type:	Non point source fugitive emission control.

Problem Statement
Dust associated with vehicular traffic on gravel roads on the site.

Intervention	
Current Status:	Currently investigating workable options.

Expected Start:	Quarter 4 2010	Expected Commissioning:	Quarter 4 2010
Current Emissions:	Fugitive emissions not quantified.	Expected Emission Reductions:	Not quantified
Estimated Fixed Cost:	R0.5m	Estimated Running Cost:	R0.5m p.a.
Significance			
Some gravel roads are visually seen to be a significant source of particulate emissions in the local areas.			
Measurement, Reporting and Verification			
Dust fall out monitoring will measure in part this source to dust fall out. The measurement of dust fall out is to be done on a monthly basis and reported monthly. Monitoring is per the relevant SANS standard.			

Company Name:	Columbus Stainless		
Location:	Off Hendrina Road, Middelburg		
AQA S.21 Sector:	Metallurgical Industry		
AQA S.21 Sub-sector:	Electric Arc Furnace and Steel Making		
Intervention Title:	Waste energy recovery		
Intervention Type:	Limit electricity demand and associated CO_2 emission by utilizing waste.		
Problem Statement			
Energy associated with stack emissions is wasted leading to higher electricity demand than could be the case.			
Intervention			
Harness the wasted energy to allow for reduction in electricity consumption.			
Current Status:	Feasibility to be investigated.		
Expected Start:	Pre-feasibility investigation underway	Expected Commissioning:	Not applicable
Current Emissions:	Scope 2 CO_2 emissions of the order of 300 000t p.a.	Expected Emission Reductions:	Not yet quantified
Estimated Fixed Cost:	To be determined	Estimated Running Cost:	To be determined
Significance			
Lower electricity consumption will lower GHG emission by the generator.			
Measurement, Reporting and Verification			
Reductions will be associated with improved electricity consumption which is measured and reported on monthly.			

Company Name:	Columbus Stainless
Location:	Off Hendrina Road, Middelburg
AQA S.21 Sector:	Metallurgical Industry

AQA S.21 Sub-sector:	Electric Arc Furnace and Steel Making
Intervention Title:	Steel Plant Bag House Hot Ducting
Intervention Type:	Air pollution control equipment.

Problem Statement

The existing hot ducting at the Steel Plant has deteriorated such that it threatens the availability of the air pollution control equipment for this process.

Intervention

Renew the hot ducting at the Steel Plant.

Current Status:	Order placed.		
Expected Start:	Currently underway	Expected Commissioning:	2011
Current Emissions:	Interventions to ensure pollution control equipment availability	Expected Emission Reductions:	N/A
Estimated Fixed Cost:	R9.5m	Estimated Running Cost:	N/A

Significance

Intervention is necessary to ensure the availability of air pollution control equipment for this process.

Measurement, Reporting and Verification

N/A

Company Name:	Exxaro Base Metals: Zincor
Location:	The zinc refinery is located 50km east of Johannesburg in the Ekhurhuleni Metropolitan Municipality, in Springs. The coordinates are as follows: latitude: 26°18'42.8"S; longitude: 28° 28'19.9"E
AQA S.21 Sector:	**Category 4:** Metallurgical Industry
AQA S.21 Sub-sector:	**Subcategory 4.14:** *"The production and processing of zinc, nickel or cadmium by the application of heat excluding metal recovery."* However, there is no nickel produced at Zincor and cadmium is a by product of the Zincor process. The main activity at Zincor is the production of Zinc. **Subcategory 4.16:** *"Process in which sulphide ores are smelted, roasted calcined or converted."* Zinc sulphates are roasted, Sulphur captured to produce sulphuric acid and zinc oxides used further in the process
Intervention Title:	Zincor Air Quality Intervention Action Plan.
Intervention Type:	• Ongoing maintenance of critical equipment at the Acid Plant • Investigate efficient usage of equipment and thus improving the fugitive emission management system • Control of dust emissions from residue disposal facilities.

Problem Statement

- Process fugitive gas emissions in the sulphuric acid plant (including roasters)
- Dust emissions from the residue disposal facility

Intervention

1. 3 x Mini Shuts, 1 x maintenance shut per year. Identify gas leaks and repair accordingly
2. Annual MECS Global portable gas analyzer audit and recommendations. Investigate Acid Plant operational efficiency in terms of conversion and the catalyst with recommendations for improvement. This is followed by the implementation of the recommendations from the audit report.
3. Evaluation of new catalyst products for the Acid Plant.

4. Continuous in-stack monitoring 5. Rehabilitation of residue disposal facility (Dam 7L3) 6. Continuous dust and SO2 fence-line monitoring 7. Monthly discussions at Springs Industrial Air Quality Forum			
Current Status:	1. Mini and Maintenance shuts - carried out annually. 2. MECS Global gas analyzer report and recommendations – carried out annually 3. Evaluation of new catalyst – currently under review 4. Rehabilitation of Residue Disposal Facility (Dam 7L3) – Rehabilitation plan being developed by Golder Associates. 5. Fence line monitoring of dust and SO_2 as well as in stack monitors – Ongoing 6. Springs Industrial Air Quality Forum Meetings - Monthly		
Expected Start:	1. Mini and Maintenance shuts – presently ongoing 2. MECS Global gas analyzer report and recommendation – November 2010 3. Evaluation and review of new catalysts – January 2010 4. Rehabilitation of Residue Disposal Facility – 2011 5. In stack SO_2 Monitoring – continuous 6. Fence line Dust Fall out monitoring – January 2005 7. Fence Line SO_2 monitoring – May 2005	Expected Commissioning:	1. Mini and Maintenance shuts – Ongoing process 2. MECS Global gas analyzer report and recommendation – carried out annually. 3. Evaluation of new catalysts – dependant on results of review. 4. Rehabilitation of Residue Disposal Facility – 2020 5. In stack SO_2 Monitoring – presently operating 6. Fence line Dust fall out monitoring – Ongoing monitoring 7. Fence line SO_2 monitoring – Ongoing monitoring.
Current Emissions:	0.17 – 0.2 %	Expected Emission Reductions:	Approximately 0.15 %
Estimated Fixed Cost:	Fixed Cost for Acid Plant Maintenance 2011 **R45,228,799.32** Rehabilitation Cost of Residue Disposal Facility : **R135, 800, 000.00** over 15 years	Estimated Running Cost:	Total Acid Plant Maintenance cost for the period January to August 2010 **R24,638,480.48** Annual Dust and SO_2 monitoring cost: **R83,356.80**

Significance

- Effective management of fugitive emissions will most likely result in reduced local dispersion potential of SO_2 and dust.
- Interventions implemented at Zincor will positively impact on the air quality of the priority area.

Measurement, Reporting and Verification

- The North West University undertakes monthly independent fence line SO_2 monitoring and reporting. An annual SO_2 report is submitted and discussed with the authorities in Zincor's annual Environmental Management Master Plan (EMMP).
- MECS Global gas analyzer undertakes annual independent surveys on the efficiency of the Acid Plant. Recommendations are implemented during shuts.
- SGS Laboratories undertakes monthly independent fence line dust fall out monitoring and reporting. An annual dust fall out report is submitted and discussed with the authorities in Zincor's annual Environmental Management Master Plan (EMMP).

- Monthly feedback on Air Quality is provided at the Springs Industrial Air Quality Forum meetings which are attended by the Ekurhuleni Metropolitan Municipality.

Company Name:	Ferrometals
Location:	Moses Kotane Drive, Ferrobank, Emalahleni
AQA S.21 Sector:	Category 4: Metallurgical Industry [Pelletising and Sintering Plant]
AQA S.21 Sub-sector:	Subcategory 4.5: Sinter plants

Intervention Title:	Fugitive dust management		
Intervention Type:	Improved fugitive emission management system or intervention.		
Problem Statement			
Fugitive dust from point and area sources is the greatest challenge to compliance to ambient air quality standards.			
Intervention			
• Scrubber Maintenance. • Containment – air purging portals to be installed - completed. • Considering design changes that will reduce fugitive dust from escaping to the magnitude that it currently does. The extraction system efficiency will be optimised through this, thus reducing fugitive dust generation. • ChemPlant and Bag Plant – focus on preventative maintenance. • Clean dust extraction ducting at the product screen during weekly shuts. • Drive of Chemplant Fan must be repaired in order to run it at 80% speed. Currently running at 65% causing less dust extraction- completed. • Unblock all dust extraction ductings - completed. • Extend the dust extraction ducting at Product Screen to the pellet transfer feedpoint during the steel belt shutdown. • Repair leaking fan casing during shutdown. • Inspect bag plant fan impeller during shutdown - completed. • Inspect and repair Bagplant Fan damper during shutdown – completed. • Bag plant pulsing system optimised – completed.			
Current Status:	Consideration of alternatives for most effective and practical solution.		
Expected Start:	June 2010	Expected Commissioning:	June 2011 (some of the mitigation measures have been completed while others are ongoing)
Current Emissions:	Monthly exceedence of ambient dust fallout and TSP emission limits.	Expected Emission Reductions:	Compliance with ambient fallout and TSP emission limits.
Estimated Fixed Cost:	R 4 0000 000.00	Estimated Running Cost:	R 40 000.00 per month
Significance			
Priority Area-wide air quality.			
Measurement, Reporting and Verification			
TSP monitoring (point source) and continuous dust fallout monitoring conducted by external party.			

Company Name:	Ferrometals
Location:	Moses Kotane Drive, Ferrobank, Emalahleni
AQA S.21 Sector:	Category 4: Metallurgical Industry [Logistics (Material handling)]
AQA S.21 Sub-sector:	Subcategory 4.9: Ferro-alloy production

Intervention Title:	Fugitive dust management		
Intervention Type:	Improved fugitive emission management system or intervention		
Problem Statement			
Fugitive dust from point and area sources is the greatest challenge to compliance to ambient air quality standards.			
Intervention			
• Receiving raw materials by rail (offloading tipplers) - Quenching before tipping and installation of fogger to suppress dust during tipping. • SME's on gravel roads - Water car (7day/week only day shift) • Crushing/screening operation (Final product) - Quenching (Dust suppression system after tipping point, before material crushing) - water suppression; Final product Bag plant optimisation, housekeeping. [This is completed] • Metal Recovery Plant - Quenching (Dust suppression system before tipping point at Grizzly) [This is completed] • Quenching of slag before it is tipped for processing at the Metal Recovery Plant. [This is completed] • Water tanker for continuous dust suppression on site roads. • Street Sweeping Machine – regular dust extraction from paved roads. • Continuous focus on housekeeping to reduce fugitive dust sources. • Revegetation of exposed dusty surfaces on site. This includes topsoil, grassing, and tree planting to aesthetically improve the area, create a dust barrier and reduce wind erosion prevalent on exposed surfaces. • Screening and consolidation of stockpiles for closure and capping as per IWWMP.			
Current Status:	Plans in progress		
Expected Start:	January 2010	Expected Commissioning:	Certain interventions are already completed with others in progress.
Current Emissions:	Monthly exceedence of ambient dust fallout and TSP emission limits.	Expected Emission Reductions:	Compliance with ambient fallout and TSP emission limits.
Estimated Fixed Cost:	R 4 000 000.00	Estimated Running Cost:	R75 000.00 per month
Significance			
Priority Area-wide air quality.			
Measurement, Reporting and Verification			
TSP monitoring (point source) and continuous dust fallout monitoring conducted by external party.			

Company Name:	Ferrometals
Location:	Moses Kotane Drive, Ferrobank, Emalahleni
AQA S.21 Sector:	Category 4: Metallurgical Industry (Convertor - IC3)
AQA S.21 Sub-sector:	Subcategory 4.9: Ferro-alloy production

Intervention Title:	Fugitive dust management		
Intervention Type:	Improved fugitive emission management system or intervention		
Problem Statement			
Fugitive dust from point and area sources is the greatest challenge to compliance to ambient air quality standards.			
Intervention			
• Control of raw materials transfer, screening areas and conveyor belts. • Air abatement equipment preventative maintenance.			
Current Status:	Consideration of alternatives for most effective and practical solution.		
Expected Start:	January 2012	Expected Commissioning:	June 2012
Current Emissions:	Monthly exceedence of ambient dust fallout and TSP emission limits.	Expected Emission Reductions:	Compliance with ambient fallout and TSP emission limits.
Estimated Fixed Cost:	R 2 000 000.00	Estimated Running Cost:	R 30 000.00 per month
Significance			
Priority Area-wide air quality.			
Measurement, Reporting and Verification			
TSP monitoring (point source) and continuous dust fallout monitoring conducted by external party.			

Company Name:	Ferrometals
Location:	Moses Kotane Drive, Ferrobank, Emalahleni
AQA S.21 Sector:	Category 4: Metallurgical Industry (Furnace 1, 2, 3)
AQA S.21 Sub-sector:	Subcategory 4.9: Ferro-alloy production

Intervention Title:	Fugitive dust management
Intervention Type:	Improved fugitive emission management system or intervention

Problem Statement

Fugitive dust from point and area sources is the greatest challenge to compliance to ambient air quality standards.

Intervention

- Yearly - filter bags replacement
- Fan maintenance
- Control of F123 raw materials transfer, screening areas and conveyor belts
- Fugitive dust generation points to be identified and design changes considered to minimise fugitive emissions.
- Minimise venting events through preventative maintenance of the plant.

Current Status:	Consideration of alternatives for most effective and practical solution.		
Expected Start:	January 2012	Expected Commissioning:	June 2012
Current Emissions:	Monthly exceedence of ambient dust fallout and TSP emission limits.	Expected Emission Reductions:	Compliance with ambient fallout and TSP emission limits.
Estimated Fixed Cost:	R 2 000 000.00	Estimated Running Cost:	R 30 000.00 per month

Significance

Priority Area-wide air quality.

Measurement, Reporting and Verification

TSP monitoring (point source) and continuous dust fallout monitoring conducted by external party.

Company Name:	Ferrometals
Location:	Moses Kotane Drive, Ferrobank, Emalahleni
AQA S.21 Sector:	Category 4: Metallurgical Industry (Furnace 4 and 5)
AQA S.21 Sub-sector:	Subcategory 4.9: Ferro-alloy production

Intervention Title:	Fugitive dust management
Intervention Type:	Improved fugitive emission management system or intervention

Problem Statement

Fugitive dust from point and area sources is the greatest challenge to compliance to ambient air quality standards.

Intervention

- Control of F45 raw materials transfer, screening areas and conveyor belts
- Casting Bay management.
- ETP1 and ETP2 management
- Fines management
- Installation of a chiller to cool gaseous emissions from Furnace 4 and Furnace 5
- Minimise venting events through preventative maintenance

Current Status:	Consideration of alternatives for most effective and practical solution.		
Expected Start:	January 2012	Expected Commissioning:	June 2012
Current Emissions:	Monthly exceedence of ambient dust fallout and TSP emission limits.	Expected Emission Reductions:	Compliance with ambient fallout and TSP emission limits.
Estimated Fixed Cost:	R 4 000 000.00	Estimated Running Cost:	R 50 000.00 per month

Significance

Priority Area-wide air quality.

Measurement, Reporting and Verification

TSP monitoring (point source) and continuous dust fallout monitoring conducted by external party.

Company Name:	Ferrometals
Location:	Moses Kotane Drive, Ferrobank, Emalahleni
AQA S.21 Sector:	Category 4: Metallurgical Industry (Furnace 6)
AQA S.21 Sub-sector:	Subcategory 4.9: Ferro-alloy production

Intervention Title:	Fugitive dust management		
Intervention Type:	Improved fugitive emission management system or intervention		
Problem Statement			
Fugitive dust from point and area sources is the greatest challenge to compliance to ambient air quality standards.			
Intervention			
• Yearly - filter bags replacement • Overall of main fans A and B (pending capital) • Control of F6 raw materials transfer, screening areas and conveyor belts • Fugitive dust generation points to be identified and design changes considered to minimise fugitive emissions. • Minimise venting events through preventative maintenance of the plant.			
Current Status:	Consideration of alternatives for most effective and practical solution.		
Expected Start:	January 2012	Expected Commissioning:	June 2012
Current Emissions:	Monthly exceedence of ambient dust fallout and TSP emission limits.	Expected Emission Reductions:	Compliance with ambient fallout and TSP emission limits.
Estimated Fixed Cost:	R 4000 000.00	Estimated Running Cost:	R 60 000.00 per month
Significance			
Priority Area-wide air quality.			
Measurement, Reporting and Verification			
TSP monitoring (point source) and continuous dust fallout monitoring conducted by external party.			

Company Name:	Elkem Ferroveld
Location:	Moses Kotane Drive, Ferrobank, Emalahleni
AQA S.21 Sector:	Category 3: Carbonization and Coal Gasification
AQA S.21 Sub-sector:	Subcategory 3.5: Electrode paste production

Intervention Title:	Fugitive dust management		
Intervention Type:	Improved fugitive emission management system or intervention.		
Problem Statement			
Fugitive dust from point and area sources is the greatest challenge to compliance to ambient air quality standards.			
Intervention			
• As per baseline study conducted in 2007, Elkem Ferroveld does not generate excessive amounts of dust. By Ferrometals addressing its fugitive sources, Elkem will also benefit. • Installation of a scrubber system on certain stacks, will also contribute to a reduction of TSP and fallout.			
Current Status:	Consideration of alternatives for most effective and practical solution.		
Expected Start:	January 2012	Expected Commissioning:	June 2012
Current Emissions:	Monthly exceedence of ambient dust fallout and TSP emission limits.	Expected Emission Reductions:	Compliance with ambient fallout and TSP emission limits.
Estimated Fixed Cost:	R 750 000.00	Estimated Running Cost:	R 100 000.00
Significance			
Priority Area-wide air quality.			
Measurement, Reporting and Verification			
TSP monitoring (point source) and continuous dust fallout monitoring conducted by external party.			

Company Name:	Evraz Highveld Steel and Vanadium Limited
Location:	Portion 29 of the farm Schoongezicht 308 JS; Old Pretoria Main Road; eMalahleni
AQA S.21 Sector:	Metallurgical Industry (Category 4) Mineral Processing, Storage and handling (Category 5)
AQA S.21 Sub-sector:	4.6: Basic oxygen furnace steel making 4.7: Electric arc furnace and steel making (primary and secondary) 4.12: Pre reduction and direct reduction 4.20: Slag processes 5.1: Storage and handling of ore and coal

Intervention Title:	Short term, medium term and long term emissions intervention projects

Intervention Type:

The intervention types include the following:

(i) Short term (0-3 months)

Includes the following:

- Improved corporate awareness on emissions management
- Environmental monitoring network development and implementation
- Improved site operational procedures and more focus on discipline
- Improved and enforced shut down procedures
- Improved reporting procedures
- Development of an emissions improvement strategy
- Updating the corporate air quality management plan and the emissions inventory
- Pollution abatement equipment maintenance (annually)

(ii) Medium term (3 – 18 months)

Includes the following:

- Improved maintenance programs
- Precipitator rebuilds
- Emergency stack venting valves replacement
- Commencing with stack cap design and implementing two stack caps on two kiln units over the medium term. Thereafter aim is to install stack caps on all emergency venting stacks.
- Completing pollution abatement equipment efficiency studies
- Developing an advanced process optimisation model for the kiln installations.
- Study investigating towards improving the furnace venturi scrubber system
- Furnace raw gas valve replacements

(iii) Long term measures (18 months to 5 years)

Includes the following:

- Venturi gas cleaning system replacements pertaining to furnaces
- Investigating new gas cleaning technology as part of co generation
- Investigating into long term viability of current reduction process
- Finalising the installation of all kiln stack caps
- Installing the kiln combustion model on all kilns

(iv) Long term measures (> 5 years)

This will be confirmed (requirements for over the longer term > 5 years) once all the required investigations has been completed and the long term strategy finalised.

Problem Statement

Particulate emissions from point stack sources and also include SOx emissions and fugitive emissions. Ambient air concentrations to be confirmed (forms part of medium term project) together with status quo pertaining to stack emissions. Projects have already commenced.

Intervention

Intervention include emissions reduction activities on the short, medium and long term

Current Status:	Short term interventions completed. Medium term interventions: capital approved for critical projects and projects have commenced		
Expected Start:	Short term - Already completed Medium term measures - Already commenced Long term - To be implemented after 18 months. Some investigations have already commenced	Expected Commissioning:	Short term - Already implemented Medium term - Some interventions already implemented and will take < 18 months to complete. Long term - Some projects already commenced. The bulk to commence approximately after 18 months

Current Emissions:	Elevated levels of particulates experienced and will be reduced	Expected Emission Reductions:	Envisaged emissions limits envisaged after intervention: Short term: - Upset conditions managed more sufficiently, quicker response on upset conditions and the rectification thereof Medium term: - Up to > 50% reduction of particulates on some critical installations Long term - Up to > 85% reduction of particulates on some critical installations
Estimated Fixed Cost:	Total cost of more than 500 million ZAR is envisaged over the long term	Estimated Running Cost:	Not available yet
Significance			
The significance of the intervention methods would impact positively on the eMalahleni area pertaining to air quality and also pertaining to the Highveld Priority Area objectives.			
Measurement, Reporting and Verification			
An emissions improvement strategy has been involved and includes: - Ambient and point source monitoring program - Quality assurance and quality control for ensuring action plan implementation, monitoring and ensuring the quality thereof - Internal and external reporting and incident recording protocol has been developed and has been implemented - Provision to be made for external verification of air quality monitoring			

Company Name:	Impala Platinum Refineries		
Location:	Corner of East Geduld and Cowles Streets, Springs, Gauteng (Ekurhuleni)		
AQA S.21 Sector:	Metallurgical Industry		
AQA S.21 Sub-sector:	Precious and base metal refining		
Intervention Title:	Ammonium chloride removal		
Intervention Type:	investment in air pollution control technology		
Problem Statement			
Ammonium chloride emissions from this stack have a high visual impact due to Particulate Matter (PM)			
Intervention			
Installation of a cloud chamber to reduce the ammonium chloride to atmosphere			
Current Status:	Awaiting fixed quote from supplier in order to compile vote application for project funding approval		
Expected Start:	June 2011	Expected Commissioning:	1st Quarter 2013
Current Emissions:	Ammonium Chloride emissions from ignitions amount to 2.65 mol/hr. This estimates to 90Kg ammonium Chloride per day. Ignition time amount to two hours per day. This equates to 45Kg/hr.	Expected Emission Reductions:	Ammonium Chloride emissions will be reduced to 45mg/Nm3 or 0.21Kg/hr

Estimated Fixed Cost:	R28 mil	Estimated Running Cost:	An estimated monthly cost of R57000.00
Significance			
Ammonia Chloride is seen as a white plume exiting the stack. This plume can be observed from great distances and creates the impression of major air pollution. With the cloud chamber installed, this visual appearance will be eliminated.			
Measurement, Reporting and Verification			
The emissions will be monitored using a continuous online measuring system (opsis) that will be monitored on a daily basis. This will form part of Impala's Quality process as procedures and best practices will be Audited by internal quality auditors to ensure practice and procedures are followed and adhered to. This process will also be audited by an independent auditing company to verify the internal quality practices conform to quality procedures.			

Company Name:	Impala Platinum Refineries.		
Location:	Corner of East Geduld and Cowles Streets, Springs, Gauteng (Ekurhuleni).		
AQA S.21 Sector:	4. Metallurgical Industry.		
AQA S.21 Sub-sector:	4.17 Precious and base metal production and refining		
Intervention Title:	Boiler off-gas (PM10 and SO_2).		
Intervention Type:	Investment in air pollution abatement technology.		
Problem Statement			
Ongoing boiler off-gas monitoring is in progress to establish the requirements (if any) to ensure compliance with NEM: Air Quality Act 2004.			
Intervention			
Current Status:	Preliminary funds allocated in the 5-year capex expenditure horizon.		
Expected Start:	January 2012	Expected Commissioning:	December 2014
Current Emissions:	PM10 = ± 1000mg/Nm³ (peak) SO2 = ±700mg/Nm³ (peak)	Expected Emission Reductions:	PM10 = <50mg/Nm³ SO2 = 400mg/Nm³
Estimated Fixed Cost:	R220m	Estimated Running Cost:	N/A
Significance			
Reduction in ambient SO2 and PM – will be confirmed by the ambient stations upon commissioning			
Measurement, Reporting and Verification			
Continuous gas monitoring system is already installed and capable of providing the required data. A competent company personnel is allocated to ensure data monitoring and reporting as well as to ensure an independent party verification in connection with the Operations personnel (the user of the monitoring equipment).			

Company Name:	Middelburg Ferrochrome
Location:	Middelburg
AQA S.21 Sector:	50
AQA S.21 Sub-sector:	

1.

Intervention Title:	Air Quality Management Plan		
Intervention Type:	Improvement of Air Quality		
Problem Statement			
Establish and implement Air Quality Management Plan			
Intervention			
Establishing of an Air quality Management Plan to ensure monitoring and measurement of current Air Pollution activities. Improvement of current technologies to ensure compliance with future requirements			
Current Status:	AQMP submitted to DEA 2009, in progress onsite and monitored on a regular basis		
Expected Start:	2009	Expected Commissioning:	In progress
Current Emissions:	All onsite	Expected Emission Reductions:	As required by plan
Estimated Fixed Cost:	As required by plan, part of operational budgets	Estimated Running Cost:	As required by plan, part of operational budgets
Significance			
A number of initiatives will be covered by the plan addressing fugitive and are sources, also improvements in quantification of sources.			
Measurement, Reporting and Verification			
As required by the plan.			

Intervention Title:	Air Quality Management Plan		
Intervention Type:	Improvement of Air Quality		
Problem Statement			
Fugitive Emissions			
Intervention			
Identify, monitor and measure fugitive emissions and investigate capturing systems that may be implemented at MFC if feasible			
Current Status:	In progress		
Expected Start:	2009	Expected Commissioning:	In progress
Current Emissions:	All fugitives	Expected Emission Reductions:	To be addressed
Estimated Fixed Cost:	R20 mil	Estimated Running Cost:	R 200 000 p.a.
Significance			
The fugitive emissions onsite will be identified and problems with controlling it will be treated, this will result in a minimisation of the current fugitives.			
Measurement, Reporting and Verification			
Equipment costs will be significant and cannot be implemented at this stage however a number of initiatives and process control measures are used currently to prevent fugitives as much as possible.			

Intervention Title:	Air Quality Management Plan		
Intervention Type:	improvement of Air Quality		
Problem Statement			
Area Source Emissions			
Intervention			
Investigate options for the control of area source emissions			
Current Status:	In progress		
Expected Start:	2003	Expected Commissioning:	In progress
Current Emissions:	Emissions from roads and stockpiles	Expected Emission Reductions:	Not yet assessed
Estimated Fixed Cost:	To be sourced	Estimated Running Cost:	
Significance			
Source emissions onsite contribute to dust deposits in the communities surrounding the MFC site, this is controlled through the wetting of roads and surfacing of roads			
Measurement, Reporting and Verification			
Equipment costs will be significant and cannot be implemented at this stage however a number of initiatives and process control measures are used currently to prevent fugitives as much as possible.			

Company Name:	Protea Chemicals Inland
Location:	Located in 1 Berrange Road, Germiston, and at Springs (37 Radon Road)
AQA S.21 Sector:	Category 1: Combustion Installations Category 7: Inorganic Chemicals Industry Category 6: Organic Chemicals Industry
AQA S.21 Sub-sector:	Subcategory 1.1: Solid fuel combustion installations Subcategory 7.4: Manufacturing activity involving the production, use in manufacturing or recovery of antimony, arsenic, beryllium, cadmium, chromium cobalt, lead, mercury, selenium, not associated with the application of heat Subcategory 7.2: Primary production of acids Subcategory 7.1: Primary production and use in manufacturing of ammonia, fluorine, and chlorine Subcategory 6.1: Organic chemical manufacturing
Intervention Title:	To ascertain the ambient air quality of the fuel burning appliance at the Tank farm and to conduct perimeter monitoring of both sites, namely wadeville and springs.
Intervention Type:	Air pollution technology apparatus, also to implement a fugitive emission management system, with perimeter monitoring.

Problem Statement			
To ascertain emission data from the fuel burning appliance at the Tank Farm in Wadeville			
Intervention			
Employ a contractor to provide the current samples, and analysis versus the input data into the fuel burning appliance.			
Current Status:	Decision to made on a contractor and to further implement for both perimeter monitoring and emission monitoring of the fuel burning appliance		
Expected Start:	4th Quarter 2010	Expected Commissioning:	3rd Quarter 2011
Current Emissions:	Possible fugitive emission sources include the various acid based products, e.g. acetic acid, sulphuric acid. HCl scrubber is identified as a sources of emission however level are predicted to be low. These are primarily from the vented piping on the tanks. At springs recent levels of dust were assessed with relatively low dust levels. Tests were conducted for Soda Ash, Ammonium sulphate, sodium sulphate. The fuel burning appliance will have possibly low levels of emissions as the	Expected Emission Reductions:	

	boiler is Sasol gas fired.		
Estimated Fixed Cost:	Not yet determined	Estimated Running Cost:	Not yet determined
Significance			
Low significance due to the nature of the operations			
Measurement, Reporting and Verification			
An independent party will conduct the measurements, utilising either passive diffusion technology and or perimeter monitoring at both sites. Dust will be measure using the gravimetrical analysis at Springs.			

Company Name:	SILICON SMELTERS – RAND CARBIDE		
Location:	Portions 60 and 101 of the farm Joubertsrust 310JS CNR OF VOORTREKKER ROAD AND CHRISTIAAN DE WETS STREET WITBANK		
AQA S.21 Sector:	Category 4: Metallurgical Industry		
AQA S.21 Sub-sector:	Sub-category 4.9: Ferro-alloy Production		
Intervention Title:	D+E Furnace – Tap Hole fume Extraction System		
Intervention Type:	Improved fugitive emissions intervention.		
Problem Statement			
Release of Si02 fume from furnace tap holes during tapping process.			
Intervention			
Tap hole fume extraction system which consists of 2 x new fume extraction fans connecting to a new smoke hood arranged concentrically around the furnace above the tap holes.			
Current Status:	Designs currently being finalised. Commercial offered accepted – order placed.		
Expected Start:	In progress	Expected Commissioning:	December 2010
Current Emissions:		Expected Emission Reductions:	
Estimated Fixed Cost:	R6 million	Estimated Running Cost:	R180 000/annum
Significance			
Immediate area around tap hole condition will be improved. Reduction should be noticed in ambient air emissions – PM 10 monitoring had just commenced.			
Measurement, Reporting and Verification			
PM10 monitoring station was installed mid September 2010. Daily monitoring is already taking place. Monthly analysis reporting will be conducted by Gijima AST.			

Intervention Title:	D+E & F Furnace Dust Plant Maintenance
Intervention Type:	Improved fugitive emissions management intervention system.
Problem Statement	
Silica fume emissions from dust plants.	

Intervention			
Replace 17 filter bags D+E Dust Plant and 26 filter bags at F Dust Plant. Repair all cracks on main & reverse air ducting's. Repair all cracks on filter compartment hoppers. Repair all cracks on filter compartment bag plates. Replace all main inlet & reverse air damper stuffing box seals.(Air sealing fan unit)			
Current Status:	Capex Approved – order placed.		
Expected Start:	In progress – October 2010	Expected Commissioning:	Mid October 2010
Current Emissions:	D+E Dust Plant – 31mg/Nm^3 F Dust Plant – 42mg/Nm^3	Expected Emission Reductions:	Repeat stack monitoring will be conducted end of October 2010
Estimated Fixed Cost:	R60 000	Estimated Running Cost:	R480 000/annum
Significance			
Reduction of silica fume emissions into surrounding community.			
Measurement, Reporting and Verification			
In-stack monitoring results			

Intervention Title:	E Furnace – Electrode Fume Extraction System		
Intervention Type:	Improved fugitive emissions intervention.		
Problem Statement			
Electrode paste releases CTPV's when heated.			
Intervention			
System to draw/extract paste fume originating inside the electrode columns and forced into feed pipes – this is then absorbed into the furnace mix.			
Current Status:	Capex Approved.		
Expected Start:	In progress	Expected Commissioning:	December 2010
Current Emissions:		Expected Emission Reductions:	
Estimated Fixed Cost:	R100 000	Estimated Running Cost:	+/-R60 000/annum
Significance			
Fines generated during subsequent handling of briquettes should be minimised. Containment of fumes at electrode casing level – extracted and absorbed into furnace mix.			
Measurement, Reporting and Verification			
PM10 monitoring station was installed mid September 2010. Daily monitoring is already taking place. Monthly analysis reporting will be conducted by Gijima AST.			

Intervention Title:	E Furnace – Rotating Doors Attached to Furnace Charging Level
Intervention Type:	Improved fugitive emissions management intervention system.
Problem Statement	
Release of Silica fume from top of furnace due to normal operation and / or abnormal events.	
Intervention	
System comprising individual panels which would span ¾ of circumference of furnace.	

Current Status:	Capex Approved – order placed.		
Expected Start:	In progress	Expected Commissioning:	December 2010
Current Emissions:		Expected Emission Reductions:	
Estimated Fixed Cost:	R600 000	Estimated Running Cost:	Maintenance – R100 000/year
Significance			
This should reduce fugitive fumes from furnace mix burden and charging floor level.			
Measurement, Reporting and Verification			
PM10 monitoring station was installed mid September 2010. Daily monitoring is already taking place. Monthly analysis reporting will be conducted by Gijima AST.			

Company Name:	Sasol Synfuels (Proprietary) Limited
Location:	PduP Kruger road, Secunda, Mpumlanga
AQA S.21 Sector:	Petroleum industry Carbonization and Coal Gasification
AQA S.21 Sub-sector:	Sub-category 2.2: Storage and handling of petroleum products Sub-category 3.3: Tar production

Intervention Title:	Reduction of fugitive emissions		
Intervention Type:	Implementation of a leak detection and repair program to reduce fugitive emissions.		
Problem Statement			
Possible fugitive emissions from leaking process equipment.			
Intervention			
Implementation of a leak detection and repair program.			
Current Status:	Database and initial measurements completed for Sasol Synfuels. Currently the database is being extended to include the affiliates Solvents and Monomers.The tagging and monitoring will commence end of November 2010.		
Expected Start:	In progress	Expected Commissioning:	Implementation in progress and expected to be completed June 2012.
Current Emissions:	In process of quantifying	Expected Emission Reductions:	To be quantified only after implementation (A test run indicated a reduction of approximately 15%)
Estimated Fixed Cost:	R30M (total)	Estimated Running Cost:	Additional personnel will be appointed to maintain the program.
Significance			
This intervention will reduce the fugitive emissions from leaking process equipment. The benefits of implementation include: • Reduction in low level VOC's; • Reduce risks of fires and explosions; • Ensure compliance with legislation; and • Less product losses.			
Measurement, Reporting and Verification			
Reporting will be done to the Licensing Authorities as per requirements of Section 21 of the National Environmental Management: Air Quality Act. (Act No. 39 of 2004)			

Intervention Title:	Installation of Vapour recovery unit at Fuel loading facility		
Intervention Type:	Installing air pollution control technology: Vapour recovery unit (VRU)		
Problem Statement			
VOC emissions from fuel loading facilities			
Intervention			
Project is implemented to adhere to international best practice standards on Fuel loading			
Current Status:	Commissioning phase		
Expected Start:	Beneficial operation planned for December 2010	Expected Commissioning:	Beneficial operation planned for December 2010
Current Emissions:	Not measured	Expected Emission Reductions:	The VRU will recover the collected vapours with an efficiency of approximately 90%
Estimated Fixed Cost:	R40 Million	Estimated Running Cost:	Normal maintenance cost
Significance			
To reduce emissions from fuel loading facilities (petrol, diesel and illuminating paraffin)			
Measurement, Reporting and Verification			
Measurements will be done after commissioning.			

Intervention Title:	Short term tar unit debottlenecking (STUD), bypass of the forced feed evaporator (FFE) at Coal Tar filtration		
Intervention Type:	Installation of a bypass to prevent light oil from entering the forced feed evaporator		
Problem Statement			
Force feed evaporator vents VOC from light oil feed.			
Intervention			
Installation of a bypass to prevent light oil from entering the forced feed evaporator.			
Current Status:	In execution phase		
Expected Start:	End November 2010	Expected Commissioning:	End January 2011
Current Emissions:	Highly variable according to process conditions eg variation in feed	Expected Emission Reductions:	Approximately 70% reduction of vapours
Estimated Fixed Cost:	R15.4 Million	Estimated Running Cost:	Minimal, normal maintenance
Significance			
To reduce point source VOC emissions.			
Measurement, Reporting and Verification			
Measurement of stack VOC emissions after commissioning of FFE bypass will be done by third party.			

Intervention Title:	Installation of Evapostops on various tanks on the Synfuels site		
Intervention Type:	Installation of Evapostops		
Problem Statement			
VOC emissions from various tanks.			
Intervention			
Installation of Evapostops on various tanks on the Synfuels site.			
Current Status:	Ready for execution, awaiting feedback from the Department of Environmental Affairs (DEA). The current legislation requires the installation of Internal Floating roofs (IFR). Sasol Synfuels proposed the installation of Evapostops. The benefits of installing Evapostops instead of internal floating roofs are: • The same recovery as IFR; • No Environmental authorisation required; • Shorter installation durations; Presentation was done at the Refinery Quarterly meeting held in April at Sasol Synfuels, Secunda A formal request was submitted to DEA on 18 April 2010.		
Expected Start:	As soon as approval is obtained from DEA	Expected Commissioning:	Depends on the feedback from DEA
Current Emissions:	Varies according to product	Expected Emission Reductions:	86% - 92% vapour reduction
Estimated Fixed Cost:	R550 million	Estimated Running Cost:	Minimal, normal maintenance
Significance			
To reduce VOC emissions from various tanks and comply with NEM: AQA S21 requirements.			
Measurement, Reporting and Verification			
Measurements will be done by a third party to determine actual reduction.			

Intervention Title:	Wet Sulphuric Acid plant		
Intervention Type:	Commissioning of a Wet sulphuric acid plant to reduce H_2S		
Problem Statement			
Hydrogen sulphide emissions from Sasol Synfuels complex might result in odour related complaints.			
Intervention			
Wet sulphuric acid plant to reduce hydrogen sulphide emissions from the complex.			
Current Status:	Commissioned		
Expected Start:	Already commissioned, February 2010	Expected Commissioning:	February 2010
Current Emissions:	Before commissioning of the Wet sulphuric acid plant: Average of 7.5 t/h	Expected Emission Reductions:	Approximately 1.2 t/h Depends on the gas loads
Estimated Fixed Cost:	R1.05billion	Estimated Running Cost:	Normal maintenance cost
Significance			
To reduce H_2S from the Secunda complex by approximately 1.2 t/h, depending on the gas loads.			
Measurement, Reporting and Verification			
Hydrogen sulphide emissions, point source as well as ambient, are reported on a quarterly basis to DEA.			

Intervention Title:	Reduction of Particulate matter from boilers		
Intervention Type:	Upgrade of boiler 9 on Eastern factory		
Problem Statement			
Particulate matter from boilers exceeding normal operating parameters due to air ingress from damaged air heater.			
Intervention			
Air heater replacement and general overhaul of Boiler 9 to reduce particulate matter emissions.			
Current Status:	Execution phase		
Expected Start:	September 2009	Expected Commissioning:	Implementation in progress and expected to be completed January 2011.
Current Emissions:	Boiler is off line, no emissions	Expected Emission Reductions:	Estimated to reduce particulate matter emissions from the worst performing boiler to within the permit requirement
Estimated Fixed Cost:	R520Million	Estimated Running Cost:	Normal maintenance cost
Significance			
This intervention will reduce particulate matter from boiler 9.			
Measurement, Reporting and Verification			
Equipment is verified on a yearly basis by a third party. Particulate matter from Steam plant is reported on quarterly basis to DEA.			

Intervention Title:	Reduction of Particulate matter from boilers		
Intervention Type	Ammonia pressure and quality control project to reduce particulate matter		
Problem Statement			
Ammonia quality and pressure not up to standard			
Intervention			
Improve quality and pressure of ammonia to increase the effectiveness of the conditioning agent.			
Current Status:	Basic Engineering		
Expected Start:	June 2010	Expected Commissioning:	Jan 2011
Current Emissions:	Depends on the process	Expected Emission Reductions:	To be determined after implementation
Estimated Fixed Cost:	R 2.0 M	Estimated Running Cost:	Normal maintenance cost
Significance			
This intervention will reduce particulate matter from boilers.			
Measurement, Reporting and Verification			
Daily readings are available. Equipment is verified on yearly basis by a third party.			

PFG Building Glass:

Emission Reduction Intervention	**Description of Intervention**	**Possible Date**	**Cost**	**Comments**
Replace existing float furnace with design which minimises emissions and removes use of furnace oil	Furnace currently being replaced. Significant improvements in emission expected	Late 2009 Measurements to be taken in mid 2010	R 250 m	. Measurements taken ,significant improvement in emissions as a result of the design change evident. Continue to measure annually.
Increase windscreen recycling and laminate recycling in line with group objective. Target of 400 tonnes per month glass being achieved.	Currently established in certain geographical locations.– being extended into PG Group. Financial viability being determined.	End 2010 / Early 2011. Project will likely continue through to next year to extend to PG outlets countrywide.	R0.5m	Outlets countrywide currently being visited. Long term project. 400 tonnes glass currently being recovered .New target of 900 tonnes for 2011
Look at extending recycling to PET and polystyrene, batteries, ink cartridges	Currently in contact with recycling companies to ascertain viability	Expected start August 2010.	R10 000	Trial intervention for PET currently being planned. Recycler identified.
If move to road from rail successful – reduce diesel fugitive emissions	Reduce holding of diesel for loco	Start Mid 2009. Anticipate completion end 2010.	R? m	Reduced diesel holding will reduce fugitive emissions Diesel holding reduced.

Company Name:	TRANSALLOYS (Proprietary) Limited
Location:	Portion 34 of the farm Elandsfontein 309 JS Clewer road, Emalahleni, Mpumalanga
AQA S.21 Sector:	Scheduled Process 30: Iron and Steel Processes Scheduled Process 36: Lime, Dolomite & Magnesite Processes Scheduled Process 53: Manganese Processes Scheduled Process 63: Silicon Processes
AQA S.21 Sub-sector:	FURNACES

Intervention Title:	Reduce secondary emissions from furnace operations in the furnace building
Intervention Type:	Implementation of tap-hole fume extraction system (Medium to Long Term)

Problem Statement

Secondary emissions as a result of tapping the furnace and casting of metal.

Intervention

1. Determine actual emission levels and compare results with prescribed national standards and limits
2. Implement medium-term action plans and programs to reduce secondary emission levels
3. Implement long-term action plans and programs for emission reductions, i.e. the design and installation of a secondary emission reduction system (if required) per furnace group. After the installation of the said system, its effectiveness will be evaluated and adjusted for further improvements.

Current Status:	CAPEX approval in phases with first approvals expected in 2013		
Expected Start:	**2014 – 2017 (phased approach)**	Expected Commissioning:	Forecast date on which the intervention will start delivering air quality improvement results - **2014**
Current Emissions:	No current emission levels being monitored.	Expected Emission Reductions:	Estimated fall-out, stack emission and particulate levels to comply with DEA authorization regarding emission levels as stated in the above mentioned document 13/6 dated 30 March 2010 (pg. 13/14)
Estimated Fixed Cost:	Approximately R 7 million	Estimated Running Cost:	Approximately R1m per annum. Running costs will depend, however, on Project design of the interventions. .

Significance

The interventions will improve the local (1Km radius) air quality. District and Priority Area air quality is not significantly affected by secondary emissions.

Measurement, Reporting and Verification

- Continuous PM 10 Monitoring inside Transalloys premises
- Continuous Dust Fall-out Monitoring inside and outside Transalloys premises
- Investigate Continuous Monitoring Devices which measure actual emission at source.

Company Name:	TRANSALLOYS (Proprietary) Limited
Location:	Portion 34 of the farm Elandsfontein 309 JS Clewer road, Emalahleni, Mpumalanga
AQA S.21 Sector:	Scheduled Process 30: Iron and Steel Processes Scheduled Process 36: Lime, Dolomite & Magnesite Processes Scheduled Process 53: Manganese Processes Scheduled Process 63: Silicon Processes
AQA S.21 Sub-sector:	BAG FILTER PLANTS

Intervention Title:	Reduce emissions from bag houses
Intervention Type:	Refurbishment of emission abatement equipment, replacement of bag house filter bags and condition-based monitoring of emissions (Short to medium term, depending on specific interventions)

Problem Statement

Secondary emissions from bag house plants.

Intervention

1. Install continuous monitoring system on all bag plants, compare monitoring results with DEA standards and limits and, in the case of non-compliance to DEA limits and standards, refurbishment of emission abatement equipment, replacement of bag house filter bags and condition-based monitoring of emissions. The following bag plants are applicable:

   AAF BAG PLANT
   AAF SOUTH
   AAF NORTH
   ELKEM BAG PLANT
   FILTER MEDIA BAG PLANT

2. Bag house dust pneumatic conveying to briquetting plant silos.
3. It is anticipated that all bag filters will require some form of refurbishment

Current Status:	Various projects initiated, CAPEX approval for major capital expenditure starting 2011 for individual projects done once scope of work had been defined.

Expected Start:	2010 -2014	Expected Commissioning:	Forecast date on which the intervention will start delivering air quality improvement results – From 2011
Current Emissions:	No current emission levels being monitored / measured	Expected Emission Reductions:	Emission reduction calculations to be done as data becomes available.
Estimated Fixed Cost:	Approximately R 20 million	Estimated Running Cost:	

Significance

The interventions will improve air quality on local (1Km radius) and district (10 Km radius) levels, with a less significant impact on the Priority-wide area.

Measurement, Reporting and Verification

Incorporate SCADA & measuring field instruments to identify problem areas.

Company Name:	TRANSALLOYS (Proprietary) Limited
Location:	Portion 34 of the farm Elandsfontein 309 JS Clewer road, Emalahleni, Mpumalanga
AQA S.21 Sector:	Scheduled Process 30: Iron and Steel Processes Scheduled Process 53: Manganese Processes
AQA S.21 Sub-sec	Raw Materials Plant
Intervention Title:	Reduce emissions from Raw Materials Plant
Intervention Type:	Tippler dust suppression (Short Term)
Problem Statement	
Dust emissions from raw material tippler during off-loading of various Raw Materials	
Intervention	
Implement dust suppression system	
Current Status:	Tenders issued during August/September 2010 – adjudication completed. Order to be placed during November 2010

Expected Start:	2010
Expected Commissioning:	Forecast date on which the intervention will start delivering air quality improvement results – From 2011
Current Emissions:	Ongoing fall-out dust monitoring indicates that the industrial standard i.t.o. SANS 1929:2005 is exceeded from time to time.
Expected Emission Reductions:	Dust suppression will reduce fall-out dust to within the industrial standard (SANS
Estimated Fixed Cost:	Approximately R 0.5 million
Estimated Running Cost:	To be determined in practice, estimated to be approximately R200 000 p.a.

Significance	
Will bring about improvement in the local (1Km radius) air quality	

Company Name:	TRANSALLOYS (Proprietary) Limited
Location:	Portion 34 of the farm Elandsfontein 309 JS Clewer road, Emalahleni, Mpumalanga
AQA S.21 Sector:	Scheduled Process 30: Iron and Steel Processes Scheduled Process 53: Manganese Processes
AQA S.21 Sub-sector:	Crushing and screening plant
Intervention Title:	Reduce emissions from crushing & screening operations
Intervention Type:	Implement dust extraction system (short term)
Problem Statement	
Dust emissions from crushing and screening operation	
Intervention	
Implement dust extraction system	
Current Status:	Capex application approved July 2010, Tenders issued July 2010, Order raised July 2010, project in progress
Expected Start:	2010
Expected Commissioning:	Forecast date on which the intervention will start delivering air quality improvement results – January 2011
Current Emissions:	Dust emissions from Crushing and Screening Plant not being directly monitored – fall-out dust sampling in the area conforms to industrial standards.
Expected Emission Reductions:	Reduction in dust emissions from Crushing and Screening Plant to be monitored once implemented.
Estimated Fixed Cost:	R1 638 162.90
Estimated Running Cost:	To be determined once commissioned – estimated around R 200 000 p.a.
Significance	
Will bring about improvement in the local (1Km radius) air quality	

Company Name:	Vanchem Vanadium Products (Pty) Ltd
Location:	Van Eck Road, Ferrobank, Witbank 1035
AQA S.21 Sector:	Highveld Priority Area
AQA S.21 Sub-sector:	Unknown

Intervention Title:	Kiln 1SO2 Dry Scrubber		
Intervention Type:	SO2 Removal using a dry sorbent		
Problem Statement			
At Vanchem, SO2 gas is liberated from the three kiln stacks, used to roast ore. This is due to the Sulphur compounds found in the materials (ore, salts, coal etc.) used in the process. Currently the Kilns on Vanchem are emitting amounts of SO2 into the atmosphere, exceeding the acceptable and legal limits.			
Intervention			
Kiln 1 has a pulse jet baghouse. The baghouse is cleaned continuously in situ by a quick pulse of high pressure air. In the Sodium Bicarbonate sorbent process, dry sodium bicarbonate is injected into the ducting between the kiln and the dust collecting equipment. The sorbent particles are transported with the flue gas to the fabric filter bag where they are collected along with the entrained fly ash. The particles react with SO2 while they are in the entrained flow mode during their transport phase as well as on the filter surface, where the major removal of SO2 takes place. When the pressure drop of fabric filter reaches a preset value, the particles on the surface are removed by using a fabric cleaning technique. The advantage of the process is the simplicity of the equipment and it can be retrofitted to the existing baghouse.			
Current Status:	Currently the project is tendered, approved and the construction and implementation has already commenced.		
Expected Start:	February 2010	Expected Commissioning:	January 2011
Current Emissions:	15 000 mg/Nm^3	Expected Emission Reductions:	80% reduction expected (12 000 mg/Nm^3)
Estimated Fixed Cost:	R 20 Mil	Estimated Running Cost:	R 5210 / Hour
Significance			
80% reduction in SO2 results measured in the Stack as well as ambient results for Kiln 1 only. Will only be possible to determine after commissioning and an ambient study performed afterwards.			
Measurement, Reporting and Verification			
Point source emissions to be measured and reported by Levego and the ambient studies to be performed and reported by Airshed.			

Intervention Title:	Kiln 2 & 3 SO2 Dry Scrubber		
Intervention Type:	SO2 Removal using a dry sorbent		
Problem Statement			
At Vanchem, SO2 gas is liberated from the three kiln stacks, used to roast ore. This is due to the Sulphur compounds found in the materials (ore, salts, coal etc.) used in the process. Currently the Kilns on Vanchem are emitting amounts of SO2 into the atmosphere, exceeding the acceptable and legal limits.			
Intervention			
The wet scrubber currently utilised for Kiln 2 & 3 will be replaced with a pulse jet baghouse. The baghouse is cleaned continuously in situ by a quick pulse of high pressure air. In the Sodium Bicarbonate sorbent process, dry sodium bicarbonate is injected into the ducting between the kiln and the dust collecting equipment. The sorbent particles are transported with the flue gas to the fabric filter bag where they are collected along with the entrained fly ash. The particles react with SO2 while they are in the entrained flow mode during their transport phase as well as on the filter surface, where the major removal of SO2 takes place. When the pressure drop of fabric filter reaches a preset value, the particles on the surface are removed by using a fabric cleaning technique. The advantage of the process is the simplicity of the equipment and it can be retrofitted to the existing baghouse.			
Current Status:	After completion of the Kiln 1 baghouse and dry scrubber, the process and effectiveness of the new technology will be determined. If found effective the technology will be installed as one baghouse feeding both Kiln 2 and 3. CAPEX will be applied for after determination of effectiveness.		
Expected Start:	February 2012	Expected Commissioning:	December 2015
Current Emissions:	13 000 mg/Nm^3 (Kiln 2) 10 000 mg/Nm^3 (Kiln 2)	Expected Emission Reductions:	80% combined reduction expected (18400 mg/Nm^3)
Estimated Fixed Cost:	R 65 Mil	Estimated Running Cost:	R 15630 / Hour
Significance			
80% reduction in SO2 results measured in the Stack as well as ambient results for Kiln 2 and 3. Will only be possible to determine after commissioning and an ambient study performed afterwards.			
Measurement, Reporting and Verification			
Point source emissions to be measured and reported by Levego and the ambient studies to be performed and reported by Airshed.			

Company Name	Zimco Aluminium Company a div of Zimco Group (Pty) LTD - ZIMALCO		
Location	3 Falkirk rd, Industrial Sites, Benoni		
AQA S21 Sector	Metallurgical Industry		
AQA S21 Sub-sector	Sub category 4.21.Metals recovery		
Intervention Title	Dross Plant extraction		
Intervention Type	Investment in air pollution control technology;		
Problem Statement			
Current standard exceeded for Particulate matter for the NEM:AQA – metal recovery process.			
Intervention			
Improving of baghouse			
Current status	Maintenance cost – work in progress		
Expected start	August 2010	**Expected commissioning**	November 2010
Current emissions	**See Poltech report attached**	**Expected Emission Reductions**	Approximately 20mg/Nm2
Estimated fixed cost	R30 000.00	**Estimated running costs**	R12 000.00 / Annum
Significance			
Fall out will be controlled to <1 km			
Measurement, Reporting and verification			
Annual monitoring by an Accredited Inspection Authority			

Intervention Title	Dross cooler extraction		
Intervention Type	Investment in air pollution control technology;		
Problem Statement			
Current standard exceeded for Particulate matter.			
Intervention			
Improving of baghouse			
Current status	Maintenance cost – work in progress		
Expected start	July 2010	**Expected commissioning**	September 2010
Current emissions	**See Poltech report attached**	**Expected Emission Reductions**	Reduce to Approximately 20mg/Nm2
Estimated fixed cost	R30 000.00	**Estimated running costs**	R12 000.00 / Annum
Significance			
Fall out will be controlled to <1 km			
Measurement, Reporting and verification			
Annual monitoring by an Accredited Inspection Authority			

Company Name	Zimco Aluminium Company a div of Zimco Group (Pty) LTD - ZIMALCO		
Location	3 Falkirk rd, Industrial Sites, Benoni		
AQA S21 Sector	Metallurgical Industry		
AQA S21 Sub-sector	Sub category 4.4: Secondary Aluminium Production		
Intervention Title	Main smoke stack		
Intervention Type	Investment in air pollution control technology;		
Problem Statement			
Reduction of the Particulate Matter readings to a more consistent levels although they do comply with APPA as well as the NEM :AQA for Secondary Aluminium Production.			
Intervention			
Replacing of baghouse			
Current status	Intervention has been capitalized, waiting approval.		
Expected start	June 2011	**Expected commissioning**	March 2012
Current emissions	**See Poltech report attached**	**Expected Emission Reductions**	Approximately 70%
Estimated fixed cost	R3500000.00	**Estimated running costs**	R50 000.00 / Annum
Significance			
Fall out will depend on the wind strength but will be approximately 5 km			
Measurement, Reporting and verification			
Annual monitoring by an Accredited Inspection Authority			

Company Name:	Eskom Holdings Ltd
Location:	Arnot Power Station – 40 km south-east of Middleburg Camden Power Station – 15 km south-east of Ermelo Duvha Power Station – 15 km south-east of eMalahleni Grootvlei Power Station – 32 km south-south-east of Heidelberg Hendrina Power Station – 18 km north-west of Hendrina Kendal Power Station – 9 km west-south-west of Ogies Komati Power Station – 35 km south-east of eMalahleni Kriel Power Station – 42 km south of eMalahleni Majuba Power Station – 31 km north-north-west of Volksrust Matla Power Station – 45 km south of eMalahleni Tutuka Power Station – 22 km north-east of Standerton
AQA S 21 Sector:	Category 1: Combustion installations Category 5: Mineral processing, storage and handling
AQA S.21 Sub-sector:	Sub-category 1.1: Solid fuel combustion installations Sub-category 5.1: Storage and handling of ore and coal

	Tutuka fabric filter plant retrofit
	Upgrade of pollution abatement technology

Emissions of particulate matter (ash) from the stacks of Tutuka Power Station

A fabric filter plant will be retrofitted on all 6 units of Tutuka Power Station, to replace the current electrostatic precipitator. A 120 days outage is required for each unit to install the retrofit.

	Business case approved by Investment Committee; still to be presented to the Eskom Board for approval.		
	First unit in 2013. Thereafter, one unit will be retrofitted each year.		2013-2018
	Particulate emissions from Tutuka currently average around 180 mg/Nm³		Emissions will be less than 50 mg/Nm³ after the FFP retrofit
	R3.9 billion (2010 real overnight costs)		R30 million per annum (for rebagging every 4 years)

The greatest improvement in emissions will be evident during start-up. The more than fourfold reduction in particulate emissions will result in an at least fourfold reduction in tonnages of ash emitted (and ground-level PM10 concentrations attributable to Tutuka stacks) in the vicinity of Tutuka Power Station. The improvement is expected over at least 10 km.

Particulate emissions from Tutuka's stacks are monitored with opacity monitors, and reported to the Licencing Authority at least annually. A full dynamic correlation test is performed by an independent consultant every 4 years, and a spot check is performed by an independent consultant 2 years after the full correlation test. Eskom's emissions data integrity is audited by an independent party annually.

	Matla ESP upgrade
	Upgrade of pollution abatement technology NOTE: The ESP upgrade may be stopped after the second unit if a decision is made to retrofit a fabric filter plant at Matla.

Emissions of particulate matter (ash) from the stacks of Matla Power Station

The ESPs at Matla Power Station are being upgraded and the SO_3 plants refurbished.

	In progress. The first unit was completed in March 2010; the second unit is scheduled for December 2010. The remaining four units will not undergo the ESP upgrade if a decision is made to retrofit fabric filter plants at Matla.		
	March 2010		Two units will be completed by end 2010. If the ESP upgrade programme goes ahead, the programme will be completed by 2014.
	Average between 70 mg/Nm³ and 200 mg/Nm³		Emissions will be reduced to at least less than 75 mg/Nm³
	R312 million (2010 real costs)		No additional costs

Ambient PM10 attributable to Matla Power Station will be reduced by around 50%

Particulate emissions from Matla's stacks are monitored with opacity monitors, and reported to the Licencing Authority at least annually. A full dynamic correlation test is performed by an independent consultant every 4 years, and a spot check is performed by an independent consultant 2 years after the full correlation test. Eskom's emissions data integrity is audited by an independent party annually.

	Particulate abatement technology upgrade plan
	Plan to upgrade pollution abatement technology

Emissions of particulate matter (ash) from power station stacks. Funds for the upgrades need to be secured, and the outages for the upgrades need to be incorporated into the outage schedule, if possible.

A plan detailing the type of upgrade and scheduling of the upgrade for five of Eskom's coal-fired power stations in the Highveld Priority Area will be compiled.

	The plan is currently being compiled		
	Work on the plan started in 2010.		The plan will be completed by July 2011, but results in air quality will only be realised when the upgrades are implemented.
	Average particulate emissions range between 50 mg/Nm³ and 200 mg/Nm³ at the five power stations		The target is to reduce particulate emissions at all stations to less than 50 mg/Nm³
	n/a		n/a

Improvements in air quality will only be realised when the plan is rolled out.

The plan will be presented to the Highveld Priority Area Multi-Stakeholder Reference Group, when completed in July 2011.

[redacted]	Particulate abatement technology upgrade plan		
[redacted]	Upgrade of pollution abatement technology		
[redacted]			
Emissions of particulate matter (ash) from power station stacks			
[redacted]			
Upgrades (probably fabric filter plant retrofits or ESP upgrades) are to be performed at coal-fired power stations to reduce particulate emissions to less than 50 mg/Nm³. 120 day outages are required for each unit to be retrofitted with a fabric filter plant. Implementation will be determined by the reserve margin and opportunity for outages.			
[redacted]	Plan is currently being compiled. Thereafter the business cases need to be compiled and approved, and contracts placed, before construction can commence		
[redacted]	Upgrades will start in 2014 at the earliest.	[redacted]	2014 at the earliest
[redacted]	Average particulate emissions range between 50 mg/Nm³ and 200 mg/Nm³ at the five power stations	[redacted]	Emissions will be reduced to less than 50 mg/Nm³
[redacted]	R17-28 billion (to be confirmed)	[redacted]	Dependent on the number of fabric filter plant retrofits. Likely R50-100 million per annum
[redacted]			
Ambient PM10 levels attributable to Eskom's power station stacks will be reduced.			
[redacted]			
Particulate emissions from power station stacks are monitored with opacity monitors, and reported to the Licencing Authority at least annually. A full dynamic correlation test is performed by an independent consultant every 4 years, and a spot check is performed by an independent consultant 2 years after the full correlation test. Eskom's emissions data integrity is audited by an independent party annually.			

[redacted]	Coal quality improvement feasibility study		
[redacted]	Plan for raw material modification		
[redacted]			
Sulphur dioxide and particulate emissions from power station stacks			
[redacted]			
The potential for reducing the sulphur content of the coal and improving coal quality using different beneficiation techniques is being investigated, and the associated emission reduction calculated with the Coal Quality Enhancement Model (CQEM)			
[redacted]	In progress		
[redacted]	The study has been underway for several years already.	[redacted]	Study for first station will be completed by April 2011. Other stations will be completed in 2011 and 2012.
[redacted]	n/a	[redacted]	Emission reductions will only be realised when the coal quality improvement programme is implemented.
[redacted]	n/a	[redacted]	n/a
[redacted]			
Emission reductions will only be realised when the coal quality improvement programme is implemented.			
[redacted]			
n/a			

[redacted]	Coal quality improvement
	Raw material modification

[redacted]

Sulphur dioxide and particulate emissions from coal-fired power stations

[redacted]

The quality of the coal will be improved (i.e. calorific value increased and ash content reduced) and the sulphur content of the coal reduced either by changing the mining plan or beneficiating the coal from tied mines, or by changing coal contracts to secure better coal from the spot market.

[redacted]	Feasibility study is underway and options are being assessed.		
	Lead time depends on the improvement option selected. A change in the mining plan will be quicker to implement; beneficiation can start earliest 2016 (two years for EIA, 3 years to place contract, await delivery and implement)	[redacted]	Depends on lead time.
	SO2: Average of 1500 to 4000 mg/Nm³		10-30% (preliminary estimate; will need to be determined for each station)
	Depends on option selected. To be determined for each station.		Depends on option selected. CAPEX costs will be low compared to the increased cost of the coal.

[redacted]

SO_2 concentrations may be reduced by 10-30% in the areas impacted by plumes from coal-fired power stations.

[redacted]

SO_2 emissions will be monitored with a continuous emission monitoring (CEM) system. At present, one unit at each power station is fitted with a CEM system, and SO_2 emissions (mass) from the entire power station are calculated by mass balance from measured coal qualities and the amount of coal burnt. All units of all stations will be fitted with a CEM system by 2014.

[redacted]	Flue Gas Desulphurisation at Kusile Power Station
	Installation of pollution abatement technology

[redacted]

Sulphur dioxide from power station stacks

[redacted]

Flue gas desulphurisation will be installed at Kusile Power Station.

[redacted]	Project has been approved; contract to be placed shortly. Construction of Kusile has commenced.		
	Construction of Kusile commenced in 2007.	[redacted]	Kusile Power Station with FGD will be commissioned between 2014 and 2017.
	n/a		SO_2 emissions from Kusile Power Station will be reduced by 90%.
	n/a		n/a

[redacted]

Ambient SO2 levels concentrations attributable to Kusile Power Station will be 90% lower than what they would have been had FGD not been retrofitted to Kusile.

[redacted]

In-stack measurements of SO_2 emissions will be made with a continuous gaseous emission monitoring system. Ambient SO_2 concentrations will be recorded at the ambient air quality monitoring station in Phola.

[redacted]	FGD retrofit plan		
	Plan to upgrade pollution abatement technology		
[redacted]			
Sulphur dioxide emissions from the stacks of coal-fired power stations			
[redacted]			
A plan detailing when FGD will be retrofitted to which power stations will be compiled. The plan is dependent on the supply of water by the second phase of the Lesotho Highland Project; the availability (or ability to import) sorbent (limestone or lime) of suitable quality; the space allocation at power stations and the remaining life of power stations. A 12 week outage is required to line stacks prior to FGD operation, and a 4 week outage is required for FGD tie-in. Eskom will engage with the Department of Water Affairs and the Department of Environmental Affairs to ensure the availability of the required resources.			
[redacted]	Underway		
	Started in 2006.	[redacted]	The plan will be completed by December 2012. FGD retrofits can only commence once additional water is supplied by the second phase of the Lesotho Highlands Project, currently scheduled for completion in 2020.
	SO_2 emissions average between 1500 and 4000 mg/Nm³		FGD will reduce emissions by 90%.
	An FGD retrofit on a 3600 MW station will cost R10 billion per power station (costs to be confirmed)		Around R320 million per annum for a 3600 MW station (costs to be confirmed)
[redacted]			
FGD is the only technology which can reduce emissions from Eskom's power station to levels less than 500 mg/Nm³.			
[redacted]			
Sulphur content of the coal used at power stations is measured on at least a weekly basis, and usually on a daily basis. SO_2 emissions will be monitored with a continuous emission monitoring (CEM) system. At present, one unit at each power station is fitted with a CEM system, and SO_2 emissions (mass) from the entire power station are calculated by mass balance from measured coal qualities and the amount of coal burnt. All units of all stations will be fitted with a CEM system by 2014.			

[redacted]	NOx reduction feasibility study		
	Plan to upgrade pollution abatement technology		
[redacted]			
Emissions of oxides of nitrogen from power station stacks.			
[redacted]			
A feasibility study will be conducted to assess which technology is required to be retrofitted at each power station in order to reduce NOx emissions to less than 750 mg/Nm³			
[redacted]	Contract being placed.		
	Early 2011	[redacted]	Report to be completed by March 2012
	NOx emissions from Eskom's stations range between 400 and 1100 mg/Nm³ at 10% O_2		Emission reductions will only be realised when the upgrades/retrofits recommended are implemented.
	R5 million for the feasibility study		n/a
[redacted]			
There are a number of technologies to reduce NOx emissions from power stations, including low NOx burners and overfire air, selective non-catalytic reduction and selective catalytic reduction technologies. The most appropriate technology for each power station needs to be determinined, taking into account the configuration of the power station and the required emission reduction.			
[redacted]			
The findings of the feasibility study will be presented to the Highveld Priority Area Multi-stakeholder Reference Group.			

[redacted]	NOx emission reduction retrofits
	Upgrade of pollution abatement technology
[redacted]	
Emissions of oxides of nitrogen from power station stacks.	
[redacted]	
Suitable NOx emission reduction technology will be retrofitted to power stations. A outage of up to 4 months is required for installation of overfire air. Retrofits will be coincided with the fabric filter plant retrofits.	

[redacted]	Feasibility study being initiated.		
	2014 at the earliest, depending on procurement and delivery	[redacted]	2014 at the earliest
	NOx emissions from Eskom's stations range between 400 and 1100 mg/Nm³ at 10% O_2		Emissions will be reduced to less than 750 mg/Nm³.
	It will cost over R2 billion to retrofit low NOx burners and overfire air to a 3600 MW power station.		To be determined. Dependent on technology selected.

[redacted]
Currently, NO_2 levels are well below the ambient air quality limits in the vicinity of Eskom's coal-fired power stations.
[redacted]
NO_x emissions will be monitored with a continuous emission monitoring (CEM) system. At present, one unit at each power station is fitted with a CEM system, and NO_x emissions (mass) from the entire power station are calculated using measured, station-specific emission factors. All units of all stations will be fitted with a CEM system by 2014.

[redacted]	Fugitive emission management plan
	Improved fugitive emission management system.
[redacted]	
Fugitive emissions from coal stockyard, ashing facilities and materials handling at power stations.	
[redacted]	
A fugitive emission management plan will be compiled for each power station. The plan will identify sources of fugitive emissions at power stations, current measures which are employed to reduce fugitive emissions, and assess whether additional measures are required to control fugitive emissions. Where required, a monitoring programme for fugitive emissions will be compiled and implemented. Annual monitoring reports will be issued.	

[redacted]	Fugitive emission management plans are currently being compiled		
	Fugitive emission management is already underway.	[redacted]	Fugitive emission management plans will be completed by December 2010.

[redacted]	Emissions vary depending on the weather conditions (emissions mainly occur during windy conditions) and on the type of ashing facility (wet/dry)	[redacted]	Dust emissions will be suppressed by water and rehabilitation of ash dumps. Emission reductions are difficult to quantify.
	To be determined, based on the fugitive emission management plans		To be determined, based on the fugitive emission management plans

[redacted]
Fugitive emissions mainly impact in the immediate vicinity (few kilometres) of the source.
[redacted]
An annual fugitive emission management report will be produced for each power station.

[redacted]	Majuba Rail Project		
[redacted]	Construction of rail infrastructure		
[redacted]			
Fugitive and vehicle exhaust emissions from the trucks transporting coal from mines to power stations.			
[redacted]			
A 68 km railway line will be constructed between Ermelo and Majuba Power station to transport coal to the station. This will result in a significant reduction in the number of trucks transporting coal to Majuba by road.			
[redacted]	Funding from the World Bank has been secured. Project is approved but contracts are still to be placed.		
[redacted]	Construction is provisionally scheduled to start in July 2011, subject to the placement of contracts	[redacted]	February 2014, subject to the placement of contracts and construction
[redacted]	Emissions are from trucks on the roads	[redacted]	Emissions from trucks on the road will be eliminated.
[redacted]	Approximately R4.2 billion	[redacted]	To be confirmed
[redacted]			
The elimination of the trucks will improve local air quality adjacent to the roads.			
[redacted]			
Emission reductions cannot be measured but dustfall measurements could be made to show the effectiveness of the measures.			

[redacted]	Kriel ambient air quality monitoring station
[redacted]	Ambient air quality monitoring
[redacted]	
Measurements of ambient air quality (PM10, SO_2 and NO_x) in populated areas in the Highveld Priority Area are needed to assess the current air quality and the success of interventions.	

[redacted]			
An ambient air quality monitoring station will be established in Kriel town.			
[redacted]	Monitoring station has been established; reporting still to commence.		
[redacted]	Monitoring station established in July 2010	[redacted]	Reporting to commence in January 2011
[redacted]	n/a	[redacted]	n/a
[redacted]	R600 000	[redacted]	R400 000 per annum
[redacted]			
The monitoring station will allow the impact of emissions from Kriel and Matla power stations on Kriel town to be accurately assessed.			
[redacted]			
Quarterly ambient air quality monitoring reports will be compiled.			

[redacted]	Ambient air quality monitoring network
	Ambient air quality monitoring

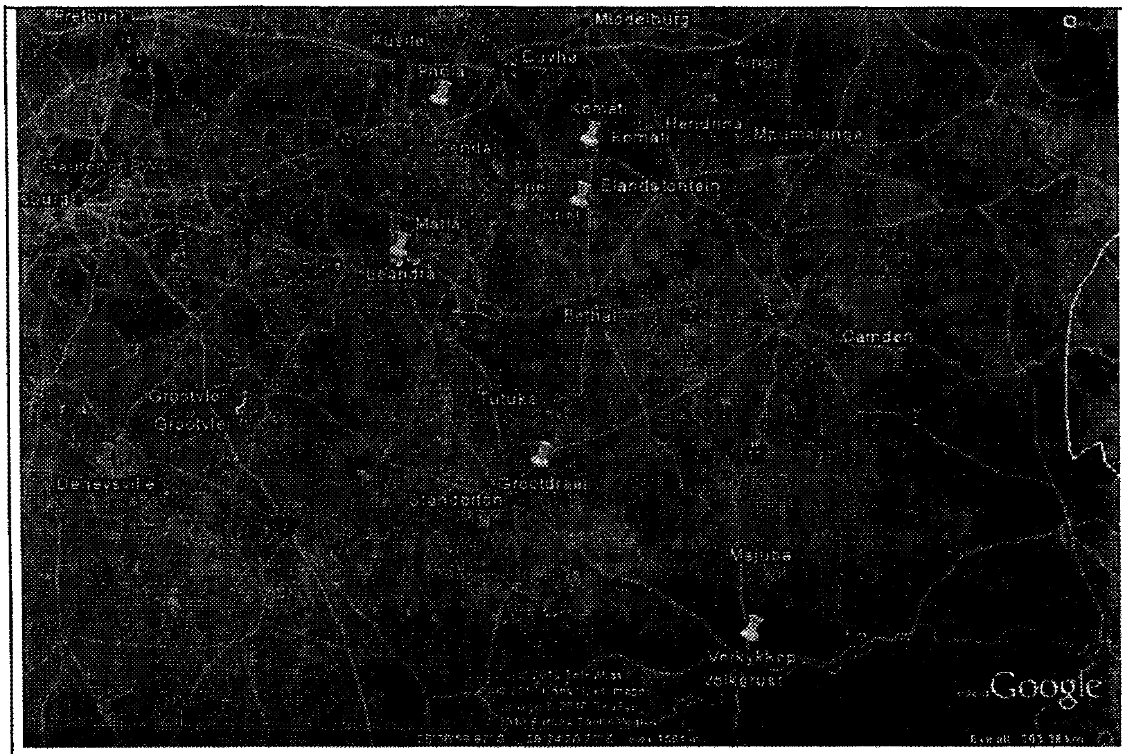
[redacted]

Measurements of ambient air quality (PM10, SO_2, NO_x and O_3) in the Highveld Priority Area are needed to assess the current air quality and the success of interventions.

[redacted]

Eskom has a network of monitoring stations in the Highveld Priority Area which monitor regional air quality and air quality in populated areas. The locations and parameters monitored at Eskom's monitoring stations in the Highveld Priority Area are as follows:

Monitoring station	**Parameters monitored**	**Location of station**	**Description of site**
Phola	PM10, SO2, NOx, met	22 km south-west of eMalahleni; 12.5 km north-east of Kendal Power Station; 15 km south-east of Kusile Power Station	Populated area
Leandra	PM10, SO2, met	In Leandra, off the N17	Populated area
Grootvlei	PM10, SO2, NOx, O3, met	2 km west of Grootvlei Power Station	Populated area
Komati	PM10, SO2, NOx, met	2 km west-south-west of Komati Power Station	Populated area
Elandsfontein	PM10, SO2, NOx, O3, Hg, met	23 km north of Bethal	Regional
Grootdraai	PM10, SO2, NOx, met	At Grootdraai Dam, 9 km north-east of Standerton	Regional
Verkykkop	PM10, SO2, NOx, O3, met	4 km north of Volksrust	Regional



The locations of Eskom's ambient air quality monitoring stations are shown in yellow.

[redacted]	Operational		
	Underway since the late 1970s.	[redacted]	Already commissioned
	n/a		n/a
	R5 million		R2.5 million per annum
[redacted]			
The monitoring stations aid in the assessment of current air quality and the success of interventions in the Highveld Priority Area			
[redacted]			
Quarterly ambient air quality monitoring reports will be compiled.			

[redacted]	Stack emission monitoring
	Stack emission monitoring
[redacted]	
Emissions of particulates, SO_2 and NO_x from power station stacks.	
[redacted]	

Continuous monitoring of particulates is conducted using opacity monitors for all of Eskom's power station stacks. One stack at each power station is fitted with a continuous emission monitoring (CEM) system, measuring SO2 and NOx. All stacks of all power stations will be equipped with CEM systems for SO_2 and NO_x measurements by 2014.			
	All stacks monitor particulate emissions. One stack at each power station monitors SO_2 and NO_x.		
	Particulate monitoring has been conducted for decades. CEM systems for SO_2 and NO_x were fitted on one stack per power station in 2009 and 2010.		Ongoing
	n/a		n/a
	R100 million (2010 real costs)		R27 million per annum (2010 real costs)
Continuous emission measurements of particulates, SO_2 and NOx from all power station stacks will allow emissions from Eskom's activities to be accurately assessed.			
Emission reports will be submitted annually to the Licencing Authority. For the opacity monitors measuring particulate emissions, a full dynamic correlation test is performed by an independent consultant every 4 years, and a spot check is performed by an independent consultant 2 years after the full correlation test. The gaseous CEM systems will be verified by a third party. Eskom's emissions data integrity is audited by an independent party annually.			

	Offset project pre-feasibility study		
	Offset project pre-feasibility study		
In many cases, domestic emissions, such as those from fuel burning in towns and people's houses, have a larger impact on ambient air quality in populated areas than tall stack areas. Reducing emissions from power stations will thus not result in compliance with ambient air quality standards in all parts of the Highveld Priority Area. Offset projects have the potential to achieve greater improvements in ambient air quality in a more cost effective manner.			
A pre-feasibility study will be conducted to identify potential offset projects for the Highveld Priority Area, and air quality improvement which could be achieved by implementing the offset projects.			
	Study has been initiated.		
	Study has already started.		Study should be completed by July 2012.
	n/a		To be determined in the study
	n/a		n/a
Offset projects will target populated areas, and the improvements will mainly be in local air quality.			

Methods for measuring, reporting and verifying the implementation of the offset projects and the resultant improvement in ambient air quality will be proposed in the study. The findings of the offset project pre-feasibility study will be presented to the Highveld Priority Area Multi-Stakeholder Reference Group.

	Air Quality Research
	Research

In order to successfully manage air quality in the Highveld Priority Area, more information is required on the transport of pollutants in the atmosphere, and their deposition and impact on the environment. Research into new abatement technologies is required in order to find more innovative ways of reducing emissions that are compatible with local resource availability

Ambient air quality research into:

- Atmospheric dispersion modelling: Eskom has been making solid progress in defining the correct use of complex models under South African conditions and has committed to sharing this knowledge with the local modelling fraternity to ensure consistency in model use.
- Deposition and impacts: The focus is on predicting when significant impacts are likely to happen, given our current and future emissions scenarios, so that any necessary remedial actions can be planned long in advance of the signs of ecological damage becoming evident.
- Heavy metals: The South African Government is aiming to introduce regulation of mercury emissions in the near future. Since the exposure pathways differ significantly from country to country, local knowledge will be essential to properly inform the regulatory process.
- New abatement technologies: The removal of SO_2 using flue gas desulphurisation (FGD) proposes a problem for South Africa as there are severe constraints on water availability and suitable calcium-based sorbents, both required in very significant quantities for FGD. Research in this area is thus focused on SO_2 removal using non-calcium based and low water use technologies.

	Underway		
	Eskom has been conducting air quality research since 1978		Reports are compiled annually.
	n/a		n/a
	n/a		R10.25 million for 2009/10 financial year (excluding new abatement technologies research)

Research aids in the mitigation of pollution and in an understanding of the impacts of pollution over the entire Priority Area.

Reports detailing the progress made during the year are compiled annually.

[redacted]	Internal energy efficiency improvement programme
[redacted]	Energy efficiency improvement
[redacted]	
Generation of electricity at coal-fired stations results in emissions to the atmosphere of particulates, SO_2 and NO_x	
[redacted]	

Eskom's internal energy efficiency programme aims to:

- Reduce non-essential electricity consumption in Eskom facilities (for example, that used for lighting)

  Annual measured and verified savings as at the end of March 2010 were 30.6 GWh (contribution by non-essential consumption was 9.6 GWh) and 75.3 GWh since the project started in 2003 (contribution by non-essential consumption was 46.7 GWh). These savings were achieved through energy efficiency initiatives at Lethabo Power Station, Braamfontein and Rosherville buildings, the Eskom employee compact fluorescent lamp (CFL) exchange programme and initiatives in buildings in the northern region. Further initiatives are currently underway.

- Reduce line losses in the transmission and distribution of energy
- Improve the thermal energy efficiency of the existing fleet of coal-fired power stations which relates primarily to the efficient use of resources (mainly coal)

The internal Eskom energy efficiency target is to save 1 billion kilowatt hours by the end of the 2012/2013 financial year.

[redacted]	Underway		
[redacted]	Started in 2003	[redacted]	Energy efficiency improvements already being realised.
[redacted]	n/a	[redacted]	n/a
[redacted]	n/a	[redacted]	n/a
[redacted]			

An improvement in thermal efficiency relates primarily to resource efficiency (use of coal). A reduction in energy consumption in Eskom's facilities relates directly to reduced emissions from power stations (a kWh saved relates to water savings, avoided CO_2, NO_x and SO_2 emissions). This assists in addressing the current demand/supply constraints.

[redacted]

Metering is being installed at key Eskom facilities to measure and manage electricity consumption. The metered information will be monitored via a meter data management system. Savings already achieved has been monitored and verified. These savings will be continuously monitored to ensure that the savings are sustained into the future.

[redacted]	Demand side management
[redacted]	Energy efficiency improvement
[redacted]	
Generation of electricity at coal-fired stations results in emissions to the atmosphere of particulates, SO_2 and NO_x	
[redacted]	
Eskom's Demand Side Management programme is being achieved with energy efficient motors and pumps in the industrial and	

commercial sectors, and hot water load management within municipal environments. There has more recently been a renewed focus on the mass roll out of energy efficient products including CFLs and solar water heaters. A verified, cumulative saving of 2372 MW has been achieved since the programmes were initiated in 2003. Eskom's Demand Side Management department has a target to effect a 3000 MW saving in electricity consumption by 2013 and a further 5000 MW by 2026.			
	Underway		
	Started in 2003.		Energy efficiency improvements already being realised.
	n/a		n/a
	n/a		n/a
While an improvement in energy efficiency does not directly translate into a reduction in emissions from a power station, or does reduce the demand for new power stations.			
Improvements in energy efficiency are measured and verified.			

Company Name:	Anglo American Thermal Coal Goedehoop Colliery		
Location:	Goedehoop Colliery is situated in the Mpumalanga Province, within the Witbank coalfield.		
AQA S.21 Sector:			
AQA S.21 Sub-sector:			
Intervention Title:	Dust Suppression and monitoring		
Intervention Type:	Dust suppression, monitoring.		
Problem Statement			
Dust is the main air pollutant on the Colliery. Dust is emitted from the coal mining processes, haul roads, and coal stockpiles.			
Intervention			
▪ Water dousers are used to spray haul roads at the mini-pit and discard dumps. ▪ Dust tech / Eco-bond are applied on mini-pit haul roads and hard parks. ▪ Water canons spray water at coal tipping and crusher areas. ▪ Continuous miners are equipped with scrubbers and wet collection systems to decrease dust emission underground. ▪ Coal stock yards, and roads within the stock yards are watered to suppress dust production. ▪ Dust fallout monitoring takes places using both non-directional and directional dust monitoring systems. ▪ Gravimetric dust sampling takes place, using random statistically representative number of employees to collate data.			
Current Status:	All these dust suppression methods are ongoing.		
Expected Start:	Ongoing process	Expected Commissioning:	
Current Emissions:	All dust fallout readings are within the SANS 1929: 2005 limits.	Expected Emission Reductions:	
Estimated Fixed Cost:		Estimated Running Cost:	Dust fallout monitoring – R20 000/ month Rehabilitation – R105 M for Bank 5 and Schoonie Dumps (Once off) And R36 M allocated to each pit (3 mini pits)- Once off. Roads Watering – R1.5 M/ annum Dust tech/Ecobond – R33000/annum
Significance			
Dust suppression Local dust suppression will result in less fugitive dust emissions locally, within the district, and the HPA.			
Measurement, Reporting and Verification			
Dust fallout monitoring is conducted by SGS.			

Company Name:	Anglo American Thermal Coal Greenside Colliery		
Location:	Greenside Colliery is situated in the Mpumalanga Province, within the Witbank coalfield. It consists of Greenside Main and Nooitgedacht Section, about 40km south of Greenside Main.		
AQA S.21 Sector:			
AQA S.21 Sub-sector:			
Intervention Title:	Dust Suppression and monitoring		
Intervention Type:	Dust suppression, monitoring.		
Problem Statement			
Dust is the main air pollutant on the Colliery. Dust is emitted from the coal mining processes, haul roads, and coal stockpiles. Dust from the Greenside Discard Dump and from the gravel roads to Nooitgedacht. Vehicle entrained dust is the dominant source of dust pollution.			
Intervention			
▪ Water tankers run for 12 hours/day, these spray water on the co-disposal facility to suppress dust from the site. ▪ The operation has a dust fallout monitoring system which consists of 4 single and 2 directional dust buckets.			
Current Status:	All these dust suppression methods are ongoing.		
Expected Start:	Ongoing process	Expected Commissioning:	
Current Emissions:	All dust fallout readings are within the SANS 1929: 2005 limits.	Expected Emission Reductions:	Dust suppression by water-spraying of the gravel-roads on the Discard Dump and to Nooitgedacht, using water-trucks. Two water tankers running 12 hours/day to spray Co-disposal Dump. At Greenside a watering truck is used to wet the haul and secondary roads Rehabilitation of the Discard Dump. Dust fall-out monitoring network implemented. Operation of a dust fallout monitoring programme, consisting 4 single and 2 directional dust bucket monitoring network.
Estimated Fixed Cost:	R 0	Estimated Running Cost:	Discard Rehabilitation – R 1000 000 / annum, Roads watering – R 700 000/annum. Dust fall-out monitoring – R 45 000/annum.
Significance			
Local dust suppression will result in less fugitive dust emissions locally, within the district, and the HPA. Dust emissions from operations and roads are routinely monitored. Monthly dust monitoring results indicate that dust fall-out is slight in terms of the CAPCO guidelines. During winter, the dust levels were found to be higher due to ploughing by the farmers and wind-blown dust from empty fields.			
Measurement, Reporting and Verification			
Dust fallout monitoring is conducted by SGS			

Company Name:	Anglo American Thermal Coal Isibonelo Colliery
Location:	Isibonelo Colliery is situated in the Mpumalanga Province, within the southern reaches of the Witbank coalfield.
AQA S.21 Sector:	
AQA S.21 Sub-sector:	
Intervention Title:	Dust Suppression and monitoring
Intervention Type:	Dust suppression, monitoring.
Problem Statement	
Dust is the main air pollutant on the Colliery. Dust is emitted from the coal mining processes, haul roads, and coal stockpiles.	

Intervention			
▪ Use of water sprays at plant conveyor belt transfer points, in the bunker and at the tip ▪ Dust fallout is monitored by the use of dust buckets (10) around the colliery and 1 directional dust buckets is used to monitor export and import dust. ▪ Use of water trucks to suppress the dust as required on the haul roads is maintained regularly			
Current Status:	All these dust suppression methods are ongoing.		
Expected Start:	Ongoing process	Expected Commissioning:	Has began in 2003 and there has been improvements since then
Current Emissions:	Most dust fallout readings are within the SANS 1929: 2005 limits. Except in windy conditions and when the farmers are ploughing their areas.	Expected Emission Reductions:	We are happy if the readings are in the residential threshold (<600), but sometimes the readings are in the industrial which is acceptable.
Estimated Fixed Cost:		Estimated Running Cost:	Road Watering – R000.00 Dust Fallout Monitoring – R 6 459.71/month
Significance			
Local dust suppression will result in less fugitive dust emissions locally, within the district, and the HPA. This will result in less complains from the communities around the mine.			
Measurement, Reporting and Verification			
Dust fallout monitoring is conducted by SGS and we receive monthly reports plus an annual report.			

Company Name:	Anglo American Thermal Coal Kleinkopje Colliery		
Location:	Kleinkopje Colliery is situated in the Mpumalanga Province, within the Witbank coalfield.		
AQA S.18 Sector:	Spontaneous combustion of coal and spoils in the declared Highveld Priority Area in terms of section 18 NEM:AQA Act 2004 (Act no. 39 of 2004)		
AQA S.18 Sub-sector:			
Intervention Title:	Spontaneous Combustion		
Intervention Type:	Spontaneous Combustion Suppression		
Problem Statement			
Spontaneous combustion is an air pollutant at Kleinkopje Colliery, and needs to be suppressed.			
Intervention			
▪ Water sprayers are directed at the digging face and coaling hot spots to suppress smoke. ▪ Cladding of high-wall. ▪ Buffer blasting is being implemented at the Colliery to combat spontaneous combustion. ▪ Open blast holes and sealing holes too hot to blast are being plugged. ▪ Levelling and cladding hot blasted interburden benches. ▪ Water cannons were installed at the tip stockpiles to cool hot coal.			
Current Status:	All these dust suppression methods are ongoing.		
Expected Start:	Ongoing process	Expected Commissioning:	2010
Current Emissions:	Benzene, Toluene, Ethyl benzene and Xylene (BTEX), SO_2 and NO_2	Expected Emission Reductions:	Company standards wish to comply to Directive 2008/50/EC
Estimated Fixed Cost:	R 69,598-00	Estimated Running Cost:	R 4,899,367-00
Significance			
Spontaneous Combustion suppression Local spontaneous combustion suppression will result in less fugitive emissions locally, within the district, and the HPA.			
Measurement, Reporting and Verification			
Ambient emissions is currently recorded every second year by a 3rd party. The operation is in the process of procuring continuous air monitoring equipment to measure and detect emissions and changes in emissions fallout.			

Company Name:	Anglo American Thermal Coal Kleinkopje Colliery

Location:	Kleinkopje Colliery is situated in the Mpumalanga Province, within the Witbank coalfield.
AQA S.18 Sector:	Mining, haul and stockpiling of coal in the declared Highveld Priority Area in terms of section 18 NEM:AQA Act 2004 (Act no. 39 of 2004)
AQA S.18 Sub-sector:	Locations in declared Highveld Priority Area in terms of section 18 NEM:AQA Act 2004 (Act no. 39 of 2004)
Intervention Title:	Dust Suppression and monitoring
Intervention Type:	Dust suppression, monitoring.

Problem Statement

Dust is the main air pollutant on the Colliery. Dust is emitted from the coal processing plant, mining processes, haul roads, and coal stockpiles.

Intervention

- An airborne particle sampling program has been in place since August 2002 to monitor dust emissions from mining activities and their impact on the boundaries of the mining area.
- Recycled water is used for dust suppression on haul roads.
- Dust-a-Side (natural petroleum resin emulsion product) is used on the main haul roads at Kleinkopje. Haul roads in Pit 5 West and 2A North and South as well as roads 200m into the Ramps were treated with Dust-a-Side from 2009 onwards.
- Water sprayers wet the digging face to suppress dust and smoke
- The high-wall is cladded.
- Tipping areas have a dust suppression system with "Dust Down Solutions"
- Water cannons are installed at the tip stockpiles to reduce dust.
- Rehabilitation and vegetation of previously mined areas to reduce dust.

Current Status:	All these dust suppression methods are ongoing.		
Expected Start:	Ongoing process	Expected Commissioning:	August 2002
Current Emissions:	All ambient dust fallout readings are within the SANS 1929: 2005 limits.	Expected Emission Reductions:	Emission levels to be kept within range of SANS 1929:2005
Estimated Fixed Cost:	R 5,751,246-00 (Dust aside and monitoring)	Estimated Running Cost:	R 26,788,830-00 of the annual operational, running and maintenance costs

Significance

Dust suppression
Local dust suppression and rehabilitation will result in less fugitive dust emissions locally, within the district, and the HPA.

Measurement, Reporting and Verification

Dust monitoring is performed by SGS Environmental using SANS 1929:2005 as South African Standard. Sampling is done by using DustWatch and single bucket monitoring units. The results of dust monitoring are reported on a monthly basis to Anglo American Thermal Coal Kleinkopje Colliery. SGS is a SANAS accredited testing laboratory thus the results are seen as verified through accreditation.
[A brief description of how the expected emission reductions will be measured, reported and verified by an independent party]

Company Name:	Anglo American Thermal Coal Kriel Colliery
Location:	Kriel Colliery is situated within the Mpumalanga Province, within the Witbank coalfield.
AQA S.21 Sector:	
AQA S.21 Sub-sector:	
Intervention Title:	Dust suppression and monitoring
Intervention Type:	Dust suppression and monitoring

Problem Statement

Dust is the main air pollutant on the Colliery. Dust is emitted from the coal mining processes, haul roads, and stockpiles

Intervention

- Dust-a-side application on 13.8km of haul roads
- A water tanker run once in two days across the haul roads
- Water sprayed at tip area during tipping to suppress dust
- Operation of a dust fallout monitoring programme
- Water sprayers installed within all crushers
- Purchasing of new cyclones for capturing dust at the crushing plant

Current Status:	All dust suppression methods are ongoing		
Expected Start:	Ongoing	Expected Commissioning:	

Current Emissions:	Dust fallout readings are within the SANS 1929:2005 limits	Expected Emission Reductions:	
Estimated Fixed Cost:		Estimated Running Cost:	Road Watering – R 7 000 000 Dust Monitoring – R 81 000 Cyclones – R 400 000
Significance			
Dust suppression. Local dust suppression will result in less fugitive dust emissions locally, within the district, and in the HPA			
Measurement, Reporting and Verification			
Dust fallout monitoring is conducted using an outside contractor.			

Company Name:	Anglo American Thermal Coal Landau Colliery
Location:	Landau Colliery is a business unit of Anglo American Thermal Coal, a division of Anglo American plc, and consists of two sections, namely the Kromdraai and Navigation Sections. Landau Colliery is situated in the Emalahleni Local Municipality, which falls within the Nkangala District Municipality. The Kromdraai Section is situated 15 km north-west of Emalahleni and the Navigation Section is situated 6 km south-west of Emalahleni.
AQA S.21 Sector:	
AQA S.21 Sub-sector:	
Intervention Title:	Dust Suppression and monitoring
Intervention Type:	Dust suppression, monitoring.

Problem Statement

Dust is the main air pollutant on the Colliery. Dust is emitted from the coal mining processes, haul roads, coal silos and coal stockpiles. Dust from the Landau Colliery co-disposal site and from coal transport routes in KwaMthunzi Vilakazi. Vehicle entrained dust is the dominant source of dust pollution.

Intervention

- Water tankers run for 12 hours/day, these spray water on the haul roads and co-disposal facility to suppress dust from the site.
- A road-wetting system which incorporates evaporation rates for the area is used to inform the rate of watering (liters/m2/hour) and used for each pit and unpaved road.
- Chemical stabilisers are also used increases the effectiveness of watering roads, decreases water use and can also lowers the required frequency of application.
- The operation has a dust fallout monitoring system, which consists of 17 single, and 4 multi directional buckets. Landau Colliery uses receptor impact monitoring applies for beyond the operational fence line and evaluated against the SANS 1929 standards for dust deposition to assess compliance.
- Dust Management is incorporated into the mine EMS system and ensures that all measurements are handled as per guidelines stipulated in SANS 1929: 2005 and that mine section managers are actively involved in minimising dust in their own sections.

Current Status:	All these dust suppression methods are ongoing.		
Expected Start:	Ongoing process	Expected Commissioning:	
Current Emissions:	All dust fallout readings are within the SANS 1929: 2005 limits.	Expected Emission Reductions:	Dust suppression by water-spraying of the gravel-roads on the Discard Dump, Kromdraai pit, Schoongezicht and Umlalazi sections using water-trucks, tip sprays and other dust suppression measures. Water tankers running 12 hours/day to spray. At Landau Colliery a watering truck is used to wet the haul and secondary roads Rehabilitation of the Discard Dump. Dust fall-out monitoring network implemented. Operation of a dust fallout monitoring programme, consisting 17 single and 4 directional dust bucket monitoring network.

			Pit closure is exercised when water tankers are on breakdown Operational crew guides water monitoring as per current production route.
Estimated Fixed Cost:	R 0	Estimated Running Cost:	Discard Rehabilitation – R 1340 000 / annum, Roads watering – R 840 000/annum. Dust fall-out monitoring – R 184000/annum.

Significance

The dust monitoring data is being analysed against the SANS1929 dustfall standards, which are the most current standards in South Africa. Although SANS1929 permissible dustfall limit for residential areas being 600mg/m2/day, the mine's has set a target is to maintain dustfall levels below 300mg/m2/day. Local dust suppression will result in less fugitive dust emissions locally, within the district, and the HPA.

Dust emissions from operations and roads are routinely monitored. Monthly dust monitoring results indicate that dust fall-out is slight in terms of the CAPCO guidelines. During winter months, the dust levels were found to be higher and consequently dust suppression rates are increased.

The mine intends to compile a detailed emissions inventory that should also be regularly maintained (annually). The EIAide software application developed specifically for Anglo American will be used to store the emissions data. This emissions inventory would be updated annually.

A prioritised list of potentially significant air pollutants from the mine is also to be complied and this will require an assessment of concentrations of other pollutants in the vicinity of the mine. A monitoring plan, including monitoring network design, will be established to create a baseline of SO2, NOx, PM10, and VOC (with emphasis on benzene) concentrations in ambient air.

A risk assessment looking at dust pollutants has been compiled and a mitigation plan developed to ensure that South African Ambient Air Quality Standards or the EC Limit Values are not exceeded.

The Investigation of the cause of high dust levels is done, these are logged as incidents in the mine's EMS system, remedial measures are undertaken, and periodically assessments with SGS of the performance of these measures through monitoring and through inspection is undertaken. This system is largely in place but needs to be upgraded to be more effective in prevention of future recurrences.

Measurement, Reporting and Verification

Dust fallout monitoring is conducted by SGS and the mine's Environmental management team. Air management is guided by Air quality standards, Threshold emission rates for PM10, SO2, and NOx, Community perception and significance threshold for reporting and health risk criteria.

Company Name:	Anglo American Thermal Coal Mafube Colliery
Location:	Mafube Colliery is situated within the Mpumalanga Province, within the Witbank coalfield.
AQA S.21 Sector:	
AQA S.21 Sub-sector:	
Intervention Title:	Dust suppression and monitoring
Intervention Type:	Dust suppression and monitoring

Problem Statement

Dust is the main air pollutant on the Colliery. Dust is emitted from the coal mining processes, haul roads, and stockpiles

Intervention

- Two 83000L water bowser are used to spray haul roads. The bowsers are filled at least 4 times per shift during dry period.
- Operation of a dust fallout monitoring programme, consisting 20 single and 2 directional dust bucket monitoring network
- Use compactor on the discard dump to compact loose materials.
- Vegatating all the topsoil stockpiles that will not be used in the near future.
- Water sprays in all drilling machines and along conveyors.
- Compile an emissions inventory & identify potentially significant pollutants.
- Dustex application on the haul road and temporary LDV road.

Current Status:	All dust suppression methods are ongoing		
Expected Start:	Ongoing	Expected	

		Commissioning:	
Current Emissions:	Dust fallout readings are within the SANS 1929:2005 limits	Expected Emission Reductions:	
Estimated Fixed Cost:		Estimated Running Cost:	Dustex (30000L) – R 90000 Road Watering – R 18 000/month (average) Dust Monitoring – R110 000/annum Discard Compacting – R4.70/ton (average monthly tonnage = 70 000) Topsoil Vegetating – R 12500/Ha
Significance			
Dust suppression. Local dust suppression will result in less fugitive dust emissions locally, within the district, and in the HPA			
Measurement, Reporting and Verification			
Dust monitoring			

Company Name:	Anglo American Thermal Coal, New Denmark Colliery		
Location:	Coal Mine situated in the Farm Slagkraal, Standerton, Mpumalanga		
AQA S.21 Sector:			
AQA S.21 Sub-sector:			
Intervention Title:	NDC Methane Flaring Project		
Intervention Type:	The project is aimed at reducing the methane emissions by flaring it before being released to the atmosphere. Carbon credits will be given on the stock exchange. This is an investment to the company		
Problem Statement			
Methane was emitted from underground working through a vertical ventilation shaft as it is.			
Intervention			
The project will reduce methane emissions to the atmosphere by burning it with water and CO2			
Current Status:	The project is still to be implemented. The project falls under a listed activity, and a basic assessment is required. The public participation is scheduled for the 29th.		
Expected Start:	2011, after environmental authorisation has been granted.	Expected Commissioning:	End of 2011
Current Emissions:	100 % methane emitted as it is through the ventilation shaft	Expected Emission Reductions:	Reduce methane emission by 15%
Estimated Fixed Cost:	R 9.2 Million	Estimated Running Cost:	R 300 000/ year
Significance			
To reduce the emissions of methane locally, within the district, and within the HPA region.			
Measurement, Reporting and Verification			
The emissions will be measure and reported on a monthly basis			

Company Name:	Anglo American Thermal Coal Zibulo Colliery
Location:	Zibulo Colliery is situated within the Mpumalanga Province, within the Witbank coalfield.
AQA S.21 Sector:	
AQA S.21 Sub-sector:	
Intervention Title:	Dust suppression and monitoring
Intervention Type:	Dust suppression and monitoring
Problem Statement	
Dust is the main air pollutant on the Colliery. Dust is emitted from the coal mining processes, haul roads, and stockpiles	
Intervention	
▪ Dust fallout monitoring, with 12 single and 3 directional dust buckets ▪ Haul roads are watered daily to suppress dust	

Current Status:	All dust suppression methods are ongoing		
Expected Start:	Ongoing	Expected Commissioning:	Dust fallout is ongoing
Current Emissions:	Dust fallout readings are within the SANS 1929:2005 limits	Expected Emission Reductions:	
Estimated Fixed Cost:		Estimated Running Cost:	R196 000 for dust monitoring annually
Significance			
Dust suppression. Local dust suppression will result in less fugitive dust emissions locally, within the district, and in the HPA			
Measurement, Reporting and Verification			
Dust fallout monitoring is conducted by SGS.			

Scaw Metals:

Notwithstanding the general process mentioned above, we already commenced with the more advanced investigation of the following:

1. Using different bags in the Direct Reduced Iron (DRI) kiln bag houses to reduce emissions further and to extend the life of the bags. This entails sourcing these bags and then running various trials under different operating conditions to determine the feasibility.
2. Development of an electricity co-generation plant that would use waste heat, dust and char from the DRI kilns. This plant will include additional emission abatement infrastructure, which will achieve the new standards. Pre-feasibility study is in progress at the moment and we expect to complete this by the end of 2010. Then approval will be sought from shareholders for the commencement of the bankable feasibility study.

Company Name:	Omnia Fertilizer a Division of Omnia Group Limited
Location:	Farm Weltevreden, Dryden, Delmas District
AQA S.21 Sector:	One (1) and Seven (7)
AQA S.21 Sub-sector:	1.1, 7.1 & 7.6
Intervention Title:	Confirmation monitoring of Air Emissions at Omnia Fertilizer's Dryden Factory
Intervention Type:	• Omnia Fertilizer initiated a project to proactively ensure that all Omnia Fertilizer factories comply with the new requirements within the required time frame. The proposed Air Quality Compliance project will be conducted in three phases, namely: Phase 1: Monitoring of the emissions at our existing plants to confirm our actual emissions. Phase 2: Identify facilities where online monitoring is required, select suitable monitoring equipment, install the monitoring and investigate air pollution abatement technologies available. Phase 3: Implementation of the appropriate additional Air pollution abatement equipment/technologies where required. • Dust monitoring • Proposals have been obtained to install a dust monitoring system.
Problem Statement	
Annual stack monitoring at the Omnia Fertilizer Dryden facility has indicated that both the ammonia and particulate matter concentrations where well below the permitted levels. The problem however is that the monitoring only takes place annually and it is only focused on particulate matter and ammonia (as required by APPA Permit), thereby not measuring the emissions from the boiler or the reactors used for the production of liquid fertilizer.	
Intervention	
• As a first phase of the Air Quality Compliance project, Omnia Fertilizer has appointed SI Analytics to confirm what the actual existing emissions are at the factory. SI Analytics will provide the following services:	

A mobile monitoring unit to be used to monitor each stack / point source. Two units may be required to complete the job with the given time frame.
Each stack / point source will be monitored for the appropriate gas emissions (and where applicable dust) for such a period that the data will reflect emissions for each shift, day and night time shifts, as well as weekend shifts. The monitoring will be done to determine the Time Weighted Average emissions from the factory.
A report describing:
The methodology and equipment that were used,
The conditions during the monitoring events,
The findings, conclusions and recommendations on:
Based on all the above-mentioned information suggest future monitoring requirements.
Propose/suggest monitoring equipment and periods with proposed suppliers and prices.

Current Status:	SI Analytics has been appointed for the first phase of the project and the initiation meeting will take place on the 15th of September 2010.		
Expected Start:	October 2010	Expected Commissioning:	Initial results by December 2010 and final results after a year of monitoring, October 2011.
Current Emissions:	According to previous studies, Omnia Fertilizer's Dryden factory is currently compliant in terms of ammonia, however thorough monitoring needs to be conducted to determine more exact levels of ammonia, phosphorus, particulate matter, sulphur dioxide and nitrogen oxides. Current ammonia levels are measured at 9.29 mg/Nm^3 (newly required levels are 30 mg/Nm^3) and particulate matter at 31.9 mg/Nm^3 Nm^3 (newly required levels are 25 mg/Nm^3).	Expected Emission Reductions:	This can only be confirmed on confirmation of current emissions (phase 1 of the Air quality compliance project). It is anticipated that a 3-5% reduction per annum can be applied to the particulate matter levels, thereby complying with the new requirements within the given timeframe.
Estimated Fixed Cost:	Confirmation project: R 580 000 Dust monitoring: R 130 000	Estimated Running Cost:	Estimated R1 500 000

Significance
Once Omnia Fertilizer has determined the impact of its operations on the surrounding environment the correct monitoring technology/equipment can be installed, and production processes can be modified/adapt to, not only comply with the newly required standards, but to also eliminate or reduce the impact on the surroundings. By implementing these measures Omnia Fertilizer will assist is reducing the severe impact that industry, especially in the Highveld Priority area, has on the already suffering environment.

Measurement, Reporting and Verification
• Omnia Fertilizer initiated a project to proactively ensure that all Omnia Fertilizer factories comply with the new requirements within the required time frame. The proposed Air Quality Compliance project will be conducted in three phases, namely: Phase 1: Monitoring of the emissions at our existing plants to confirm our actual emissions. SI Analytics will supply Omnia with a report. Phase 2: Identify facilities where online monitoring is required, select suitable monitoring equipment, install the monitoring and investigate air pollution abatement technologies available. Phase 3: Implementation of the appropriate additional Air pollution abatement equipment/technologies where required. Omnia will liaise with the department after the completion of the Air Quality Compliance Project for approval of mitigation measures and reporting frequencies.

Company Name:	Xstrata South Africa (Pty) Ltd
Location:	Xstrata Coal SA is a mining company with operations in the Mpumalanga Province. Four operations are situated on various farms between the towns of Emalahleni, Kriel and Ogies and two operations are situated on various farms between the towns of Breyten and Ermelo. All the coal mining activities – which includes the extraction, processing, storage and handling of coal – is conducted within the mine boundaries as defined in terms of the Mine Health and Safety Act 29/1996.
AQA S 21 Sector:	Category 5: Mineral Processing, Storage and Handling
AQA S 21 Sub-sector:	NA – see attached legal opinion

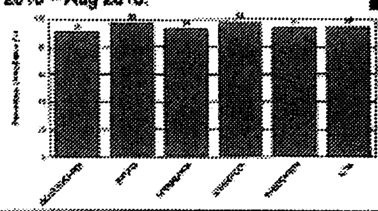
Intervention Title:	Ambient dust monitoring and management
Intervention Type:	This intervention is a combination between an investment in air pollution control technology and improved ambient dust monitoring and management system.

Problem Statement

The XCSA Coal mine activities have an impact in terms of air quality in the fact that ambient dust is created due to the extraction of opencast coal and transport and processing of the coal.

Intervention

Various mitigation measures are already implemented to minimize the ambient dust qualities of the areas within the mining boundaries.

Current Status:	Expansion of existing dust monitoring system by the addition of pm10 samplers at critical locations around the mining operations.		
Expected Start:	January 2011	Expected Commissioning:	June 2011
Current Emissions:	The current monitoring results are used to calculate the percentage compliance for all the XCSA export monitoring sites in terms of the SANS 1929 standard - levels for industrial area (600 – 1200 mg/m2/day). The table below indicates the XCSA compliance in terms of this target from Jan 2010 – Aug 2010. 	Expected Emission Reductions:	With the addition of the pm10 samplers it is expected that XCSA would be able to better quantify the air quality data – from which models can be updated to confirm the predictions that was made during the baseline air quality studies for our operations.
Estimated Fixed Cost:	An estimate amount of R100.000.00 to be spend on the installation of pm 10 samplers. (Dependant on the number of units that will be installed – R60.000 per unit)	Estimated Running Cost:	Not known at this stage

Significance

The significance of the intervention will be in respect of the local area where the mining operations are situated (40km radius)

Measurement, Reporting and Verification

The measurement, reporting and verification will form part of the existing XCSA monitoring system – samples are collected and analysed on a monthly basis – results are populated into a database which is linked with a Geographical Information System. Reports are available one month after sample run. An annual review is done on the XCSA monitoring system by an independent 3rd party.