Western Cape Government
Environmental Affairs and Development Planning

BETTER TOGETHER.

State of Environment Outlook Report for the Western Cape Province

Air Quality Chapter

2024

DOCUMENT DESCRIPTION

Document Title and Version:

Air Quality Chapter

Report Name:

State of Environment Outlook Report for the Western Cape Province 2024

Acknowledgements:

Western Cape Government Environmental Affairs & Development Planning:

Dr Joy Leaner, Sally Benson, Bhawoodien Parker, Etienne Roux, Shawn Le Roux, Claudia Frazenburg, Thapelo Letsholo, Mpendulo Dlamini, Gerard van Weele, Lize Jennings-Boom.

Date:

March 2024

TABLE OF CONTENTS

TABLE OF FIGURES

LIST OF TABLES

ABBREVIATIONS AND ACRONYMS

ACSA	Airports Company South Africa
AEL	Atmospheric Emission Licence
AQMP	Air Quality Management Plan
AQO	Air Quality Officer
As	Arsenic
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
C_2H_4	Ethylene
C_6H_6	Benzene
CCT	City of Cape Town
Cd	Cadmium
CFCs	Chlorohydrocarbons
CH_4	Methane
Cl	Chlorine
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
Cr	Chromium
DEA&DP	Department of Environmental Affairs and Development Planning
F	Fluoride
GDPR	Gross Domestic Product Per Region
GHG	Greenhouse Gas
GN	Government Notice
GWP	Global Warming Potential
H_2O	Water
H_2S	Hydrogen sulphide
H_2SO_4	Sulphuric Acid
N_2O	Nitrous Oxide
NH_3	Ammonia
Hg	Mercury
IEC	International Electrotechnical Commission
ISO	International Organisation for Standardisation
NAAQS	National Ambient Air Quality Standards
NAEIS	National Atmospheric Emissions Inventory System
NEM: AQA	National Environmental Management: Air Quality (Act 39 of 2004)
NEMA	National Environmental Management Act (107 of 1998)
NO	Nitric Oxide

NO_2	Nitrogen Dioxide
NO_x	Oxides of Nitrogen
O_3	Ozone
PAEL	Provisional Atmospheric Emissions Licence
PAH	Polycyclic Aromatic Hydrocarbons
Pb	Lead
PCB	Polychlorinated biphenyl
PERO	Provincial Economic Review and Outlook
PM_{10}	Particulate Matter with an aerodynamic diameter of less than 10 μm
$PM_{2.5}$	Particulate Matter with an aerodynamic diameter of less than 2.5 μm
PPB	Parts Per Billion
SAAQIS	South African Air Quality Information System
SANAS	South African National Accreditation System
SANBI	South African National Biodiversity Institute
SBIDZ	Saldanha Bay Industrial Development Zone
SO_2	Sulphur dioxide
SO_x	Oxides of sulphur
SoEOR	State of Environment Outlook Report
StatsSA CS	Statistics South Africa Community Survey
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compounds
WCG	Western Cape Government
WWTW	Wastewater Treatment Works
$\mu g/m^3$	Micrograms per cubic meter

GLOSSARY

Aerosols	Liquid or solid particles small enough to become airborne.
Ambient air quality	The quality of outdoor air in our surrounding environment that humans and the environment is exposed to.
Atmosphere	The thin layer of gases surrounding earth which sustain life on the planet, and which is composed mainly of nitrogen and oxygen. It consists of two main layers: the troposphere, which extends from sea level to about 17 km above sea level; and the stratosphere, which extends from 17 km above sea level to about 48 km above sea level.
Concentration	When an air pollutant is measured in ambient air it is referred to as the concentration of that pollutant in air. Ambient pollutant concentrations are measured for various reasons, e.g. to determine whether concentrations exceed health risk thresholds (air quality standards); to determine how different sources of pollution contribute to ambient air concentrations in an area; to validate dispersion modelling conducted for an area; to determine how pollutant concentrations fluctuate over time in an area; and to determine areas with the highest pollution concentrations.
Criteria Pollutant	The pollutants as prescribed by Section 9 (1) of the NEM: AQA are atmospheric particulate matter (PM_{10} and $PM_{2.5}$), oxides of nitrogen (NOx), sulphur dioxide (SO_2), ozone (O_3), carbon monoxide (CO) and lead (Pb). The pollutants have been identified as being a threat to health, well-being and the environment. The National Ambient Air Quality Standards (NAAQS) have been established to determine the permissible limit of each pollutant in the ambient air. Within South Africa these pollutants are emitted from sources such as mining, industry, power generation, agricultural activities, residential activities and transportation.
Emissions	The discharge of air pollution from a source of pollution.
GDPR	A subnational gross domestic product for measuring the size of a region's economy.
Greenhouse gas	Gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and re-emit infrared radiation, and includes carbon dioxide, methane and nitrous oxide.
Heavy Metals	Metallic elements with high atomic weights, such as, mercury (Hg), chromium (Cr), cadmium (Cd), arsenic (As), and lead (Pb), which, even at low levels, can harm living organisms. They do not break down or decompose and tend to accumulate in plants, animals, and people causing health concerns.
Particulate Matter (PM)	The collective name for fine solid or liquid particles added to the atmosphere by processes at the earth's surface, and includes atmospheric aerosol particles, dust, smoke, soot, pollen and soil particles. Particulate matter can be principally characterised as discrete particles spanning several orders of magnitude in size, with inhalable particles falling into the following general size fractions: • PM_{10} (generally defined as all particles equal to and less than 10

microns in aerodynamic diameter; particles larger than this are not generally deposited in the lung)

- $PM_{2.5}$, also known as fine fraction particles (generally defined as those particles with an aerodynamic diameter of 2.5 microns or less)
- PM<10->2.5, also known as coarse fraction particles (generally defined as those particles with an aerodynamic diameter greater than 2.5 microns, but equal to or less than a nominal 10 microns); and
- Ultra-fine particles generally defined as those with an aerodynamic diameter of less than 0.1 microns.

1 INTRODUCTION

Air pollution occurs when a substance which is harmful or poisonous to humans or the environment is introduced into the air. The World Health Organisation (WHO, 202316) defines air pollution as any substance, *i.e*., chemical, physical, or biological, that contaminates the natural properties of the air. This includes greenhouse gas (GHG) emissions that alter the thermal dynamics of the atmosphere.

Air pollutants are able to travel over great distances away from the source and settle in areas where people reside. Air pollutants can also remain in the environment for prolonged periods of time, influencing the surrounding environment, human health, and the overall quality of life. Therefore, it is important to continue efforts to reduce air pollution and greenhouse gas (GHG) emissions.

Air pollution concerns in South Africa date back to the early days of industrialisation, with coal mining and heavy industries contributing to ambient air pollution levels. The Western Cape has largely been spared from the heavy industrial pollution, but nevertheless faces challenges with smaller industries, transport emissions, indoor air pollution and wind transported dust and marine aerosols.

This chapter addresses air quality in the Western Cape, including the sources and impacts of air pollution, particularly as it relates to the current state of air quality and the management thereof, in the Western Cape. It is encouraged that this chapter be read together with the Energy and Waste Management chapters of the Western Cape State of Environment Outlook Report, due to the interconnectedness of these themes. It must be noted that this Chapter provides a broad overview of air pollution, the sources, and their possible impacts within the Western Cape. Due to budget constraints, ambient air quality monitoring is limited, and it is not an in-depth quantification of the air pollution in the Western Cape.

2 DRIVERS AND PRESSURES

Air quality is a pressing global concern shaped by a complex interplay of factors that span human activities and natural phenomena. As population growth accelerates and economies expand, the demand for energy, transportation, and industrial production intensifies, driving up emissions of pollutants that degrade air quality. Concurrently, environmental changes and the impacts of greenhouse gas emissions alter atmospheric dynamics, exacerbating air pollution challenges. This introduction explores how population growth, economic activities, environmental changes, and greenhouse gas emissions intertwine to shape the landscape of air quality, influencing both local communities and the global environment. Understanding these drivers is essential for formulating effective strategies to safeguard public health and mitigate environmental impacts in our increasingly interconnected world. Specific to the Western Cape, the following are drivers of air quality and air quality change:

- Population increase;
- Climate change with Western Cape impacts;
- Urbanisation associated drivers such as transport; and
- Some land use practices such as landfilling of waste.

From these drivers, pressures of land change in the Western Cape include:

- Changes in agricultural production;
- Investment and increased demand for commodities resulting in urban, agricultural, and infrastructural expansion, and more mining;
- Mining in specific regions – i.e. West Coast.

Anthropogenic air pollution is produced by amongst others, fossil fuel combustion from various sources such as power generation, waste and agricultural crop burning, transport vehicles, as well as residential and commercial activities. Air pollution arises not only from fossil fuel combustion but also from natural substances and chemical emissions originating from various sources. Natural sources include volcanic eruptions, which release sulfur dioxide, ash, and particulate matter into the atmosphere, contributing to localized and even global air quality issues depending on the scale of the eruption. Additionally, biogenic emissions from vegetation, such as volatile organic compounds (VOCs), play a role in the formation of ground-level ozone and secondary organic aerosols, which can affect air quality and human health.

Chemical emissions from anthropogenic sources include industrial processes, agriculture (e.g., ammonia emissions from livestock and fertilizer use), and transportation (e.g., nitrogen oxides from vehicle exhaust). These emissions contribute to the formation of particulate matter, ozone, and other pollutants that can have adverse effects on human health and the environment. Regulatory efforts and technological advancements aim to reduce emissions from these sources to improve air quality and mitigate associated health risks. Thus, understanding and addressing both natural and anthropogenic sources of air pollution are essential for effective air quality management and public health protection. Air pollutants are classified into primary and secondary air pollutants. The different sources of air pollution in the Western Cape are discussed below.

Primary air pollutants result from combustion processes that release gaseous and particulate emissions directly into the atmosphere. Examples of these pollutants are NO_2, CO, CO_2, SO_2 and PM. Secondary air pollutants are formed when gases react with each other in the atmosphere, in the presence of a natural catalyst. An example of a secondary pollutant is surface ozone (O_3); which is formed when volatile organic carbons (VOC's) and oxides of nitrogen (NOx) react in the presence of sunlight.

2.1 Emissions from Mobile Sources

Motorised vehicles are a significant contributor to air pollution due to their combustion engines that release NOx, CO, PM, VOCs, and hydrocarbons, as well as tyre and brake wear that releases particulates. Factors such as population growth, partial migration, the state of public transport infrastructure, and high tourist activity contribute to increased volumes of mobile sources, especially private vehicles. Increased traffic volumes often correspond to higher levels of vehicle emissions, although the development and introduction of low emission technology for motorised vehicles result in lower emissions.

Approximately two thirds of the Province's population reside in the Greater Cape Town region, resulting in high traffic volumes within the City of Cape Town (CCT) Metropolitan area. The high traffic volumes contribute to the development of brown haze or smog that has a detrimental impact on human health (DEA&DP, 2021). The 2023 INRIX Global Traffic Scorecard and TomTom Traffic Index indicate that Cape Town commuters spend between 83 to 127 hours in traffic, with 48 of those hours in congestion, ranking the city as the 2nd worst in Africa and the 9th worst in the world, in terms of traffic congestion (Dunbar, 2024). Aside from this costing CCT commuters an extra R882 annually in fuel costs (Dunbar, 2024), there are also impacts to air quality that needs to be considered. The city is investing R444 million over the next three years in road projects and public transport improvements to alleviate the congestion (Dunbar, 2024); this may reduce the air pollution from these sources. Currently, air quality monitoring is not taking place along the highways and major roads in the City of Cape Town. This is critically required to manage air pollution from these sources, so that data collected can inform human health risk assessment studies in respect of the impacts of air pollution on the citizens and the environment.

There are also three (3) major ports in the Western Cape, namely, Cape Town, Mossel Bay and Saldanha Bay. During 2020, the number of shipping vessels that entered the port of Cape Town was 1804, and the port of Mossel Bay was 312, while Saldanha Bay had 636 shipping vessels entering its port (DEA&DP, 2020). The emissions from these vessels contribute to the total emissions from mobile sources. Sources of air emissions from the marine sector include tugs and tows, dredges, and other vessels operating inside ports powered by diesel engines (Browning, 2006). As a result, it is critical to monitor and regulate emissions from ships when they enter ports.

Additionally, airports (*i.e.*, aircraft) also contributes to atmospheric emissions. Based on information provided by Airports Company South Africa (ACSA), there are 90 airports located within the Western Cape, ranging from small landing strips to major airports (DEA&DP, 2020). Emissions from aircraft engines, *i.e.*, CO, CO_2, NOx, SO_2, particulates, trace compounds and partly combusted hydrocarbons or VOCs, a form of fossil fuel combustion. Unlike emissions from other types of mobile sources, a large fraction of aircraft emissions are emitted at higher altitudes. This can have an impact on local ground-level air quality, as well as contribute to global environmental impacts (ICAO, 2019).

The Energy Consumption and Carbon Dioxide equivalent (CO_2e) Emissions Database for the Western Cape indicates that the transport sector is the second highest contributor of GHG emissions in the Province (DEA&DP, 2022).

2.2 Emissions from Industry

The combustion of fuels in the industrial and energy sectors, such as gas, paraffin, coal, heavy fuel oil and diesel emit air pollutants and heavy metals into the environment, primarily in areas where industrial activities take place although the emissions can travel over long distances.

The Provincial Economic Review and Outlook (PERO) Report (2023), indicates that manufacturing contributed approximately 13.8% towards the Gross Domestic Product (GDPR) in the Western Cape in 2022 (PT, 2023). Although manufacturing activities have decreased from 74.2% (1995-1998) to 69.7% (2019 – 2022) (Wesgro, 2024), the manufacturing sector is potentially a significant contributor to air pollution in the Province. The Western Cape has a mixed industrial energy use profile, with a mix of electricity, coal and diesel is used to sustain growth in manufacturing output. The increased use of diesel in South Africa by manufacturing industries has been driven by the need to compensate for unstable electricity production and distribution (i.e. Eskom's implementation of loadshedding). The West Coast District has the highest coal use in its industrial processes in the Province.

The country's leading gas production and storage facility (known as Voorbaai) is stationed at the Port of Mossel Bay near PetroSA's Mossgas gas-to-liquid refinery, operating as a service hub for the regional gas industry (DEA&DP, 2020). In the Western Cape, Saldanha Bay has been designated as the main oil rig repair hub; and hosts a large oil-storage facility. These facilities are significant sources of VOCs and hence regulated through imposing stringent conditions in their operational Atmospheric Emission Licences (AELs).

The Saldanha Bay Industrial Development Zone (SBIDZ) was promulgated by the Minister of Trade and Industry in October 2013 (SBIDZ, 2017). Today, known as Freeport Saldanha, it is situated on the outskirts of Saldanha Bay on a 330-hectare (ha) site. Freeport Saldanha is a joint project between national, provincial, and local government, which aims to attract key investors and companies operating in the upstream (offshore) oil and gas sector of the African east and west coasts (Wesgro, 2019). The zone aims to deliver engineering services, marine repair, and supply services to these enterprises. Consequently, it is likely that the envisaged concentration of industries in Freeport may increase ambient air pollution levels in the area.

2.3 Domestic Fuel Burning

The Western Cape has a mixed household energy profile, which means that residents use a combination of different energy sources (electricity and solid / liquid fuels) to meet their daily domestic energy needs. This is particularly influenced by factors such as availability and affordability of cleaner sources of energy (e.g. electricity), as well as cultural and personal preferences. In addition, load-shedding has likely contributed to the burning of solid fuels or "dirty fuels" to meet domestic energy needs (Adeeyo *et al.*, 2022).

The Census 2022 reports that in the Western Cape that electricity from mains used as energy for lighting was 96.5% and electricity from mains used as energy for cooking was 63.9% (StatsSA, 2023). However, the burning of solid fuels (wood, paraffin and coal) for cooking and space heating during the winter months is widespread in both rural and urban regions, although predominantly in low-income and informal residential areas. A study by Madonsela et al. (2022) found that in low-income areas such as Khayelitsha, indoor concentrations of particulates show significant seasonal variation. Summer levels range from 0 to 28 μg/m^3, while winter levels double. This implies that residents of low-income households are exposed to twice the indoor pollution in winter, increasing their risk of contracting cardiovascular and pulmonary diseases. Unlike ambient air pollution sources, indoor environments allow for little to no dispersion of pollutants, leading to increased direct exposure to unfiltered and polluted air masses (Singh *et al.,* 2012). Prolonged exposure to indoor air pollution has severe health implications.

2.4 Biomass Burning

Veld fires can be classified as either controlled or unmanaged (wild) fires. Veld fires are a significant source of PM, CO and VOCs. Nitrogen oxides (NOx) are also released during veld fires; however, their rate of emission varies depending on the temperature at which they burn. Veld fires therefore degrade air quality through smoke containing particulate matter (PM), toxic gases like carbon monoxide and nitrogen oxides, and volatile organic compounds (VOCs). These pollutants can cause respiratory problems, exacerbate existing conditions, and contribute to ozone formation and reduced visibility. Smoke can travel long distances, affecting air quality regionally. Alien plant infestations and longer, hotter, drier periods, exacerbated by climate change, worsen veld fire conditions by increasing fuel loads and creating more favourable conditions for fires to ignite and spread – essentially it compounds to air quality degradation risks.

Kleinmond fire which occurred in January 2022. (Source: Daily Maverick)

The peak fire season in the Western Cape typically starts in early November and can last for up to 23 weeks (World Resources Institute, 2021). Over the past 5 years, major natural fires have occurred in the Garden Route District, City of Cape Town, Overberg District, and the Cape Winelands areas.

Figure 1 Wildfires and prescribed burns April 2020 to May 2021 in the Western Cape shows all reported fires from CapeNature Reserves, Mountain Catchment Areas, and any nearby fires in natural veld to which Cape Nature fire-fighters reacted, regardless of size (Cape Nature, 2022). Fires can contribute to significant local short-term air pollution, requiring that it be managed in order to reduce potential long-term impacts on human health.

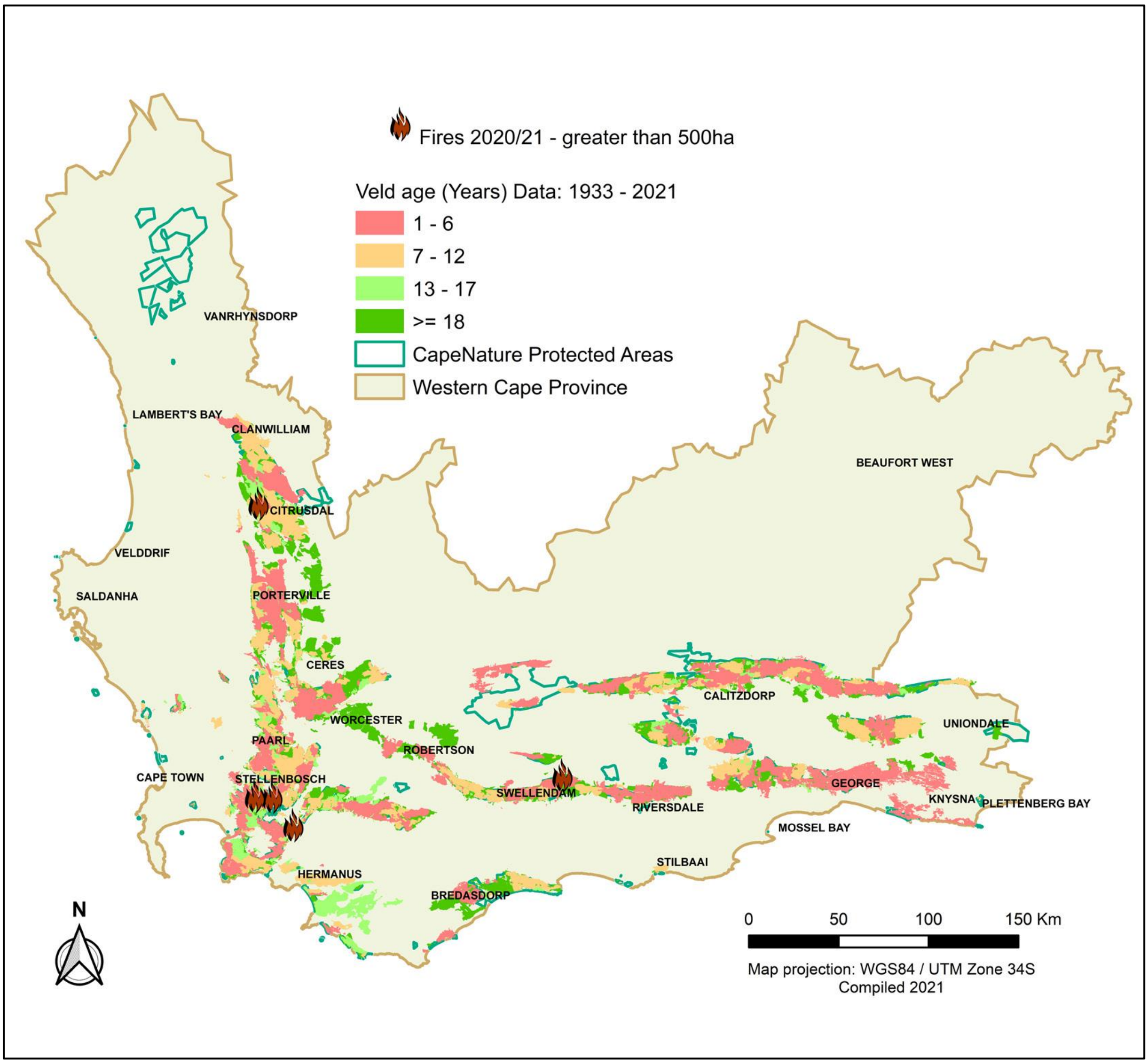

Figure 1 Wildfires and prescribed burns April 2020 to May 2021 in the Western Cape (Source: CapeNature, 2022)

2.5 Other fires

The soot or dense black smoke produced by the burning of combustible organic materials, such as tyres and plastics contain impure carbon particles and potential carcinogens, or compounds that cause cancer, such as polycyclic aromatic hydrocarbons (PAHs), benzene (C_6H_6), dioxins, polychlorinated biphenyls (PCB), and volatised heavy metals.

2.6 Agriculture, Forestry and Fisheries

The agriculture and agri-processing sectors are essential to the Western Cape economy. This sector contributed 4,37% to the province's Gross Value Added (GVA) over the past 5 years leading up to 2021, while 19% of South Africa's agriculture, forestry, and fishing GVA came from the Western Cape (Wesgro, 2022). The largest agricultural producers are located in the CWDM, WCDM, and ODM.

Agricultural activities that cause air pollution include crop spraying, burning of agricultural waste, dust, animal husbandry and emissions from farm vehicles such as tractors. Spray drift occurs when pesticides are sprayed on crops, which has the potential to disperse organo-chemicals in the surrounding vicinity and downwind of the area where sprayed (DEA&DP, 2020). Pesticide exposure is hazardous to both human health and the environment as improper use of pesticides can contaminate the air, soil, and non-targeted vegetation. Farmers often burn agricultural waste along with household waste and tyres to prevent frost damage on farms; this can lead to smoke and emissions, which may add to atmospheric particulate loading (DEA&DP, 2020).

Emissions associated with animal husbandry (pigs, sheep, goats and chickens) include ammonia (NH_3) and hydrogen sulphide (H_2S), from manure and animal waste production, known as enteric fermentation (USEPA, 1996). Livestock produce significant quantities of methane (CH_4) through enteric fermentation, mostly through burping and excretion of ruminant.

In South Africa, the vast majority of fishing activities take place in the coastal waters of the Western Cape as there are an abundance of marine resources both inshore and offshore. Hence, nearly 90% of the people directly employed in South Africa's commercial fishing industry reside in the Western Cape. There are 12 fishing harbours in the Western Cape, namely, Stilbaai, Lambertsbaai, St. Helena Bay, Saldanha Bay, Gansbaai, Arniston, Kleinmond, Hermanus, Struisbaai, Gordons Bay, Kalk Bay, and Hout Bay (DEA&DP, 2018b). Fishmeal processing plants are often located near these harbours and serve as significant causes of odour complaints. The Western Cape has a total of seven (6) fishmeal processing plants with four (4) located in St Helena Bay (WCDM), one (1) in Gansbaai (ODM), and one (1) in Mossel Bay (GRDM). Odours emitted by fish processing facilities may impact air quality, and measures to manage and reduce such odours are being implemented in the Province.

2.7 Wastewater Treatment Works

Wastewater treatment works (WWTW) emits odours and aerosols, amongst other forms of air pollution. Aeration and denitrification at the WWTW are mechanical processes that release airborne pathogens, whereas wastewater collection, treatment, and storage systems produce VOCs mostly through the volatilisation of organic compounds at the liquid surface.

The most noticeable form of air pollution from the WWTW is odour, which can vary according to the weather. The original chemical makeup of the sewage, biochemical changes that occur during treatment, and chemical additions made to the sewage during treatment, all contribute to the offensive smell of wastewater. Odour from WWTWs in the Western Cape has been actively managed and complaints addressed as a matter of urgency, where needed.

The capacity and operational conditions of WWTWs have a significant role in determining the severity or degree of air pollution. Overload, operational issues, loadshedding and maintenance backlogs can result in the discharge of substandard effluent back into the environment, lengthening exposure times and releasing more pollutants into the air.

2.8 Aerosols from Marine Sources

Aerosols from marine sources can contribute to air quality concerns in several ways. Aerosols from marine sources include sea salt, organic matter, and pollutants from ship emissions. These aerosols can contain fine particulate matter ($PM_{2.5}$), with associated human and environmental health risks. Marine aerosols can also contain sulfates, nitrates, metals, and other pollutants, depending on the sources and atmospheric conditions. These chemicals can react in the atmosphere and contribute to the formation of secondary pollutants such as ozone and secondary organic aerosols, which can further degrade air quality.

Marine aerosols can act as cloud condensation nuclei (CCN), influencing cloud formation and properties. Changes in cloud characteristics can affect regional and global climate patterns, impacting air quality and human health indirectly. Overall, understanding and monitoring the sources and impacts of marine aerosols are crucial for managing and mitigating their effects on air quality and public health.

2.9 Mining and Quarrying

Although mining is not a significant economic sector in the Western Cape, contributing only 0.1% to the Western Cape's economy in 2022 (PT, 2023), it can have implications for air quality management in the Province. Mining affects air quality primarily through dust and particulate matter from activities like blasting and machinery use, emissions from diesel engines, release of volatile organic compounds during processing, and the potential for hazardous pollutants like heavy metals. These factors contribute to local and regional air pollution, impacting both human health and the environment. Mining in the Western Cape includes limestone, dolomite, sand, salt, diamond mining (marine diamond mining is located near Vanrhynsdorp and Vredendal in the WCDM) and quarrying amongst others. Sand mining operations have increased throughout the Western Cape (DEA&DP, 2018b), which has increased air quality concerns as these often occur at a very localised scale with limited regulatory intervention.

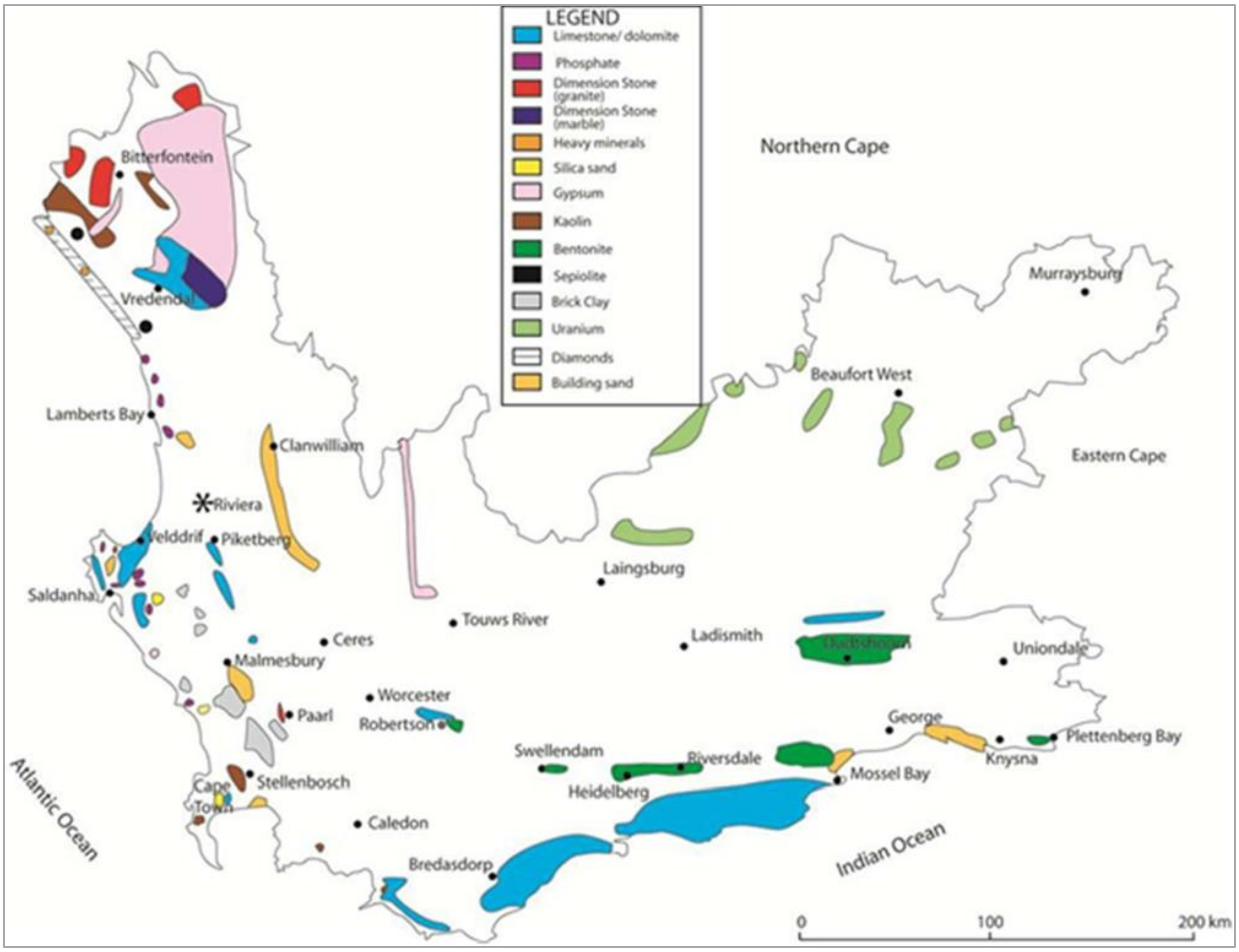

Figure 2 Mineral Resources of the Western Cape (Source: Council for Geoscience, 2013)

Shale gas production, uranium-molybdenum mining, and the development of renewable energy sources have all been proposed as possible economic development drivers for the CKDM in the future (DEA&DP, 2020). These are potential emerging sources of air pollution in the Province that will require management in the future, as per the Western Cape AQMP (DEA&DP, 2021).

2.10 Waste Disposal and Treatment Facilities

Landfill sites predominantly emit odour, and gaseous and fugitive dust. Odours are typically caused by landfill gas, created by the anaerobic process of methanogenesis that occurs as waste decays.

The informal and incomplete combustion of waste materials including household waste, plastics, and tyres at landfills can have serious negative health effects and produce pollutants like particulate matter, volatile organic compounds, and potential cancer-causing substances.

Emissions from incineration are typically determined by the composition of the waste, the efficiency of the combustion conditions and the efficacy of installed abatement technology. Incinerator emissions may include CO_2, CO, NOx, SO_2 PM, NH_3, amines, VOCs, PCBs, PAHs, metals and dioxins, and furans. However, these are strictly controlled at such facilities in the Western Cape.

Further information about (solid) waste treatment facilities in the province is included in the Chapter on Waste Management in the Province – including information on the GHG emissions from the waste sector of the Western Cape.

3 STATE OF AIR QUALITY MANAGEMENT IN THE WESTERN CAPE

3.1 Air Quality Monitoring Systems

In the Western Cape, the Department of Environmental Affairs and Development Planning (DEA&DP) implements and provides an oversight role with regards to air quality management in the Province.

Provinces and Municipalities are mandated to monitor ambient air quality in terms of Section 8 of the NEM: AQA. The DEA&DP's Directorate: Air Quality Management (D: AQM), the CCT, the WCDM and the Saldanha Bay Municipality (SBM) have installed air quality monitoring equipment within their jurisdictions. This forms part of the Western Cape Ambient Air Quality Monitoring Network ("the Network"), which assists in managing air quality across the Province.

The ambient air quality monitoring stations of the DEA&DP, CCT, SBM and WCDM are operated in accordance with the US EPA ambient air quality monitoring methods (Quality Assurance Handbook for Air Pollution Measurement Systems, Vol II), ISO/IEC17025:2005 standards and SANAS TR-07-03 requirements. Air quality monitoring data measured at the stations are recorded on data loggers, after which it is transferred *via* a modem to a server for storage and further processing. The data is quality controlled, and quality assured prior to producing daily and monthly reports. All data in the Network is reported to the South African Air Quality Information System (SAAQIS) on a monthly or quarterly basis (https://saaqis.environment.gov.za).

The DEA&DP commissioned its first ambient air quality monitoring station in 2008, as part of the Network. To date, 18 locations have been monitored at various times, with 10 currently in operation and reporting on various air quality parameters (Table 1 and Figure 3). The decommissioning of stations (e.g. Hout Bay and Oudtshoorn decommissioned in March 2023) is primarily due to current economic conditions and limited budget availability, which hamper air quality monitoring.

The set of air quality parameters measured at each monitoring station was primarily determined by the historical air quality conditions at the location. Each set of parameters measured may include complimentary sets of parameters, i.e., SO_2, O_3 and NO_2 (vehicle emissions and combustion), PM_{10} and CO (combustion), and H_2S and CO_2 (odour and combustion), which often provides an indication of the possible causes of air pollution in an area.

Meteorological parameters (wind speed and direction, ambient temperature, pressure, relative humidity) are also measured at these stations to provide context and understanding of the potential areas of impact from the measured air pollutants (AQMP, 2021). This report shows the ambient monitoring concentrations for PM_{10}, NO_2 and SO_2, as measured at the DEA&DP, Saldanha Bay (SBM) and City of Cape Town (CCT) owned monitoring stations.

Table 1 List of parameters monitored at the DEA&DP Air Quality Monitoring Stations

LOCATION OF STATIONS	AIR QUALITY PARAMETERS MEASURED
WORCESTER	SO_2, O_3, NO_2, CO, PM_{10}, meteorological parameters
PAARL	SO_2, O_3, NO_2, CO, meteorological parameters
STELLENBOSCH	SO_2, O_3, NO_2, CO, CO_2, PM_{10} & $PM_{2.5}$, meteorological parameters
SALDANHA BAY	H_2S, CO_2, meteorological parameters
MALMESBURY	SO_2, O_3, NO_2, CO, PM_{10}, meteorological parameters
HOUT BAY (Decommissioned March 2023)	H_2S and meteorological parameters
KHAYELITSHA	SO_2, O_3, NO_2, CO, CO_2, PM_{10}, & $PM_{2.5}$, meteorological parameters
OUDTSHOORN (Decommissioned March 2023)	H_2S, CO_2, meteorological parameters
GEORGE	SO_2, O_3, NO_2, CO, PM_{10}, meteorological parameters
MOSSEL BAY	H_2S, VOC's (BTEX), meteorological parameters
HERMANUS	SO_2, O_3, NO_2, CO, CO_2, PM_{10} & $PM_{2,5}$, meteorological parameters
MAITLAND	SO_2, NO_2, CO, PM_{10}, meteorological parameters

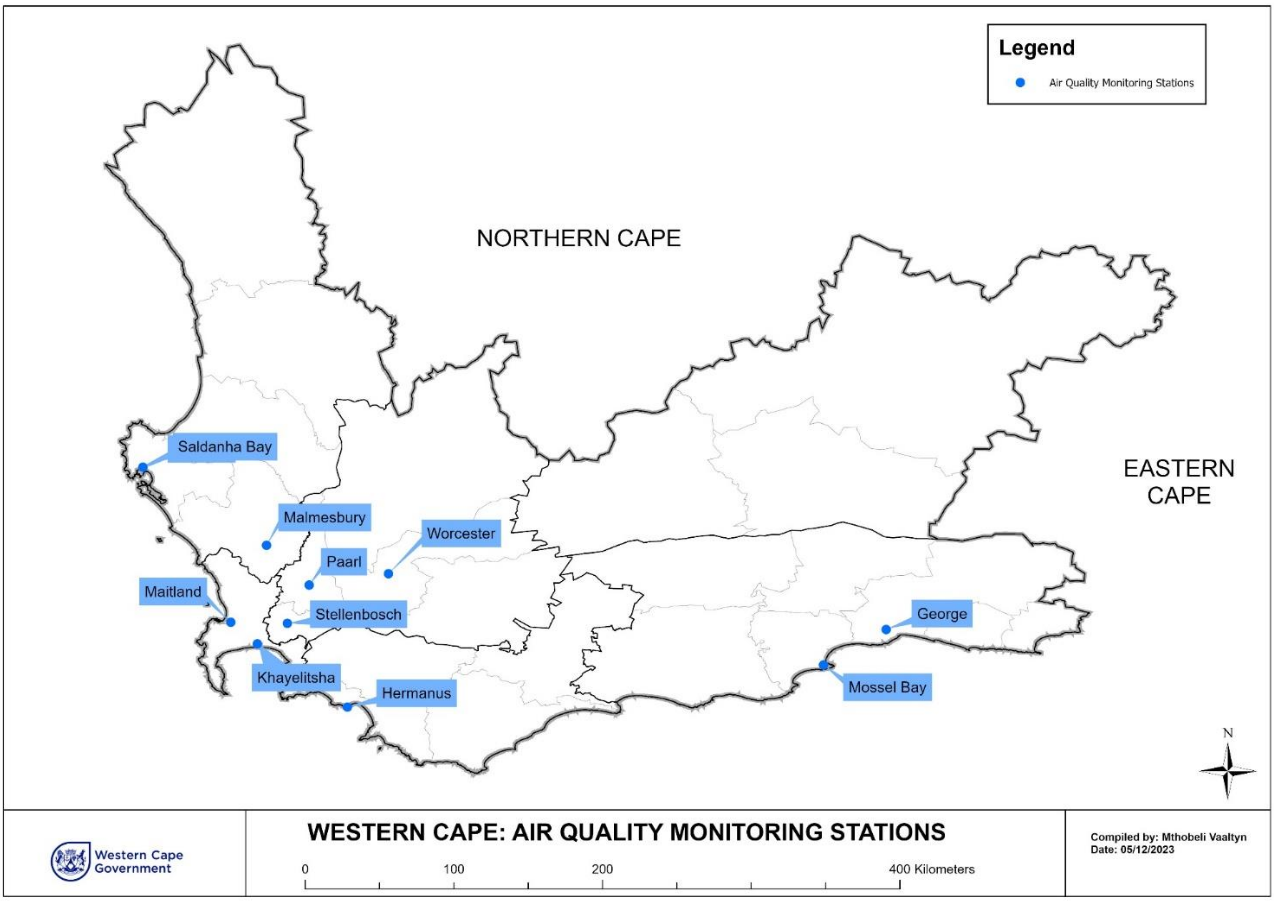

Figure 3 Location of the Ambient Air Quality Monitoring Stations operated by DEA&DP

3.2 Air Quality Measurements

3.2.1 Particulate Matter

Particulate matter (PM) is the collective name given to airborne particles that include dust, smoke, soot, pollen, and soil particles. Particulate matter can either be emitted naturally (e.g. windblown dust, ocean/sea spray) or generated through human activity (e.g. stack emissions, open cast mining, vehicle emissions). Particulate matter is categorised by particle size, *viz.* inhalable particles of 10 micrometre and smaller are referred to as PM_{10}; while fine inhalable particles of 2.5 micrometre or less are referred to as $PM_{2.5}$ (USEPA, epa.gov/pm-pollution/particulate-matter-pm-basics) (AQMP, 2021).

Particulate matter can adversely affect human health, respiratory illnesses (i.e., asthma and bronchitis) and cardiovascular diseases. It can also affect vegetation by inhibiting plants' growth by coating the leaves, thereby blocking the penetration of natural light for photosynthesis. Also, deposition onto soils of various metals in particulate matter can be absorbed by vegetation, stunting plant growth. Uptake of metals by plants can also impact vegetables and fruit. The National Ambient Air Quality Standards (NAAQS) for Particulate Matter (PM_{10} and $PM_{2.5}$) are presented in Table 2 National Ambient Air Quality Standards for Particulate Matter.

Table 2 National Ambient Air Quality Standards for Particulate Matter

Pollutant	Standard	24-hour	Annual Average
Units		µg/m³	µg/m³
PM_{10}	South African Standard (Effective from 1 January 2015)[1]	75	40
PM_{10} Frequency of exceedances allowed		4	0
$PM_{2.5}$	South African Standard (Effective from 1 January 2016 to 31 December 2029)[2]	40	20
$PM_{2.5}$	South African Standard (Effective from 1 January 2030)[2]	25	15
$PM_{2.5}$ Frequency of exceedances allowed		0	0
1) As listed in the NEM: AQA. Government Gazette No. 32816. 24 December 2009 2) As listed in the NEM: AQA. Government Gazette No. 35463. 29 June 2012			

Annual average PM_{10} concentrations monitored at selected DEA&DP monitoring stations, for the period from 2010 to 2022 are presented in Figure 4. All monitoring stations indicate that the PM_{10} concentrations are below the 40 µg/m³ annual average standard (threshold). However, over the years there has been an increasing PM_{10} trend observed at some locations, particularly at George and Worcester. Sources that emit PM_{10} to the environment needs to be regulated to ensure that concentrations do not exceed the NAAQS in the Province. Monitoring at these locations must be prioritised in order to facilitate early detection and management interventions where PM_{10} levels increase rapidly or approach and/or exceed guideline concentrations.

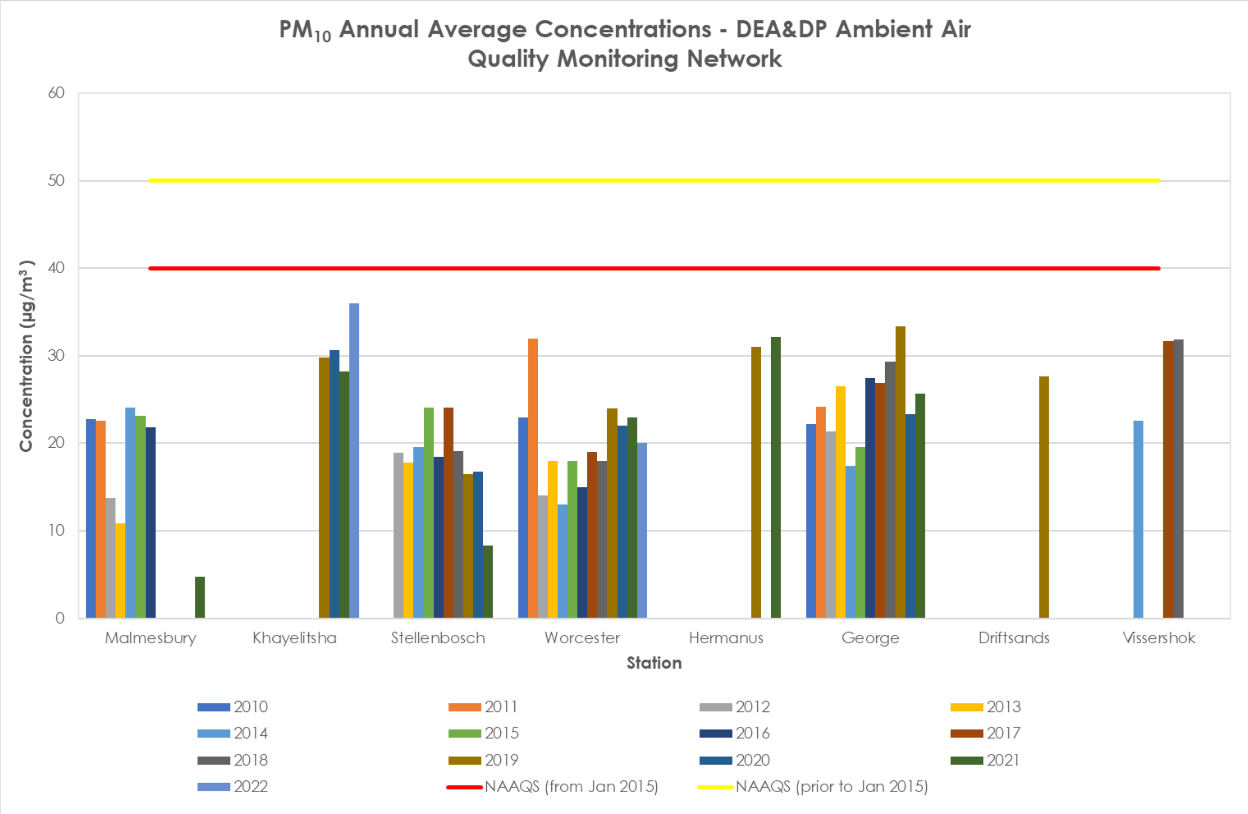

Figure 4 Annual average Particulate Matter (PM_{10}) concentrations (µg/m³) for 2010-2022

Figure 5 represents the annual average PM_{10} concentrations monitored at the CCT monitoring stations from 2010 to 2022. The annual PM_{10} NAAQS of 40 µg/m³ was exceeded at the Khayelitsha and Wallacedene monitoring stations. The elevated PM_{10} levels monitored at these stations are likely attributed to local influences such as windblown dust and wood burning for cooking and space heating. This indicates that PM monitoring is critical and needs to be prioritised in the province's low-income areas.

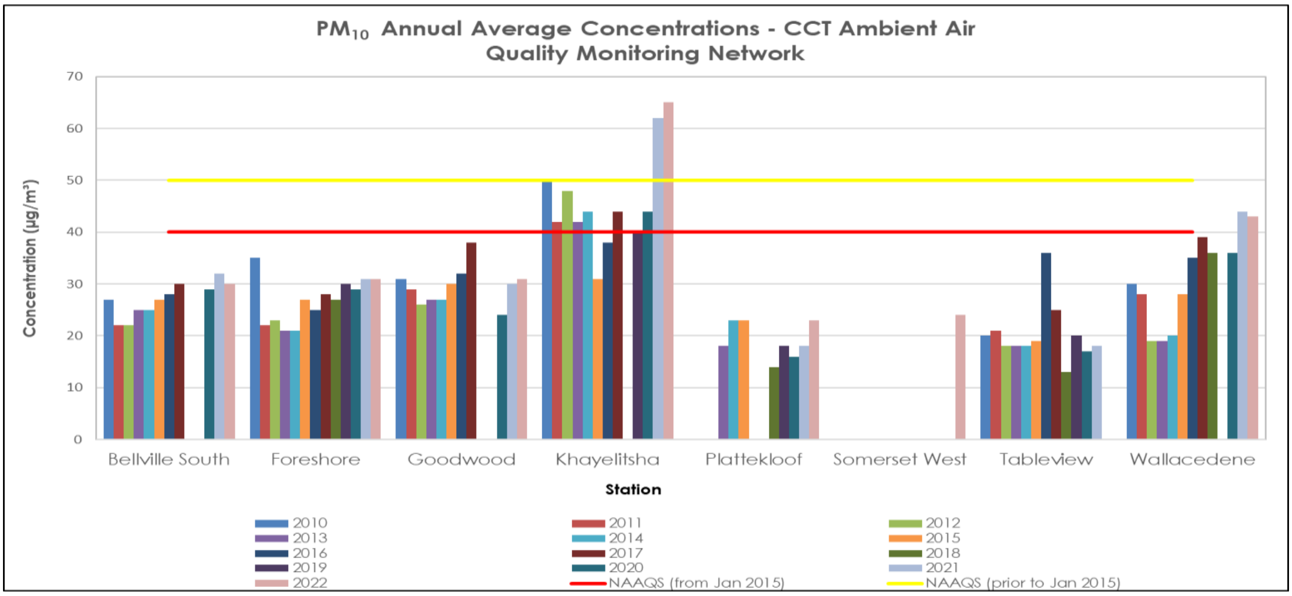

Figure 5 Annual average Particulate Matter (PM_{10}) concentrations (µg/m³) for 2010-2022

Figure 6 represents the PM_{10} concentration trends as measured at the SBM monitoring station for the period 2015 to 2018. Due to budget constraints, the PM_{10} monitoring equipment was decommissioned in 2018.

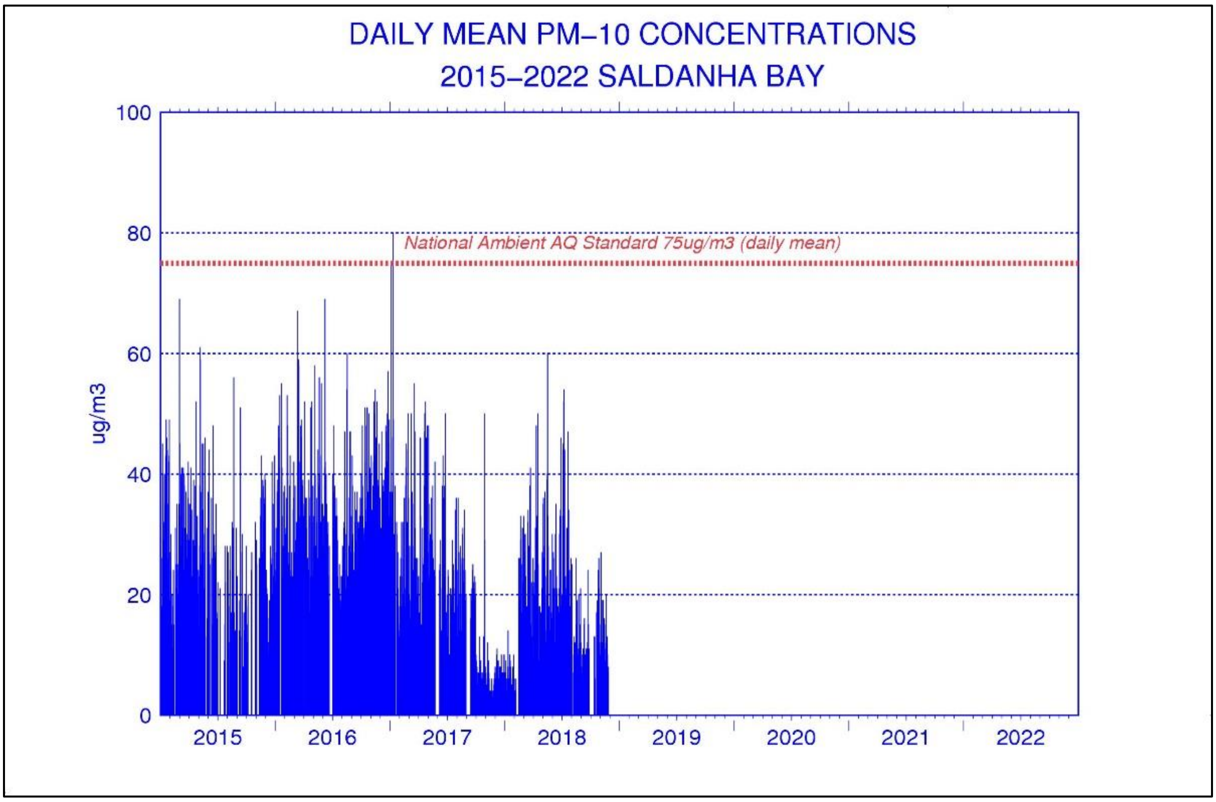

Figure 6 Annual average Particulate Matter (PM_{10}) concentrations (µg/m³) for 2015-2022 (Source: Saldanha Bay Municipality AQM Network).

Given the observations with respect to increasing trends and exceedances in particulate matter, it is critical that monitoring in this regard be prioritised in the province.

3.2.2 Oxides of Nitrogen

Nitrogen dioxide (NO_2) is a reddish-brown gas that has a detectable odour and is a highly corrosive and oxidising agent. The sources of NO_2 include fuel combustion in motor vehicles and can also be found in industrial and chemical manufacturing processes. Small quantities can be produced naturally by plants, soil and water, but human activities such as the combustion of fossil fuels and biomass are the major source of NO_2 in the air.

Since NO_2 is relatively insoluble, it can penetrate deep into the lungs and cause tissue damage. Effects of NO_2 exposure include alveolar tissue disruption and obstruction of the respiratory bronchioles. Long-term effects of exposure include increased susceptibility to lung infections. The relevant NAAQS for ambient NO_2 levels are presented in Table 3 National Ambient Air Quality Standards for NO2

Table 3 National Ambient Air Quality Standards for NO_2

Pollutant	Standard	1-hour	Annual Average
Units		µg/m³	µg/m³
NO_2	South African Standard[3]	200 (106 ppb)	40 (21 ppb)
Frequency of exceedances allowed		88	0
3) As listed in the NEM:AQA. Government Gazette No. 32816. 24 December 2009			

The annual NO_2 concentrations at the DEA&DP monitoring stations, for the period 2010 to 2022 are represented in Figure 7. Although the annual NO_2 averages were below the annual NO_2 NAAQS of 40 µg/m³, a slight increase in in pollutant concentrations over time, are observed.

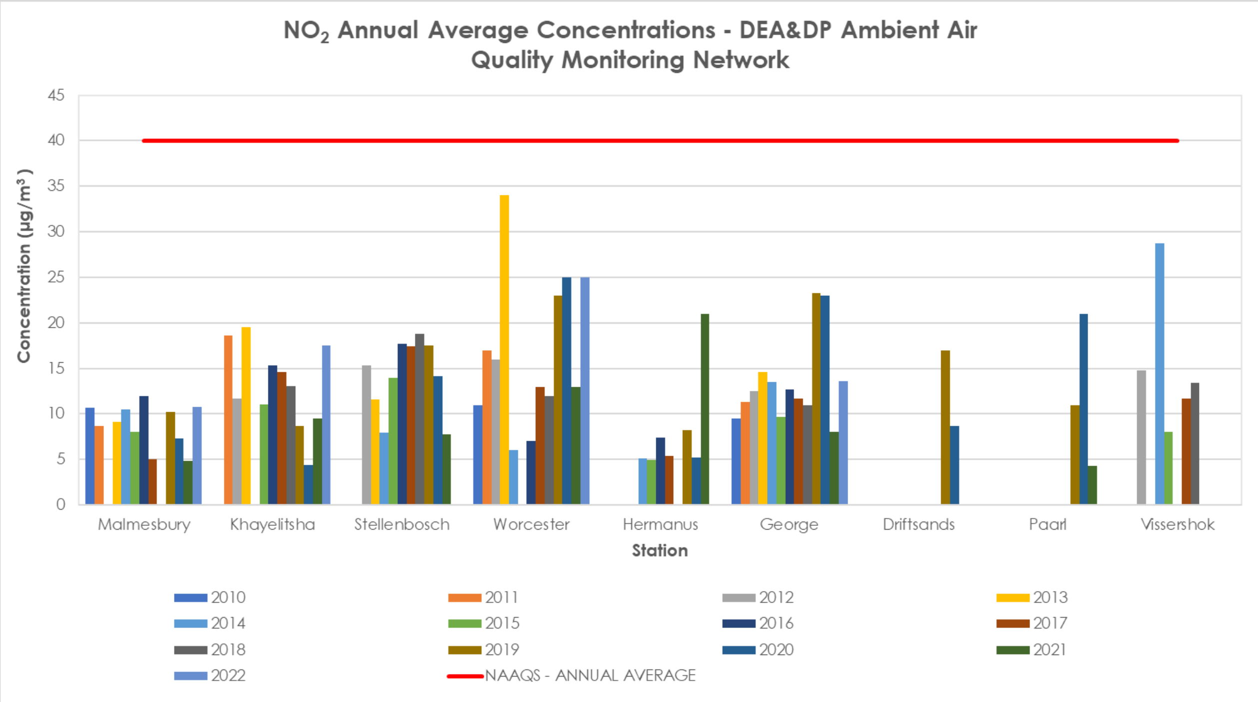

Figure 7 Annual average Nitrogen dioxide (NO_2) concentrations (µg/m³) for 2010-2022

The annual average NO_2 concentrations at the CCT monitoring stations, for the period 2010 to 2022 are represented in Figure 8. The NO_2 concentrations remained below the annual average threshold of 40 µg/m³. However, the pollutant levels show increasing trends over time.

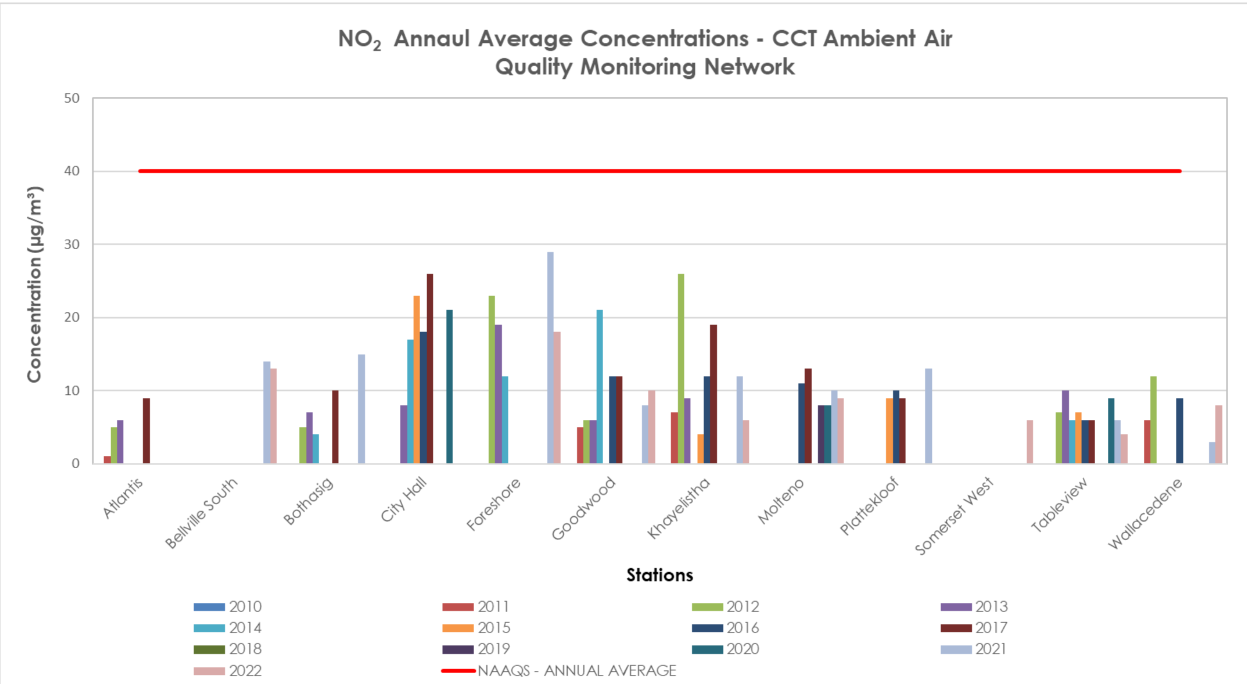

Figure 8 Annual average Nitrogen dioxide (NO_2) concentrations (µg/m³) for 2010-2022 (Source: City of Cape Town AQM Network)

Figure 9 shows the daily maximum mean NO_2 levels as measured at the SBM monitoring station. The graph shows that NO2 concentrations measured are below the are below the NAAQS.

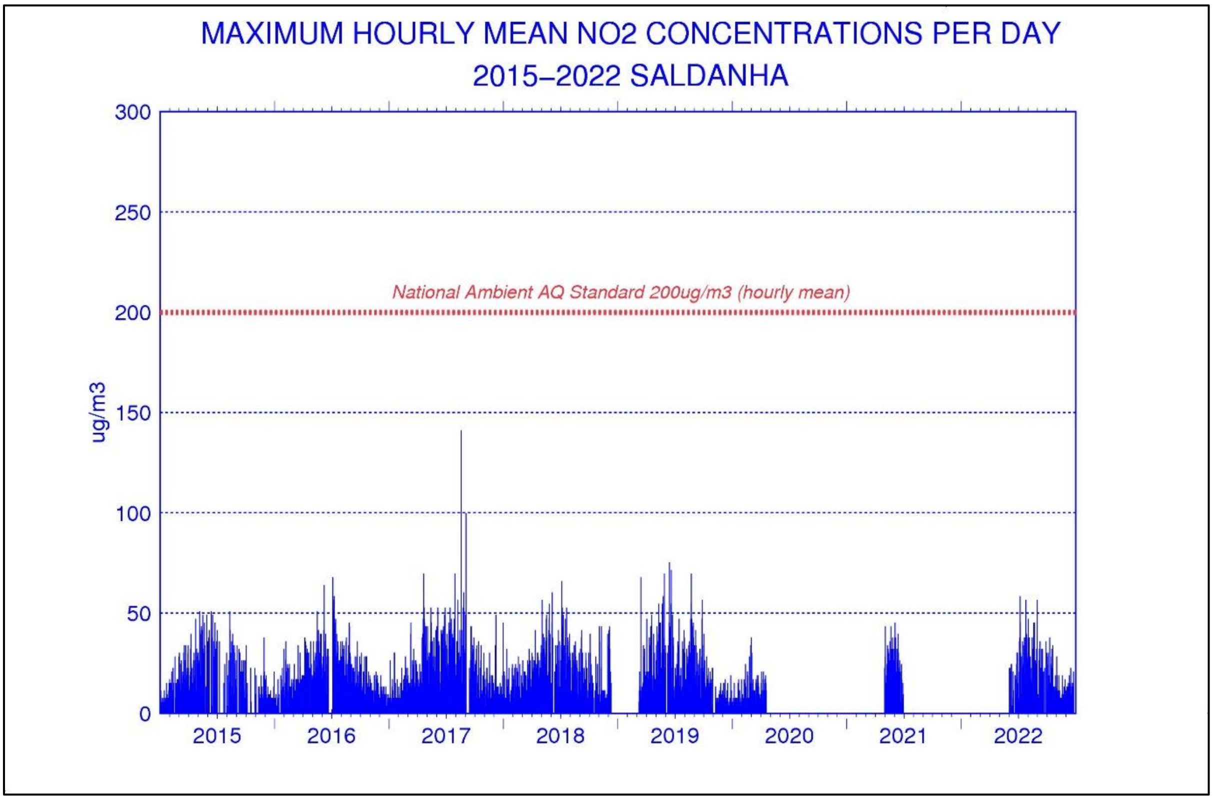

Figure 9 Annual average Nitrogen dioxide (NO_2) concentrations (µg/m³) for 2010-2022 (Source: Saldanha Bay Municipality AQM Network).

Overall, the increasing trends in NO_2 observed indicates that monitoring of this pollutant must be prioritised in the province.

3.2.3 Sulphur Dioxide

Sulphur Dioxide (SO_2) is a colourless gas with a strong odour. It is also a primary pollutant, which reacts easily with other substances to form secondary pollutants such as sulfuric acid (H_2SO_4). Fossil fuels used by power plants and industrial facilities are the primary emitters of SO_2 into the atmosphere. Smelting and heavy equipment that burns fuel with a high sulphur content also contribute to emission levels (USEPA, 2017).

Sulphur Dioxide is damaging to human respiratory function when inhaled, causing coughing and shortness of breath. Long term exposure or exposure to a large dose can result in chronic respiratory disease and the risk of acute respiratory illness. Sulphur dioxide can impact the receiving environment, including the acidification of waterbodies, stunting plant growth, a reduction in plant yields and the corrosion of natural and manmade structures. The NAAQS for ambient SO_2 levels are presented in Table 4 National Ambient Air Quality Standards for SO2

.

Table 4 National Ambient Air Quality Standards for SO_2

Pollutant	Standard	10 minutes	1-hour	24-hour	Annual Average
Units		µg/m³	µg/m³	µg/m³	µg/m³
SO_2	South African Standard[4]	500 (191 ppb)	350 (134 ppb)	125 (48 ppb)	50 (19 ppb)
Frequency of exceedances allowed		526	88	4	0
3) As listed in the NEM:AQA. Government Gazette No. 35463. 29 June 2012					

The annual SO_2 concentrations at the DEA&DP monitoring stations, for the period 2010 to 2022 are represented in Figure 10. All stations recorded annual average SO_2 concentrations below the annual SO_2 NAAQS of 50 µg/m³ however, it is noted that the pollutant levels have increased over time.

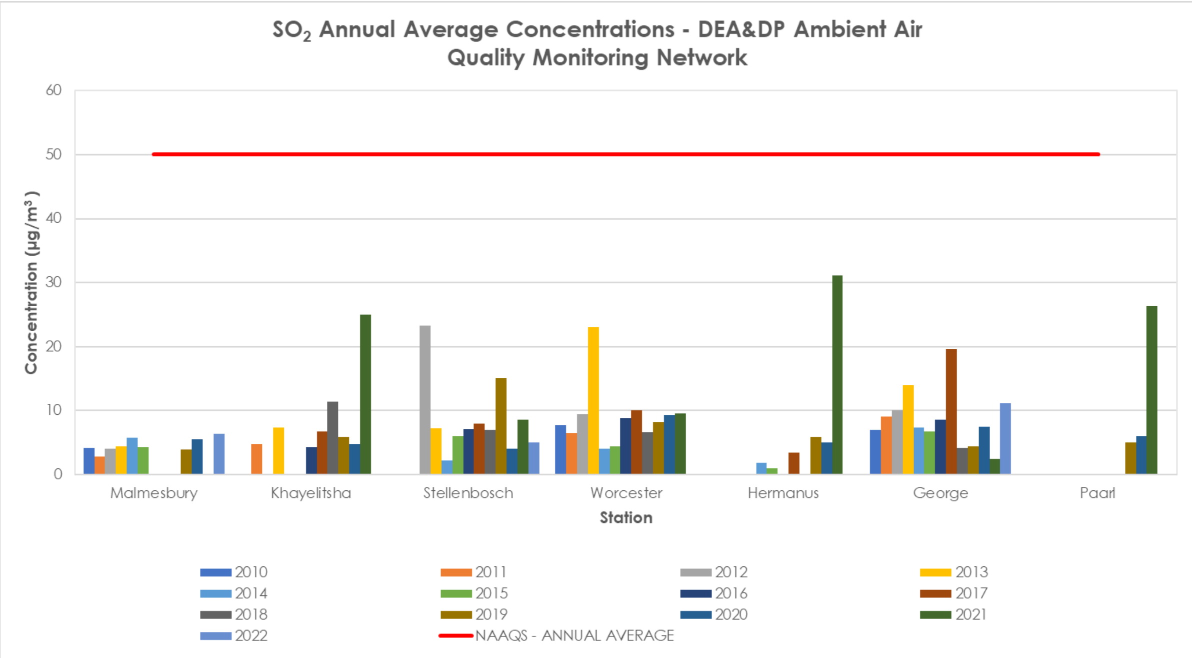

Figure 10 Annual average Sulphur Dioxide (SO_2) concentrations (µg/m³) for 2010-2022

The annual SO_2 concentrations at the CCT monitoring stations, for the period from 2010 to 2022 are represented in Figure 11. Similarly, SO_2 concentrations are below the respective annual NAAQS of 50 µg/m³.

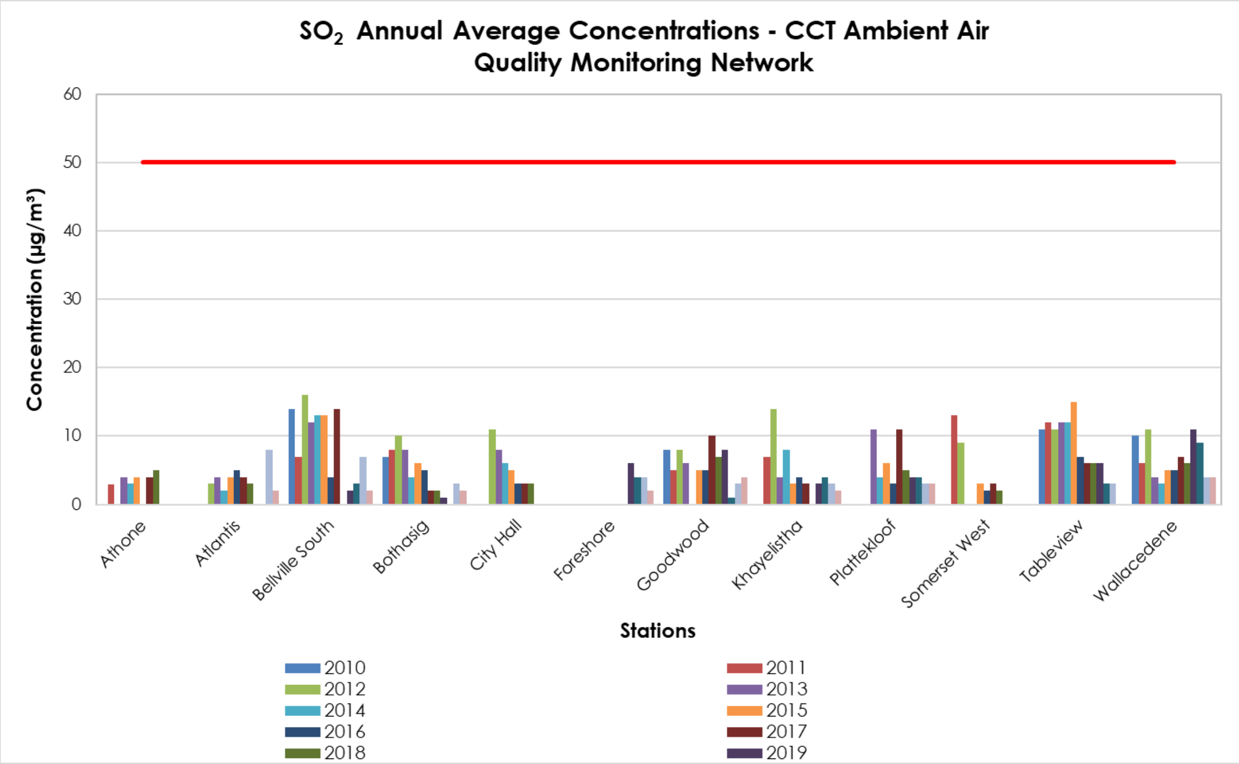

Figure 11 Annual average Sulphur Dioxide (SO_2) concentrations (µg/m³) for 2010-2022 (Source: City of Cape Town AQM Network)

The Saldanha Bay station also reported overall compliance with the daily NAAQS for the 2015 to 2022 monitoring period (Figure 12).

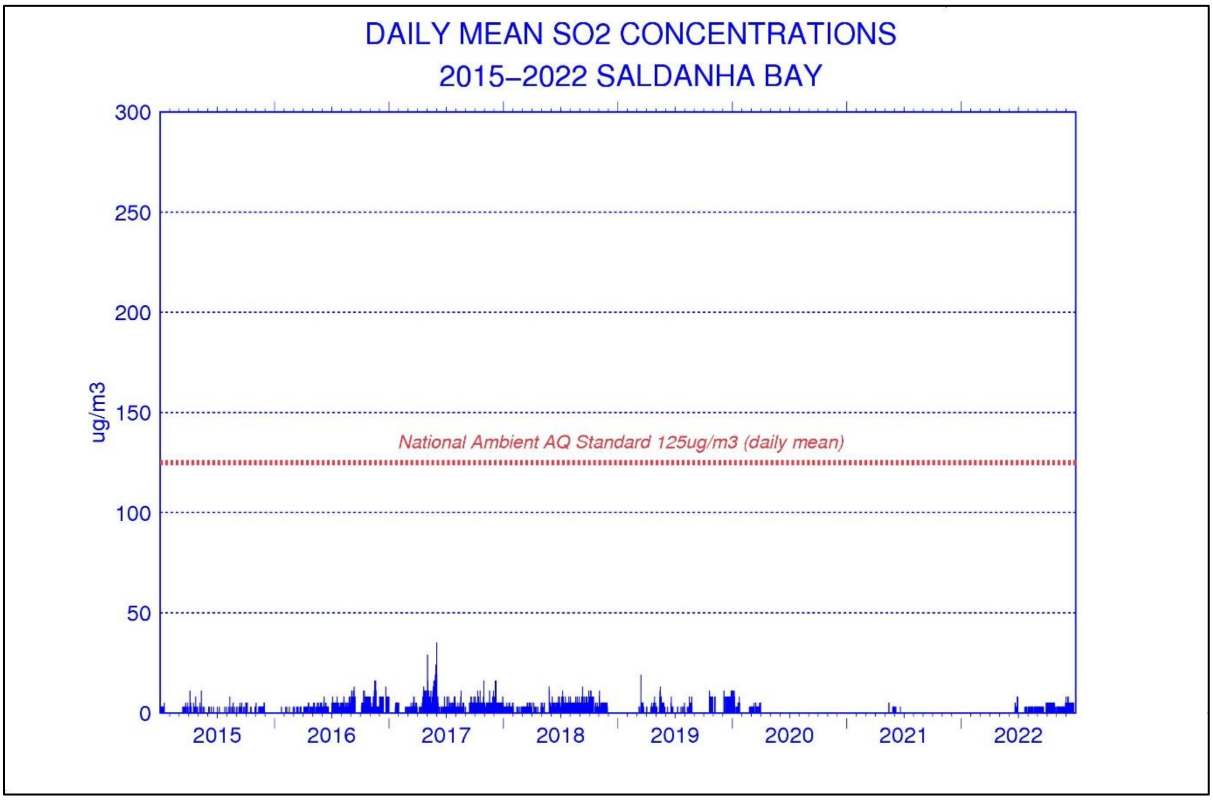

Figure 12 Annual average Sulphur Dioxide (SO_2) concentrations (µg/m³) for 2015-2022 (Source: Saldanha Bay Municipality AQM Network)

Although a slight upward trend of the pollutant concentrations measured over time have been noticed, the air quality in the Western Cape Province is generally compliant with the NAAQS.

Exceedances of the annual average PM_{10} NAAQS of 40 µg/m³ were observed at both the Khayelitsha and Wallacedene monitoring stations. These elevated levels of PM_{10} are concerning as in most instances, PM_{10} is used as a proxy to understand an areas' level of exposure in correlation with potential health issues.

Both Khayelitsha and Wallacedene are low-income areas, and the elevated PM_{10} levels measured highlights the disproportionate impact of air pollution between high-income and low-income areas. Residents in low-income areas often rely on wood burning for cooking and space heating that contribute to higher levels of particulate matter, and increased health risks. This disparity emphasises the need for targeted interventions and policies to address air quality issues in previously disadvantaged communities, such as programmes aimed at reducing the use of solid fuels, ensuring equitable health outcomes for all residents.

A Human Health Risk Assessment Study (HHRA) conducted by the Western Cape Government between 2013 and 2016 estimated the annual economic impact of air pollution on human health in the region to be R8.7 billion, emphasising the threat that air pollution poses to both public health and the local economy (DEA&DP, 2016). The increasing trends in other criteria pollutants have also been measured, as indicated above. The recorded increasing air pollutant concentrations is an indication that the air quality is stable but declining in the Province.

It is important to note that continuous monitoring of ambient air quality informs management strategies that allow authorities to ensure effective air quality management in the Province and curb the risk of residents being affected. The Department and Municipalities are faced with significant challenges in monitoring air quality caused by budget constraints across the Province. This led to a reduction in funds for maintaining and upgrading the monitoring Network. The recent budget cuts, compounded by increased loadshedding, have all impacted on the air quality monitoring infrastructure, resulting in increased maintenance, repairs, and troubleshooting efforts by officials.

Funding for air quality monitoring for the Department, along with Municipalities in the Province, must be prioritised to address staff shortages, replace aging analysers, and to implement a backup power supply system to mitigate the impact of loadshedding for the monitoring Network.

3.3 Greenhouse Gas Emissions

Greenhouse gases (GHG) is the collective term for gases in the earth's atmosphere which absorb and trap radiation within the thermal infrared range, a process also known as the Greenhouse Effect. Gases including water vapour (H_2O), carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and lower atmosphere ozone (O_3) are considered the primary GHG either due to high volumes or their virulence as a greenhouse gas. Anthropogenic sources such as the combustion of coal, liquid fuels and natural gases are major contributors to the accumulation of GHG emissions in the atmosphere.

The main GHG emitted through human activity is CO_2, and its accumulation in the atmosphere is closely observed as an indicator of climate change. Carbon Dioxide emissions from human activities are therefore monitored in order to measure CO_2's contribution to the Greenhouse Effect, and the contribution from other GHGs is similarly tracked and reported on in terms of their effect relative to carbon dioxide. This allows reporting in a single unit, namely "*carbon dioxide equivalent*" or "*CO_2e*", which gives an indication of combined global warming potential (GWP). Typically, for the sake of brevity, the total contribution is simply reported as "*carbon emissions*".

The DEA&DP's Air Quality Directorate compiled a Western Cape Air Pollutant and Greenhouse Gas Inventory, which houses data on point, non-point and mobile sources of air pollution in the Province (DEA&DP, 2015). Updating the Emissions Inventory is ongoing, to improve the information available to manage air quality in the Western Cape (AQMP, 2021).

The GHG Emissions Inventory for the Western Cape is updated every two / three years (depending on data availability). The GHG Emission Inventory is an expansion of the Energy Consumption GHG Emissions Database which has been collated since 2012. This complete GHG Emissions Inventory now includes emissions from the following sectors: Energy (including transport fuels), Industrial Process and Product Use (IPPU), Waste (including Wastewater Treatment Works) and the Agriculture, Forestry and Other Land Use Sector (AFOLU). The first iteration of the complete GHG Emissions Inventory was completed in 2022 using 2018 as the baseline year.

The GHG Emissions profile for the Western Cape (2018) is shown in the figure below, with Energy dominating this picture (88%). This is in line with the national emissions profile, where the energy sector is responsible for over 80% of GHG emissions. It is unfortunately not possible to provide a district profile aligned with the full GHG emissions Inventory as the information is not always available according to geographic boundaries.

There have been some data challenges, in particular with the IPPU and waste sectors. The IPPU sector has some significant data gaps and does not provide a true reflection of the sector's emissions for the Western Cape. Currently, only facilities that emit above a defined threshold are required to report their emissions to the national GHG reporting system and for the Western Cape this is a very small number of facilities. In the Waste section, there are significant data gaps for some of the districts, private waste disposal figures are not always available and wastewater treatment data is extremely difficult to capture.

An update of the Western GHG Inventory is currently underway and will capture data for 2020, 2021 and 2022. This work will be finalised by March 2025.

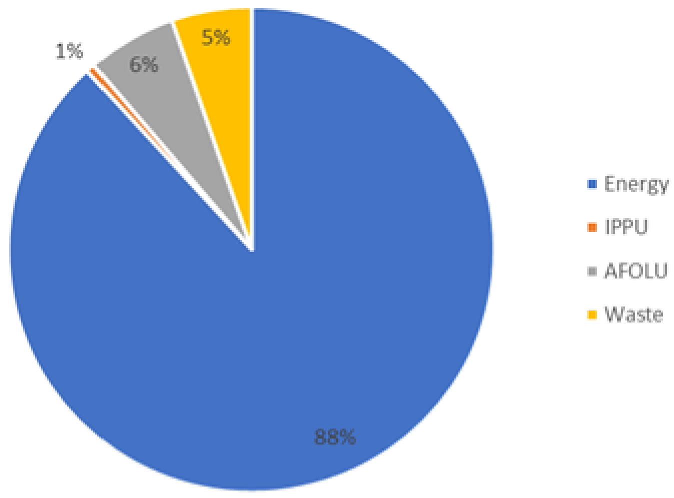

Figure 13 Emissions by high-level sector in the Western Cape

Source: DEA&DP, 2022

4 IMPACTS OF AIR POLLUTION

Air pollution has far-reaching consequences, affecting not only public health and the environment but also affecting the climate and economic development. These consequences could disproportionately burden the most vulnerable members of society, including women, the elderly, and children residing in economically disadvantaged areas.

4.1 Impacts on Human Health

Exposure to high levels of air pollution may increase the risk of lung cancer, heart disease, and respiratory infections, among other human health problems. The impact of air pollution, in general, typically depends on the makeup of the ambient air and this, in turn, is influenced by factors such as the type of fuel used, the conditions under which it is burned, how well the area is ventilated, and the duration of exposure.

Chlorofluorocarbons (CFCs), among other compounds, have the capacity to rise through the atmosphere, interact with, and disintegrate stratospheric ozone molecules. A decrease in the ozone layer (caused by human industrial activity) could directly affect human health and the environment since it filters UV light from the sun. This includes eye damage, skin cancer, and sunburn. The southernmost point of Africa, South Africa, is the African nation most exposed to rising radiation levels and the one that is nearest to the area of severe ozone depletion over the Antarctic (the "ozone hole").

Exposure to air pollution (represented as daily air pollution concentrations or air quality index values) may have a short-term influence on an individual's health. The effects may be exacerbated on certain days (or seasons) of high pollution levels in the atmosphere. Exposures lasting a few hours to a few days may cause ear, nose, and throat discomfort depending on the pollutant. The discomfort usually goes away when the concentration levels of a pollutant lowers or disperse (State of Global Air, 2020). The longer the exposure period, or the more frequent the exposure, the higher a person's risk of acquiring a more permanent condition, *i.e.*, chronic heart disease, respiratory conditions, infections of the lungs, lung cancer, diabetes, and other health issues, as well as of dying from such conditions prematurely. It is noted that the WHO (2016) identifies indoor air quality related to cook fuels as a major concern in relation to indoor air quality and links it to premature death or serious illness in women and children who often are involved in indoor domestic activities close to the source of emission such as cooking.

In major cities like Cape Town, air quality is impacted by pollution, particularly during autumn and winter temperature inversions, due to its geographical and climatic conditions. These temperature inversions often align with morning rush hour traffic, causing visible haze (brown haze, Figure 3-3), especially during the winter months, with stable atmospheric conditions.

Figure 4-1: Brown haze over the City of Cape Town ***(Photograph by: Dr Johanna von Holdt)***

Scientific research has revealed that a mother's exposure to air pollution during pregnancy can affect her baby and how healthy the babies are in their first month of life (State of Global Air, 2020). Babies who are born prematurely or underweight are at a higher risk of developing other serious illnesses and dying from them. According to a growing body of research, air pollution may play a role in the development of several other diseases, including those that affect the brain (State of Global Air, 2020). A person's life expectancy, or the number of years they could anticipate living, might be shortened as a result of these impacts of air pollution (State of Global Air, 2020). The Western Cape government undertook a Human Health Risk Assessment Study (2013 – 2016), which used PM_{10} as a proxy indicator, and estimated the economic impact of air pollution on human health in the Western Cape to be R8,7 billion per annum (DEA&DP, 2016). This suggests that air pollution is a large threat not only to human health.

4.2 Impacts on Biodiversity

Biodiversity can be directly impacted by air pollution, while indirect effects may result from contaminated soil and water resources. The effects of air pollution on biodiversity are dependent on the type of contaminant and level of exposure.

The most frequent contaminants that have a negative impact on flora are SO_2, fluoride (F), chlorine (Cl), ozone (O_3), and ethylene (C_2H_4). These have the following effects: "burning" at the tips or margins of the leaves, stunted development, early leaf growth, delayed maturity, early flowering, and decreased yield or quality (Florentina and Ion, 2011). These effects would typically be more pronounced in close proximity to sizable urban and industrial regions, and especially in the vicinity of point sources of pollution, such as power stations, smelters, incinerators, landfills, pulp and paper mills, and other fossil fuel burning facilities.

Ground-level ozone (O_3) is a prevalent air pollutant and distinct from the naturally occurring O_3 in the upper atmosphere, which protects life on Earth by absorbing harmful ultraviolet rays. Unlike direct emissions from stacks or vehicle exhausts, ground-level ozone is a byproduct formed when other pollutants, predominantly NOx and VOCs, undergo reactions in the atmosphere in the presence of sunlight. Plants exposed to O_3 are oxidised or "burnt" by the pollutant, and this process damages plant leaves, reducing their survival rates (Figure 12). Factors such as soil moisture, the presence of other air pollutants, insects or diseases, and environmental stresses contribute to the severity of ozone-induced damage.

Figure 2 Photo of healthy (left) and ozone-injured (right) tulip tree (yellow poplar) foliage (Source: www.nps.gov)

Terrestrial acidification remains a significant environmental issue for developing countries due to rising emissions of acidic precursor trace gases, mainly SOx and NOx. There have been a global and local concerns of ecological damages due to acid rain in regions downwind of large coal intensive industries. South Africa, with a major industrialised economy in the Southern Hemisphere, faces this challenge mainly in the Highveld, where about 90% of the country's emissions of industrial dust, SOx and NOx are concentrated (Josipovic, *et al.,* 2011, Shikwambana *et al*., 2020). Acid rain can negatively affect natural environments and can cause harm to small insects and freshwater life. Figure 13 shows leaf damage on plants from a simulated acid rain deposition in a lab environment. While both acid rain and surface ozone can harm plants, acid rain primarily affects plants indirectly through soil and water, whereas surface ozone directly damages plant tissues through oxidative stress (Singh & Agrawal, 2007; Saxena *et al.,* 2016).

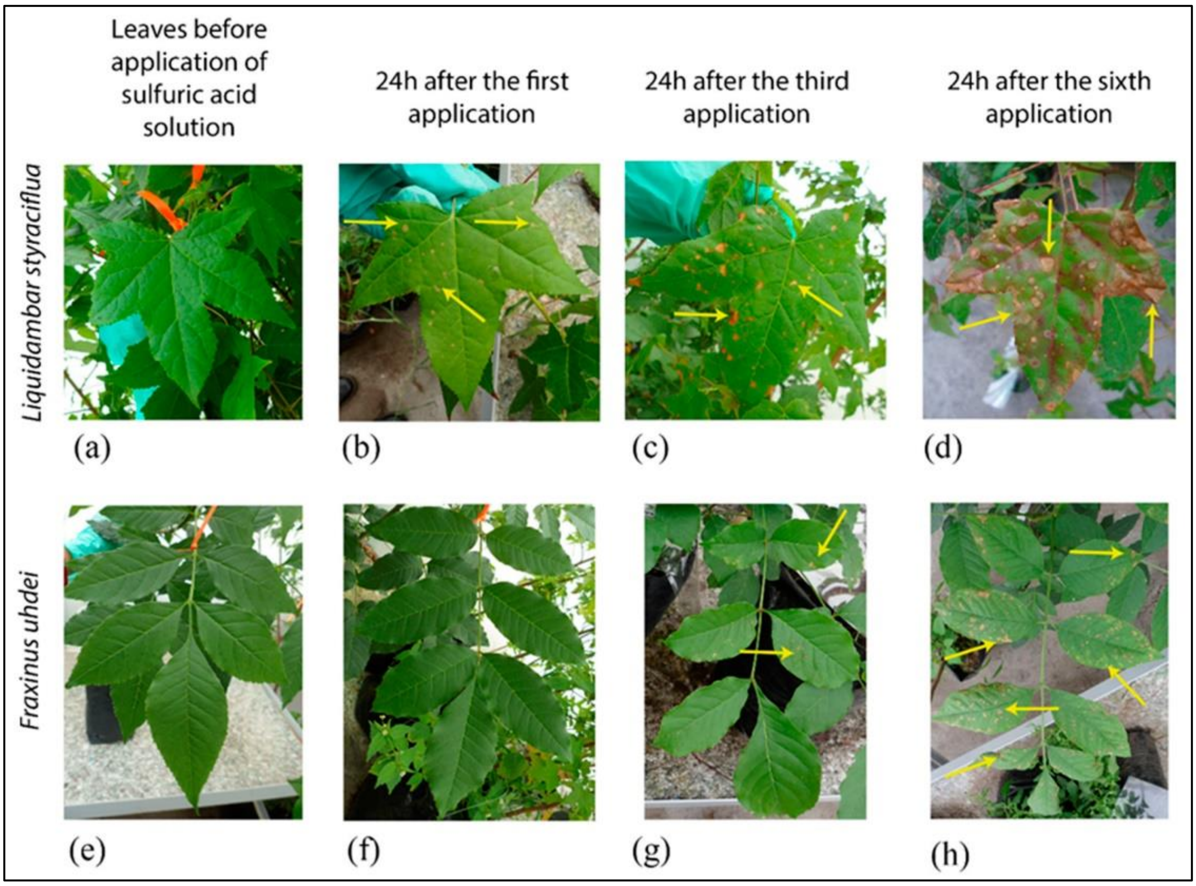

Figure 3 Visible leaf damage of simulated acid rain (pH 2.5). Liquidambar styracifflua (a–d). Fraxinus uhdei (e–h). Arrows indicate some areas of damage caused by the sprayed acidic solution on the margins and the intercostal leaf zones of both species (Source: *Rodríguez-Sánchez, et al., 2020)*

Despite a limited amount of research conducted on the effects of air pollution on the biodiversity of the Western Cape, recent studies have confirmed the occurrence of acid rain in the Greater Cape Town area (See: Swartz *et al.*, 2022; Mompati, 2019; Abiodun *et al.*, 2014; Wilson, 2008). This adds a specific dimension to the potential impacts of air pollution on the region's biodiversity. While the extent of research in the Western Cape is not well documented, it is safe to assume that the broader impacts of air pollution on biodiversity are similar to those observed in other regions, that face similar challenges.

For more information with regards to the Biodiversity in the Western Cape, refer to the Chapter on Biodiversity of this report.

4.3 Impacts on Economic Development

Besides being a health problem, poor air pollution can also have a negative impact on the local, regional and global economy. The repercussions of air pollution on the economy ranges from health care costs, reduced tourism and investment, increased energy costs, higher environmental clean-up costs to crop and livestock loss and damage. Additionally, air pollution places a significant financial burden on both the economies of low- and middle-income countries and the global economy due to disease, early death, lost wages, and increased health-care costs, which in turn restrains productivity and economic progress. This toll is particularly heavier on women, who often face greater exposure due to factors such as maternal health issues, domestic chores close to emission sources, and spending more time indoors. For instance, those exposed to air pollution are more likely to miss work and have decreased productivity, both of which undermine their contribution to the workforce and the economy (World Bank Group, 2022). Unfortunately, it is the poor that has to bear the brunt of an unfair share of the financial burden because they have the fewest resources to address the health effects of air pollution (World Bank Group, 2022).

As indicated in section 3.1, the Western Cape Human Health Risk Assessment Study estimated the economic impact of air pollution to be R8.7 billion per annum in the Western Cape (DEA&DP, 2016). Thus, air pollution poses a large threat to the economy of the Province, and hence air quality management needs to be prioritised in order to prevent future diseases in this area.

4.4 Impacts on Climate Change

Climate change is directly related to emissions of greenhouse gases, such as CH_4, VOCs, and CO_2, as well as the criteria pollutants NO_2, SO_2, O_3, PM, C_6H_6, and CO (AQMP, 2021). Several sources of "conventional" (primarily from uses of conventional fuels) air pollutants are also sources of carbon dioxide (CO_2) and other greenhouse gases (GHGs).

Rising global temperatures and changing rainfall patterns have been scientifically linked to climate change. Additionally, more frequent extreme weather occurrences like heat waves or heavy rain are also possible. A shift in agricultural resources, a change in the distribution ranges of disease vectors (such as malaria mosquitoes), changes in the distribution ranges of extreme weather events, and other effects on social welfare and development could all be brought on by extreme weather events and changing weather and climate patterns. Developing countries such as South Africa are very vulnerable to these impacts of climate change.

However, due to the close link between greenhouse gas emissions and air pollution in general, a reduction of the one is bound to lead to a concurrent reduction in the other.

5 RESPONSES

5.1 Air quality regulation in the Western Cape

Over time, South Africa has established various laws and regulations to address air quality. The National Environmental Management: Air Quality Act (Act 39 of 2004; NEM: AQA) is a significant legislative tool that aims to regulate and manage air quality in the country. The National Department of Forestry, Fisheries and the Environment (DFFE) identified a set of criteria pollutants, for which National Ambient Air Quality Standards (NAAQS) have been promulgated. These criteria pollutants are carbon monoxide (CO), particulate matter (PM), sulphur dioxide (SO_2), ozone(O_3), nitrogen dioxide (NO_2), benzene (C_6H_6) and lead (Pb).

The Bill of Rights enshrined in the Constitution states that South Africans have the right to an environment that is not harmful to their health and well-being. In response to the potential impact of air pollution on the environment and human's policies, tools and legislation have been developed to manage air pollutants in the ambient environment.

5.2 Policy, Tools and Legislation

To enable and give effect to Section 24 (b) of the Constitution of the Republic of South Africa, the National Environmental Management Act No. 107 of 1998 (NEMA) and the National Environmental Management: Air Quality Act No. 39 of 2004 (NEM: AQA) were promulgated. The main objective of the NEM: AQA can be summarised as the protection of the environment and human health, in a sustainable development framework, through reasonable measures of air pollution control.

The National Framework for Air Quality Management in South Africa provides norms and standards for all technical aspects of air quality management in South Africa (DEA, 2018).

Since the promulgation of the NEM: AQA, various regulations and policies have been developed, as well as various amendments to the NEM: AQA. The National Dust Control Regulations (GN 827 of Gazette No. 36974), the National Ambient Air Quality Standards (GN 1210 of Gazette No. 32816) and the Declaration of a Small Boiler as a Controlled Emitter and Establishment of Emission Standards (GN 831 of Gazette No. 36973) are just a few of the legislations promulgated in terms of NEM: AQA.

Annexure 1 provides a summary of the regulations promulgated under NEM: AQA, to date (DEA&DP, 2015).

To further give effect to the public right to a healthy living environment, according to Section 8 of NEM: AQA, Municipalities were granted executive authority over air pollution control within their areas of jurisdiction. Each Municipality within the Province, in conjunction with oversight from the Provincial government, is mandated to ensure the implementation of the NEM: AQA across the Province. Since 2007, 17 Municipal by-laws that govern air quality management have been gazetted in the Western Cape (DEA&DP, 2021).

5.3 Air Quality Management Plans and Air Quality Officers

As per Section 15 of the NEM: AQA, it is mandatory that the Province and Municipalities develop Air Quality Management Plans (AQMPs) for effectively addressing air quality in their respective regions. To ensure the ongoing relevance and effectiveness of these AQMPs, it is necessary to conduct a review every five years. This review process is a measure of assessing the effectiveness of the set AQMP objectives and targets, as well as their validity in light of new developments and economic growth.

In compliance with this requirement, the DEA&DP is currently implementing its third (3rd) generation AQMP, that was adopted in 2021. Great strides have been made in air quality management since the adoption and the implementation of the first (1st) and second (2nd) generation Western Cape AQMPs. The development and review of the AQMPs occurred in multiple stages, starting with an assessment of the existing air quality management processes. Public engagement was also conducted to gather input and ensure inclusivity. Subsequently, a comprehensive plan was compiled, incorporating a Vision, Mission, and Goals for air quality management in the Province. The plan also identifies the necessary actions to achieve the defined objectives.

The vision for air quality management in the Western Cape is "*Clean and healthy air for all in the Western Cape*", complimented by the mission statement, *"To ensure the effective and consistent implementation of sustainable air quality management practices, by all spheres of government, relevant stakeholders and civil society to progressively achieve and efficiently maintain clean and healthy air in the Western Cape*".

All the District and Local Municipalities, including the Metropolitan Municipality, within the Western Cape have adopted their respective Municipal Air Quality Management Plans (AQMPs), which have been integrated as sector plans within their broader Integrated Development Plans (IDPs) (DEA&DP, 2021).

The City of Cape Town Metropolitan was the first Municipality that adopted an AQMP in 2009. Other District and Local Municipalities followed suit, with Beaufort West Local Municipality adopting its AQMP in 2022. Many of the Municipalities are already implementing their 2nd Generation AQMPs with a few undertaking a review on their 1st Generation AQMPs. To date, the Western Cape Province is fully compliant with Section 15(1) and (2) of NEM: AQA and has 31 adopted AQMPs (*viz*. 1 Provincial and 30 Municipalities).

Section 14 of NEM: AQA places an obligation for the mandatory designation of Air Quality Officers (AQOs) within the jurisdictions of all three (3) spheres of government. To date, the Western Cape has 29 out of 30 AQOs appointed, with the Overberg District Municipality in the process of designating an AQO. Table 6 presents a summary of the status of the air quality management plans and air quality officer designation per Metropolitan, District and Local Municipality.

Table 5 Status of AQMP's and designated AQO's in the Municipalities of the Western Cape

AUTHORITY	YEAR AQMP ADOPTED	SECOND GENERATION AQMP	THIRD GENERATION AQMP	AIR QUALITY OFFICER DESIGNATED
City of Cape Town	2009	2024		✓
Cape Winelands	2009	2018	In progress	✓
DEA&DP	2010	2016	2021	✓
Drakenstein	2011	2020	In progress	✓
West Coast	2011	2019		✓
Garden Route	2011	2013	2019	✓
Overberg	2012	In progress		X
Bergrivier	2012	2019	In progress	✓
Matzikama	2012	2020	In progress	✓
Saldanha Bay	2012	2020	In progress	✓
Swartland	2012	2019	In progress	✓
Central Karoo	2012	2016	In progress	✓
Cape Agulhas	2013	2019	In progress	✓
Overstrand	2013	2017	In progress	✓
Witzenberg	2014	2020	In progress	✓
George	2013	2019	In progress	✓
Hessequa	2013	2019	In progress	✓
Bitou	2013	2019	In progress	✓
Knysna	2013	2019	In progress	✓
Kannaland	2013	2021	In progress	✓
Mossel Bay	2013	2019	In progress	✓
Oudtshoorn	2013	2019	In progress	✓
Theewaterskloof	2014	2015	In progress	✓
Prince Albert	2014	In progress		✓
Swellendam	2015	In progress		✓
Stellenbosch	2015	2018	2022	✓
Cederberg	2016	2019		✓
Laingsburg	2016	In progress		✓

AUTHORITY	YEAR AQMP ADOPTED	SECOND GENERATION AQMP	THIRD GENERATION AQMP	AIR QUALITY OFFICER DESIGNATED
Breede Valley	2017	In progress		✓
Langeberg	2017	In progress		✓
Beaufort West	2022			✓

5.4 Atmospheric Emission Licensing

To effectively manage air quality and oversee the implementation of the Atmospheric Emission Licensing System in the Province, the NEM: AQA outlines specific legal responsibilities for AQOs and Licensing Authorities (LAs). Furthermore, it emphasises the importance of making information regarding air quality easily accessible to the public.

In the Western Cape, the DEA&DP's Directorate: AQM has the responsibility to facilitate the atmospheric emissions licensing system, with respect to Atmospheric Emissions Licenses (AELs) and Provisional Atmospheric Emissions Licenses (PAELs). As of December 31, 2022, the Province was regulating a total of 116 AELs and 13 PAELs. The AELs and PAELs issued annually during the period 2010 - 2022 are summarised in Table 7.

The D: AQM initiated an AEL Compliance Inspection Programme in 2013. The Programme applies strategic enforcement action on targeted sectors that are deemed likely to have a significant environmental burden in the Province (DEA&DP, 2021). In the Western Cape, a total of 44 facilities have been formally inspected by the DEA&DP, in association with the Licensing Authorities, where applicable. It should be noted that the number of compliance inspections undertaken by the D: AQM are limited to four (4) per annum, due to human resources and budget constraints. This is complimented by compliance inspections undertaken by other Licensing Authorities (CCT, GRDM, WCDM, CWDM) in the Western Cape.

To date, all District Municipalities and Metropolitan are designated as Licensing Authorities for all facilities that require an AEL to operate whereas Local Municipalities are responsible for controlled emitters. These facilities are monitored through record reviews, inspections, and compliance monitoring (DEA&DP, 2021).

Table 6 Summary of the AELs and PAELs issued by Licensing Authorities in the Western Cape during 2010 – 2022

	REGULATED AS AT 31 DECEMBER 2022																										NUMBER ISSUED IN YEAR	
Licensing Authority	2010		2011		2012		2013		2014		2015		2016		2017		2018		2019		2020		2021		2022		2022	
	PAEL	AEL	PAEL	AEL	PAEL	AEL	PAEL	AEL	PAEL	AEL	PAEL	AEL	PAEL	AEL	PAEL	AEL	PAEL	AEL	PAEL	AEL	PAEL	AEL	PAEL	AEL	PAEL	AEL	PAEL	AEL
WCDM	0	0	5	1	1	1	6	1	7	9	12	9	12	12	12	13	12	15	11	17	10	18	2	20	2	19	3	4
GRDM	5	0	4	0	7	2	2	14	3	6	2	23	0	26	0	27	0	26	0	27	0	30	2	26	1	23	1	0
ODM	0	0	0	0	0	0	1	0	2	0	5	0	1	4	0	5	0	5	0	5	0	5	0	5	0	5	0	1
CKDM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CCT	0	0	2	0	1	3	3	2	14	19	16	31	18	32	26	6	19	42	14	50	15	52	9	56	10	54	5	7
CWDM	0	0	1	0	0	0	0	0	4	11	5	10	6	9	6	8	6	8	4	10	1	13	0	14	0	12	0	0
DEA&DP	0	0	0	0	0	0	0	0	1	0	3	0	1	3	0	3	0	3	0	3	0	3	0	3	0	3	0	0
TOTAL PAEL | AEL	5	0	12	1	9	6	12	17	31	45	43	73	38	86	44	62	37	99	29	112	26	121	13	124	13	116	9	13

5.5 Gender Mainstreaming

Gender mainstreaming involves integrating gender considerations for men and women into legislation, policy and practices. According to the national Department of Women, Youth and Persons with Disabilities (DWYPD, 2015): "*Gender mainstreaming includes a process of assessing the implications of any planned action, legislation, policies, budgets and programmes, in all areas and at all levels, for women, men, boys and girls. It involves the integration of gender considerations into all structures; systems and processes; organisational decisions and activities; implementation of corrective measures for prevention and alleviation of prejudice, removal of barriers, and reduction of disparities between women and men, boys and girls, and ultimately achieving gender equality, not just in equity, but in lived experience*,"

Aligned with the National DFFE's Environmental Sector Gender Framework and promoting gender equity, such as the National Framework for Women Empowerment and Gender Equality (2000), the Constitution (Act No. 108 of 1996), the Sector Gender Framework for the Environment Sector, the Women's Charter for Effective Equality (1994), and the Strategic Framework for Gender Equality within the Public Service (2006), the D: AQM is actively integrating gender mainstreaming into its responsibilities and obligations.

The air quality monitoring data shows that elevated PM_{10} levels are measured in low-income settlements. It should be noted that often, women and children are disproportionately affected by poor air quality, particularly in low-income settlements where household activities like cooking and heating with fires are common practices. This disparity emphasises the need for targeted interventions and policies to address air quality issues in previously disadvantaged communities, such as programmes aimed at reducing the use of solid fuels, ensuring equitable health outcomes for all residents.

In response, the D: AQM supports initiatives like the Garden Route Clean Fires Campaign, which educates communities on the dangers of air pollution from the use of solid fuels for cooking and heating. The initiative promotes the use of efficient cooking stoves (such as "The Rocket Stove"), and benefits of using dry wood chopped in smaller pieces instead of large wet logs. These efforts will focus specifically on women, as they often bear the brunt of indoor air pollution and its consequences. According to the World Health Organization (WHO), approximately 2.6 billion people worldwide still rely on solid fuels for cooking and heating, leading to various health issues.

The Western Cape RAC project (Refrigeration & Air Conditioning) also promotes the participation of women in the programme. During 2019, two (2) female candidates (out of nine (9) candidates) were selected and completed the RAC Cool Training Programme in Bavaria while, a female RAC Technician was trained at the West Coast College on the safe use and handling of natural refrigerant gases. There are plans for further assessments to better understand the role and representation of women in the air quality sector. These assessments aim to provide valuable insights and guide future initiatives to ensure inclusivity and gender equality in air quality management. To date, there are 15 female AQOs out of a total of 31 appointed AQOs in the Province (including the Provincial AQO), ensuring that women are represented amongst Air Quality Management professionals within the Western Cape.

6 CONCLUSION

OUTLOOK: STABLE, BUT DECLINING

Air pollutants can disperse over large areas across National, Provincial and local borders. Through the mitigation of air pollution, the subsequent health effects, both immediate and long-term, including respiratory illnesses, can be diminished, alongside the alleviation of the detrimental impacts on the environment like those attributed to climate change. Primary sources of air pollution vary between different regions, but mainly stem from industrial and mobile sources, the domestic use of fuels like wood for cooking and heating, controlled and uncontrolled veld fires, and other activities.

In the Western Cape, major contributing sources to the air pollution include vehicle emissions, economic activities (industries and mining), veld fires and residential energy use. The 2023 INRIX Global Traffic Scorecard and TomTom Traffic Index indicate that CCT commuters spend between 83 to 127 hours in traffic, with 48 of those hours in congestion, ranking the city as the 2nd worst in Africa and the 9th worst in the world, in terms of traffic congestion. This high traffic congestion in turn cost CCT commuters an extra R882 annually in fuel costs. The CCT is investing R444 million over the next three years to alleviate traffic congestion through road projects and improvements to public transport services. However, the lack of roadside ambient air quality monitoring stations further complicates efforts to accurately assess the extent of pollution and its sources. This gap in monitoring limits the effectiveness of policies and interventions aimed at improving air quality and mitigating health risks associated with prolonged exposure to traffic-related pollutants.

The increasing trends in PM_{10}, NO_2 and SO_2 over the years raises concern that air quality in the Province is stable, but declining, albeit the fact that the monitoring data is mostly below the NAAQS. Exceedances of PM_{10} have been observed, particularly in low-income settlements like Khayelitsha and Wallacedene. This could be attributed to open fires for cooking and heating. These residential areas account for more than half of the daily NAAQS exceedances of PM_{10} in the region. The disproportionate impact of air quality between high income areas and low-income areas has been discussed previously. However, it is important to note that the exceedances are increasing in these areas instead of decreasing, therefore asserting that people in these low-income areas are exposed to more harmful levels of air pollution than those in the high-income areas.

Air quality management relies on the active engagement and collaboration of various levels of government. Taking an integrated approach will facilitate coordinated planning and the development of effective systems. For instance, if spatial planning can create cities with efficient designs, it will contribute to improved transportation efficiency and, subsequently, enhance overall air quality.

The monitoring of air quality is important and budget limitations across the Province severely hampers this. The DEA&DP has experienced a significant reduction in budget, which has impacted on recapitalising and/or maintaining the Network. These challenges have recently become compounded by the increased loadshedding experienced in the country, which has placed an enormous strain on both the aged and new equipment in the Network, resulting in equipment requiring increased maintenance and repair, as well as increased troubleshooting when analysers experience problems. As a result, air quality monitoring officials increasingly perform in-house maintenance and troubleshooting, and analysers are often taken out-of-service for repair. Given these challenges, the DEA&DP has made the difficult decision to temporarily decommission two (2) stations in the Network until financial and human resources become available to allow the Network to operate effectively. The decommissioning of the two (2) stations aims to allow officials to dedicate their time and effort to the stations where criteria pollutants are measured and reported to the SAAQIS, in real time. Budget is required to resource the unfunded vacant posts in air quality monitoring, to replace the aged analysers in the Network, and to install a back-up power supply system to reduce the impact of loadshedding on the Network. In addition, increased compliance monitoring and enforcement of air quality regulated facilities in the Province can only occur if human resource capacity is increased.

The Western Cape Government undertook a Human Health Risk Assessment Study (2013 – 2016). The study used PM_{10} as a proxy indicator and estimated the economic impact of air pollution on human health in the Western Cape to be R8.7 billion per annum (DEA&DP, 2016). This suggests that air pollution is likely one of the largest threats not only to human health, but also to the economy of the Western Cape.

Table 8 gives an overview of the key air quality aspects in the Western Cape as it illustrates the key pressures, impacts, challenges, progress and critical areas for action.

Table 7 Overview of key air quality aspects in the Western Cape

Aspect	Summary
Pressures	• Transportation (especially diesel); • Domestic fuel burning; • Veld fires and biomass burning; • Rise in industrial activities; and • Availability of electricity.
Impacts	• Brown haze; • Indoor air pollution; • Impacts on environment and biodiversity; • PM_{10} increasing in low-income areas in CCT; • Economic impacts; • Health effects and burden on health care system; • Transboundary air pollution; and • Carbon footprint / climate change (ozone depletion).
Challenges	• Limited availability of monitoring data (spread and historical) for the Province; • Lack of budget to monitor air quality and replace aged infrastructure. The network is at risk of collapse unless air quality monitoring is prioritised; • Lack of collaborative governance to manage of Transboundary Air Pollution; • Obstacles in the implementation of renewable solutions / technologies which will reduce emissions; • Reduction of vehicle emissions (developing effective public

Aspect	Summary
	transport systems); • Reliable electricity supply (Eskom's load shedding affects the quality of data captured which in turn affects the understanding of ambient air quality); and • Wear and tear of monitoring equipment due to Eskom's load shedding
Progress	• Number of operational monitoring stations; • Updated of Local, District and Provincial AQMPs; • Promulgation of By-laws; • Implementation of licensing procedures and compliance monitoring; • Awareness raising initiatives; • Inter-departmental relations and information sharing; • Authority structures and mandates / forums; • Air quality compliant with the South African National Ambient Air Quality Standards; and • Legislation promulgated to address GHG levels.
Critical areas for action	• Prioritise air quality monitoring in the Province. • Improve spatial and temporal resolution of monitoring network; • Improve capacity in terms of licensing and compliance monitoring; • Overcome obstacles to innovative (green) urban development; • Revolutionise transportation systems; and • Inter-governmental and inter-sectoral collaboration for developing effective and innovative solutions towards reducing impacts of air pollution on human health and the environment. • Reduce Indoor Air Pollution Impact on Women and Children by engaging in clean cook stove campaigns.

ANNEXURE A: A summary of the regulations promulgated under NEM: AQA, to date.

Legislation	Commencement Date	Description / Purpose
National Ambient Air Quality Standards	24 December 2009 (GN. 1210 of	The notice provides for the assessment of ambient air quality standards in terms of Section 5.2.1.3. of the National

Legislation	Commencement Date	Description / Purpose
	Gazette No. 32816)	Framework for Air Quality Management in South Africa.
List of Activities which Result in Atmospheric Emissions which have or may have a Significant Detrimental Effect on the Environment, including Health, Social Conditions, Economic Conditions, Ecological Conditions or Cultural Heritage	01 April 2010 (GN 248 of Gazette No. 33064)	The regulations make provision for minimum emission standards to apply to both permanently operated plants and for experimental (pilot) plants with a design capacity to the one of a listed activity, as it is applicable under normal working conditions.
National Ambient Air Quality Standard for Particulate Matter with Aerodynamic Diameter less than 2.5-micron metres ($PM_{2.5}$)	29 June 2012 (GN 486 of Gazette No. 35463)	The regulations make provision for the regulation of particulate matter of aerodynamic diameter less than 2.5-micron metres ($PM_{2.5}$).
National Dust Control Regulations	01 November 2013 (GN 827 of Gazette No. 36974)	The regulations prescribe general measures for the control of dust in all areas.
Declaration of a Small Boiler as a Controlled Emitter and Establishment of Emission Standards	01 November 2013 (GN 831 of Gazette No. 36973)	The regulations regulate the emissions and requirements as set out for any small boiler under normal operating conditions subject to the provisions for start-up, soot-blowing and incidences of abnormal conditions.
Regulations Prescribing the Format of the Atmospheric Impact Report	02 April 2015 (GN 747, as amended by GNR 284)	The regulations make provision for any person required to submit an atmospheric impact report in terms of Section 30 of the NEM: AQA to do so in the prescribed format.
National Atmospheric Emission Reporting Regulations	02 April 2015 (GN 283)	The regulations are for the reporting of data on sources of atmospheric emissions to National Atmospheric Emissions Inventory System (NAEIS) and compilation of atmospheric emission inventories.
Amendments to the List of Activities which Result in Atmospheric Emissions which have or may have a Significant Detrimental Effect on the Environment, including Health, Social Conditions, Economic Conditions, Ecological Conditions or Cultural Heritage	12 June 2015 (GN 551 of Gazette 38863)	The regulations make provision for additional requirements in terms of when waste ceases to be waste as per section 1 of the National Environmental Management: Waste Act 59 of 2008, as amended. Further amendments were made to the following listed activities: Sub-category 2.1 (Combustion installations) Subcategory 3.4 (Char, Charcoal and Carbon Black Production) Subcategory 4.3 (Primary Aluminium Production)

Legislation	Commencement Date	Description / Purpose
		Subcategory 5.3: Clamp Kilns for Brick Production
Declaration of Small-scale Char and Small-scale Charcoal Plants as Controlled Emitters and Establishment of Emission Standards	18 September 2015 (GN. 602 of Gazette No. 39220)	The regulations make provision for small-scale char and small-scale charcoal plants as controlled emitters and establishment of emission standards (production capacity smaller than 20 tonnes per month).
Regulations Prescribing the Atmospheric Emission Licence (AEL) Processing Fee	11 March 2016 (GN. 250 of Gazette No. 39805)	The regulations make provision for an applicant of an AEL to pay the prescribed processing fees, as indicated in the Annexure A, before or on the date of the submission of the application or as directed by the licensing authority.
Regulations for the Procedure and Criteria to be followed in the Determination of an Administrative Fine in terms of section 22a of the Act	18 March 2016 (GN. 332 of Gazette 39833)	The regulations provide for the determination of administrative fine, as well as for an applicant to pay the applicable AEL processing fee as stipulated. The regulations make provision for the payment of an administrative fee, in addition to the administrative fee payable in terms of section 24G of NEMA
Air Quality Offsets Guideline	18 March 2016 (GN. 333 of Gazette No. 39833)	The regulations make provision for guidance on situations under which offsets can be applied during the implementation of the atmospheric emission licensing system stipulated in Chapter 5 of NEM: AQA. Also provides guidance in terms of principles that should be adhered to in recommending and implementing offsets as well as the responsibilities of the different role players.
National Pollution Prevention Plans Regulations	08 January 2016 (GN. 5 of Gazette No. 39578)	The regulations intend to provide for a tool for authorities to obtain information pertaining to greenhouse gases. The regulations stipulate that companies conducting particular processes that emit greenhouse gases directly into the atmosphere must prepare, submit and implement a pollution prevention plan in respect of the greenhouse gases.
Declaration of Greenhouse Gases as Priority Air Pollutants	08 January 2016 (GN. 6 of Gazette No. 39578)	The notice intends to declare greenhouse gases as priority air pollutants. The notice stipulates that people conducting certain listed production processes which result in the emission of

Legislation	Commencement Date	Description / Purpose
		greenhouse gases that are listed as priority air pollutants must prepare and submit a pollution prevention plan.
National Greenhouse Gas Emission Reporting Regulations	03 April 2017 (GN. 622 of Gazette No. 40762)	The regulations intend to provide for the reporting of greenhouse gases. The regulations make the reporting of greenhouse gases mandatory and allow for data that could be more accurate and reliable.
The 2017 National Framework for Air Quality Management in the Republic of South Africa	26 October 2017 (GN. 1144 of Gazette No. 41996)	Revisions to the 2012 National Framework for Air Quality Management, with improvements on matters pertaining to establishing real-time air quality monitoring, access to real-time data captured on SAAQIS, and SAAELIP.
Strategy to Address Air Pollution in Dense Low-Income Settlements	17 May 2019 (GN. 666 of Gazette No. 42464)	The goal of the strategy is to map out the path that the country needs to take in reducing the impact of air pollution in dense low-income settlements. It aims to provide a coordinated approach in implementation of efforts directed at ensuring that ambient air quality in dense low-income settlements is in compliance with National Ambient Air Quality Standards, thereby ensuring the right to air that is not harmful to people's health and well-being as required by section 24 of the Constitution of South Africa.
Amendments to the List of Activities which Result in Atmospheric Emissions which have or may have a Significant Detrimental Effect on the Environment, including Health, Social Conditions, Economic Conditions, Ecological Conditions or Cultural Heritage	22 May 2019 (GN. 686 Gazette No. 42472)	Part 3, Category 1, Subcategory 1.1 of the Listed Activities was amended by the deletion that existing plants shall comply with a new emission limit of 1000 mg/Nm^3 for sulphur dioxide (SO_2).
Amendments to the National Greenhouse Gas Emission Reporting Regulations	11 September 2020 (GN. 994 Gazette No. 43712)	These regulations were written to put emphasis that the Republic of South Africa must strive to meet obligations under UNFCCC and instrument treaties to which it is a signatory.
Regulations Regarding the Phasing-Out and Management of Ozone-Depleting Substances	11 January 2021 (As amended in GN. 10 Gazette No. 44065)	The purpose of these regulations is to regulate the management and phasing-out of identified ozone-depleting substances that are still being used in the Republic of South Africa.
Technical Guidelines for the Validation and Verification of Greenhouse Gas Emissions	12 November 2021 (GN. 1496 Gazette 45452)	The purpose of the Verification Guideline is to support the implementation of the mandatory

Legislation	Commencement Date	Description / Purpose
		GHG reporting regime in South Africa. The Verification Guideline provides direction to the Competent Authority, Data Providers and Independent Assessors on the verification process for the National Greenhouse Gas Emissions Reporting Regulations (NGERs) and details the responsibilities of these role players. This Verification Guideline is applicable to all anthropogenic emissions by sources and removals by sinks as outlined in Annexure 1 of the NGERs.
Methodological Guidelines for Quantification of Greenhouse Gas Emissions – Carbon Sequestration in the Forestry Industry	28 January 2022 (GN. 1700 Gazette No. 45816)	Greenhouse gas (GHG) emissions represented by the variable "E" in the Carbon Tax formula are calculated in accordance with the methodology set out in the Technical Guidelines for Monitoring, Reporting and Verification of Greenhouse Gas Emissions by Industry (DEA, 2017). The purpose of these guidelines is to provide guidance on the methodology for determining the sequestration or "S" factor in the Carbon Tax formula. The guidelines aim to facilitate the understanding and completion by companies of the MRV tool for reporting, and the verification of the information reported. The guidelines are in line with the Accounting Rulebook that contain the accounting rules for the Carbon Tax Act 15 of 2019.
Amendment to the Notice Declaring Temporary Asphalt Plans as Controlled Emitters	26 April 2024 (GN. R. 4753 of Gazette No. 50550)	The Amendment redefines the definition of a temporary asphalt plants as well as the roles and responsibilities of the different organs of state

7 REFERENCES

Abiodun, B.J., Ojumu, A.M., Jenner, S. and Ojumu, T.V., 2014. The transport of atmospheric NO x and HNO 3 over Cape Town. *Atmospheric Chemistry and Physics*, 14(2), pp.559-575.

Adeeyo, R.O., Edokpayi, J.N., Volenzo, T.E., Odiyo, J.O. and Piketh, S.J., 2022. Determinants of solid fuel use and emission risks among households: insights from Limpopo, South Africa. *Toxics,* 10(2), p.67.

Browning, L.H., 2006. *Current Methodologies and Best Practices for Preparing Port Inventories.* Prepared for the United States Environmental Protection Agency by ICF Consulting, April 4, 2006.

Council for Geoscience (2013). Mineral Resources. www.geoscience.org.za (January 2013).

DEA, 2012. *Ambient Air Quality Standards. Republic of South Africa*, GN 35072, 2 March 2012.

DEA, 2018. The National Framework for Air Quality Management in the Republic of South Africa.

DEA&DP, 2015. State of Air Quality Management 2015. Department of Environmental Affairs and Development Planning. Western Cape Government.

DEA&DP, 2016. Shale Gas Development in the Karoo Basin: A Brief Update. Western Cape Government.

DEA&DP, 2018a. Department of Environmental Affairs and Development Planning, 2018. Energy Consumption and CO2e Emission Database for the Western Cape, March 2018

DEA&DP, 2018b. Department of Environmental Affairs and Development Planning, 2018. State of Environment Outlook Report for the Western Cape Province, February 2018.

DEA&DP, 2020. State of Air Quality Management: Western Cape 2020. Department of Environmental Affairs and Development Planning. Western Cape Government.

DEA&DP, 2021. Western Cape Air Quality Management Plan, 2021. Department of Environmental Affairs and Development Planning. Western Cape Government.

DEA&DP, 2022. Western Cape Climate Change Response Strategy. 2022. Department of Environmental Affairs and Development Planning. Western Cape Government.

DoW (2015). Strategic Plan 2015 -2020. [online] Available at: https://www.gov.za/sites/default/files/gcis_document/201610/dow-annual-report-2015-16a.pdf.

Dunbar, R., 2024. Cape Town has the ninth-worst traffic congestion in the world. [online] Cape Business News. Available at: https://www.cbn.co.za/industry-news/transport-logistics-freight-services/cape-town-has-the-ninth-worst-traffic-congestion-in-the-world/#:~:text=TRAFFIC%20congestion%20in%20Cape%20Town [Accessed 12 Jul. 2024].

Josipovic, M., Annegarn, H.J., Kneen, M.A., Pienaar, J.J. and Piketh, S.J., 2011. Atmospheric dry and wet deposition of sulphur and nitrogen species and assessment of critical loads of acidic deposition exceedance in South Africa. *South African Journal of Science*, 107(3), pp.1-10, Unpublished Data.

State of Global Air 2020. Special Report. Boston, *MA: Health Effects Institute*.

Florentina, I. and Ion, B. The Effects of Air Pollutants on Vegetation and the Role of Vegetation in Reducing Atmospheric Pollution. *The Impact of Air Pollution on Health, Economy, Environment and Agricultural Sources*, 2011.

Madonsela, B.S., Maphanga, T., Chidi, B.S., Shale, K. and Zungu, V., 2022. Assessment of air pollution in the informal settlements of the Western Cape, South Africa. *Journal of Air Pollution and*

Health.

Maponya, P. and Rampedi, I.T., 2013. Impact of air pollution on maize production in the Sasolburg Area, South Africa. *Journal of Agricultural Science*, 5(11), p.181.

Mompati, M.K., 2019. Atmospheric deposition of sulphur and nitrogen over Eastern South Africa (Doctoral dissertation, North-West University (South Africa).

PT, 2023. Provincial Treasury, 2023. Provincial Economic Review and Outlook. Western Cape Government.

Rodríguez-Sánchez, V.M., Rosas, U., Calva-Vásquez, G. and Sandoval-Zapotitla, E., 2020. Does acid rain alter the leaf anatomy and photosynthetic pigments in urban trees?. *Plants*, 9(7), p.862.

Saxena, P., Sonwani, S. and Kulshrestha, U.C., 2016. Impact of tropospheric ozone and particulate matter on plant health. Sustaining Future Food Security In Changing Environments, Nova Science Publishers, Inc. New York, p.21.

SBIDZ, 2017. http://www.sbidz.co.za/ [accessed on 10 April 2017].

Shikwambana, L., Mhangara, P. and Mbatha, N., 2020. Trend analysis and first time observations of sulphur dioxide and nitrogen dioxide in South Africa using TROPOMI/Sentinel-5 P data. *International Journal of Applied Earth Observation and Geoinformation*, 91, p.102130.

Singh, A. and Agrawal, M., 2007. Acid rain and its ecological consequences. *Journal of Environmental Biology*, 29(1), p.15.

Singh, U., Garg, A., Rani, B., Maheshwari, R. & Prasad, M. 2012. Indoor Air Pollution & Its Impact on Public Health : A Review. *Advances in Bioresearch*.

StatsSA CS, 2016. http://cs2016.statssa.gov.za/ [accessed on 31 May 2017].

StatsSA, 2023. Statistics South Africa | Census Dissemination. [online] census.statssa.gov.za. Available at: https://census.statssa.gov.za/#/province/1/2.

Swartz, J.S., Van Zyl, P.G., Beukes, J.P., Galy-Lacaux, C., Labuschagne, C., Brunke, E.G., Mkololo, T. and Pienaar, J.J., 2022. Wet season chemical composition of atmospheric wet deposition at Cape Point. *Clean Air Journal*, 32(1), pp.1-9.

The World Bank Annual Report 2022. https://doi.org/10.1596/AR2022EN.

USEPA, 1996. Compilation of Air Pollution Emissions Factors (AP-42). 6th edition, volume 1 as contained in the AirCHIEF (AIR Clearinghouse for Inventories and Emission Factors) CD-ROM (compact disk read only memory), US Environmental Protection Agency, Research Triangle Park, North Carolina.

USEPA, 2017. Air Quality System: Criteria Air Pollutants https://www.epa.gov/criteria-air-pollutants [accessed on 10 April 2017].

Wesgro, 2019. Western Cape District Municipality Economy Factsheets, 2019.https:cdn.investwesterncape.com/attachments/cjyo3ajxx018ot6qpz1v2tkea-district-fact-sheets-2019.pdf [accessed 28 August 2020].

Wesgro, 2022. An Overview of the Western Cape’s Agriculture Sector. [online] Available at: https://www.wesgro.co.za/uploads/files/Wesgro-Research_An-Overview-of-the-Western-Capes-Agriculture-Sector_2022.11_USD-Version.pdf [Accessed 9 Jul. 2024].

Wilson, D., 2008. Atmospheric deposition of combined nitrogen in the Cape Metropolitan Area: a threat to a species rich ecosystem? (Master's thesis, University of Cape Town).

WHO, 2016. Burning Opportunity: Clean Household Energy for Health, Sustainable Development, and Wellbeing of Women and Children. World Health Organization. www.who.int.org.

WHO (2023). Air Pollution. [online] World Health Organization. Available at: https://www.who.int/health-topics/air-pollution#tab=tab_1 [Accessed 3 Jul. 2024].

World Resources Institute (2021). Global Forest Watch. [online] Globalforestwatch.org. Available at: https://www.globalforestwatch.org/ [Accessed 3 May 2023].

Department of Environmental Affairs and Development Planning
Leeusig Building, 3rd Floor, 1 Dorp Street, Cape Town, 8001
Private Bag X9086, Cape Town, 8000
Telephone: +27 (0)21 483 4091 / Facsimile: +27 (0)21 483 3016
Email: enquiries.eadp@westerncape.gov.za

Western Cape Government
Environmental Affairs and Development Planning

BETTER TOGETHER.