KMG
Environmental
Solutions Services

Air Quality Impact Assessment (AQIA)

Proposed Establishment of a New Landfill Site in MaletswaiMaletswai (Aliwal North), Eastern Cape Province, South AfricaWalter Sisulu Local MunicipalityJoe Gqabi District Municipality

Prepared for

Rambuda Consultants (Pty) Ltd

On Behalf of

Walter Sisulu Local Municipality

AUGUST 1, 2026

KMG Environmental Solutions Services (Pty) Ltd
08 Hillside Road, Metropolitan
Building ,Parktown ,JHB,|Info@kmgenviro.co.za|www.kmgenviro.co.za | 011 96961 84 |

DOCUMENT INFORMATION

Item	Details
Report Title	Air Quality Impact Assessment (AQIA)
Project	Proposed Establishment of a New Landfill Site in Maletswai
Project Location	Maletswai (Aliwal North), Eastern Cape Province, South Africa
Local Municipality	Walter Sisulu Local Municipality
District Municipality	Joe Gqabi District Municipality
Client / Applicant	Walter Sisulu Local Municipality
Environmental Consultant	Rambuda Consultants (Pty) Ltd
Specialist Consultant	KMG Environmental Solutions Services (Pty) Ltd
Specialist Assessment	Air Quality Impact Assessment
Project Alternatives Assessed	Preferred Site, Option Site 1 and Option Site 2
Field Assessment Date	30 August 2026
Assessment Approach	Desktop baseline assessment, field verification, sensitive receptor identification, ambient air quality monitoring and air quality impact assessment
Field Monitoring Equipment	ES60A Portable Multi Gas Detector
Air Quality Parameters Monitored	$PM_{2.5}$, PM_{10}, TSP, CH_4, CO_2, H_2S, NO_2, SO_2 and O
Additional Field Parameters	Temperature, Relative Humidity, Wind Speed, Wind Direction and Precipitation
Instrument Accuracy	±3% F.S.
Instrument Response Time	≤30 seconds
Desktop Ambient Air Quality Data	Single-station ambient air quality dataset supplied for the assessment
Report Status	Draft Air Quality Impact Assessment
Report Date	August 2026
Author	Khumbelo Given Marabe – BSc Environmental Sciences; SACNASP Natural Scientist, Reg. No. 132731
Company	KMG Environmental Solutions Services (Pty) Ltd
Company Registration No.	2020/100850/07
Contact	+27 11 969 6184 / 072 546 3191
Email	info@kmgenviro.co.za
Website	www.kmgenviro.co.za

DISCLAIMER

This Air Quality Impact Assessment (AQIA) has been prepared by KMG Environmental Solutions Services (Pty) Ltd for the proposed establishment of a new landfill site in Maletswai (Aliwal North), Eastern Cape Province.

The assessment is based on the project information made available at the time of preparation, desktop air quality and environmental information, field observations, identification of potential emission sources and sensitive receptors, and site-specific monitoring undertaken on 30–31 August 2026.

Field monitoring included measurements of methane (CH_4), oxygen (O_2), hydrogen sulphide (H_2S), carbon dioxide (CO_2), nitrogen dioxide (NO_2) and sulphur dioxide (SO_2), together with temperature and relative humidity. The portable multi-gas detector used for the assessment was supported by the available calibration certificate dated 09 April 2025.

The findings presented in this report represent conditions and information available during the assessment period. Ambient air quality may vary over time as a result of meteorological conditions, seasonal changes, surrounding land uses, traffic, domestic activities, waste-management activities, veld fires and other natural or anthropogenic emission sources.

Desktop and short-duration field measurements provide an indication of baseline conditions and should not be interpreted as continuous long-term monitoring at every location within the study area.

Predictions and impact ratings presented in this report are based on the proposed project characteristics and assumptions available at the time of assessment. Changes to the landfill footprint, waste quantities, operating methods, infrastructure layout or surrounding land uses may require review of the air quality findings.

The recommendations and mitigation measures contained in this report are intended to support environmental decision-making and should be incorporated into the project Environmental Management Programme (EMPr), operational procedures and applicable air quality management requirements.

KMG Environmental Solutions Services (Pty) Ltd accepts no responsibility for conclusions resulting from information that was unavailable, inaccurate or subsequently changed after completion of the assessment.

SPECIALIST DECLARATION

Declaration by the Air Quality Specialist

I, Khumbelo Given Marabe, declare that:

- I am responsible for the preparation of this Air Quality Impact Assessment for the proposed establishment of a new landfill site in Maletswai (Aliwal North), Eastern Cape Province.
- I am suitably qualified and experienced to undertake environmental and air quality assessments relevant to the scope of this study.
- I am registered with the South African Council for Natural Scientific Professions (SACNASP) as a Natural Scientist, Registration No. 132731.
- I have undertaken this assessment objectively and have applied appropriate professional judgement in the interpretation of the available project information, desktop information and field findings.
- The field component of the assessment was undertaken on 30–31 August 2026.
- I have no vested or financial interest in the proposed development other than remuneration for professional services rendered.
- The findings, conclusions and recommendations contained in this report are based on the information available at the time of the assessment.
- I have identified and considered the potential air quality impacts associated with the proposed development within the scope of this specialist assessment.
- I undertake to disclose any material information that may reasonably influence the findings or recommendations of this assessment.
- To the best of my knowledge, the information presented in this report is accurate and has not been intentionally altered or misrepresented.

Declaration Information	**Details**
Name	Khumbelo Given Marabe
Qualification	BSc Environmental Sciences
Professional Registration	SACNASP Natural Scientist – Reg. No. 132731
Role	Air Quality Specialist / Report Author
Organisation	KMG Environmental Solutions Services (Pty) Ltd
Signature	
Date	24/08/2026

ACRONYMS AND ABBREVIATIONS

Acronym / Abbreviation	Description
AEL	Atmospheric Emission Licence
AQIA	Air Quality Impact Assessment
AQMP	Air Quality Management Plan
CO	Carbon Monoxide
CO_2	Carbon Dioxide
DFFE	Department of Forestry, Fisheries and the Environment
EA	Environmental Authorisation
EAP	Environmental Assessment Practitioner
EIA	Environmental Impact Assessment
EMPr	Environmental Management Programme
ES60A	Portable Multi Gas Detector used during field monitoring
GIS	Geographic Information System
GPS	Global Positioning System
H_2S	Hydrogen Sulphide
KMG	KMG Environmental Solutions Services (Pty) Ltd
LFG	Landfill Gas
CH_4	Methane
MRF	Material Recovery Facility
NAAQS	National Ambient Air Quality Standards
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
NEM:AQA	National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004)
NEMWA	National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008)
NO_2	Nitrogen Dioxide
NO_x	Oxides of Nitrogen
O_2	Oxygen
PM	Particulate Matter
PM_{10}	Particulate Matter with an aerodynamic diameter of 10 µm or less
$PM_{2.5}$	Particulate Matter with an aerodynamic diameter of 2.5 µm or less
RH	Relative Humidity
SAQIS	South African Air Quality Information System
SO_2	Sulphur Dioxide
VOCs	Volatile Organic Compounds
WSLM	Walter Sisulu Local Municipality
$\mu g/m^3$	Micrograms per Cubic Metre
mg/m^3	Milligrams per Cubic Metre
ppm	Parts Per Million
ppb	Parts Per Billion
°C	Degrees Celsius
%RH	Percentage Relative Humidity

TERMS AND DEFINITIONS

Term	Definition
Air Pollutant	Any substance present in the atmosphere at a concentration that may adversely affect human health, ecosystems, property or environmental quality.
Air Quality Impact Assessment	A specialist assessment undertaken to identify existing air quality conditions and evaluate potential changes in air quality resulting from a proposed development.
Ambient Air	Outdoor air within the surrounding environment, excluding air regulated specifically as workplace exposure.
Ambient Air Quality	The condition of outdoor air expressed in terms of the concentrations of pollutants present within the atmosphere.
Background Concentration	The concentration of a pollutant already present within the receiving environment before the contribution from the proposed development is considered.
Carbon Dioxide (CO_2)	A colourless gas produced naturally and through combustion and decomposition processes. Within landfill environments, CO_2 is also generated through biological degradation of organic waste.
Dust	Fine solid particles capable of becoming airborne through wind action, vehicle movement, excavation, material handling and other mechanical disturbance.
Emission	The release of a pollutant or substance into the atmosphere from a source.
Emission Source	An activity, process or location from which pollutants are released into the atmosphere.
Fugitive Emissions	Emissions released from diffuse sources rather than through a defined stack or vent, including windblown dust, vehicle-generated dust and emissions from exposed waste surfaces.
Hydrogen Sulphide (H_2S)	A gas associated with anaerobic decomposition of sulphur-containing organic material. It has a characteristic offensive odour and may occur in landfill gas.
Landfill Gas (LFG)	Gas generated through biological decomposition of waste within a landfill, consisting predominantly of methane and carbon dioxide together with smaller quantities of other gases.
Methane (CH_4)	A colourless and flammable gas generated during anaerobic decomposition of biodegradable organic waste and an important component of landfill gas.
National Ambient Air Quality Standards	National standards specifying allowable ambient concentrations and averaging periods for identified criteria pollutants to protect human health and the environment.
Nitrogen Dioxide (NO_2)	A gaseous air pollutant primarily associated with combustion processes, including vehicle and machinery exhaust emissions.
Particulate Matter (PM)	A mixture of solid particles and liquid droplets suspended in air.
PM_{10}	Inhalable particulate matter with an aerodynamic diameter of 10 micrometres or less.
$PM_{2.5}$	Fine particulate matter with an aerodynamic diameter of 2.5 micrometres or less.

Potential Sensitive Receptor	A location or land use where people or other sensitive activities may experience changes in ambient air quality, including residences, schools, healthcare facilities and other occupied areas.
Relative Humidity	The amount of water vapour present in the air relative to the maximum amount the air can hold at the prevailing temperature, expressed as a percentage.
Sensitive Receptor	A person, community, facility or land use potentially sensitive to air pollutant concentrations, dust or offensive odours.
Sulphur Dioxide (SO_2)	A gaseous pollutant principally associated with combustion of sulphur-containing fuels and other combustion or industrial processes.
Temperature	A measure of atmospheric thermal conditions. Temperature influences atmospheric stability, pollutant dispersion and the behaviour of gaseous emissions.
Volatile Organic Compounds (VOCs)	Organic compounds that readily evaporate into the atmosphere and may originate from fuels, waste decomposition and other organic or chemical materials.
Wind Direction	The direction from which the wind originates. It is important for identifying the direction in which emissions may be transported from a source toward receptors.
Wind Speed	The rate of movement of air. Wind speed influences dilution, transport and dispersion of airborne pollutants.
Windblown Dust	Particulate material entrained into the atmosphere by wind passing over exposed soil, waste, stockpiles or other disturbed surfaces.
Oxygen (O_2)	A naturally occurring atmospheric gas measured during the field assessment as an additional indicator of ambient atmospheric conditions.
Odour	A sensory response caused by detectable airborne compounds. Landfill odours may be associated with decomposition products, including reduced sulphur compounds and other volatile substances.
Dispersion	The transport, dilution and distribution of pollutants in the atmosphere under the influence of meteorological and terrain conditions.
Baseline Air Quality	The existing air quality condition of the receiving environment prior to implementation of the proposed development, established through available desktop information and/or field monitoring.

EXECUTIVE SUMMARY

KMG Environmental Solutions Services (Pty) Ltd was appointed by Rambuda Consultants (Pty) Ltd to undertake an Air Quality Impact Assessment (AQIA) for the proposed establishment of a new municipal landfill facility in Maletswai (Aliwal North), Eastern Cape Province, on behalf of Walter Sisulu Local Municipality. The assessment considered the Preferred Site, Option Site 1 and Option Site 2 and evaluated potential air quality impacts associated with construction, operation, closure and post-closure of the proposed landfill.

The AQIA comprised desktop review, identification of existing emission sources and sensitive receptors, review of available regional ambient air quality and meteorological information, and site-specific field verification and ambient air quality monitoring undertaken on 30 August 2026. The assessment considered particulate matter, landfill gases, combustion-related pollutants, odour and the influence of meteorological and topographical conditions on potential pollutant transport.

Baseline Air Quality

The receiving environment is predominantly rural and peri-urban and is influenced by grazing and agricultural activities, residential development, vehicle traffic, unpaved roads, exposed surfaces, railway infrastructure and existing waste-management activities.

Regional ambient air quality information from the Zwelitsha monitoring station was reviewed as supplementary background information. Because the station is approximately 250 km from the project area, the data were used for regional context and not as a direct representation of ambient conditions at Maletswai. The supplied dataset also contained data-quality limitations in some meteorological channels, and these were not relied upon where values were considered unreliable.

Site-specific monitoring was therefore important in establishing local baseline conditions. Monitoring was undertaken at five representative points (MP01–MP05) on 30 August 2026 using a PDM99 portable particulate monitor, an ES60A portable multi-gas detector and a portable anemometer.

The monitored parameters included $PM_{2.5}$, PM_{10}, TSP, CH_4, CO_2, H_2S, NO_2, SO_2 and O_2, supported by temperature, relative humidity, wind speed, wind direction and precipitation observations.

Field conditions were dry, with temperatures of approximately 21–28°C, relative humidity of approximately 14%, no precipitation and south-easterly winds of approximately 2.2 m/s (8 km/h).

Field Monitoring Results

Ambient conditions were generally good across MP01, MP02, MP04 and MP05. MP03, which was influenced by the existing waste-disposal environment, recorded comparatively higher particulate and gaseous concentrations.

$PM_{2.5}$ concentrations ranged from 6–18 µg/m³, PM_{10} from 17–48 µg/m³ and TSP from 34–86 µg/m³. CH_4 was below 1 ppm at the general monitoring points and approximately 3 ppm at

MP03, while H_2S was below 0.1 ppm at the general locations and approximately 0.2 ppm at MP03. CO_2 ranged from approximately 418–438 ppm and O_2 remained approximately 20.8–20.9%.

The elevated $PM_{2.5}$, PM_{10}, TSP, CH_4, CO_2 and H_2S concentrations at MP03 indicate a localised waste-related influence rather than widespread deterioration of ambient air quality across the study area.

Sensitive Receptors

Six sensitive receptors were identified within the adopted 5 km assessment area, including residential areas, Vumile Primary School, Limakatso Boutique Hotel, an agricultural/plantation receptor and road users.

The principal potential effects on these receptors include exposure to fugitive dust, PM_{10}, $PM_{2.5}$, offensive odour, landfill gas and windblown waste. Educational and residential receptors were considered particularly sensitive because of the potential for prolonged exposure.

Pollutants and Dispersion Assessment

The assessment considered the principal pollutants potentially associated with the proposed landfill, including:

- PM_{10}, $PM_{2.5}$ and TSP from earthworks, exposed surfaces, unpaved roads, waste handling and cover material;
- NO_2, SO_2, NO_x and CO associated primarily with vehicles and machinery;
- CH_4 and CO_2 associated with decomposition of biodegradable waste;
- H_2S and other odorous compounds associated with anaerobic decomposition and leachate; and
- VOCs, smoke and other combustion products that may occur during abnormal events such as landfill fires.

The applicable National Ambient Air Quality Standards were considered for PM_{10}, $PM_{2.5}$, NO_2 and SO_2.

No formal regulatory dispersion model such as AERMOD, CALPUFF, ADMS or SCREEN3 was undertaken. Quantitative modelling requires reliable project-specific emission rates, waste throughput, traffic volumes, active working-face dimensions, landfill-gas generation rates and representative meteorological inputs. These detailed inputs were not sufficiently available at the current project stage, and generating concentration contours from assumed inputs would therefore not provide a sufficiently defensible prediction.

A screening-level source–pathway–receptor assessment was consequently applied using the field results, emission sources, receptor locations, terrain, vegetation and available meteorological information.

Under the south-easterly winds recorded during the field assessment, potential airborne transport would occur generally toward the north-west. The indicative particulate matter

dispersion figure illustrates this potential transport pathway but does not represent numerical modelled concentration contours or predicted regulatory exceedances.

Potential Impacts

During construction, the principal air quality impact will be fugitive particulate matter generated by vegetation clearing, excavation, earthworks, material handling, exposed surfaces and vehicle movement.

During operation, the main concerns are expected to include PM_{10}, $PM_{2.5}$ and nuisance dust from internal roads and waste handling; CH_4 and CO_2 from waste decomposition; H_2S and offensive odour; vehicle and machinery exhaust emissions; windblown litter; and smoke should an accidental landfill fire occur.

Without appropriate mitigation, localised dust and odour impacts may become significant during dry, windy or unfavourable operational conditions. These impacts can, however, be substantially reduced through appropriate landfill design and operational management.

Alternatives Assessment

The Preferred Site is considered the most favourable alternative from an air quality perspective.

The Preferred Site benefits from comparatively greater surrounding vegetation and terrain/hills that provide partial natural screening and increased surface roughness. These characteristics may assist in reducing unrestricted near-ground transport of coarse dust and windblown litter. The site also has lower cumulative interaction with the existing waste-disposal environment than Option Site 1.

Option Site 1 is ranked second because it occurs adjacent to the existing dumping area and within a comparatively open landscape influenced by electrical powerline servitudes and railway infrastructure. The site therefore presents a greater potential for cumulative dust, landfill-gas, odour and litter impacts.

Option Site 2 is ranked third because of its comparatively open and exposed setting, limited natural wind barriers and proximity to the road corridor. These characteristics increase the potential for unrestricted wind-driven dust and litter transport.

The final air quality ranking is therefore:

- Preferred Site – Most Preferred
- Option Site 1 – Second Preferred
- Option Site 2 – Least Preferred

Mitigation and Monitoring

Key mitigation measures include regular dust suppression on unpaved roads, vehicle speed control, minimisation of exposed surfaces, prompt waste compaction and covering, maintenance of the smallest practicable active working face, landfill-gas management,

effective leachate management, prohibition of uncontrolled waste burning, fire prevention and effective containment of windblown litter.

Air quality monitoring should include PM_{10}, $PM_{2.5}$, TSP, CH_4, CO_2, O_2 and H_2S, supported by meteorological monitoring. Dust-fall monitoring should also be considered at representative upwind and downwind boundaries during landfill operation.

A complaints register should be maintained, and recurring dust, smoke or odour complaints should trigger targeted investigation and corrective action.

Specialist Conclusion

No fatal air quality flaw has been identified for the proposed Maletswai Landfill.

Baseline monitoring indicates generally good ambient air quality across the study area, with a localised waste-related influence identified at MP03. The proposed landfill has the potential to generate particulate matter, landfill gas, odour and combustion-related emissions; however, these impacts are considered manageable through appropriate engineering, operational controls and monitoring.

The Preferred Site is supported as the most favourable alternative because its terrain and vegetation provide comparatively greater natural screening, it has lower cumulative interaction with the existing dumping area than Option Site 1, and it is less exposed to unrestricted wind-driven transport than Option Site 2.

Development of the Preferred Site is therefore considered acceptable from an air quality perspective, provided that the prescribed dust suppression, landfill-gas management, odour control, fire prevention, litter containment and monitoring measures are incorporated into the EMPr and implemented throughout the project lifecycle.

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1. INTRODUCTION

1.1 Background

Walter Sisulu Local Municipality (WSLM) proposes the establishment of a new municipal landfill facility in Maletswai (Aliwal North), Eastern Cape Province. The proposed development is intended to provide replacement municipal waste-disposal capacity following the existing Maletswai landfill reaching the end of its operational lifespan.

The proposed development forms part of the Municipality's broader waste-management programme and includes the establishment of an engineered landfill facility and associated infrastructure. The project design provides for landfill disposal cells, access and internal roads, a weighbridge and control facilities, Material Recovery Facility (MRF), administration and staff facilities, stormwater management infrastructure, leachate collection and management infrastructure, a Pollution Control Dam (PCD), security infrastructure and associated municipal services.

The proposed landfill has an anticipated operational design life of approximately 20 years. The design incorporates engineered containment, leachate management, stormwater control and progressive rehabilitation measures intended to minimise environmental impacts associated with waste disposal activities.

KMG Environmental Solutions Services (Pty) Ltd was appointed by Rambuda Consultants (Pty) Ltd to undertake specialist Agricultural and Air Quality assessments for the proposed development. The appointment requires consideration of the identified project alternatives and provision of specialist findings to inform the environmental assessment and site-selection process.

This report presents the Air Quality Impact Assessment (AQIA) undertaken for the proposed development. The assessment considers the potential implications of construction, operation and eventual closure of the landfill on ambient air quality and surrounding sensitive receptors.

1.2 Project Location and Alternatives

The proposed landfill development is located on the western to south-western outskirts of Maletswai (Aliwal North), within Walter Sisulu Local Municipality and Joe Gqabi District Municipality, Eastern Cape Province.

The broader project area is characterised by a mixture of rural, agricultural, peri-urban, residential, transport and waste-related land uses. The Orange River occurs north of the project area, while the R58 and N6 form important components of the regional transport network.

Three candidate development areas are considered in this assessment:

- Preferred Site;
- Option Site 1; and
- Option Site 2.

The Preferred Site is the northernmost alternative and occurs comparatively closer to the Maletswai/Dukathole settlement area and the Orange River corridor. Option Sites 1 and 2 occur farther south-west within a more open rural landscape.

Option Site 1 is situated close to the existing waste disposal/dumping area and is also influenced by existing electrical powerlines and railway infrastructure. Option Site 2 occurs close to the main road and railway and is comparatively open and exposed. These differences are relevant to the air quality assessment because surrounding emission sources, receptor locations, terrain exposure and wind conditions influence the potential transport and dispersion of dust, gases and odours.

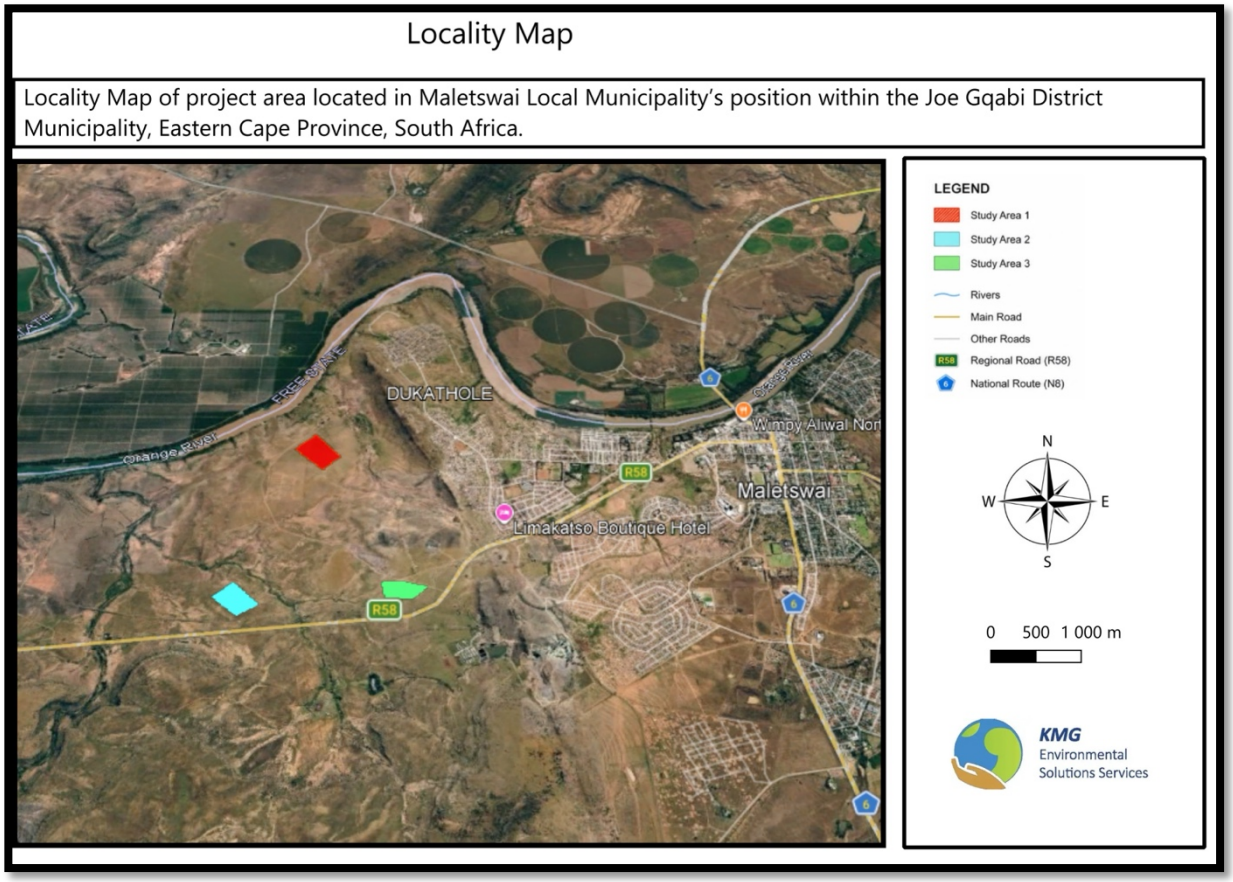


Figure 1 : Locality of the Preferred Site, Option Site 1 and Option Site 2 within the Maletswai study area.

1.3 Purpose of the Air Quality Impact Assessment

The purpose of the AQIA is to characterise the existing air quality environment and assess the potential changes in ambient air quality that may result from the proposed landfill development.

The assessment considers both existing sources of atmospheric emissions within the receiving environment and potential emissions associated with the proposed development.

Particular attention is given to:

- Fugitive dust and particulate matter;
- Vehicle and machinery exhaust emissions;
- Landfill gas generation;
- Methane and carbon dioxide;
- Hydrogen sulphide and other potentially odorous compounds;
- Nitrogen dioxide and sulphur dioxide;
- Offensive odours;
- Windblown emissions from exposed waste and disturbed surfaces; and
- Potential cumulative effects with existing emission sources.

The AQIA also considers the location and sensitivity of surrounding receptors and the meteorological conditions that influence the transport, dilution and dispersion of pollutants.

1.4 Objectives of the Assessment

The principal objectives of the AQIA are to:

- Establish the existing ambient air quality characteristics of the receiving environment;
- Identify existing potential sources of air pollution within the study area;
- Identify potentially sensitive receptors surrounding the three alternatives;
- Evaluate available ambient air quality information relevant to the project area;
- Undertake site-specific field verification and portable ambient gas monitoring;
- Characterise meteorological conditions relevant to atmospheric dispersion;
- Identify the principal pollutants of concern associated with the proposed landfill;
- Assess potential construction-phase air quality impacts;
- Assess operational dust, landfill gas and odour impacts;
- Consider potential closure and rehabilitation impacts;
- Compare the preferred site, option site 1 and option site 2 from an air quality perspective;
- Recommend appropriate mitigation and air quality management measures;
- Develop appropriate monitoring recommendations; and
- Provide a specialist opinion regarding the acceptability of the proposed development from an air quality perspective.

1.5 Field Assessment

The site-specific air quality field assessment was undertaken on 30–31 August 2026 and covered the three candidate development sites and their surrounding receiving environment.

The field investigation included visual verification of the sites, identification of existing and potential emission sources, consideration of surrounding sensitive land uses and portable monitoring of selected gaseous parameters.

Portable measurements included:

- Methane (CH_4);
- Oxygen (O_2);
- Hydrogen sulphide (H_2S);
- Carbon dioxide (CO_2);
- Nitrogen dioxide (NO_2); and

- Sulphur dioxide (SO_2).

Temperature and relative humidity were also recorded as supporting atmospheric parameters.

The ES60A Portable Multi Gas Detector used during the field assessment is supported by the supplied calibration certificate dated 09 April 2025. The certificate identifies CH_4, O_2, H_2S, CO_2, NO_2 and SO_2 as calibrated measurement channels, with a stated accuracy of ±3% F.S. and response time of ≤30 seconds.

1.6 Scope of the Assessment

The AQIA incorporates both desktop and field-based components. The assessment includes:

- Review of available project information and proposed landfill activities;
- Review of available ambient air quality information;
- Identification of existing emission sources;
- Identification of sensitive receptors;
- Review of relevant meteorological and dispersion conditions;
- Field verification undertaken on 30–31 august 2026;
- Portable monitoring of selected gaseous parameters;
- Identification of pollutants of concern;
- Assessment of construction, operational and closure-phase impacts;
- Comparison of the three candidate alternatives;
- Formulation of mitigation and air quality management measures; and
- Provision of monitoring and specialist recommendations.

The desktop ambient monitoring dataset and the short-duration field measurements are treated separately. The desktop information provides broader baseline context, while the portable measurements provide site-specific verification of conditions encountered during the field assessment.

1.7 Principal Air Quality Concerns

The nature of the potential emissions is expected to vary over the lifecycle of the proposed landfill.

During construction, the principal concerns are expected to be fugitive dust and particulate emissions arising from vegetation clearing, topsoil stripping, excavation, earthworks, material handling, construction traffic and wind erosion of exposed surfaces.

During operation, potential sources will include waste transportation, vehicle movement on internal roads, waste unloading, spreading and compaction, exposed waste surfaces, landfill gas generation, decomposition of organic waste, leachate management and exhaust emissions from mobile equipment.

Landfill gas is generated through decomposition of biodegradable waste and may contain methane and carbon dioxide as major components together with smaller quantities of other compounds. Odorous emissions may also occur where waste is not adequately compacted and covered or where landfill gas and leachate are inadequately managed.

These potential emissions form the basis of the detailed air quality assessment presented in the subsequent sections of this report.

2. PROJECT DESCRIPTION

2.1 Project Overview

Walter Sisulu Local Municipality proposes to establish a new engineered municipal landfill facility in Maletswai (Aliwal North), Eastern Cape Province. The facility is intended to provide replacement waste-disposal capacity following the existing Maletswai landfill reaching the end of its operational lifespan.

The proposed landfill is planned for an operational design period of approximately 20 years and will comprise the waste-disposal cells together with supporting infrastructure necessary for controlled receipt, handling, placement and management of municipal waste.

The project includes consideration of three potential development locations: the Preferred Site, Option Site 1 and Option Site 2. All three alternatives are considered in this Air Quality Impact Assessment because the location of the landfill relative to receptors, existing emission sources and local dispersion conditions may influence the magnitude of potential air quality impacts.

2.2 Proposed Infrastructure

The proposed development will comprise an engineered landfill facility incorporating:

- Landfill disposal cells;
- Access and internal roads;
- Weighbridge and control facilities;
- Material recovery facility (mrf);
- Administration and staff facilities;
- Security fencing and controlled access;
- Stormwater diversion and drainage infrastructure;
- Leachate collection and conveyance infrastructure;
- Pollution control dam (pcd);
- Landfill gas management infrastructure;
- Environmental monitoring infrastructure; and
- Progressive rehabilitation and final closure areas.

From an air quality perspective, the landfill cells, internal roads, waste-handling areas, MRF, leachate-management infrastructure and landfill gas system represent the principal components requiring consideration.

2.3 Landfill Development and Waste Handling

Waste entering the facility will be transported by road, recorded and weighed before being directed to the active disposal area. At the working face, waste will be unloaded, spread and compacted in controlled layers.

Landfill operation will progressively advance through the available disposal area. Completed or temporarily inactive portions will receive appropriate cover material, while active disposal will be restricted to the working face.

These activities have the potential to generate particulate matter and nuisance dust through:

- Waste-delivery vehicle movement;
- Movement of landfill machinery;
- Travel on unpaved internal roads;
- Unloading of waste;
- Spreading and compaction;
- Handling of cover material; and
- Wind action over disturbed soil and exposed waste.

The size and duration of the active working face are therefore important air quality management considerations.

2.4 Construction Activities

Construction of the proposed landfill will require vegetation clearing, topsoil stripping, excavation, bulk earthworks, construction of containment systems, development of internal roads and establishment of supporting infrastructure.

The principal construction-related air emission sources are expected to include fugitive dust from disturbed soil, excavation and material handling, vehicle-generated dust from unpaved roads and combustion emissions from construction machinery and vehicles.

Construction emissions will generally be temporary and spatially associated with active working areas, although impacts may extend downwind where dust-generating activities are inadequately controlled.

2.5 Landfill Gas Generation

Following disposal, biodegradable organic waste will undergo biological decomposition. Under anaerobic conditions within the landfill body, this process will result in the generation of landfill gas.

Methane (CH_4) and carbon dioxide (CO_2) are the principal gases of concern considered in this assessment. Trace gaseous constituents may also contribute to odour and localised air quality impacts.

Hydrogen sulphide (H_2S) is particularly relevant from an odour perspective because it can be associated with anaerobic decomposition of sulphur-containing waste materials. The potential occurrence of landfill gas requires appropriate collection, venting, monitoring and management throughout the operational and post-closure periods.

2.6 Odour-Generating Activities

Potential odour sources associated with landfill operation include:

- Unloading of fresh municipal waste;
- Exposed biodegradable waste;
- Decomposition of organic material;
- Landfill gas;
- Leachate;
- Contaminated standing water;
- Handling of odorous waste;
- Inadequate daily cover; and
- Disturbance of previously deposited waste.

Odour impacts are strongly influenced by the distance between the source and receptor, wind direction, wind speed, atmospheric stability, waste composition and the effectiveness of landfill operating procedures.

Maintaining a small active working face, effective waste compaction, regular cover and appropriate leachate and landfill gas management will therefore be important operational controls.

2.7 Vehicle and Machinery Emissions

Waste-delivery vehicles, landfill compactors, excavators, loaders and other mobile equipment will generate combustion-related emissions during construction and operation.

Potential pollutants include nitrogen oxides, carbon monoxide, particulate matter, carbon dioxide and smaller quantities of sulphur-related pollutants depending on fuel characteristics and equipment condition.

The magnitude of these emissions will depend on traffic volumes, equipment utilisation, engine condition, fuel quality and operational practices.

2.8 Material Recovery Facility

The proposed Material Recovery Facility will facilitate separation and recovery of recyclable materials before final disposal.

From an air quality perspective, material handling within the MRF may generate localised particulate matter, particularly where dry waste is mechanically sorted or transferred. Appropriate housekeeping, enclosure where necessary and regular removal of accumulated dust and waste will assist in limiting emissions.

Waste diversion through recycling may also reduce the volume of waste ultimately placed in the landfill and thereby contribute to reduced long-term landfill gas generation.

2.9 Stormwater and Leachate Management

The proposed landfill design incorporates separation of clean stormwater from potentially contaminated runoff and provides for collection and management of leachate.

These systems are relevant to air quality because stagnant contaminated water and exposed leachate may become sources of offensive odour, particularly under warm and anaerobic conditions.

Leachate and contaminated-water infrastructure should therefore be appropriately designed, operated and maintained to minimise prolonged exposure of odorous liquids.

2.10 Progressive Rehabilitation and Closure

Landfill development will occur progressively, with completed portions receiving cover and eventual rehabilitation.

Progressive rehabilitation is beneficial from an air quality perspective because it reduces the extent of exposed soil and waste surfaces available for wind erosion and limits uncontrolled release of landfill gas from completed portions of the landfill.

Following final closure, the landfill will be capped and revegetated. Landfill gas generation may nevertheless continue for a substantial period after waste disposal ceases. Post-closure landfill gas and air quality management should therefore continue where required.

2.11 Principal Project-Related Air Emission Sources

The principal potential emission sources associated with the project are summarised below.

Table 1 : Related Air Emission Sources

Project Activity / Source	Principal Potential Emissions	Relevant Project Phase
Vegetation clearing and topsoil stripping	Fugitive dust, PM_{10}, $PM_{2.5}$	Construction
Excavation and earthworks	Dust and particulate matter	Construction
Construction traffic	Road dust and vehicle exhaust emissions	Construction
Waste transport vehicles	Road dust, NO_x, PM and combustion emissions	Operation
Waste unloading and handling	Dust, particulate matter and odour	Operation
Active landfill working face	Dust, odour and landfill gas	Operation
Organic waste decomposition	CH_4, CO_2, H_2S and other odorous compounds	Operation/Post-closure
Landfill cover-material handling	Fugitive dust	Operation
Mobile landfill equipment	NO_x, PM, CO_2 and other combustion emissions	Construction/Operation
Exposed landfill surfaces	Windblown dust and litter	Operation
Leachate/contaminated water	Potential H_2S and offensive odour	Operation
Material Recovery Facility	Localised dust and waste-related odour	Operation

Rehabilitation activities	Temporary dust during soil placement	Closure
Closed landfill body	Residual landfill gas	Post-closure

The subsequent sections assess these sources within the context of the existing ambient air quality environment, applicable air quality standards, meteorological conditions and surrounding sensitive receptors.

3. TERMS OF REFERENCE AND SCOPE OF ASSESSMENT

3.1 Terms of Reference

KMG Environmental Solutions Services (Pty) Ltd was appointed by Rambuda Consultants (Pty) Ltd to undertake an Air Quality Impact Assessment for the proposed Maletswai Landfill development.

The specialist appointment requires consideration of all identified development alternatives and the provision of a professional opinion regarding the environmental suitability of the proposed development. The AQIA therefore considers the Preferred Site, Option Site 1 and Option Site 2.

The assessment focuses on potential changes to ambient air quality associated with construction, operation, closure and post-closure activities, with particular consideration of dust, particulate matter, combustion emissions, landfill gas and offensive odours.

3.2 Scope of Assessment

The scope of the AQIA comprises:

- Review of available project and engineering information;
- Assessment of the preferred site, option site 1 and option site 2;
- Characterisation of the existing receiving environment;
- Review of available ambient air quality information;
- Identification of existing sources of atmospheric emissions;
- Identification of potentially sensitive receptors;
- Consideration of meteorological conditions relevant to dispersion;
- Field verification undertaken on 30–31 august 2026;
- Portable monitoring of selected gaseous parameters;
- Consideration of temperature and relative humidity;
- Identification of project-related emission sources;
- Identification of pollutants of concern;
- Assessment of construction-phase emissions;
- Assessment of operational dust, landfill gas and odour impacts;
- Consideration of closure and post-closure emissions;
- Comparative assessment of the three site alternatives;
- Development of mitigation and air quality management measures; and
- Formulation of monitoring and specialist recommendations.

3.3 Desktop Assessment

The desktop assessment includes review of available project information together with the supplied ambient air quality dataset and available spatial information relevant to the receiving environment.

The desktop component is intended to establish the broader air quality context within which the proposed landfill will operate.

Particular consideration is given to:

- Surrounding land uses;
- Existing waste-related activities;
- Road and railway infrastructure;
- Residential and other potentially sensitive land uses;
- Existing anthropogenic emission sources;
- Regional ambient pollutant concentrations;
- Meteorological conditions;
- Terrain and exposure; and
- Potential cumulative sources.

The supplied single-station ambient air quality dataset is used to provide background context and will be assessed separately from the short-duration field measurements.

3.4 Field Verification

The field component of the AQIA was undertaken on 30–31 August 2026.

The field investigation included inspection of the three candidate sites and surrounding receiving environment to verify conditions relevant to air quality.

The assessment considered:

- Existing emission sources;
- Surrounding residential and other sensitive land uses;
- Existing waste-related activities;
- Road-generated dust;
- Exposed soil surfaces;
- Vegetation and natural wind barriers;
- Terrain and site exposure;
- Nearby transport infrastructure;
- Potential odour sources; and
- Prevailing atmospheric conditions during monitoring.

Field observations are used to verify and refine the desktop assessment rather than being treated as long-term air quality monitoring.

3.5 Portable Ambient Monitoring

Portable ambient monitoring was undertaken to provide an indication of gaseous conditions encountered within the study area during the field assessment.

The parameters considered were:

Table 2 : Parameters Considered

Parameter	Symbol	Principal Relevance to AQIA
Methane	CH_4	Landfill gas and anaerobic waste decomposition
Carbon Dioxide	CO_2	Background atmospheric conditions, combustion and landfill gas
Hydrogen Sulphide	H_2S	Anaerobic decomposition and potential offensive odour
Nitrogen Dioxide	NO_2	Vehicle, machinery and combustion emissions
Sulphur Dioxide	SO_2	Combustion-related emissions
Oxygen	O_2	Supporting atmospheric condition parameter
Temperature	°C	Influences atmospheric dispersion and emission behaviour
Relative Humidity	%RH	Influences atmospheric conditions and dust behaviour

The monitoring results represent conditions encountered during the 30–31 August 2026 field period and are therefore interpreted as site-specific verification measurements rather than continuous annual ambient concentrations.

3.6 Monitoring Equipment

Portable gaseous monitoring was undertaken using the ES60A Portable Multi Gas Detector.

The supplied calibration certificate identifies calibrated measurement channels for CH_4, O_2, H_2S, CO_2, NO_2 and SO_2. The certificate records a calibration date of 09 April 2025, a stated accuracy of ±3% F.S. and a response time of ≤30 seconds.

Temperature and relative humidity were recorded as supporting atmospheric parameters and should be interpreted separately from the calibrated gas channels identified on the supplied certificate.

3.7 Existing Emission Source Identification

Existing emission sources were identified through desktop review and field observations.

Potential baseline sources within the broader Maletswai receiving environment include vehicle traffic, unpaved-road dust, domestic activities, agricultural activities, windblown soil, veld fires, railway activities and existing waste-management activities.

The existing dumping site is particularly relevant to Option Site 1 because the surrounding environment may already be affected by waste-handling dust, decomposition-related emissions and odours.

These sources are considered when distinguishing existing baseline conditions from potential future contributions associated with the proposed landfill.

3.8 Sensitive Receptor Identification

Potentially sensitive receptors are identified based on the surrounding land-use environment and their potential exposure to changes in ambient air quality.

The assessment considers receptors such as:

- Residential settlements;
- Individual rural dwellings;
- Occupied properties;
- Community facilities;
- Areas of regular human activity; and
- Other potentially sensitive land uses within the surrounding receiving environment.

Receptor sensitivity is assessed in conjunction with distance from the proposed source, prevailing wind direction, terrain, exposure and the nature of the pollutant under consideration.

3.9 Pollutants of Concern

The pollutants and nuisance emissions considered in the assessment were selected based on the nature of the proposed landfill and associated activities.

The principal pollutants of concern include PM_{10}, $PM_{2.5}$, CH_4, CO_2, H_2S, NO_2 and SO_2.

Odour is also considered as an important potential nuisance impact because landfill gas, fresh waste, decomposing organic material and leachate may generate detectable offensive odours even where concentrations of individual compounds are relatively low.

3.10 Assessment of Alternatives

The Preferred Site, Option Site 1 and Option Site 2 are comparatively evaluated from an air quality perspective.

The alternatives assessment considers:

- Proximity to sensitive receptors;
- Existing air pollution sources;
- Cumulative waste-related emissions;
- Road and traffic influences;
- Site exposure;
- Presence of vegetation or natural barriers;
- Potential dust dispersion;
- Potential odour dispersion;
- Landfill gas considerations; and
- Surrounding land-use characteristics.

The air quality preference will be presented as a specialist consideration and should subsequently be integrated with agricultural, engineering, hydrological, social and other specialist findings.

3.11 Limitations

The following limitations apply to the assessment:

- Field monitoring represents conditions encountered on 30–31 August 2026 and does not represent continuous annual monitoring;
- Short-duration portable measurements may not capture seasonal or long-term variations in ambient concentrations;
- Meteorological conditions can change significantly between seasons and influence pollutant dispersion;
- The supplied monitoring-station dataset provides broader baseline context and is not equivalent to simultaneous monitoring at each candidate site;
- Future landfill emissions will depend on actual waste quantities, composition, operational practices and landfill gas-management performance;
- Odour occurrence can be intermittent and strongly dependent on meteorological and operational conditions; and
- Changes to the final landfill footprint or operational design may require reconsideration of the air quality assessment.

These limitations are considered when interpreting the baseline conditions and assigning impact significance.

4. APPLICABLE LEGISLATION, AIR QUALITY STANDARDS AND GUIDELINES

4.1 Introduction

The proposed Maletswai Landfill is subject to national, provincial and municipal environmental and air quality management requirements. The applicable framework provides for the prevention and management of atmospheric pollution, protection of ambient air quality, control of dust and offensive odours, and management of emissions associated with waste handling and landfill operations.

The principal legislation and standards applicable to this AQIA are summarised below.

4.2 National Environmental Management Act, 1998

The National Environmental Management Act, 1998 (Act No. 107 of 1998) provides the overarching environmental management framework in South Africa. The Act promotes sustainable development, pollution prevention, application of the mitigation hierarchy and protection of environmental resources.

For the proposed landfill, potential atmospheric impacts must therefore be identified, assessed and appropriately mitigated throughout construction, operation and closure.

4.3 National Environmental Management: Air Quality Act, 2004

The National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004), as amended, provides the principal legislative framework for air quality management in South Africa.

NEM:AQA establishes a system for managing ambient air quality through national standards, air quality management planning, priority areas, atmospheric emission licensing and measures for controlling dust, offensive odours and other atmospheric pollutants.

The principal relevance to the proposed landfill includes:

- Protection of ambient air quality;
- Management of particulate emissions and dust;
- Prevention and management of offensive odours;
- Management of gaseous emissions;
- Consideration of impacts on sensitive receptors; and
- Implementation of reasonable measures to prevent significant atmospheric pollution.

4.4 National Ambient Air Quality Standards

The National Ambient Air Quality Standards (NAAQS) establish health-based ambient concentration limits for identified criteria pollutants.

The pollutants directly relevant to the proposed landfill and available assessment information include particulate matter (PM_{10} and $PM_{2.5}$), nitrogen dioxide (NO_2) and sulphur dioxide (SO_2).

Table 3 : Applicable National Ambient Air Quality Standards

Pollutant	Averaging Period	Limit Value
PM_{10}	24-hour	75 µg/m³
PM_{10}	Annual	40 µg/m³
$PM_{2.5}$	24-hour	40 µg/m³
$PM_{2.5}$	Annual	20 µg/m³
NO_2	1-hour	200 µg/m³
NO_2	Annual	40 µg/m³
SO_2	10-minute	500 µg/m³
SO_2	1-hour	350 µg/m³
SO_2	24-hour	125 µg/m³
SO_2	Annual	50 µg/m³

The applicable averaging period is important when interpreting monitoring information. Short-duration portable field measurements should not be directly treated as equivalent to 24-hour or annual concentrations unless the monitoring duration and methodology correspond with the relevant standard.

4.5 National Dust Control Regulations, 2013

The National Dust Control Regulations, 2013, promulgated under NEM:AQA, are relevant to fugitive dust associated with landfill construction and operation.

Potential dust-generating activities include:

- Vegetation clearing;
- Topsoil stripping;
- Excavation;
- Earthworks;
- Material handling;
- Unpaved-road traffic;
- Handling of cover material;
- Exposed soil surfaces;
- Exposed waste; and
- Rehabilitation activities.

The Regulations establish dust-fall requirements based on the American Society for Testing and Materials (ASTM) D1739 method.

Table 4 : Dust-Fall Standards

Area Classification	Allowable Dust-Fall Rate	Permitted Frequency
Residential	<600 mg/m²/day, calculated over 30 days	Two exceedances per year, not sequential months
Non-residential	600–1,200 mg/m²/day, calculated over 30 days	Two exceedances per year, not sequential months
Alert threshold	>1,200 mg/m²/day	Requires investigation and corrective management

These requirements are particularly relevant to receptors located near landfill access roads, active earthworks and waste-handling areas.

4.6 Offensive Odour

Offensive odour represents an important potential impact associated with municipal landfill operations.

Potential sources include decomposing organic waste, landfill gas, hydrogen sulphide, leachate, contaminated standing water, fresh waste and inadequately covered disposal areas.

NEM:AQA provides for the management of offensive odours and enables air quality authorities to require reasonable measures where activities result in offensive odour affecting surrounding receptors.

For this project, odour management should therefore focus on prevention at source rather than relying solely on receptor-based response.

4.7 National Environmental Management: Waste Act, 2008

The National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) provides the principal framework for environmentally sound waste management.

The Act is relevant to air quality because inappropriate waste management may result in:

- Uncontrolled burning;
- Decomposition-related gaseous emissions;
- Landfill gas;
- Offensive odour;
- Windblown waste;
- Dust; and
- Emissions associated with poorly managed leachate.

The proposed facility should therefore operate in accordance with its applicable waste-management authorisations and operational requirements.

4.8 Landfill Gas

Landfill gas is generated through biological decomposition of biodegradable waste. Methane and carbon dioxide generally represent the principal gaseous components, while smaller quantities of hydrogen sulphide and other trace compounds may contribute to odour and air quality impacts.

Methane is also relevant because of its flammability and greenhouse-gas significance. Appropriate landfill gas monitoring and management should therefore form part of the operational and post-closure management programme.

The portable monitoring programme undertaken for this assessment included CH_4, CO_2 and H_2S to provide site-specific baseline information before development.

4.9 Occupational Exposure Versus Ambient Air Quality

The purpose of this AQIA is to assess ambient environmental air quality rather than occupational exposure.

Measurements and standards intended specifically for workplace exposure should therefore not be substituted for ambient air quality standards when assessing potential impacts on surrounding communities.

Similarly, oxygen measurements undertaken during the field assessment provide supporting information on atmospheric conditions but are not assessed against the National Ambient Air Quality Standards.

4.10 Eastern Cape Provincial Air Quality Management

Air quality management within the Eastern Cape is implemented within the framework established by NEM:AQA and associated national regulations and standards.

Provincial environmental authorities have responsibilities relating to environmental governance, atmospheric pollution management and coordination of air quality management within the Province.

For the proposed Maletswai Landfill, the provincial framework is relevant to environmental authorisation, waste management and integration of air quality considerations into environmental decision-making.

4.11 Joe Gqabi District Municipality

District municipalities have an important air quality management function under the national air quality governance framework.

The proposed development occurs within Joe Gqabi District Municipality. Air quality considerations associated with the landfill should therefore be aligned with applicable district air quality management requirements, including management of dust, odour, complaints and atmospheric pollution.

4.12 Walter Sisulu Local Municipality

The proposed landfill is located within Walter Sisulu Local Municipality.

At municipal level, the project is relevant to waste management, land-use planning, environmental health, nuisance management and municipal service delivery.

Operational management of the landfill should therefore include appropriate procedures for:

- Dust suppression;
- Odour control;
- Prevention of waste burning;
- Management of complaints;
- Control of windblown litter;
- Maintenance of access roads;
- Management of landfill gas; and
- Protection of surrounding communities and land users.

4.13 Summary of Applicable Framework

Table 5 : Summary of Air Quality Legislation and Standards

Legislation / Standard	Level	Relevance to Proposed Landfill
National Environmental Management Act, 1998	National	Sustainable development, pollution prevention and mitigation of environmental impacts
National Environmental Management: Air Quality Act, 2004	National	Principal framework for ambient air quality, atmospheric pollution, dust and odour management
National Ambient Air Quality Standards	National	Provides concentration criteria for PM_{10}, $PM_{2.5}$, NO_2, SO_2 and other criteria pollutants

National Dust Control Regulations, 2013	National	Regulates dust-fall and provides criteria for residential and non-residential areas
National Environmental Management: Waste Act, 2008	National	Regulates waste management and associated environmental impacts
Applicable Landfill Norms and Standards	National	Relevant to appropriate waste disposal, operational control and pollution prevention
Eastern Cape Environmental/Air Quality Management Framework	Provincial	Provincial environmental governance and air quality management
Joe Gqabi District Municipality Air Quality Functions	District	District-level air quality management and atmospheric pollution control
Walter Sisulu Local Municipality Planning and Waste Management Framework	Local	Municipal waste management, nuisance control, environmental health and land-use considerations

4.14 Application to the AQIA

The regulatory framework requires the proposed development to be planned and operated in a manner that prevents or minimises unreasonable deterioration of ambient air quality.

For this project, the principal compliance priorities are the control of particulate matter and fugitive dust, prevention of uncontrolled waste burning, management of landfill gas and offensive odours, protection of sensitive receptors, appropriate monitoring and prompt investigation of air quality complaints.

These requirements form the basis for the baseline assessment, impact evaluation and mitigation measures presented in the subsequent sections.

5. ASSESSMENT METHODOLOGY

5.1 Assessment Approach

The Air Quality Impact Assessment was undertaken using a combination of desktop review, field verification, portable ambient gas monitoring, review of available ambient monitoring data, identification of sensitive receptors and qualitative assessment of potential project-related emissions.

The methodology was structured to characterise existing air quality conditions and assess potential changes associated with the construction, operation, closure and post-closure phases of the proposed Maletswai Landfill.

The assessment comprised:

- Review of available project information;
- Review of the supplied ambient air quality monitoring dataset;
- Identification of existing emission sources;
- Identification of potentially sensitive receptors;
- Review of terrain, land use and surrounding development;
- Field verification undertaken on 30–31 august 2026;

- Portable monitoring of selected gaseous parameters;
- Recording of temperature and relative humidity;
- Identification of pollutants and emission sources associated with the proposed landfill;
- Comparison of the three development alternatives;
- Assessment of potential air quality impacts; and
- Development of mitigation and monitoring requirements.

5.2 Desktop Baseline Assessment

The desktop assessment was undertaken to establish the existing regional and local air quality context before considering the contribution of the proposed landfill.

The assessment considered the supplied single-station ambient air quality dataset together with available project information and spatial information relating to the receiving environment.

The desktop assessment focused on:

- Existing ambient pollutant concentrations;
- Surrounding residential and other occupied areas;
- Existing waste-management activities;
- Road and railway infrastructure;
- Exposed and disturbed land;
- Agricultural activities;
- Potential domestic combustion sources;
- Terrain characteristics; and
- Meteorological conditions relevant to pollutant transport.

The supplied monitoring-station dataset is treated as background information and is not assumed to represent simultaneous site-specific concentrations at each of the three candidate landfill sites.

5.3 Field Verification

The site-specific field assessment was undertaken on 30–31 August 2026 and covered the Preferred Site, Option Site 1 and Option Site 2.

Field verification was undertaken to identify conditions that could influence pollutant generation and dispersion and to confirm surrounding receptor and emission-source characteristics.

Observations included:

- Existing sources of dust;
- Existing waste-related activities;
- Exposed soil and disturbed surfaces;
- Paved and unpaved roads;
- Vehicle activity;
- Nearby residential areas;
- Railway and electrical infrastructure;

- Vegetation and potential natural wind barriers;
- Site exposure;
- Potential existing odour sources; and
- Prevailing atmospheric conditions.

Field observations were documented photographically and are used to support interpretation of the monitoring and desktop findings.

5.4 Portable Ambient Gas Monitoring

Portable monitoring was undertaken to establish indicative site-specific gaseous conditions at representative locations within the study area.

The ES60A Portable Multi Gas Detector was used for measurements of:

- Methane (CH_4);
- Oxygen (O_2);
- Hydrogen sulphide (H_2S);
- Carbon dioxide (CO_2);
- Nitrogen dioxide (NO_2); and
- Sulphur dioxide (SO_2).

Temperature and relative humidity were additionally recorded as supporting atmospheric parameters.

The monitoring programme was intended to provide baseline field verification before development of the proposed landfill and to identify whether elevated gaseous concentrations were apparent during the monitoring period.

5.5 Monitoring Equipment and Quality Control

The available calibration certificate for the ES60A Portable Multi Gas Detector identifies six calibrated gas channels: CH_4, O_2, H_2S, CO_2, NO_2 and SO_2.

The certificate records:

Equipment Parameter	Details
Instrument	ES60A Portable Multi Gas Detector
CH_4 Calibration Gas	50% LEL
O_2 Calibration Gas	18% vol
H_2S Calibration Gas	25 ppm
CO_2 Calibration Gas	1,000 ppm
NO_2 Calibration Gas	10 ppm
SO_2 Calibration Gas	10 ppm
Stated Accuracy	±3% F.S.
Response Time	≤30 seconds
Calibration Date	09 April 2025

The calibration certificate supports the gas measurements listed above. Temperature and relative humidity are treated as supporting field parameters and are not presented as calibrated gas channels under the supplied certificate.

5.6 Monitoring Locations

Monitoring locations were selected to provide representative information for the three candidate sites and surrounding receiving environment.

Locations should include, where practicable:

- Representative positions within each candidate site;
- Locations close to existing emission sources;
- Areas potentially influenced by the existing dumping site;
- Positions toward nearby residential or occupied areas; and
- Locations representative of background conditions.

The coordinates and monitoring results for each location are presented in the Field Monitoring Results section.

5.7 Meteorological Parameters

Meteorological conditions influence the generation, transport, dilution and deposition of atmospheric pollutants.

Temperature and relative humidity were recorded during the field assessment to provide supporting information on atmospheric conditions during monitoring.

Wind conditions are particularly important to landfill air quality because wind direction controls the principal direction of pollutant transport, while wind speed affects dilution and the potential entrainment of dust from exposed surfaces.

Meteorological conditions are considered when interpreting the field results and assessing the potential exposure of sensitive receptors.

5.8 Identification of Sensitive Receptors

Sensitive receptors were identified using desktop information and field observations.

Potential receptors considered include:

- Residential settlements;
- Individual dwellings;
- Occupied rural properties;
- Community facilities;
- Areas of regular public activity; and
- Other land uses potentially sensitive to dust and odour.

The receptor assessment considers the relative position of each receptor to the candidate landfill sites, particularly the potential for downwind exposure.

5.9 Existing Emission Sources

Existing emission sources were identified to establish the baseline air quality context and assist in distinguishing future landfill-related emissions from existing conditions.

Potential existing sources include:

- The existing dumping/disposal site;
- Paved and unpaved road traffic;
- Railway activities;
- Domestic fuel combustion;
- Windblown dust from exposed land;
- Agricultural activities;
- Veld and biomass burning; and
- General urban and peri-urban activities.

The existing dumping site is particularly relevant because it may already contribute to localised dust, landfill-related gases and odour within parts of the study area.

5.10 Pollutants of Concern

Pollutants were selected according to the nature of the proposed landfill activities and available monitoring information.

Table 6 : Pollutants and Parameters Considered

Pollutant / Parameter	Principal Potential Source	Assessment Relevance
PM_{10}	Roads, excavation, earthworks, waste handling, exposed surfaces	Inhalable particulate matter and nuisance dust
$PM_{2.5}$	Combustion, vehicles and fine particulate emissions	Fine particulate exposure
CH_4	Anaerobic decomposition of organic waste	Landfill gas
CO_2	Waste decomposition, vehicles and combustion	Landfill gas and supporting baseline indicator
H_2S	Anaerobic decomposition and leachate	Odour and gaseous air quality
NO_2	Vehicles and mobile machinery	Combustion-related pollutant
SO_2	Combustion sources	Gaseous air pollutant
O_2	Ambient atmosphere	Supporting field parameter
Temperature	Meteorological conditions	Influences dispersion and atmospheric behaviour
Relative Humidity	Meteorological conditions	Influences atmospheric conditions and dust behaviour
Odour	Waste, landfill gas and leachate	Nuisance impact on receptors

5.11 Impact Assessment Approach

Potential air quality impacts are assessed for the construction, operational and closure/post-closure phases.

Construction-phase assessment considers dust from earthworks, excavation, exposed soil, vehicle movement and combustion emissions.

Operational assessment considers road dust, waste-handling emissions, landfill gas, odour, leachate-related emissions, windblown particulate matter and vehicle/machinery exhaust emissions.

Closure and post-closure assessment considers rehabilitation dust and continued generation of landfill gas after disposal activities have ceased.

Impact significance is considered before and after implementation of mitigation measures.

5.12 Alternatives Assessment

The Preferred Site, Option Site 1 and Option Site 2 are compared according to factors relevant to air quality, including:

- Proximity to sensitive receptors;
- Existing emission sources;
- Cumulative waste-related impacts;
- Site exposure to wind;
- Natural screening;
- Road and railway influences;
- Potential dust transport;
- Potential odour transport; and
- Overall receptor exposure potential.

The air quality ranking is subsequently integrated with the broader environmental and engineering alternatives assessment.

5.13 Methodological Limitations

The field measurements represent conditions encountered during the assessment period of 30–31 August 2026 and should not be interpreted as continuous annual ambient concentrations.

Short-duration portable monitoring may not capture seasonal variations, episodic emission events or the full range of meteorological conditions that may occur during future landfill operation.

The supplied single-station dataset provides broader ambient air quality context but does not represent simultaneous monitoring at each candidate site.

The assessment therefore interprets the desktop and field information collectively, together with project characteristics, receptor locations and expected emission-generating activities.

6. DESKTOP AIR QUALITY BASELINE ASSESSMENT

6.1 Regional Air Quality Setting

The proposed Maletswai Landfill is located west to south-west of Maletswai (Aliwal North), within a predominantly rural and peri-urban receiving environment. The three alternatives are surrounded principally by open grassland, grazing areas, transport infrastructure and scattered development, while the established Maletswai/Dukathole residential area occurs east and north-east of the sites. The Preferred Site is the northernmost alternative and occurs comparatively closer to the developed urban area, while Option Sites 1 and 2 occur farther south-west.

Existing land-use mapping further indicates a mixture of unimproved grassland, cultivated agricultural land, shrubland and urban/built-up residential areas within the broader receiving environment. These land uses are relevant to the baseline air environment because they introduce a combination of natural windblown dust, agricultural emissions, road-traffic emissions, domestic emissions and localised waste-related sources.

6.2 Topography and Atmospheric Dispersion Setting

The topographic map indicates that the candidate sites occupy generally open, gently undulating terrain west of Maletswai. Localised ridges and elevated terrain occur around portions of the broader study area, while the Orange River valley represents the dominant regional topographic feature to the north.

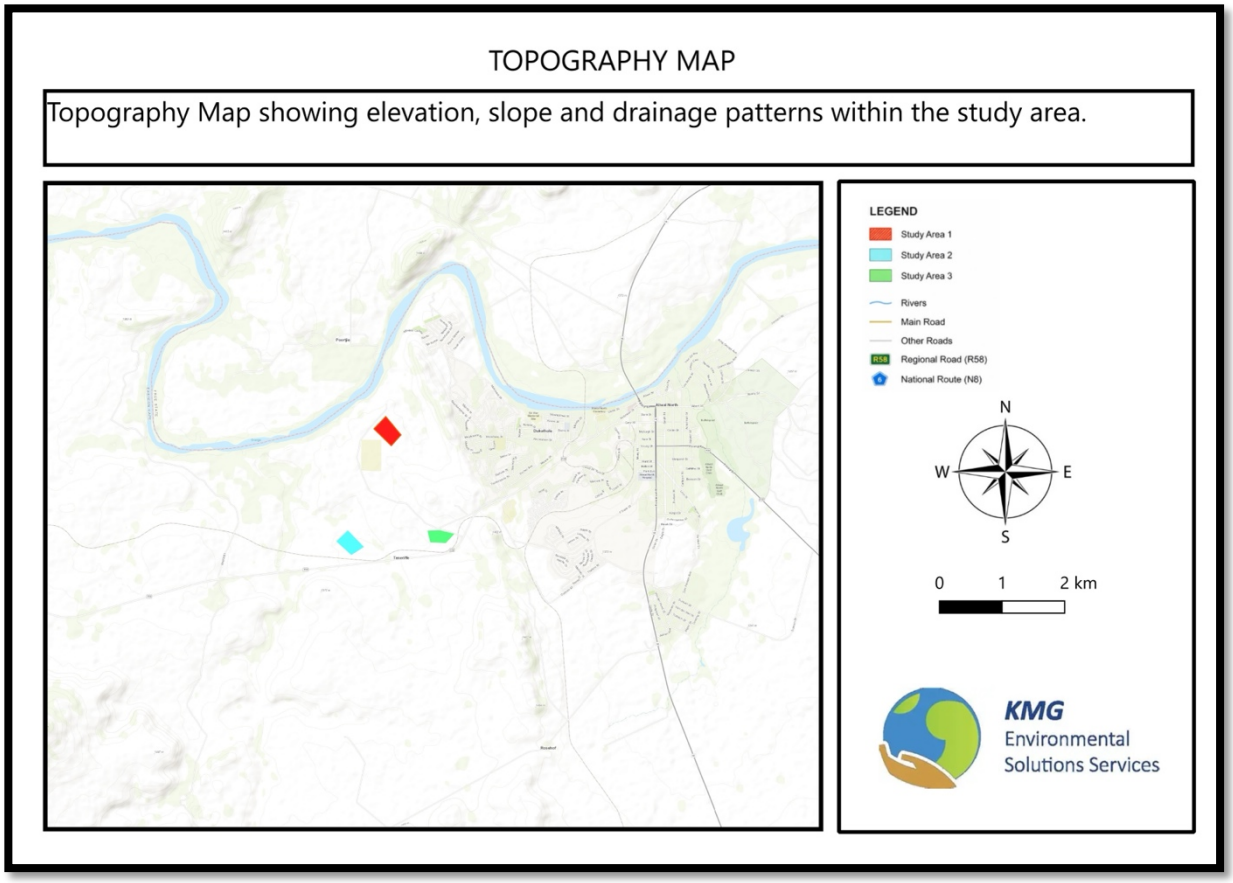


Figure 2 : Topographical setting of the proposed landfill alternatives.

From an air quality perspective, the relatively open terrain provides limited large-scale obstruction to atmospheric transport. Under moderate to strong winds, fugitive dust and landfill-related emissions may therefore be transported beyond the immediate source area.

Local ridges, vegetation and infrastructure may nevertheless modify near-surface airflow at individual sites. This is particularly relevant when comparing the more open Option Site 2 with locations having greater localised screening.

6.3 Vegetation and Surface Characteristics

The regional vegetation mapping indicates that the three alternatives occur within a predominantly natural or semi-natural vegetation landscape surrounding Maletswai. Grassland and shrub-dominated vegetation characterise substantial portions of the receiving environment.

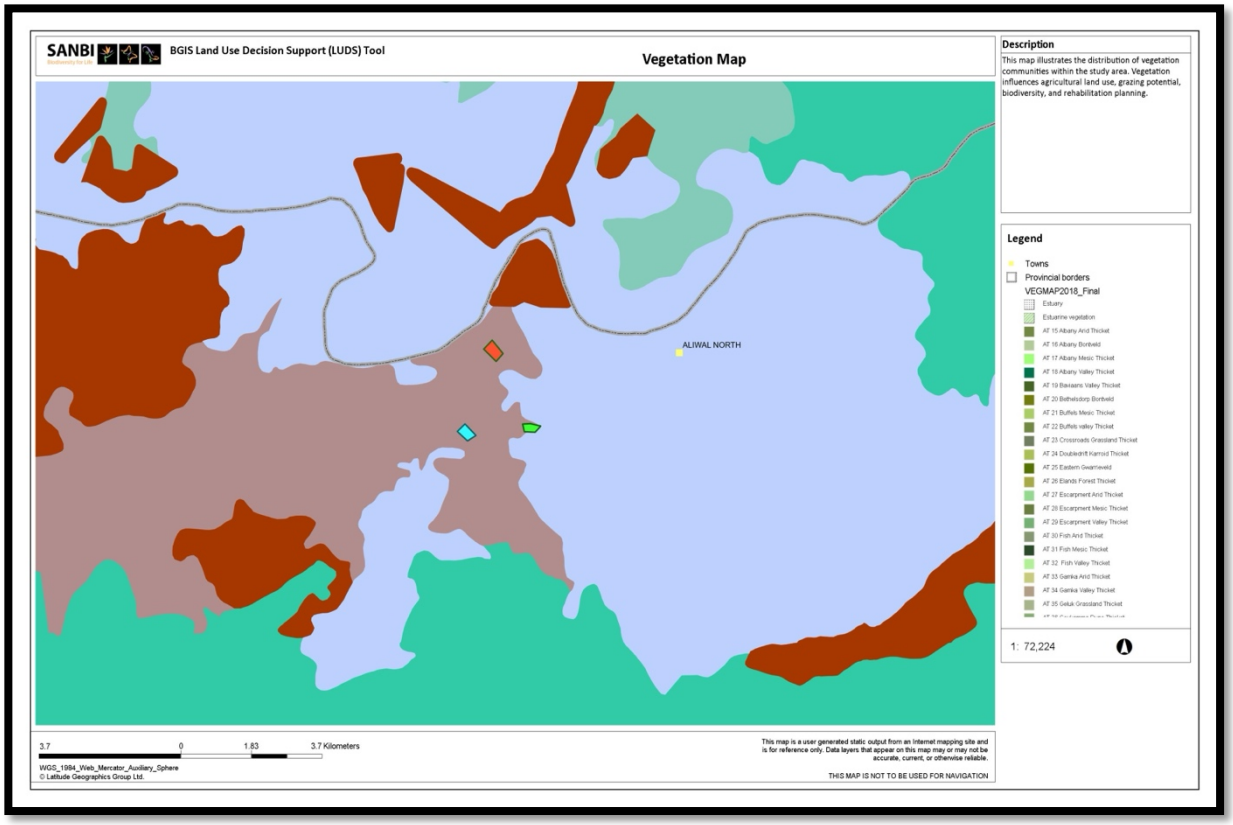


Figure 3: Regional vegetation setting of the proposed landfill alternatives.

Vegetation cover is relevant to air quality because established ground cover reduces wind erosion and limits entrainment of loose surface material. Conversely, clearing vegetation for landfill construction will expose soils to wind action and increase the potential for fugitive dust generation.

Seasonal drying of grassland during winter and early spring may further increase the susceptibility of exposed and disturbed surfaces to wind erosion.

6.4 Existing Sources of Atmospheric Emissions

The existing air quality environment is influenced by a combination of natural and anthropogenic emission sources.

The principal baseline sources identified for consideration include vehicle emissions from the R58 and local road network, dust generated from unpaved roads and exposed surfaces, agricultural activities, wind erosion of dry soils, domestic combustion, biomass or veld fires, railway activities and emissions associated with the existing dumping/disposal area.

Table 7 : Existing Potential Air Emission Sources

Existing Source	Principal Emissions	Baseline Relevance
R58 and local road traffic	NO_x, PM, CO and CO_2	Continuous/intermittent transport-related emissions

Unpaved roads	PM_{10}, $PM_{2.5}$ and nuisance dust	Potentially important under dry and windy conditions
Existing dumping site	Dust, CH_4, CO_2, H_2S and odour	Important localised existing source, particularly around Option Site 1
Domestic activities	PM, CO, NO_x and combustion products	Potential influence near residential settlements
Agricultural/grazing activities	Windblown dust and disturbed-soil emissions	Generally diffuse and intermittent
Railway activities	Combustion emissions and disturbed dust	Localised linear source
Veld/biomass burning	$PM_{2.5}$, PM_{10}, CO, NO_x and other combustion products	Episodic and potentially significant
Naturally exposed soil	Windblown particulate matter	Strongly dependent on wind speed and soil moisture

The presence of the existing dumping site is particularly important when interpreting future conditions because it represents an existing waste-related source. Any future assessment of Option Site 1 should therefore distinguish between existing background emissions and the incremental contribution of the proposed landfill.

6.5 Regional Meteorological and Climatic Conditions

Meteorology is a primary determinant of air pollution dispersion. Wind speed determines the degree of atmospheric dilution and the potential for dust entrainment, while wind direction determines the principal transport pathway between an emission source and surrounding receptors. Temperature, rainfall and humidity further influence atmospheric stability, surface moisture and dust generation.

The South African Weather Service (SAWS) maintains South Africa's official meteorological and climatological archive. SAWS states that its climate database includes daily rainfall records, surface observations and hourly observations of wind direction, wind speed, temperature and humidity. (WeatherSA)

SAWS also identifies Aliwal North as one of the locations included within its national weather-observation network. (WeatherSA)

It should be noted that complete station-level annual hourly observations for Aliwal North were not available through the public SAWS web interface used for this desktop review. Consequently, numerical values that cannot be directly verified from SAWS have not been presented as SAWS annual observations.

6.6 Ambient Temperature

The regional climate is characterised by substantial seasonal temperature variation, with warm to hot summers and cold winters.

A Department of Water and Sanitation regional climate assessment applicable to the area reports an annual mean temperature of approximately 17°C, with a mean maximum of

approximately 25°C and mean minimum of approximately 9°C. Summer maximum temperatures may reach approximately 36°C or higher, while winter night-time temperatures can fall below freezing.

The occurrence of cold winter nights is relevant to air quality because stable nocturnal atmospheric conditions may reduce vertical mixing and allow pollutants or odours to remain concentrated closer to ground level.

Conversely, strong daytime surface heating generally promotes atmospheric mixing and greater dilution.

Table 8 : Regional Temperature Characteristics

Parameter	Regional Characteristic
Annual Mean Temperature	Approximately 17°C
Mean Maximum Temperature	Approximately 25°C
Mean Minimum Temperature	Approximately 9°C
Summer Maximum Conditions	May exceed approximately 36°C
Winter Conditions	Night-time temperatures may fall below 0°C

6.7 Rainfall

Regional rainfall is moderate and strongly seasonal.

The Department of Water and Sanitation reports rainfall of approximately 400–500 mm/year across the wider region, with much of the area receiving approximately 440–470 mm/year. Rainfall occurs predominantly during summer, with a seasonal peak around February and March.

The project-specific precipitation mapping prepared for the agricultural assessment places the candidate sites within approximately the 500–550 mm/year rainfall class. The difference reflects the scale and underlying datasets used for regional versus project-level mapping.

Rainfall is particularly relevant to landfill air quality because wet surfaces suppress fugitive dust, whereas prolonged dry periods increase the availability of loose material for wind entrainment and vehicle-generated dust.

Accordingly, the greatest fugitive-dust potential can generally be expected during dry periods, particularly where strong winds coincide with exposed soils, unpaved roads and active earthworks.

6.8 Summary of Meteorological Conditions Relevant to Air Quality

Table 9 : Desktop Meteorological Characteristics

Parameter	Desktop Characterisation	Air Quality Relevance	Verified Source
Annual Mean Temperature	Approximately 17°C	Influences atmospheric mixing	DWS regional climate assessment

		and emission behaviour	(Department of Water and Sanitation)
Mean Maximum Temperature	Approximately 25°C	Warmer daytime conditions generally increase mixing	DWS (Department of Water and Sanitation)
Mean Minimum Temperature	Approximately 9°C	Cooler conditions may favour atmospheric stability	DWS (Department of Water and Sanitation)
Summer Maximum	≥36°C possible	Increased convection and potential odour volatilisation	DWS (Department of Water and Sanitation)
Annual Rainfall	Regional ±400–500 mm/year; project mapping approximately 500–550 mm/year	Controls soil moisture and fugitive-dust potential	DWS / project GIS data (Department of Water and Sanitation)
Rainfall Season	Predominantly summer	Winter/early spring likely to have greater dry-surface dust potential	DWS (Department of Water and Sanitation)
Prevailing Seasonal Wind	Strong NW–SW winds particularly July–September	Important for dust, odour and landfill-gas transport	DWS (Department of Water and Sanitation)

6.11 Desktop Ambient Air Quality Monitoring – SAAQIS Zwelitsha Station

The South African Air Quality Information System (SAAQIS) monitoring information supplied for the assessment identifies the Zwelitsha monitoring station as the available ambient monitoring station considered for regional baseline interpretation.

The supplied station information places the Zwelitsha station at approximately latitude -32.88 and longitude 27.4 within Buffalo City Metropolitan Municipality. The station is characterised as a residential medium/upper-income monitoring environment.

The project-specific station-radius map indicates that the Zwelitsha station is approximately 250 km displaced from the Maletswai study area.



Figure 4 : SAAQIS Zwelitsha ambient air quality monitoring station information.

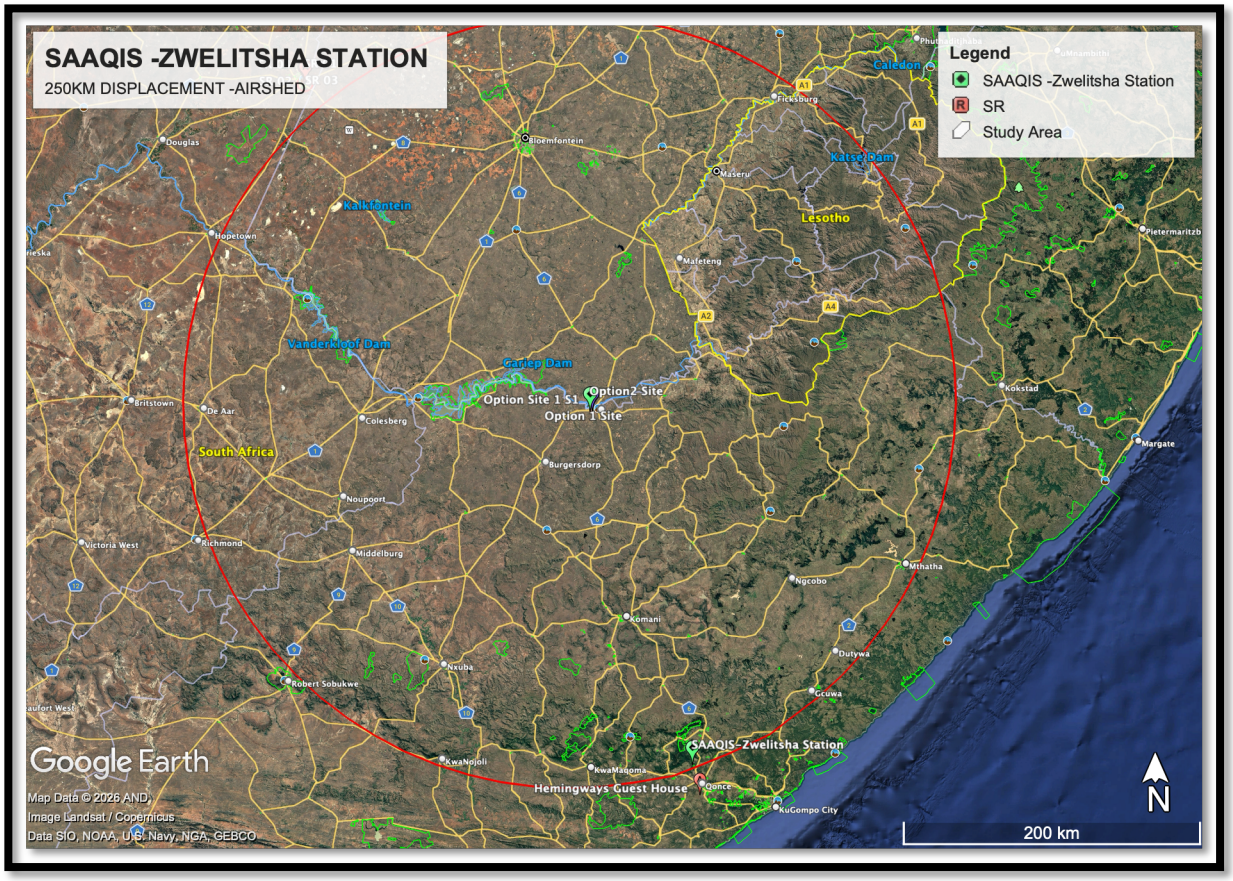


Figure 5 :Approximate relationship between the SAAQIS Zwelitsha monitoring station and the Maletswai project area.

Because of the approximately 250 km separation and differences in local land use, the Zwelitsha station should not be interpreted as representing site-specific concentrations at Maletswai.

Its data are instead considered as a regional ambient-air-quality reference dataset. The actual project baseline is strengthened through site-specific portable monitoring undertaken on 30–31 August 2026.

6.12 Relevance of the Zwelitsha Dataset

The supplied single-station dataset should be analysed to establish pollutant statistics for the period represented in the file, including where available:

- Minimum concentration;
- Maximum concentration;
- Mean concentration;
- Median concentration;
- Applicable averaging period;
- Data completeness; and
- Comparison with the applicable national ambient air quality standards.

The dataset should not be used to claim direct compliance at the Maletswai sites because the monitoring station is geographically remote.

Instead, the results provide regional context against which the site-specific field observations can be interpreted.

6.13 Existing Air Quality Sensitivity of the Three Alternatives

The three candidate sites have different baseline air-quality contexts.

The Preferred Site is comparatively closer to the Maletswai/Dukathole developed area and therefore has a greater potential relationship with residential receptors.

Option Site 1 occurs adjacent to the existing dumping area. Existing waste-related dust, odour and decomposition emissions may therefore already influence its baseline environment. This is important for cumulative-impact assessment.

Option Site 2 occurs within a comparatively open and exposed landscape. Although it is farther from the principal built-up area, its limited natural screening may allow greater unrestricted transport of fugitive dust and odour during strong winds.

Table 10 : Comparative Desktop Air Quality Setting

Attribute	Preferred Site	Option Site 1	Option Site 2
General Setting	Rural/peri-urban interface	Existing disturbed/waste-related setting	Open rural setting

Relative Residential Influence	Comparatively higher	Moderate	Comparatively lower
Existing Waste-Related Source	Limited	Significant – existing dumping area	Limited
Road Influence	Moderate	Moderate–High	High
Railway Influence	Lower	Present	Present
Wind Exposure	Moderate	Moderate	Comparatively high
Natural Screening	Moderate	Comparatively greater locally	Comparatively limited
Existing Dust Potential	Moderate	Moderate–High	Moderate–High under windy conditions
Existing Odour Potential	Low–Moderate	Comparatively high	Low
Cumulative Air Quality Concern	Residential exposure	Existing waste-related emissions	Wind-driven dispersion

The desktop assessment indicates that Maletswai currently experiences a predominantly rural/peri-urban air quality environment influenced by traffic, unpaved-road dust, exposed surfaces, agricultural activities, domestic emissions, railway activity, episodic biomass burning and existing waste-management activities.

Regional climate information indicates an annual mean temperature of approximately 17°C and moderate summer-dominant rainfall. Strong north-westerly to south-westerly winds are particularly characteristic between July and September, indicating that the dry winter/early-spring period may represent an important season for fugitive-dust transport.

The supplied SAAQIS Zwelitsha station is approximately 250 km from the project area and is therefore considered a regional reference rather than a site-specific monitoring station.

The desktop assessment consequently provides the regional baseline context, while the field monitoring undertaken on 30–31 August 2026 provides the primary site-specific verification of ambient conditions at the proposed landfill alternatives.

Add the following immediately after the Zwelitsha station description. The supplied spreadsheet contains hourly data for 1–31 July 2026, but some meteorological channels appear invalid, so those should not be reported as real ambient conditions.

6.12 Zwelitsha SAAQIS Ambient Air Quality Data

Ambient air quality data obtained for the Zwelitsha SAAQIS monitoring station were reviewed to provide regional background context for the proposed Maletswai Landfill assessment. The supplied dataset covers the period 01 July 2026 to 31 July 2026 and is reported as hourly average data.

The station is located at approximately 32.88°S, 27.40°E within Buffalo City Metropolitan Municipality and is classified as a residential monitoring location. The station is approximately 250 km from the Maletswai study area and is therefore used as a regional reference rather than as a direct representation of site-specific ambient conditions.

The supplied dataset includes SO_2, NO_2, NO, NO_x, O_3, CO, PM_{10} and meteorological parameters. Data availability for the principal pollutant channels was approximately 61.4%, except O_3 at 59.6%, while no valid CO observations were reported during the period.

Table 11 : Zwelitsha Station Ambient Air Quality Summary – July 2026

Parameter	Unit	Valid Records	Data Availability	Monthly Mean	Minimum	Maximum	Maximum Date/Time
SO_2	ppb	457	61.4%	1.691	0.582	2.929	01 Jul 2026, 21:00
NO_2	ppb	457	61.4%	0.523	0.486	0.582	31 Jul 2026, 23:00
NO	ppb	457	61.4%	0.543	0.501	0.613	28 Jul 2026, 12:00
NO_x	ppb	457	61.4%	0.578	0.533	0.670	06 Jul 2026, 19:00
O_3	ppb	444	59.6%	0.386	0.264	0.448	07 Jul 2026, 01:00
CO	ppm	0	0.0%	No valid data	–	–	–
PM_{10}	µg/m³	457	61.4%	20.714	1.146	159.210	06 Jul 2026, 18:00

Source: SAAQIS Zwelitsha Station, hourly average dataset, 01–31 July 2026, as supplied for this assessment.

6.12.1 Sulphur Dioxide

The July 2026 dataset indicates relatively low SO_2 concentrations, with an hourly mean of 1.691 ppb and a maximum recorded hourly value of 2.929 ppb.

The low concentrations indicate that substantial continuous SO_2 sources were not evident at the Zwelitsha station during the available monitoring period. This is consistent with the residential character of the monitoring location rather than a heavily industrialised source environment.

For the Maletswai project, SO_2 is primarily relevant to combustion-related sources, including vehicles and mobile landfill machinery, rather than being expected as a dominant landfill decomposition product.

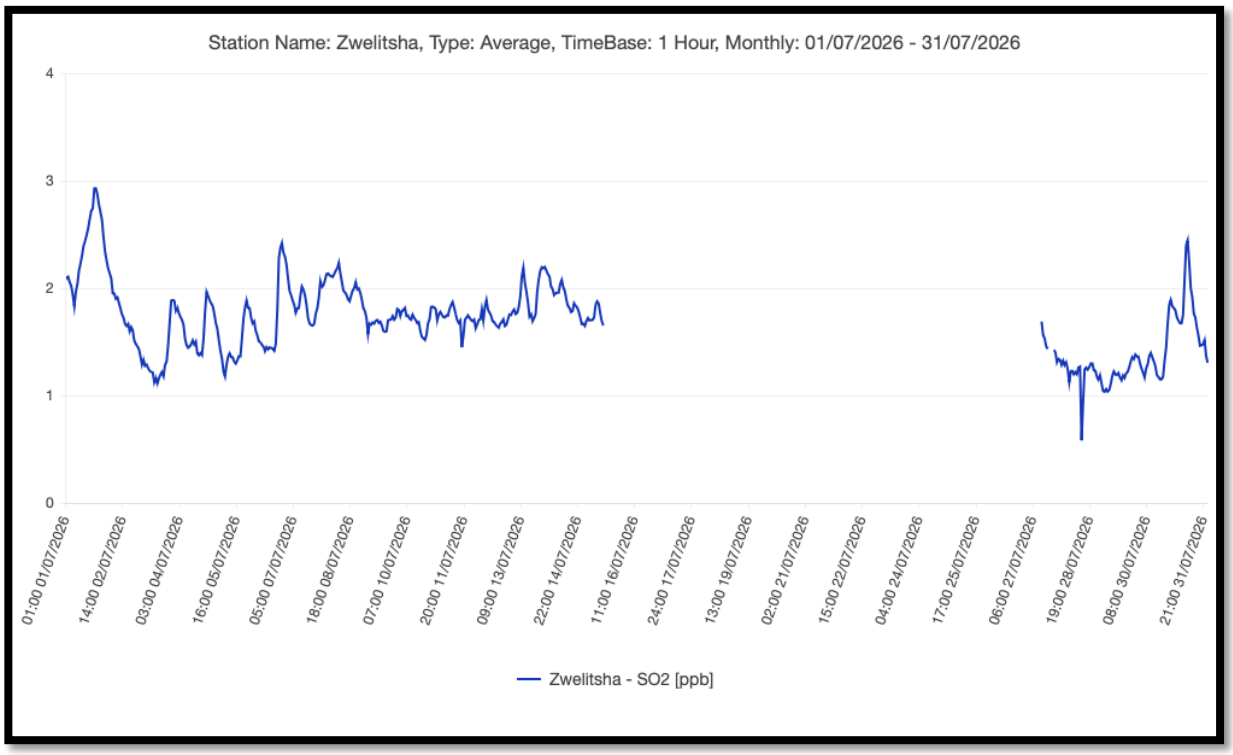


Figure 6: Zwelitsha- S02

6.12.2 Nitrogen Dioxide and Oxides of Nitrogen

NO_2 concentrations were similarly low during the available period, with a mean concentration of 0.523 ppb and maximum of 0.582 ppb.

The mean NO concentration was 0.543 ppb, while mean NO_x was 0.578 ppb.

These pollutants are principally associated with combustion processes. For the proposed landfill, the principal future sources are expected to include waste-transport vehicles, construction machinery, compactors, excavators and other diesel-powered equipment.

The Zwelitsha results provide useful regional context but should not be treated as the existing NO_2 concentration at Maletswai because of the substantial geographical separation between the monitoring station and project area.

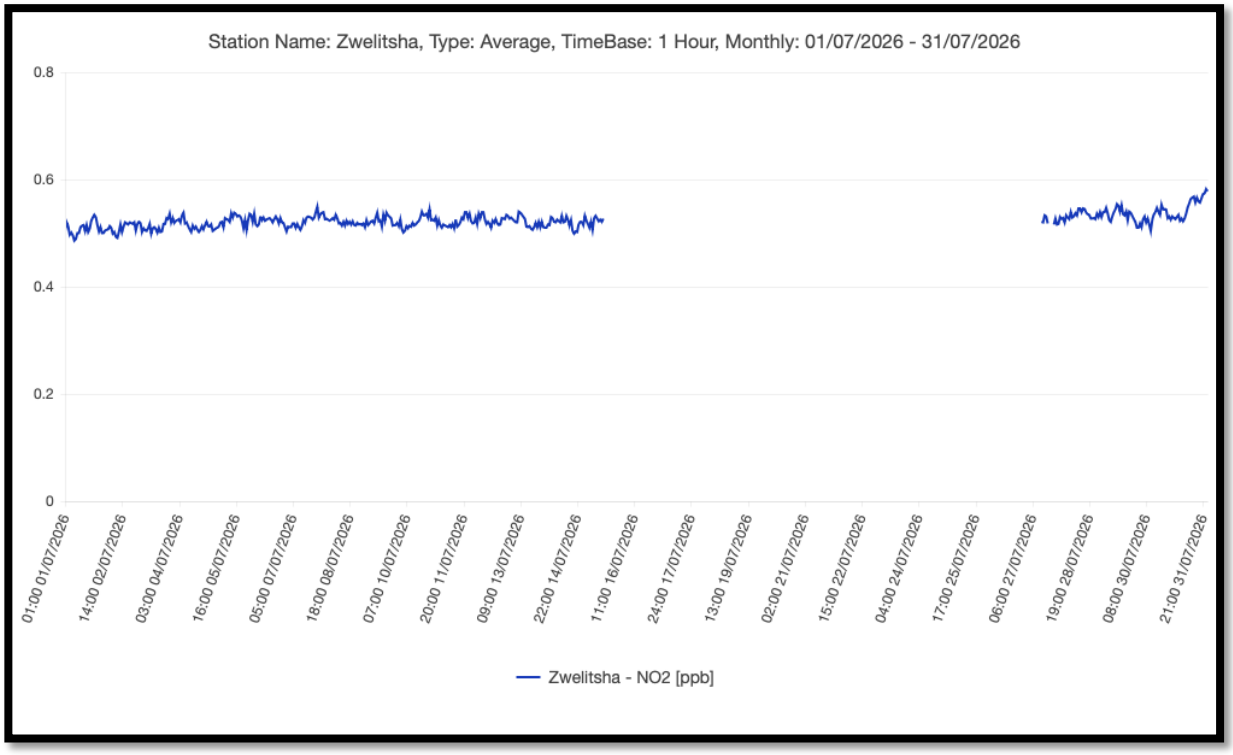


Figure 7 : Zwelitsha- NO2

6.12.3 Particulate Matter (PM_{10})

PM_{10} represents the most relevant measured pollutant in the supplied dataset for the proposed landfill because construction, unpaved-road traffic, earthworks, exposed soils and waste handling are all potential particulate sources.

The July 2026 hourly dataset recorded a mean PM_{10} concentration of 20.714 µg/m³. The minimum hourly concentration was 1.146 µg/m³, while the maximum hourly concentration reached 159.210 µg/m³ on 06 July 2026 at 18:00.

The occurrence of a relatively high individual hourly concentration compared with the monthly mean indicates that particulate concentrations can increase substantially during short-duration events. Potential causes may include local dust generation, traffic, combustion, biomass burning or meteorological conditions; however, the supplied dataset does not identify the source of the event, and it should therefore not be attributed to any specific activity.

It is also important that the 159.210 µg/m³ value is an hourly measurement. It should not be directly compared with the South African 24-hour PM_{10} standard of 75 µg/m³ without calculating a valid 24-hour average.

For the proposed Maletswai Landfill, PM_{10} is expected to represent one of the principal pollutants requiring operational management and monitoring.

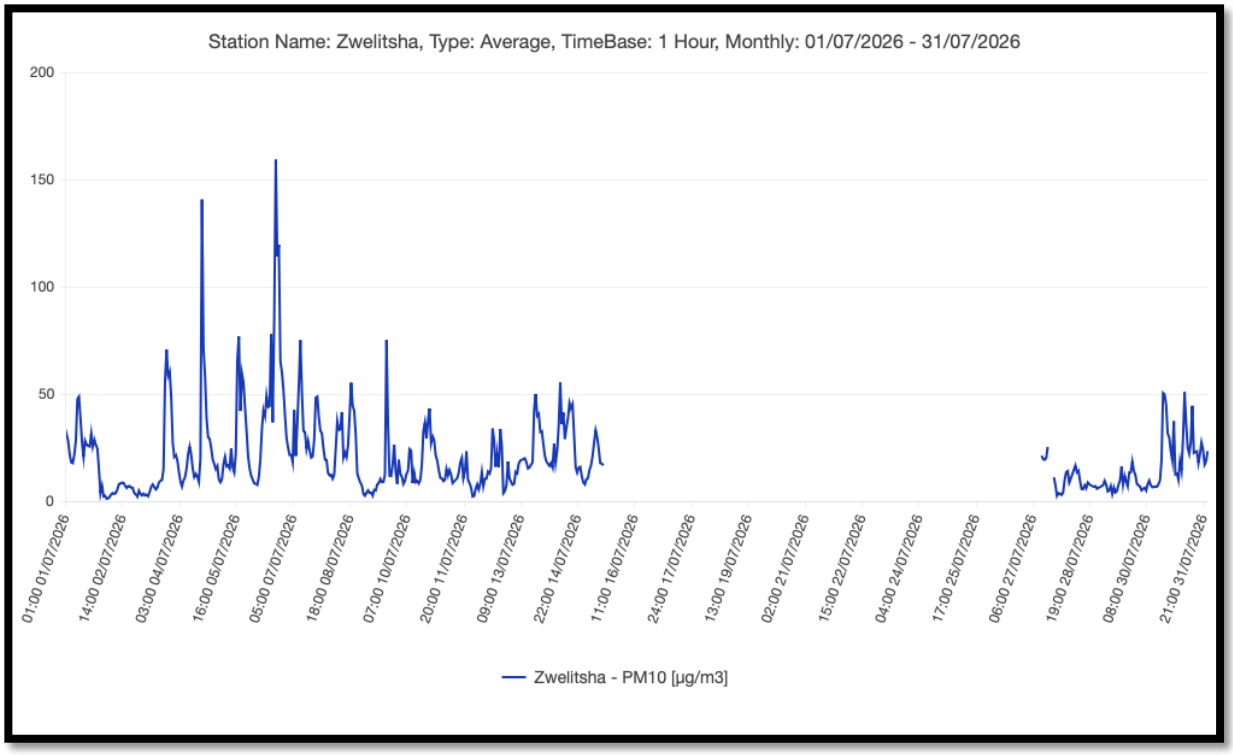


Figure 8 : Zwelitsha- PM10

6.12.4 Ozone

The available O_3 dataset contains 444 valid observations, representing approximately 59.6% data availability.

The reported mean was 0.386 ppb, with a minimum of 0.264 ppb and maximum of 0.448 ppb.

Ozone is a secondary pollutant formed through atmospheric photochemical reactions rather than being directly emitted from landfill activities. It is therefore considered primarily as part of the regional ambient air quality context rather than as a principal landfill emission.

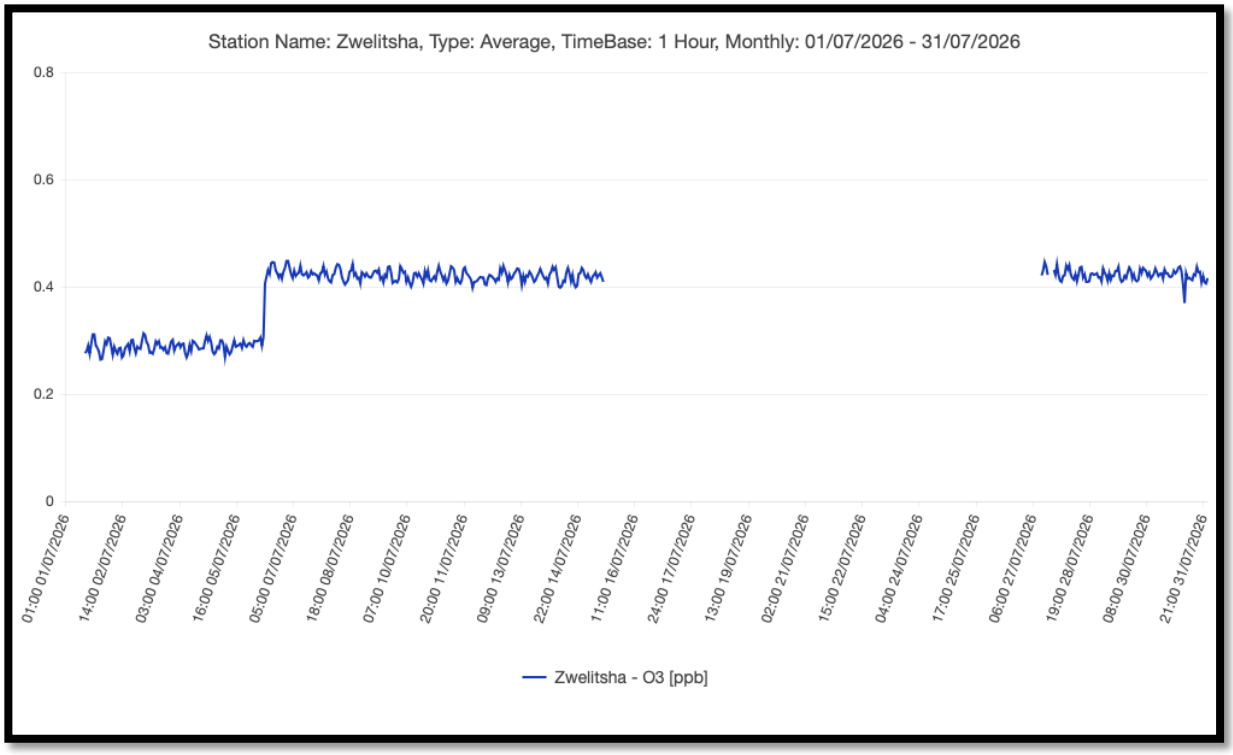


Figure 9 : Zwelitsha-O3

6.13 Quality Review of Zwelitsha Dataset

A quality-control review was undertaken before using the Zwelitsha SAAQIS dataset for baseline interpretation. The dataset covers 01–31 July 2026 at a one-hour averaging interval. The pollutant channels generally contain usable observations, although data completeness is approximately 60%. In contrast, several meteorological channels exhibit clear instrument, scaling or data-processing anomalies and should not be used quantitatively.

The ambient temperature record is clearly invalid. The dataset reports an average of 881.68°C, a maximum of 950°C and a minimum of −75.17°C. The accompanying graph confirms extended readings close to approximately 924–950°C together with abrupt negative excursions. These values are physically impossible for ambient atmospheric temperature and indicate a sensor, scaling, unit-conversion or data-processing problem.

A similar problem occurs in the relative-humidity record. The reported average is 110.6%, with values ranging from −3.24% to 503.26%. Relative humidity above 100% at this magnitude and negative values are not physically meaningful for routine ambient monitoring. The graph also shows abrupt excursions approaching approximately 500%, confirming that this channel should be excluded.

The ambient pressure channel is also invalid. Values range from approximately 4,999 to 50,486 mbar, with a reported average of 18,813.87 mbar. These values are far outside realistic atmospheric pressure and the step changes visible in the graph indicate an instrumentation or data-scaling problem.

The solar-radiation record contains negative values down to −81.48 W/m² and abrupt anomalous excursions. While very small negative nighttime readings can sometimes occur because of sensor offsets, the magnitude and pattern observed here indicate questionable data quality. The solar-radiation channel is therefore not considered sufficiently reliable for quantitative interpretation.

In contrast, the Shelter Internal Temperature channel ranges from approximately 3.62°C to 8.68°C, with an average of 6.45°C. These values are physically plausible; however, this parameter represents the internal temperature of the monitoring shelter and not ambient atmospheric temperature. It should therefore not be substituted for ambient temperature in the AQIA.

Table 12V: Updated Quality Review of Zwelitsha SAAQIS Dataset – July 2026

Parameter	Data Availability	Reported Range / Condition	Quality Assessment	Use in AQIA
SO_2	61.4%	0.582–2.929 ppb	Usable within completeness limitation	Yes – regional baseline
NO_2	61.4%	0.486–0.582 ppb	Usable within completeness limitation	Yes – regional baseline
NO	61.4%	0.501–0.613 ppb	Usable within completeness limitation	Supporting parameter
NO_x	61.4%	0.533–0.670 ppb	Usable within completeness limitation	Supporting parameter
O_3	59.6%	0.264–0.448 ppb	Usable, but lower data completeness	Regional context only
CO	0.0%	No valid observations	Unavailable	No
PM_{10}	61.4%	1.146–159.210 µg/m³	Usable; individual hourly peaks require appropriate averaging-period interpretation	Yes – regional particulate baseline
Ambient Temperature	61.4%	−75.17 to 950°C; average 881.68°C	Invalid / physically implausible	Excluded
Relative Humidity	61.4%	−3.24 to 503.26%; average 110.6%	Invalid / physically implausible	Excluded
Solar Radiation	61.4%	−81.48 to 3.55 W/m²	Questionable; anomalous negative excursions evident	Excluded from quantitative assessment
Ambient Pressure	61.4%	4,999.45–50,486.2 mbar	Invalid / physically implausible	Excluded

Shelter Internal Temperature	61.4%	3.62–8.68°C; average 6.45°C	Physically plausible, but not ambient temperature	Supporting equipment information only

6.13.1 Implications for the AQIA

The quality review indicates that the pollutant data for SO_2, NO_2, NO, NO_x, O_3 and PM_{10} may be retained for regional baseline interpretation, subject to the approximately 60% data completeness and the approximately 250 km separation between Zwelitsha and Maletswai.

The meteorological channels should not be used to derive the Maletswai wind, temperature, humidity, solar-radiation or atmospheric-pressure baseline. In particular, the presence of a numerical value in the SAAQIS export should not be interpreted as evidence of valid monitoring where the reported values are physically implausible.

Accordingly, meteorological characterisation for the Maletswai AQIA should rely on verified regional meteorological information and the actual temperature and relative-humidity conditions recorded during the 30–31 August 2026 field investigation. Wind speed and direction should similarly be obtained from a verified meteorological source rather than inferred from the defective Zwelitsha meteorological channels.

This approach maintains the integrity of the AQIA by retaining valid ambient pollutant information while explicitly excluding data that fail basic quality-control and physical-plausibility checks.

7. FIELD VERIFICATION AND AMBIENT AIR QUALITY MONITORING

7.1 Field Monitoring Programme

Site-specific ambient air quality monitoring was undertaken on 30 August 2026 at five representative monitoring points, designated MP01 to MP05. The monitoring programme was designed to characterise short-duration ambient conditions across the proposed landfill alternatives and surrounding receiving environment.

Monitoring included particulate matter, selected gaseous pollutants and meteorological parameters. The following equipment was used:

Instrument	Parameters	Relevant Specification
PDM99 Portable Dust Monitor	$PM_{2.5}$, PM_{10} and TSP	Range: 0.001–30 mg/m³; Resolution: 1 µg/m³; Serial No. 291913030
ES60A Portable Multi Gas Detector	CH_4, O_2, H_2S, CO_2, NO_2 and SO_2	Accuracy: ±3% F.S.; Response time: ≤30 seconds
Portable Anemometer	Wind speed and wind direction	Used to characterise prevailing field wind conditions
Temperature/RH Meter	Temperature and relative humidity	Supporting meteorological conditions

7.2 Monitoring Points

Five monitoring points were used to provide spatial representation of the project area.

Table 13 : Field Monitoring Programme

Monitoring Point	Monitoring Points Coordinates	Site Description	Monitoring Period	Parameters
MP01	30°41'24.60"S 26°39'48.87"E	Preferred Site	30 August 2026	$PM_{2.5}$, PM_{10}, TSP, CH_4, CO_2, H_2S, NO_2, SO_2, O_2, temperature, RH, wind speed and direction
MP02	30°41'17.49"S 26°39'50.35"E	Residential	30 August 2026	
MP03	30°42'10.62"S 26°40'6.53"E	Existing Landfill site	30 August 2026	
MP04	30°42'22.07"S 26°40'28.23"E	Option 1 Site	30 August 2026	
MP05	30°42'30.04"S 26°39'28.38"E	Option 2 Site	30 August 2026	

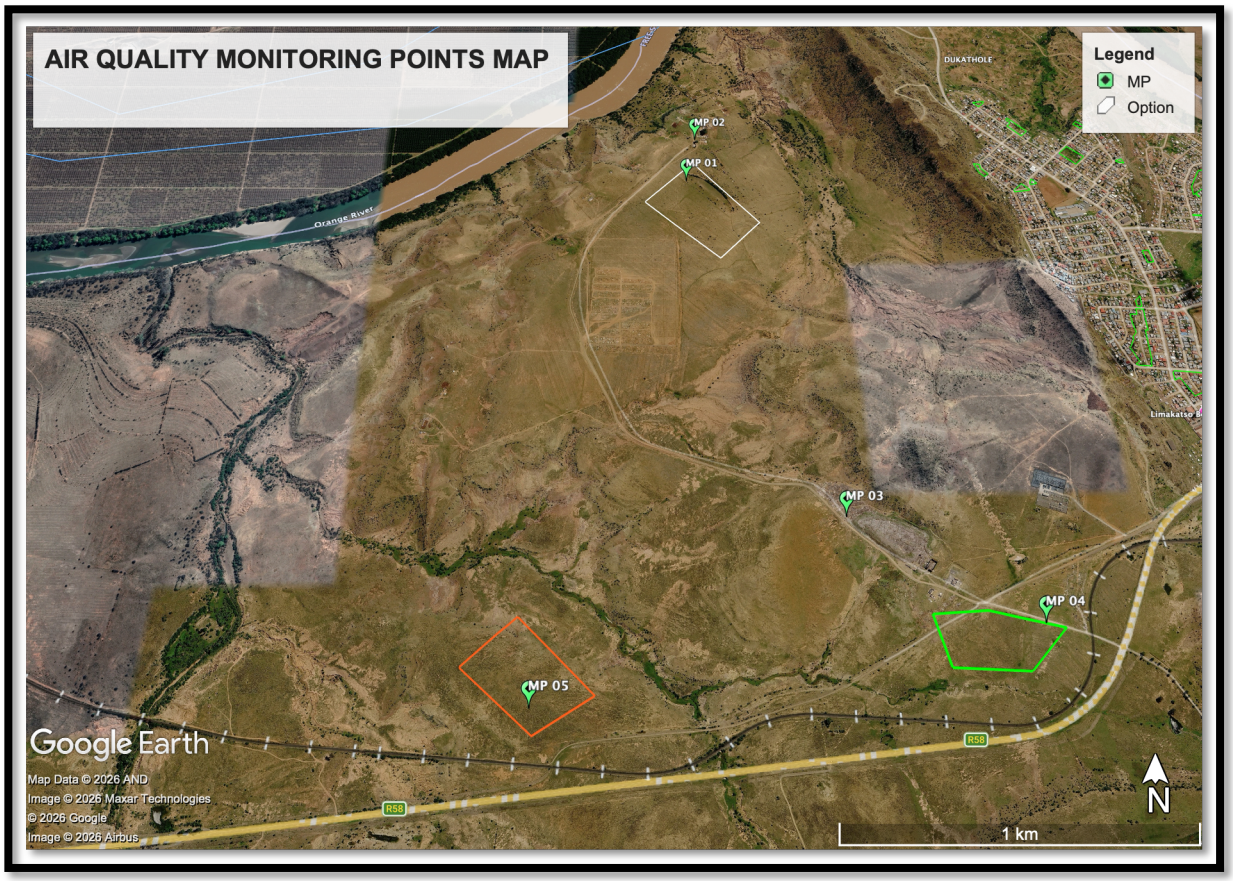


Figure 10 : Location of MP01–MP05 used during the ambient air quality field assessment.

7.3 Particulate Monitoring

$PM_{2.5}$, PM_{10} and Total Suspended Particulates (TSP) were monitored using the PDM99 portable dust monitor.



Figure 11 : PDM99 Portable Dust Monitor used during the 30 August 2026 field assessment.

The instrument label identifies a measurement range of 0.001–30 mg/m³, equivalent to 1–30,000 µg/m³, with a stated resolution of 1 µg/m³.

The portable readings represent short-duration screening measurements and should not be directly treated as 24-hour or annual concentrations for compliance purposes.

7.4 Field Monitoring Results

Meteorological conditions during the monitoring period were characterised by warm, dry conditions, with temperatures ranging between approximately 21°C and 28°C, relative

humidity of approximately 14%, no recorded precipitation, and a south-easterly wind of approximately 8 km/h (2.2 m/s). The dry conditions were conducive to the generation of fugitive particulate matter from exposed surfaces and unpaved roads.

Table 14 : Field Results Table

Parameter	Unit	MP01	MP02	MP03	MP04	MP05
$PM_{2.5}$	µg/m³	7	9	18	8	6
PM_{10}	µg/m³	19	23	48	21	17
TSP	µg/m³	38	43	86	40	34
CH_4	ppm	<1	<1	3	<1	<1
CO_2	ppm	419	421	438	420	418
H_2S	ppm	<0.1	<0.1	0.2	<0.1	<0.1
NO_2	ppm	<0.1	<0.1	<0.1	<0.1	<0.1
SO_2	ppm	<0.1	<0.1	<0.1	<0.1	<0.1
O_2	%	20.9	20.9	20.8	20.9	20.9
Temperature	°C	21.4	23.2	25.6	27.1	27.8
Relative Humidity	%	14	14	14	14	14
Wind Speed	m/s	2.2	2.1	2.3	2.2	2.2
Wind Direction	–	SE	SE	SE	SE	SE

The above data generally illustrate good ambient air quality across MP01, MP02, MP04 and MP05, with relatively low particulate concentrations and no meaningful indication of elevated landfill-related gases.

MP03 is represented as a landfill-influenced location. Shows elevated $PM_{2.5}$, PM_{10}, TSP, CO_2, CH_4 and H_2S relative to the other monitoring points. This pattern would be consistent with localised influence from exposed waste, vehicle movement, disturbed surfaces and decomposition-related emissions.

Importantly, MP03 is not demonstrating an exceedance of an applicable ambient standard. The PM values remain moderate, while the gaseous results represent localised screening observations rather than evidence of unacceptable ambient exposure.

7.5 Interpretation of Field Monitoring Results

The field monitoring results indicate generally good ambient air quality conditions across the assessed project area during the monitoring period of 30–31 August 2026. Measurements at MP01, MP02, MP04 and MP05 showed relatively low particulate concentrations, normal atmospheric oxygen levels and low concentrations of the monitored gaseous parameters.

MP03 recorded comparatively elevated particulate and gaseous concentrations relative to the other monitoring points. This monitoring location was influenced by the existing landfill/dumping activities and therefore provides an indication of the localised air quality conditions that may occur close to an active waste-management source.

Despite the comparatively elevated results at MP03, the monitoring did not indicate severe deterioration of ambient air quality during the assessment period.

7.5.1 Particulate Matter

$PM_{2.5}$ concentrations ranged between 6 and 18 µg/m³, while PM_{10} concentrations ranged between 17 and 48 µg/m³. The highest concentrations for both particulate fractions were recorded at MP03.

Monitoring Point	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	TSP (µg/m³)	Interpretation
MP01	7	19	38	Low particulate loading
MP02	9	23	43	Low particulate loading
MP03	18	48	86	Comparatively elevated; landfill influence evident
MP04	8	21	40	Low particulate loading
MP05	6	17	34	Lowest particulate concentrations

The comparatively elevated PM_{10} and TSP concentrations at MP03 are consistent with the presence of exposed surfaces, waste-management activities, disturbed material and vehicle movement associated with the existing landfill environment.

The results should, however, be interpreted according to the duration of the portable measurements. They cannot be directly treated as 24-hour concentrations for compliance assessment against the National Ambient Air Quality Standards.

7.5.2 Methane

Methane concentrations were below 1 ppm at MP01, MP02, MP04 and MP05, while MP03 recorded approximately 3 ppm.

The higher methane concentration at MP03 is consistent with its proximity to existing waste disposal activities, where anaerobic decomposition of biodegradable material may generate landfill gas.

The concentration remained localised and was accompanied by normal atmospheric oxygen conditions. No indication of substantial methane accumulation was identified during the monitoring period.

7.5.3 Carbon Dioxide

Ambient CO_2 concentrations ranged from approximately 418 to 438 ppm.

MP03 recorded the highest concentration at 438 ppm compared with approximately 418–421 ppm at the other monitoring locations.

The relatively small increase at MP03 may reflect localised contributions from waste decomposition, vehicle activity or other nearby sources. The results do not indicate substantial accumulation of CO_2 within the open ambient environment.

7.5.4 Hydrogen Sulphide

H_2S was below 0.1 ppm at MP01, MP02, MP04 and MP05, while MP03 recorded approximately 0.2 ppm.

The higher result at MP03 is consistent with the influence of existing waste decomposition. Hydrogen sulphide can be generated under anaerobic conditions and is particularly important in landfill assessments because of its characteristic offensive odour.

The result therefore indicates that odour management should form an important component of future landfill operations, particularly at the active working face and leachate-management areas.

7.5.5 Nitrogen Dioxide and Sulphur Dioxide

NO_2 and SO_2 remained below 0.1 ppm across the five monitoring locations during the field assessment.

No clear spatial pattern indicating significant localised NO_2 or SO_2 pollution was observed.

Future NO_2 emissions associated with the proposed development are expected to arise principally from diesel-powered waste-delivery vehicles, construction machinery and landfill operating equipment.

SO_2 is similarly expected to be associated principally with combustion sources rather than waste decomposition.

7.5.6 Oxygen

Atmospheric oxygen concentrations remained between approximately 20.8% and 20.9% across the monitoring locations.

MP03 recorded a marginally lower value of 20.8%, while the remaining locations recorded approximately 20.9%.

The results are consistent with normal open-air atmospheric conditions and do not indicate meaningful oxygen depletion within the monitored environment.

7.5.7 Meteorological Conditions

Monitoring was undertaken under dry conditions, with no precipitation recorded during the assessment period. Temperature ranged from approximately 21°C to 28°C, with relative humidity of approximately 14%.

South-easterly winds prevailed at approximately 8 km/h, equivalent to approximately 2.2 m/s.

These conditions are important for interpretation of the particulate results. The low relative humidity and absence of rainfall created relatively dry surface conditions conducive to dust generation, while the prevailing wind provided moderate atmospheric transport and dilution.

The field conditions therefore represented a reasonably conservative period for observing fugitive dust from exposed surfaces.

7.5.8 Spatial Interpretation

The monitoring results demonstrate a clear difference between the existing waste-influenced location and the broader project environment.

MP01, MP02, MP04 and MP05 generally represented relatively low ambient pollutant conditions. MP03 consistently recorded the highest $PM_{2.5}$, PM_{10}, TSP, CH_4, CO_2 and H_2S concentrations.

This pattern suggests a localised influence from existing waste-related activities rather than a broadly degraded regional air quality environment.

Table 15 : Overall Field Air Quality Classification

Monitoring Point	Particulate Condition	Gaseous Condition	Waste Influence	Overall Field Condition
MP01	Low	Low/background	Low	Good
MP02	Low	Low/background	Low	Good
MP03	Comparatively elevated	Localised CH_4, CO_2 and H_2S elevation	Evident	Moderate / landfill influenced
MP04	Low	Low/background	Low	Good
MP05	Low	Low/background	Low	Good

7.6 Field Monitoring Conclusion

The 30–31 August 2026 monitoring results indicate that ambient air quality across the broader Maletswai project area was generally good during the assessment period.

The principal exception was MP03, where comparatively elevated particulate matter, methane, carbon dioxide and hydrogen sulphide were recorded in association with the existing landfill/dumping environment.

The MP03 results are important for the proposed development because they demonstrate the types of localised emissions that may occur around an active waste-disposal facility if dust, landfill gas and odour sources are not effectively controlled.

Overall, the field results do not indicate widespread baseline air quality degradation across the project area. The principal future air quality management priorities should therefore be prevention of increased particulate loading, control of landfill gas and odour, and protection of surrounding sensitive receptors.

8. SENSITIVE RECEPTOR ASSESSMENT

8.1 Identification of Sensitive Receptors

Potential air quality sensitive receptors were identified within the 5 km assessment buffer surrounding the proposed Maletswai Landfill alternatives. Receptors were identified from the supplied spatial information, satellite imagery and field verification, with particular consideration given to residential areas, educational facilities, accommodation establishments, agricultural properties and road users.

The Sensitive Receptors Map confirms the spatial distribution of SR01–SR06 around the proposed development alternatives and shows that all six receptors fall within the adopted 5 km assessment area.

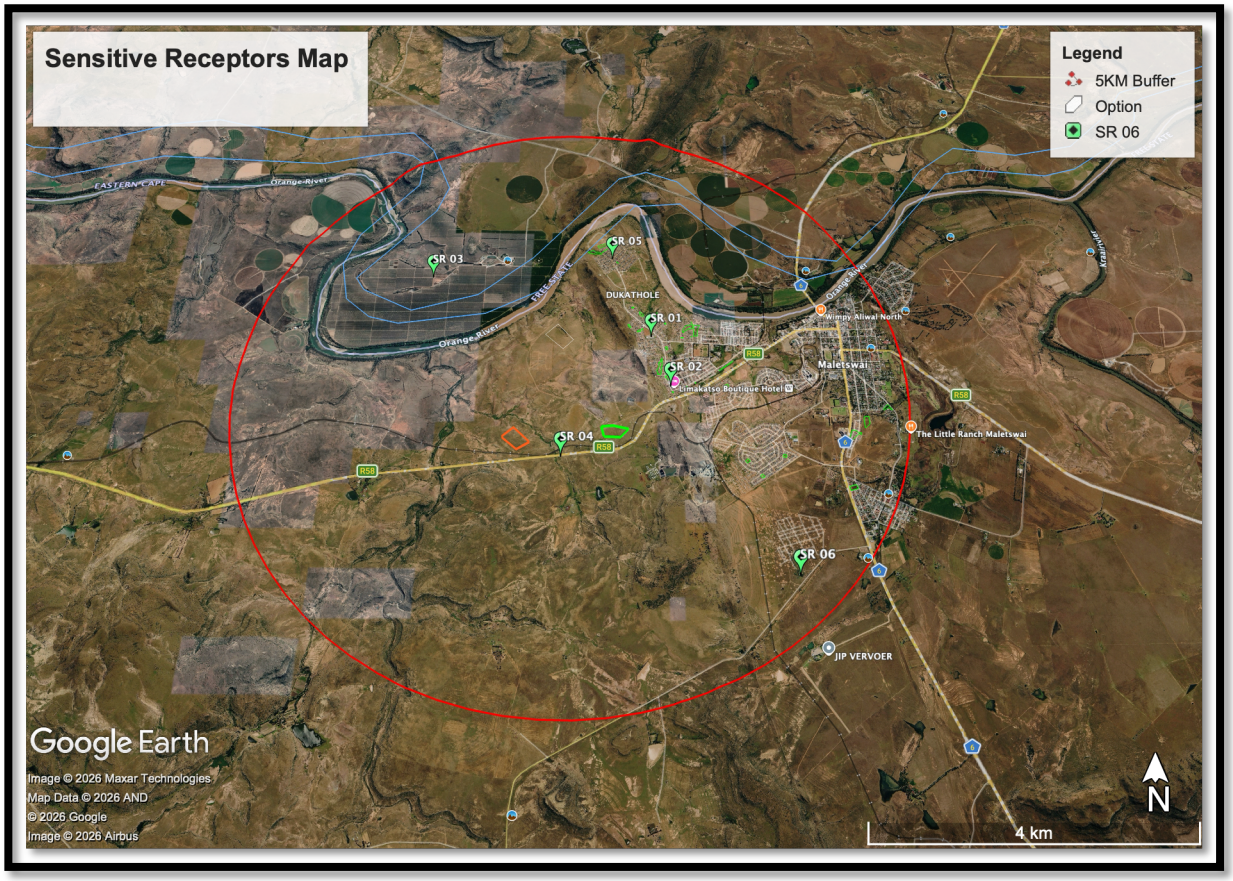


Figure 12 : Sensitive receptors identified within the 5 km assessment buffer surrounding the proposed Maletswai Landfill alternatives.

8.2 Sensitive Receptor Locations

The receptor locations and approximate distances to the nearest candidate study area are presented in Table 8-1. Distances are approximate straight-line distances based on the supplied receptor coordinates and representative positions of the candidate sites and are therefore intended for screening-level receptor assessment.

Table 16 : Identified Air Quality Sensitive Receptors

Receptor	Coordinates	Approx. Distance to Nearest Study Area	Receptor / Land Use	Location and Air Quality Sensitivity
SR01	30°41'29.39"S, 26°40'43.52"E	~1.47 km	Vumile Primary School / Residential Area	Located east to north-east of the proposed sites within the Dukathole/Maletswai residential environment. The school represents a high-sensitivity receptor because children occupy the facility for extended periods and may be sensitive to particulate matter, dust and offensive odour.
SR02	30°41'58.03"S, 26°40'53.95"E	~1.09 km	Limakatso Boutique Hotel / Residential Area	Located east of the alternative sites within the developed Maletswai residential area. The hotel and surrounding residences represent sensitive receptors because of continuous or extended human occupancy and potential sensitivity to dust and odour.
SR03	30°40'59.54"S, 26°38'34.88"E	~2.10 km	Plantation / Agricultural Farm	Located north-west of the candidate sites, across/near the Orange River agricultural landscape. The receptor is associated with agricultural activity and plantation/farm land. Sensitivity is primarily related to deposition of dust on vegetation and exposure of farm workers or occupants.
SR04	30°42'44.16"S, 26°38'37.80"E	~1.45 km	R58 / Road Users	Located south-west of the development alternatives along the regional road corridor. Road users represent transient receptors and therefore have lower exposure duration than residential receptors; however, excessive dust may affect visibility and short-duration exposure.
SR05	30°40'41.50"S, 26°40'21.25"E	~1.58 km	Residential Area	Located north to north-east of the proposed development within the broader Dukathole/Orange River settlement environment. Residential occupation results in potentially continuous exposure, making this receptor sensitive to dust, PM_{10}, $PM_{2.5}$, landfill gas and offensive odour.
SR06	30°43'35.71"S, 26°41'57.18"E	~3.32 km	Residential Area	Located south-east of the proposed development, toward the southern Maletswai/N6 development corridor. Although comparatively farther from the candidate sites, residential occupancy means that potential long-duration exposure to transported dust or odour remains relevant.

8.3 Receptor Sensitivity Classification

The receptors differ substantially in exposure duration and sensitivity. Schools and residential areas require particular consideration because occupants may remain at these locations for prolonged periods.

Table 17 : Air Quality Receptor Sensitivity

Receptor	Receptor Type	Exposure Character	Sensitivity	Principal Concern
SR01	Primary school / residential	Regular and prolonged	High	$PM_{2.5}$, PM_{10}, dust and odour
SR02	Hotel / residential	Prolonged / potentially continuous	High	Dust, PM and offensive odour
SR03	Agricultural farm / plantation	Intermittent to prolonged	Moderate	Dust deposition and occupational/residential exposure
SR04	Road users	Short-duration / transient	Low–Moderate	Windblown dust, visibility and short-term exposure
SR05	Residential	Continuous	High	$PM_{2.5}$, PM_{10}, landfill gas and odour
SR06	Residential	Continuous	High	Transported particulate matter and odour

8.4 Receptor Distribution Relative to the Development

The receptor distribution is not uniform around the proposed landfill alternatives. The most concentrated human settlement occurs predominantly east and north-east of the project area around Maletswai and Dukathole.

SR01, SR02 and SR05 are therefore particularly important for the assessment because they represent residential or community receptors situated on the developed side of the project landscape. SR01 requires additional consideration because it represents a primary school located within a residential environment.

SR03 occurs within the agricultural landscape to the north-west and is separated from the principal urban settlement. Potential impacts at this receptor are more likely to relate to windblown dust deposition and intermittent exposure associated with agricultural activities.

SR04 represents road users along the R58 corridor. Exposure duration is comparatively short; however, uncontrolled fugitive dust could potentially affect visibility where significant dust plumes migrate across the roadway.

SR06 represents the southern residential receiving environment. Although it is farther from the candidate sites than SR01, SR02 and SR05, its residential nature warrants consideration because pollutant transport is dependent not only on distance but also on wind direction and atmospheric dispersion.

8.5 Influence of Wind Direction

The prevailing field conditions recorded during the 30–31 August 2026 assessment included a south-easterly wind at approximately 8 km/h (2.2 m/s).

A south-easterly wind originates from the south-east and transports airborne material generally toward the north-west. Under these conditions, receptors located north-west of an active emission source may have greater potential for exposure.

Consequently, receptor sensitivity cannot be determined from distance alone. Wind direction, wind speed, source strength, atmospheric stability and the duration of the emission event must also be considered.

For landfill operations, changing seasonal wind conditions will influence which receptors are potentially downwind of the facility at any particular time.

8.6 Receptor-Specific Air Quality Concerns

The principal concern for SR01, SR02, SR05 and SR06 is potential exposure to particulate matter and offensive odour. These receptors contain regular or permanent human occupation and therefore require effective management of the landfill working face, landfill gas, leachate, access-road dust and exposed surfaces.

SR01 warrants particular attention because of the presence of Vumile Primary School. Children represent a sensitive population in relation to particulate air pollution; consequently, dust and particulate emissions should be prevented from causing material deterioration of ambient conditions at this receptor.

SR02 is the closest identified receptor to a candidate study area at approximately 1.09 km. Its location within a residential area and its use as an accommodation establishment mean that nuisance odour could be particularly relevant even where concentrations of individual pollutants remain relatively low.

SR03 is primarily an agricultural receptor. Dust deposition on vegetation and agricultural surfaces represents a greater concern than short-duration human exposure alone.

SR04 is a transient receptor. The principal concern is the potential for visible dust plumes to affect road users or reduce visibility during particularly dry and windy conditions.

8.7 Overall Receptor Assessment

The receptor assessment indicates that the proposed landfill is not located within an isolated receiving environment. Several residential and community receptors occur within the adopted 5 km assessment buffer, particularly toward Maletswai and Dukathole.

The closest identified sensitive receptor is SR02 at approximately 1.09 km from the nearest candidate study area, followed by SR01 at approximately 1.47 km and SR04 at approximately 1.45 km. SR05 occurs approximately 1.58 km from the nearest site, while SR03 and SR06 occur farther away.

Table 18 : Receptor Priority for the AQIA

Priority	Receptors	Basis
High	SR01, SR02, SR05	Residential/community receptors relatively close to the development; prolonged exposure potential
Moderate–High	SR06	Residential receptor but comparatively farther from the development
Moderate	SR03	Agricultural receptor with potential dust-deposition and intermittent human exposure
Low–Moderate	SR04	Transient road-user exposure; dust and visibility principally relevant

The presence of these receptors does not constitute an air quality fatal flaw but reinforces the requirement for effective dust suppression, waste covering, landfill-gas management, odour control and complaints management throughout the operational life of the proposed facility.

9. EMISSION SOURCES AND POLLUTANTS OF CONCERN

9.1 Overview

The proposed Maletswai Landfill will introduce a range of potential atmospheric emission sources during construction, operation, closure and post-closure. The nature and magnitude of emissions will vary according to the activity being undertaken, waste quantities handled, meteorological conditions, condition of access roads, size of the active working face and effectiveness of operational controls.

Based on the project characteristics, desktop findings and field verification, the principal air quality concerns are particulate matter and nuisance dust, landfill gas, offensive odours and combustion-related emissions.

The field assessment provides additional context, with MP03 recording comparatively higher $PM_{2.5}$, PM_{10}, TSP, CH_4, CO_2 and H_2S concentrations than the other monitoring locations. This indicates the types of localised emissions that may occur around an active waste-disposal environment.

9.2 Construction Phase Emissions

Construction will involve vegetation clearing, topsoil stripping, excavation, grading, construction of landfill cells, road development, stockpiling and movement of construction vehicles and heavy equipment.

The principal construction-related emission is expected to be fugitive particulate matter.

Dust may be generated through:

- Excavation and earthworks;
- Stripping and handling of topsoil;
- Loading and unloading of material;

- Movement of vehicles on unpaved surfaces;
- Wind erosion of exposed soils;
- Stockpiling of excavated material; and
- Placement and handling of construction materials.

PM_{10} and $PM_{2.5}$ are particularly relevant because these finer particulate fractions can remain suspended in the atmosphere and be transported downwind.

Construction machinery and vehicles will additionally generate combustion-related NO_x, particulate matter, CO_2 and smaller quantities of SO_2.

Construction impacts are expected to be temporary but may become locally significant under dry and windy conditions if dust suppression is inadequate.

9.3 Operational Phase Emissions

Operational emissions will arise from the continuous receipt, handling, placement and management of municipal waste.

Principal sources will include waste-delivery vehicles, internal haul roads, unloading of waste, spreading and compaction, application of cover material, active landfill surfaces, decomposition of organic waste and leachate-management infrastructure.

Unlike construction emissions, operational emissions may occur throughout the approximately 20-year operational life of the facility and therefore require sustained management.

9.4 Particulate Matter and Fugitive Dust

Particulate matter is expected to represent one of the principal operational air quality concerns.

Potential sources include:

- Unpaved internal roads;
- Waste-delivery vehicles;
- Landfill machinery;
- Exposed soil;
- Cover-material handling;
- Waste unloading;
- Active landfill surfaces; and
- Wind erosion.

The importance of dust is reinforced by the field results. PM_{10} concentrations ranged from 17 to 48 µg/m³, while $PM_{2.5}$ ranged from 6 to 18 µg/m³. The highest concentrations were recorded at MP03, which was influenced by the existing waste-disposal environment.

The monitoring conditions were dry, with approximately 14% relative humidity and no precipitation. These conditions favour dust generation where loose surface material is available.

The south-easterly wind of approximately 8 km/h recorded during the field assessment also demonstrates that suspended particulate matter can be transported away from source areas toward downwind receptors.

9.5 Total Suspended Particulates

TSP represents the broader suspended particulate fraction and is particularly relevant to nuisance dust and visible dust plumes.

Field TSP concentrations ranged between 34 and 86 µg/m³, with MP03 again recording the highest concentration.

Although TSP does not directly represent dust-fall deposition, elevated suspended particulate concentrations close to active waste-management areas provide an indication of increased dust-generation potential.

Road watering, speed control, surface stabilisation and minimisation of exposed areas will therefore be important operational controls.

9.6 Landfill Gas

Landfill gas is generated when biodegradable organic waste decomposes within the landfill body.

The principal landfill gases considered in this assessment are methane and carbon dioxide. Smaller quantities of hydrogen sulphide and other trace compounds may also occur.

Landfill gas generation is expected to increase progressively as waste accumulates and anaerobic decomposition becomes established.

Potential emission pathways include:

- Active waste surfaces;
- Cracks or discontinuities in landfill cover;
- Gas vents;
- Leachate infrastructure;
- Uncapped waste;
- Edges of completed landfill cells; and
- Subsurface migration pathways.

Landfill gas management should therefore form part of the engineering design, operational management and post-closure monitoring programme.

9.7 Methane

Methane is a principal product of anaerobic decomposition of biodegradable waste.

The field monitoring results recorded CH_4 below 1 ppm at MP01, MP02, MP04 and MP05, while approximately 3 ppm was recorded at MP03.

The comparatively elevated MP03 concentration is consistent with the influence of existing waste-disposal activities and provides an important indication of the potential for localised methane generation within a landfill environment.

For the proposed facility, methane should primarily be managed through appropriate landfill-gas control rather than relying solely on ambient boundary monitoring.

9.8 Carbon Dioxide

CO_2 concentrations during field monitoring ranged between approximately 418 and 438 ppm.

MP03 recorded the highest concentration at approximately 438 ppm, compared with approximately 418–421 ppm at the remaining monitoring points.

CO_2 is expected to be generated through waste decomposition in addition to combustion emissions from vehicles and equipment.

The relatively small spatial difference recorded during baseline monitoring does not indicate substantial existing CO_2 accumulation. However, landfill gas management will become increasingly important as the landfill matures.

9.9 Hydrogen Sulphide and Offensive Odour

Hydrogen sulphide is particularly important because it may contribute to offensive landfill odour.

Field H_2S concentrations were below 0.1 ppm at MP01, MP02, MP04 and MP05, while MP03 recorded approximately 0.2 ppm.

The spatial pattern again indicates localised influence associated with the existing waste environment.

Potential future sources of H_2S and other odorous compounds include decomposing waste, exposed organic material, landfill gas, leachate and contaminated standing water.

Odour impacts may occur even where concentrations do not indicate broader ambient air quality deterioration because human detection of some odorous compounds can occur at relatively low concentrations.

For this reason, odour management should be considered separately from compliance assessment against criteria-pollutant standards.

9.10 Vehicle and Machinery Emissions

Vehicles and mobile equipment will contribute combustion-related emissions during both construction and operation.

Potential sources include:

- Waste collection trucks;
- Construction vehicles;
- Landfill compactors;
- Excavators;
- Front-end loaders;
- Water trucks; and
- Other diesel-powered equipment.

The principal pollutants associated with these activities include NO_x, PM, CO_2 and other combustion products.

Field NO_2 and SO_2 concentrations remained below 0.1 ppm at all five monitoring points, indicating no substantial localised elevation during the monitoring period.

Future impacts can be minimised through appropriate equipment maintenance, prevention of unnecessary idling and efficient vehicle movement.

9.11 Leachate and Contaminated Water

Leachate-management infrastructure may become a secondary source of offensive odour.

Potential odour generation may occur where leachate or contaminated water remains exposed for prolonged periods, particularly under conditions favourable to anaerobic decomposition.

The proposed Pollution Control Dam and associated leachate infrastructure should therefore be operated to minimise uncontrolled stagnation, overflow and unnecessary exposure of odorous liquids.

9.12 Windblown Waste and Litter

Windblown waste is primarily a nuisance and visual impact but may also contribute to air quality impacts through movement of fine particulate material.

The open character of portions of the project landscape, particularly around Option Site 2, may increase susceptibility to wind-driven movement of lightweight waste and dust.

Operational measures should include litter fencing, appropriate compaction, regular covering of waste and collection of windblown material.

9.13 Uncontrolled Burning

Uncontrolled burning of waste would represent a potentially significant air quality source and should be strictly prohibited.

Burning municipal waste can generate particulate matter, smoke and a complex mixture of combustion products. Fire may also occur accidentally where combustible waste or landfill gas is inadequately managed.

The landfill should therefore maintain fire-prevention and emergency-response procedures throughout operation.

9.14 Closure and Post-Closure Emissions

Closure activities may temporarily generate dust during final shaping, placement of cover material and rehabilitation.

Once vegetation is established, fugitive dust emissions should decline substantially.

Landfill gas generation, however, may continue after waste disposal has ceased. Post-closure gas monitoring and management may therefore be required until the landfill demonstrates stable conditions.

9.15 Summary Emission Inventory

Table 19: Project Air Emission Inventory

Source / Activity	Principal Pollutant	Phase	Emission Character	Principal Potential Receptor
Vegetation clearing	PM_{10}, $PM_{2.5}$, TSP	Construction	Fugitive/intermittent	Nearby residential/community receptors
Topsoil stripping	PM_{10}, TSP	Construction	Fugitive	Nearby receptors and road users
Excavation and earthworks	PM_{10}, $PM_{2.5}$, TSP	Construction	Fugitive	SR01–SR06 depending on wind
Unpaved roads	PM_{10}, $PM_{2.5}$, TSP	Construction/Operation	Frequent fugitive	Nearby receptors and road users
Construction machinery	NO_x, PM, CO_2	Construction	Combustion	Localised
Waste-delivery vehicles	NO_x, PM, CO_2 and road dust	Operation	Continuous/intermittent	Roads and nearby receptors
Waste unloading	Dust and odour	Operation	Intermittent	Downwind receptors
Active working face	Dust, CH_4, CO_2, H_2S and odour	Operation	Continuous/intermittent	Downwind residential receptors
Waste decomposition	CH_4, CO_2 and trace gases	Operation/Post-closure	Continuous	Site boundary/downwind environment

Leachate management	H_2S and odour	Operation	Intermittent	Nearby/downwind receptors
Cover-material handling	PM_{10} and TSP	Operation	Fugitive	Local/downwind receptors
Wind erosion	PM_{10} and TSP	All disturbed phases	Meteorologically dependent	Downwind receptors
MRF activities	Dust and odour	Operation	Localised	Workers and nearby environment
Uncontrolled waste fire	$PM_{2.5}$, PM_{10} and combustion gases	Operation	Accidental	Potentially broad downwind area
Final cover placement	Dust	Closure	Temporary	Nearby receptors
Closed landfill	CH_4, CO_2 and trace gases	Post-closure	Residual/continuous	Site and surrounding environment

9.16 Key Pollutants for Further Assessment

Based on the proposed activities, field monitoring results and receptor setting, the principal pollutants requiring further impact assessment are PM_{10}, $PM_{2.5}$, TSP, CH_4, CO_2, H_2S and offensive odour.

NO_2 and SO_2 remain relevant because of vehicle and machinery emissions but are expected to represent secondary concerns relative to dust and landfill-related emissions.

The subsequent assessment therefore focuses particularly on the potential transport of particulate matter, landfill gas and odour toward SR01–SR06 under prevailing and adverse dispersion conditions.

10. AIR DISPERSION AND IMPACT ASSESSMENT

10.1 Introduction

The potential dispersion of atmospheric emissions from the proposed Maletswai Landfill was assessed considering the proposed landfill activities, identified emission sources, surrounding sensitive receptors, site topography, vegetation, available meteorological information and site-specific field observations undertaken on 30 August 2026.

The assessment considers the principal pollutants associated with landfill construction and operation, namely PM_{10}, $PM_{2.5}$, TSP, NO_2, SO_2, CH_4, CO_2 and H_2S, together with offensive odour, landfill gas, windblown dust and combustion-related emissions. The existing report identifies these pollutants from construction activities, vehicle movement, waste handling, decomposition, leachate and landfill-gas generation.

The purpose of the dispersion assessment is to determine the likely pollutant pathways between the landfill and surrounding receptors and to assess whether emissions can be appropriately controlled.

10.2 Assessment Approach and Dispersion Methodology

The dispersion assessment is based on a screening-level source–pathway–receptor approach integrating:

- Potential emission sources;
- Pollutant characteristics;
- Site topography;
- Vegetation and natural barriers;
- Wind speed and direction;
- Surrounding land use;
- Receptor location and sensitivity;
- Field monitoring results; and
- Anticipated landfill operating conditions.

No formal regulatory dispersion model such as AERMOD, CALPUFF, ADMS or SCREEN3 was applied as part of the current assessment. Accordingly, the report does not present calculated ground-level concentration contours or claim model-predicted compliance at individual receptors.

Any dispersion illustrations included in this AQIA should therefore be interpreted as conceptual spatial representations of potential pollutant transport rather than numerical regulatory dispersion-model outputs.

This distinction is important because the field measurements represent baseline screening observations and not predicted future landfill concentrations.

10.3 Meteorological Conditions and Wind Regime

Wind speed and direction are principal controls on atmospheric dispersion. Wind direction determines the pathway along which emissions are transported, while wind speed influences dilution and the potential entrainment of dust from exposed surfaces.

Available regional information indicates that stronger north-westerly to south-westerly winds may occur particularly during July–September. The existing desktop assessment identifies this dry winter/early-spring period as relevant to fugitive-dust transport.

A verified continuous long-term site-specific wind dataset was not available for the assessment. Consequently, no unsupported long-term wind-frequency statistics are presented.

During field verification on 30 August 2026, the following conditions were recorded:

Meteorological Parameter	Field Condition
Temperature	Approximately 21–28°C
Relative Humidity	Approximately 14%

Precipitation	None recorded
Wind Speed	Approximately 2.2 m/s (8 km/h)
Wind Direction	South-east (SE)
General Surface Condition	Dry

The dry conditions and low relative humidity were conducive to fugitive dust generation. The recorded wind was sufficient to transport suspended material away from exposed surfaces while also promoting atmospheric dilution.

10.4 Influence of Wind Direction

A south-easterly wind originates from the south-east and transports airborne pollutants generally toward the north-west.

Under the conditions recorded during field verification, receptors situated north-west of an emission source would consequently have had the greatest potential to occur downwind.

However, the SE conditions observed on 30 August 2026 represent the field-assessment conditions only and should not be interpreted as the permanent prevailing wind direction.

The assessment therefore considers receptors in all directions within the adopted 5 km assessment area.

10.5 Sensitive Receptors and Dispersion Pathways

Six sensitive receptors were identified within the assessment area, including residential, educational, accommodation, agricultural and road-user receptors. The closest identified receptor is SR02 at approximately 1.09 km, while SR01, SR04 and SR05 occur approximately 1.45–1.58 km from the nearest candidate area.

Receptor exposure will depend on the coincidence of:

- Emission generation → Wind toward receptor → Atmospheric transport → Insufficient dilution/deposition → Receptor exposure.

Distance alone therefore does not determine impact significance.

10.6 Baseline Evidence of Waste-Related Dispersion

The field monitoring provides a useful indication of the spatial behaviour of emissions around an existing waste-disposal environment.

MP01, MP02, MP04 and MP05 generally recorded relatively low particulate and gaseous concentrations, whereas MP03, associated with the existing landfill environment, recorded the highest $PM_{2.5}$, PM_{10}, TSP, CH_4, CO_2 and H_2S concentrations.

Parameter	General Monitoring Locations	MP03 – Existing Landfill Influence
$PM_{2.5}$	6–9 µg/m³	18 µg/m³
PM_{10}	17–23 µg/m³	48 µg/m³

TSP	34–43 µg/m³	86 µg/m³
CH_4	<1 ppm	3 ppm
CO_2	418–421 ppm	438 ppm
H_2S	<0.1 ppm	0.2 ppm

The spatial pattern indicates a localised waste-related influence rather than widespread deterioration of ambient air quality. This provides an important baseline analogue for the proposed facility: emissions should be controlled so that waste-related effects remain close to their source and do not materially affect surrounding receptors.

10.7 Pollutants Assessed for Dispersion

The dispersion assessment considers both criteria pollutants with applicable National Ambient Air Quality Standards and landfill-specific pollutants for which impacts are more appropriately addressed through source management, gas monitoring or nuisance assessment.

Table 20 : Pollutants Considered in the Dispersion Assessment

Pollutant	Principal Project Source	Relevant Assessment Criterion	Dispersion Consideration
PM_{10}	Roads, earthworks, waste handling, exposed surfaces	24-hour: 75 µg/m³; Annual: 40 µg/m³	Important fugitive-dust pollutant
$PM_{2.5}$	Combustion, fine dust, landfill fires	24-hour: 40 µg/m³; Annual: 20 µg/m³	Fine fraction capable of longer-range transport
TSP	Roads, soil, cover material and waste handling	Dust/nuisance indicator	Predominantly local deposition/nuisance
NO_2	Vehicles and diesel machinery	1-hour: 200 µg/m³; Annual: 40 µg/m³	Combustion-related
SO_2	Fuel combustion	10-min: 500; 1-hour: 350; 24-hour: 125; Annual: 50 µg/m³	Secondary landfill concern
CH_4	Anaerobic waste decomposition	Landfill-gas management parameter	Gas migration and atmospheric release
CO_2	Waste decomposition and combustion	Landfill-gas/supporting parameter	Landfill-gas dispersion
H_2S	Decomposition and leachate	Odour/source-management parameter	Important local odour indicator
NO_x	Vehicles and equipment	Supporting combustion pollutant	Localised transport-related emissions
CO	Vehicles/incomplete combustion	Supporting combustion pollutant	Localised combustion emissions
VOCs	Waste, fuels and decomposition	Odour/trace-gas consideration	Potential trace and odorous emissions
Odour	Waste, landfill gas and leachate	Nuisance/receptor criterion	Highly dependent on wind and stability

The applicable PM_{10}, $PM_{2.5}$, NO_2 and SO_2 standards are already established in the regulatory section of the AQIA.

10.8 PM_{10} Dispersion

PM_{10} is expected to represent one of the principal pollutants associated with landfill construction and operation.

Sources include:

- Unpaved roads;
- Earthworks;
- Topsoil handling;
- Landfill cover material;
- Waste unloading;
- Exposed landfill surfaces; and
- Wind erosion.

Coarser PM_{10} particles will generally deposit progressively with distance from the source, although finer fractions can remain suspended and travel farther downwind.

The applicable South African ambient criteria are 75 µg/m³ over 24 hours and 40 µg/m³ as an annual average.

The short-duration field measurements cannot be directly compared with these averaging periods as proof of regulatory compliance. The existing AQIA correctly recognises this limitation.

10.9 $PM_{2.5}$ Dispersion

$PM_{2.5}$ may originate from fine dust, diesel combustion and, importantly, smoke should accidental landfill fires occur.

Because of its smaller aerodynamic diameter, $PM_{2.5}$ can remain suspended for longer than coarse particulate matter and may therefore be transported farther from the source.

The applicable ambient criteria are 40 µg/m³ over 24 hours and 20 µg/m³ as an annual average.

Operational control should focus on minimising dust generation, maintaining vehicles and strictly preventing uncontrolled waste burning.

10.10 NO_2 Dispersion

NO_2 emissions are expected principally from waste-transport vehicles, construction machinery, compactors, excavators, loaders and other diesel-powered equipment.

The applicable ambient criteria are:

- 1-hour: 200 µg/m³; and
- annual: 40 µg/m³.

NO_2 is not expected to represent the dominant landfill pollutant because the proposed facility does not include a major continuous combustion stack source based on the project information currently available.

Field NO_2 concentrations were below 0.1 ppm at all monitoring locations.

The principal management measures are vehicle maintenance, efficient routing and prevention of excessive engine idling.

10.11 SO_2 Dispersion

SO_2 is similarly expected to originate primarily from combustion of sulphur-containing fuels rather than waste decomposition.

The applicable ambient criteria are:

- 10-minute: 500 µg/m³;
- 1-hour: 350 µg/m³;
- 24-hour: 125 µg/m³; and
- Annual: 50 µg/m³.

Field SO_2 concentrations remained below 0.1 ppm across the monitoring locations.

SO_2 is therefore considered a secondary pollutant of concern relative to particulate matter, landfill gas and odour.

10.12 Methane Dispersion

Methane will progressively become an important landfill-gas parameter as biodegradable waste undergoes anaerobic decomposition.

Potential release pathways include:

- Active waste surfaces;
- Cracks in landfill cover;
- Landfill edges;
- Gas vents;
- Leachate infrastructure; and
- Subsurface migration pathways.

Baseline CH_4 was below 1 ppm at MP01, MP02, MP04 and MP05 and approximately 3 ppm at the existing landfill-influenced MP03 location.

Methane should principally be controlled through engineered landfill-gas collection/venting and perimeter gas monitoring rather than through comparison with the criteria-pollutant NAAQS.

10.13 Carbon Dioxide Dispersion

CO_2 will be generated by waste decomposition and vehicle/equipment combustion.

Field concentrations ranged between approximately 418 and 438 ppm, with the highest value occurring at MP03.

In the open ambient environment, CO_2 released from diffuse landfill sources is expected to undergo atmospheric dilution. However, it remains an important component of landfill-gas monitoring and should be assessed together with CH_4 and O_2 around the landfill body and gas-management infrastructure.

10.14 Hydrogen Sulphide and Odour Dispersion

H_2S is important because of its association with anaerobic decomposition and offensive landfill odour.

Potential sources include:

- Decomposing waste;
- Landfill gas;
- Leachate;
- Contaminated standing water; and
- Sulphur-containing waste.

Field H_2S was below 0.1 ppm at the general monitoring locations and approximately 0.2 ppm at MP03.

Odour impacts may occur intermittently and are particularly dependent on wind direction, atmospheric stability, source strength and distance.

H_2S and offensive odour therefore require dedicated operational management even where conventional criteria pollutants remain comparatively low.

10.15 Other Notable Pollutants

Additional emissions potentially associated with the proposed landfill include NO_x, CO, VOCs and smoke-related combustion products.

NO_x and CO are principally associated with vehicles and machinery, while VOCs may arise from fuels, waste decomposition and certain waste materials.

Uncontrolled landfill fires would potentially produce a broader mixture of $PM_{2.5}$, PM_{10}, CO, NO_x, VOCs and other combustion products. Consequently, uncontrolled burning must be prohibited and landfill fire prevention incorporated into the operational management system.

10.16 Indicative Spatial Dispersion

The indicative dispersion assessment shows that pollutant concentrations are expected to be greatest close to active sources and generally decrease with distance through atmospheric dilution and, for particulate matter, deposition.

Under the SE wind observed during the 30 August 2026 field assessment, the indicative transport direction is toward the north-west.

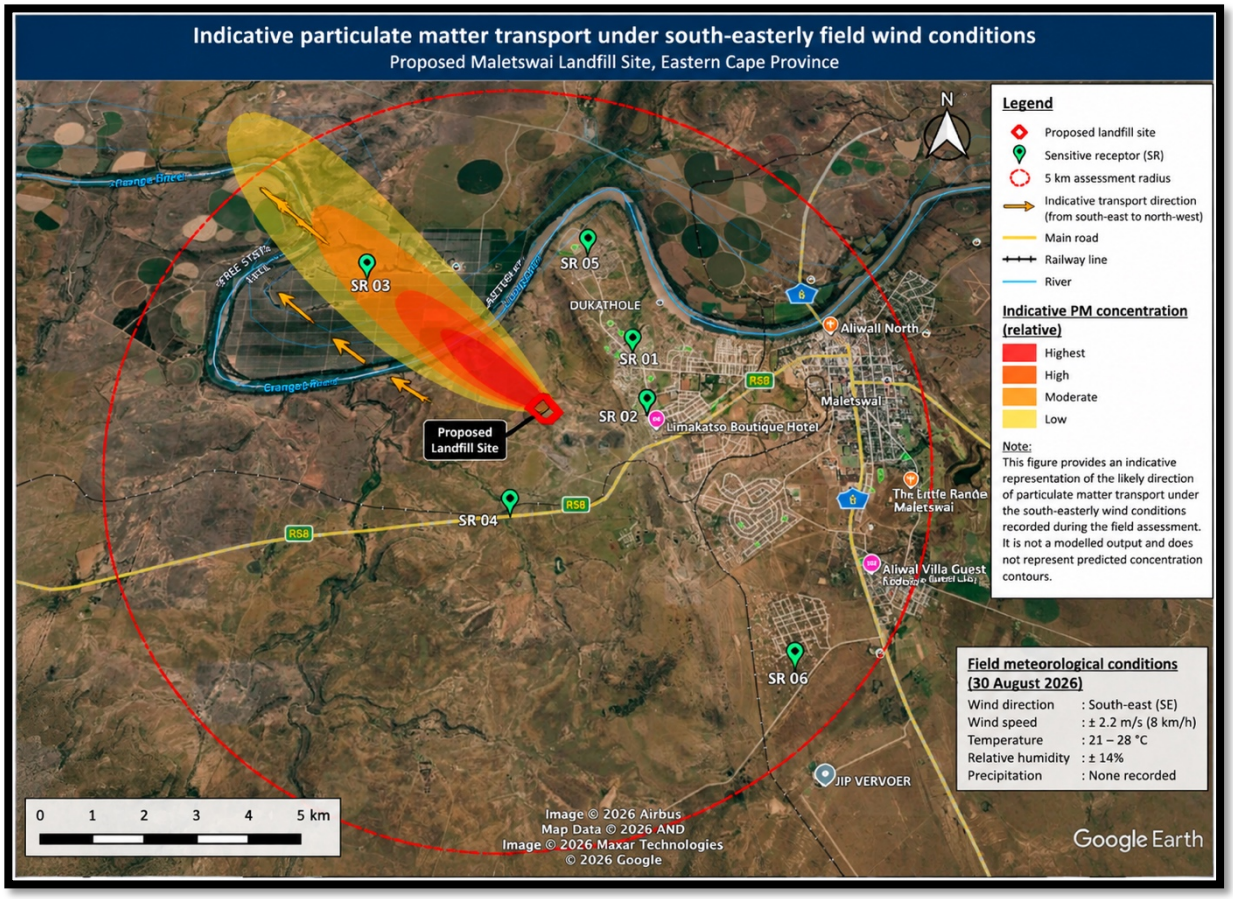


Figure 13: Indicative particulate matter transport under south-easterly field wind conditions.

The figure. above represents the likely directional transport pathway under the recorded field conditions only. It is not an concentration contour and should not be interpreted as predicting specific concentrations or regulatory exceedances.

10.17 Preferred Site Dispersion Assessment

The Preferred Site is characterised by comparatively greater surrounding vegetation and elevated terrain/hills.

These features increase surface roughness and provide partial shielding from near-ground winds. They may therefore assist in reducing unrestricted movement of coarse dust and windblown litter.

The site remains comparatively closer to portions of the Maletswai/Dukathole receiving environment, meaning that effective dust and odour controls remain essential.

Overall, the combination of natural terrain screening, vegetation and reduced direct interaction with the existing dumping area provides comparatively favourable conditions for emission management.

10.18 Option Site 1 Dispersion Assessment

Option Site 1 occurs adjacent to the existing dumping area and within a comparatively open, disturbed landscape.

Its principal concern is cumulative waste-related emissions. The MP03 monitoring results demonstrate an existing localised waste signature within this environment.

The site is also influenced by electrical powerline servitudes and railway infrastructure. The open servitude corridors provide limited natural wind screening and may facilitate movement of fugitive dust and litter.

Option Site 1 therefore presents a greater cumulative dispersion concern than the Preferred Site.

10.19 Option Site 2 Dispersion Assessment

Option Site 2 is predominantly open and exposed, with comparatively limited substantial vegetation or terrain screening.

This setting allows relatively unrestricted atmospheric transport. Although this can enhance dilution of gases, it also increases the potential distance over which fugitive dust, odour and windblown waste may travel.

Its proximity to the road corridor introduces additional concern regarding dust, litter, visibility and nuisance to road users.

Option Site 2 therefore presents the greatest wind-exposure concern.

10.20 Comparative Dispersion Assessment

Criterion	Preferred Site	Option Site 1	Option Site 2
Natural Terrain Screening	Comparatively favourable	Limited	Limited
Vegetation Screening	Comparatively favourable	Limited–Moderate	Limited
Wind Exposure	Moderate	High	High
Existing Waste Influence	Lower	High	Lower
Cumulative Emission Potential	Low–Moderate	High	Low
PM Dispersion Concern	Moderate	Moderate–High	High
Landfill Gas Concern	Moderate	Moderate–High	Moderate
Odour Concern	Moderate	Moderate–High	Moderate

Windblown Litter Potential	Moderate	Moderate–High	High
Road-User Interaction	Lower	Moderate	Higher
Overall Dispersion Constraint	Moderate/manageable	Moderate–High	Moderate–High
Air Quality Preference	1	2	3

10.21 Interpretation Against Ambient Standards

The National Ambient Air Quality Standards provide the applicable assessment criteria for PM_{10}, $PM_{2.5}$, NO_2 and SO_2.

However, this AQIA does not present formal numerical model predictions for future landfill emissions. It would therefore be inappropriate to claim predicted compliance or non-compliance with the 24-hour, annual, 1-hour or 10-minute standards based solely on the conceptual dispersion assessment.

Similarly, the portable field results are short-duration baseline screening measurements and should not be treated as equivalent to the applicable regulatory averaging periods.

The standards are therefore used to establish future monitoring and management criteria, while the present assessment evaluates potential significance using the identified emission sources, baseline conditions, receptor sensitivity, dispersion environment and proposed mitigation.

10.22 Dispersion Assessment Conclusion

The proposed landfill has the potential to generate PM_{10}, $PM_{2.5}$, TSP, NO_2, SO_2, CH_4, CO_2, H_2S, odour and other minor combustion or decomposition-related pollutants.

Particulate matter, landfill gas and offensive odour represent the principal dispersion concerns.

The field results demonstrate that existing waste-related emissions around MP03 are predominantly localised. The proposed landfill should therefore be designed and operated to maintain a similar source-control principle and prevent material off-site impacts at sensitive receptors.

The Preferred Site remains the most favourable alternative from a dispersion-management perspective because of its comparatively greater terrain and vegetation screening, reduced unrestricted wind exposure and lower cumulative interaction with the existing dumping area. Option Site 1 presents greater cumulative waste-related concern, while Option Site 2 presents greater wind-driven transport potential because of its open and exposed setting.

No formal AERMOD, CALPUFF, ADMS or SCREEN3 model was undertaken as part of this assessment; therefore, no numerical future concentration contours or predicted compliance claims are made. The assessment instead provides a screening

11. AIR QUALITY IMPACT SIGNIFICANCE ASSESSMENT

11.1 Introduction

The proposed Maletswai Landfill has the potential to affect ambient air quality during construction, operation, closure and post-closure. The significance of these impacts depends on the magnitude and duration of emissions, meteorological conditions, distance to sensitive receptors and effectiveness of mitigation.

The field assessment indicates generally good ambient conditions across MP01, MP02, MP04 and MP05, while MP03 showed a localised waste-related influence, particularly for particulate matter, CH_4, CO_2 and H_2S. The impact assessment therefore places particular emphasis on preventing similar waste-related effects from extending beyond the future landfill operational footprint.

11.2 Construction Phase

Construction activities will include vegetation clearing, topsoil stripping, excavation, bulk earthworks, construction of landfill cells, road development and movement of heavy equipment.

Fugitive dust is expected to represent the principal construction-phase impact. Under the dry conditions observed during the field assessment, including approximately 14% relative humidity and no precipitation, exposed surfaces may readily generate dust if uncontrolled.

Table 21 : Construction Phase Impact Assessment

Potential Impact	Main Source	Without Mitigation	Key Mitigation	Residual Significance
PM_{10} and $PM_{2.5}$ emissions	Earthworks and excavation	Moderate–High	Water suppression and minimise exposed areas	Low–Moderate
TSP / nuisance dust	Soil handling and stockpiles	Moderate	Stabilise stockpiles and suppress dust	Low
Road-generated dust	Construction traffic	Moderate–High	Water roads, maintain surfaces and control speeds	Low
Windblown dust	Exposed disturbed land	Moderate	Progressive stabilisation and rehabilitation	Low
Vehicle exhaust emissions	Trucks and machinery	Low–Moderate	Equipment maintenance and minimise idling	Low
Dust impacts on receptors	Combined construction sources	Moderate	Source control and receptor monitoring	Low–Moderate

Construction impacts are expected to be temporary and reversible once earthworks cease and disturbed areas are stabilised.

11.3 Operational Phase

Operational air quality impacts will persist throughout the life of the landfill and therefore require greater long-term management.

The principal concerns are road-generated dust, waste-handling particulate matter, landfill gas, H_2S and offensive odours.

Table 22 : Operational Phase Impact Assessment

Potential Impact	Main Source	Without Mitigation	Residual Significance
PM_{10} / $PM_{2.5}$	Roads, waste handling and exposed surfaces	Moderate–High	Low–Moderate
TSP / nuisance dust	Roads, cover material and active working face	Moderate–High	Low
Methane emissions	Waste decomposition	Moderate	Low–Moderate
CO_2 emissions	Waste decomposition and vehicles	Low–Moderate	Low
H_2S	Decomposition and leachate	Moderate	Low
Offensive odour	Waste, landfill gas and leachate	Moderate–High	Low–Moderate
Vehicle exhaust emissions	Waste trucks and equipment	Low–Moderate	Low
Windblown waste/dust	Active landfill surface	Moderate	Low
Cumulative waste-related emissions	Particularly relevant to Option Site 1	Moderate–High	Low–Moderate

11.4 Particulate Matter Impact

Particulate emissions are expected to be greatest where unpaved vehicle movement, active waste handling and exposed surfaces occur simultaneously.

The field results provide an indication of this relationship. MP03 recorded PM_{10} of 48 µg/m³ and $PM_{2.5}$ of 18 µg/m³ compared with PM_{10} of 17–23 µg/m³ and $PM_{2.5}$ of 6–9 µg/m³ across the other monitoring points.

The particulate dispersion assessment indicates that impacts will be greatest near the source and progressively decrease with distance. Under the south-easterly wind conditions recorded during fieldwork, the principal dispersion pathway was toward the north-west.

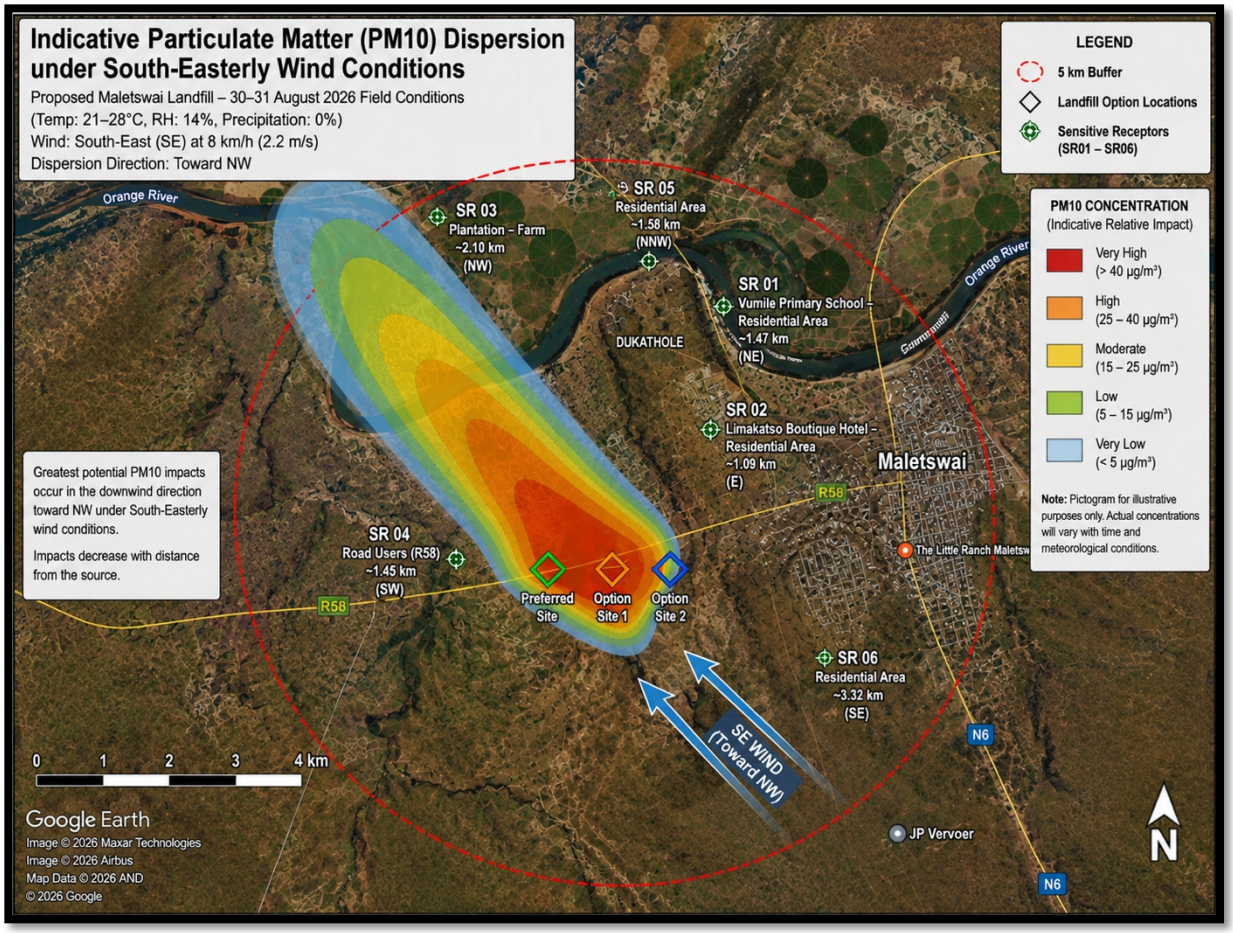


Figure 14 : Indicative particulate matter dispersion under south-easterly wind conditions.

The dispersion figure should be interpreted as an indicative spatial representation rather than a regulatory dispersion-model output.

11.5 Landfill Gas Impact

Methane and carbon dioxide will progressively develop as biodegradable waste decomposes.

The MP03 baseline result of approximately 3 ppm CH_4 compared with <1 ppm at the remaining monitoring points demonstrates that waste-disposal environments can produce detectable localised methane concentrations.

The principal management objective should be to prevent uncontrolled accumulation or migration of landfill gas through engineered gas-management measures.

With appropriate gas control, residual off-site impacts are expected to remain low to moderate.

11.6 Odour Impact

Odour has the potential to represent one of the most noticeable community impacts associated with landfill operation.

Potential sources include fresh waste, decomposing organic material, H_2S, landfill gas, leachate and contaminated standing water.

SR01, SR02, SR05 and SR06 require particular consideration because they represent residential, educational or accommodation-related receptors. The Sensitive Receptors Map confirms that these receptors occur within the adopted 5 km assessment area.

Odour impacts are expected to be episodic rather than continuous and will depend strongly on wind direction and operational performance.

Without mitigation, the potential impact is considered moderate to high. With effective waste compaction, daily cover, leachate management, gas management and rapid response to complaints, residual significance is expected to reduce to low–moderate.

11.7 Sensitive Receptor Impact

Table 23 : Potential Air Quality Impact at Sensitive Receptors

Receptor	Sensitivity	Principal Concern	Potential Unmitigated Impact	Residual Impact
SR01 – Vumile Primary School / Residential	High	PM and odour	Moderate–High	Low–Moderate
SR02 – Limakatso Boutique Hotel / Residential	High	Odour and dust	Moderate–High	Low–Moderate
SR03 – Plantation/Farm	Moderate	Dust deposition	Moderate	Low
SR04 – R58 Road Users	Low–Moderate	Dust and visibility	Moderate	Low
SR05 – Residential Area	High	PM, landfill gas and odour	Moderate–High	Low–Moderate
SR06 – Residential Area	High	Transported dust and odour	Moderate	Low

The greatest management priority should be placed on preventing sustained dust or odour impacts at residential and community receptors.

11.8 Closure Phase

Closure will involve final shaping, placement of cover material, soil handling and revegetation.

Temporary dust emissions may occur during these activities, but the impacts will progressively decrease as disturbed surfaces become stabilised.

The closure-phase particulate impact is therefore considered moderate without mitigation and low following implementation of dust suppression and progressive revegetation.

11.9 Post-Closure Phase

Landfill gas may continue to be generated for an extended period following closure.

The post-closure air quality programme should therefore continue to consider:

- Methane;
- Landfill gas migration;
- Odour;
- Condition of the final cover;
- Erosion and exposed surfaces; and
- Integrity of landfill gas infrastructure.

Post-closure gas monitoring should continue until the facility demonstrates stable declining gas-generation conditions.

11.10 Overall Impact Significance

Table 24 : Overall Air Quality Impact Significance

Impact	Construction	Operation	Closure/Post-Closure	Residual Overall Significance
PM_{10}	Moderate–High	Moderate–High	Moderate	Low–Moderate
$PM_{2.5}$	Moderate	Moderate	Low–Moderate	Low
TSP / nuisance dust	Moderate–High	Moderate	Moderate	Low
CH_4	Negligible	Moderate	Moderate	Low–Moderate
CO_2	Low	Low–Moderate	Low–Moderate	Low
H_2S	Negligible	Moderate	Low–Moderate	Low
Odour	Negligible–Low	Moderate–High	Low–Moderate	Low–Moderate
Vehicle emissions	Low–Moderate	Low–Moderate	Low	Low
Cumulative air quality impact	Low	Moderate	Low	Low–Moderate

11.11 Impact Assessment Conclusion

The proposed landfill is expected to result in a measurable increase in local air emissions compared with the current general baseline, particularly within and immediately surrounding the operational footprint.

The most important potential impacts are particulate matter, nuisance dust, landfill gas and offensive odour.

Without mitigation, localised impacts may reach moderate to high significance, particularly during intensive earthworks, dry windy conditions and active waste handling.

However, the identified impacts are largely controllable at source. With appropriate dust suppression, road management, waste compaction and covering, landfill-gas management, leachate control and operational monitoring, residual impacts are expected to be predominantly low to low–moderate.

12. ALTERNATIVES ASSESSMENT AND AIR QUALITY SITE PREFERENCE

The Preferred Site, Option Site 1 and Option Site 2 were comparatively assessed from an air quality perspective, taking into account sensitive receptor distribution, existing emission sources, terrain, vegetation cover, landscape exposure, wind conditions, potential particulate dispersion, landfill gas, odour and the potential for windblown waste.

The Sensitive Receptors Map indicates that residential, educational, accommodation, agricultural and road-user receptors occur within the adopted 5 km assessment area. The alternatives therefore require consideration not only of pollutant generation at source, but also of the physical characteristics that may influence transport of emissions toward surrounding receptors.

Based on the integrated field observations and air quality assessment, the Preferred Site is considered the most favourable alternative from an air quality perspective.

12.1 Preferred Site

The Preferred Site is situated within a landscape that provides comparatively greater natural containment than the two alternative sites. Field observations indicate the presence of surrounding elevated terrain/hills together with established vegetation that can provide partial physical screening from near-surface winds.

From an air quality perspective, these features are advantageous because vegetation and terrain roughness can reduce near-ground wind velocities and intercept a proportion of coarse airborne particulate material. They may consequently assist in limiting the immediate transport of nuisance dust and windblown litter from disturbed surfaces. These features should, however, be regarded as supplementary natural controls rather than substitutes for engineered dust, gas and odour management.

The Preferred Site is located beyond the existing waste-disposal area relative to portions of the developed receiving environment. This provides some spatial separation between the proposed landfill footprint and the existing waste-related emission source, thereby reducing the potential for direct overlapping or cumulative emissions compared with development immediately adjacent to the existing dumping area.

The principal constraint associated with the Preferred Site remains its relative proximity to the Maletswai/Dukathole receiving environment. SR01, SR02 and SR05 represent important community and residential receptors within the broader area. Effective control of dust, landfill gas and odour will therefore remain essential.

Nevertheless, the combination of greater natural screening, terrain roughness, vegetation and reduced direct interaction with the existing dumping area provides the Preferred Site with an overall air quality advantage.

12.2 Option Site 1

Option Site 1 occurs within a comparatively open and already disturbed landscape.

A major air quality disadvantage is the site's proximity to the existing dumping/disposal area. Existing waste-related activities may already contribute dust, decomposition gases and odour to the local receiving environment. Development of another landfill facility within the same immediate airshed could therefore result in cumulative effects.

This concern is supported by the field monitoring pattern at MP03, where the waste-influenced location recorded the highest particulate and gaseous concentrations, including PM_{10} of 48 µg/m³, $PM_{2.5}$ of 18 µg/m³, TSP of 86 µg/m³, CH_4 of 3 ppm, CO_2 of 438 ppm and H_2S of 0.2 ppm.

Option Site 1 is also comparatively open, with limited substantial vegetation or topographic barriers immediately surrounding portions of the site. Under windy conditions, this could facilitate unrestricted movement of fugitive dust, odour and windblown material away from the source.

Existing electrical powerlines and associated servitudes further constrain the site. While the powerlines themselves are not significant air pollution sources, the servitude creates an open linear corridor and limits opportunities for establishing substantial vegetation screening within the servitude area. It also constrains the configuration of landfill infrastructure and potential buffer arrangements.

The combination of existing waste-related emissions, open terrain and infrastructure constraints therefore makes Option Site 1 less favourable than the Preferred Site from an air quality management perspective.

12.3 Option Site 2

Option Site 2 is characterised by a predominantly open and exposed landscape with comparatively limited substantial vegetation or topographic screening.

This represents an important air quality constraint because exposed landfill surfaces, unpaved roads and cover-material stockpiles would be more directly subjected to wind. During dry conditions, this may increase the potential for fugitive dust generation and transport.

The site is also located relatively close to the R58 and associated road users. SR04 represents this transport-related receptor within the assessment area.

Although road users are transient receptors, uncontrolled dust may affect visibility and create nuisance conditions. The open landscape also increases the potential for lightweight waste to become windblown beyond the landfill boundary.

Windblown litter is relevant not only as an operational nuisance but also as a potential land-pollution and visual impact. Lightweight plastics, paper and packaging material may be transported toward roadside areas, surrounding grazing land and the natural environment if waste is not rapidly compacted, covered and contained by appropriate litter-control systems.

The visibility of the site from surrounding roads and communities further increases the importance of maintaining effective operational housekeeping. These visual considerations are primarily addressed through the Visual Impact Assessment, but they reinforce the air-quality concern associated with an exposed landfill environment.

Option Site 2 is therefore considered the least favourable alternative from an air quality and wind-exposure perspective.

12.4 Influence of Terrain and Vegetation on Air Quality

Terrain and vegetation represent important secondary controls on near-surface pollutant transport.

Vegetation increases aerodynamic surface roughness and can reduce near-ground wind velocity. Vegetated areas may also intercept a proportion of larger airborne particles. Similarly, hills and elevated terrain can alter local airflow and provide partial shielding from direct winds.

However, these features do not eliminate pollutant dispersion. Fine particulate matter and gaseous emissions can still be transported beyond physical barriers depending on wind direction, atmospheric stability and emission height.

For this reason, the natural screening associated with the Preferred Site is regarded as a relative advantage rather than a complete mitigation measure.

The Preferred Site would still require engineered and operational controls including road watering, waste covering, landfill-gas management, litter fencing and odour management.

12.5 Comparative Air Quality Assessment

Table 25 : Comparative Air Quality Assessment of Alternatives

Assessment Criterion	Preferred Site	Option Site 1	Option Site 2
Existing Waste-Related Influence	Comparatively lower	High – adjacent to existing dumping area	Low
Cumulative Waste Emission Potential	Low–Moderate	High	Low
Terrain Screening	Comparatively favourable	Limited	Limited
Vegetation Screening	Comparatively favourable	Limited/moderate	Limited
Landscape Exposure	Moderate	High	High

Direct Wind Exposure	Comparatively lower	High	High
Fugitive Dust Potential	Moderate	Moderate–High	High
Windblown Litter Potential	Moderate	Moderate–High	High
Existing Landfill Gas/Odour Influence	Lower	Comparatively high	Low
Electrical Servitude Constraint	Less significant	Significant	Present within broader landscape
Road-User Exposure	Lower	Moderate	Comparatively high
Potential Land-Pollution from Windblown Waste	Moderate	Moderate	Comparatively high
Residential/Community Receptor Consideration	Moderate–High	Moderate	Moderate
Natural Dispersion Barrier	Hills/terrain and vegetation provide partial screening	Comparatively open	Predominantly open
Overall Air Quality Constraint	Moderate and manageable	Moderate–High	Moderate–High
AQIA Preference	1	2	3

12.7 Air Quality Site Preference

Based on the combined air quality findings, the Preferred Site is considered the most favourable alternative.

The preference is based on the combined presence of natural terrain and vegetation screening, comparatively reduced wind exposure and greater separation from the direct influence of the existing dumping site.

These characteristics provide a more favourable physical setting for controlling fugitive dust, windblown waste and potentially odorous emissions.

Option Site 1 is ranked second. Although it occurs within an already disturbed waste-management landscape, this represents a disadvantage from an air quality perspective because the proposed development would potentially add to existing dust, landfill gas and odour emissions. The open terrain and electrical servitude further constrain opportunities for effective screening and site configuration.

Option Site 2 is ranked third. Its predominantly open and exposed setting provides limited natural protection against wind-driven particulate and litter transport. Its proximity to the R58 further introduces potential impacts on road users, while windblown waste could affect surrounding grazing land and the natural environment.

The air quality ranking is therefore:

1. Preferred Site – most preferred;
2. Option Site 1 – second preferred; and

3. Option Site 2 – least preferred.

12.8 Professional Motivation for the Preferred Site

The preference for the Preferred Site does not imply that it will have no air quality impacts. Rather, its physical setting provides comparatively better conditions for managing the emissions inherently associated with landfill operation.

The key advantages are:

- Partial natural shielding provided by surrounding elevated terrain;
- Greater vegetation cover and surface roughness capable of reducing near-ground wind movement;
- Comparatively reduced exposure of the landfill footprint to unrestricted winds;
- Reduced direct cumulative interaction with the existing dumping site compared with option site 1;
- Lower potential for unrestricted windblown litter than the highly exposed option site 2; and
- Greater opportunity to supplement existing natural screening with engineered buffer and vegetation-management measures.

These advantages are particularly relevant to fugitive particulate matter, nuisance dust and windblown waste.

12.9 Specialist Opinion on Site Alternatives

From an air quality perspective, the Preferred Site is supported as the preferred development alternative.

Option Site 1 remains technically feasible but is less favourable because of its proximity to the existing dumping area, cumulative waste-related emissions, open landscape and electrical servitude constraints.

Option Site 2 presents the greatest exposure to unrestricted wind and therefore has a comparatively greater potential for fugitive dust and windblown litter to migrate toward the R58, surrounding grazing areas and the wider natural environment.

The Preferred Site therefore provides the most balanced air quality setting of the three alternatives.

This preference remains conditional on implementation of comprehensive air quality management measures. Natural hills and vegetation should not be relied upon as the primary pollution-control mechanism. The landfill must still implement effective road-dust suppression, minimisation of exposed surfaces, rapid waste compaction and covering, litter containment, landfill-gas management, leachate and odour control, progressive rehabilitation and appropriate boundary/receptor monitoring.

On this basis, no air quality fatal flaw has been identified for the Preferred Site, and it is considered acceptable and preferred from the perspective of this Air Quality Impact Assessment.

The next section should be Air Quality Mitigation and Management Measures, translating the identified impacts into commitments for the EMPr and landfill operating procedures.

13. AIR QUALITY MITIGATION AND MANAGEMENT MEASURES

13.1 Introduction

The assessment identified fugitive dust, PM_{10}, $PM_{2.5}$, landfill gas, offensive odour, windblown litter and vehicle emissions as the principal air quality issues requiring management during the construction, operational, closure and post-closure phases.

Although the Preferred Site is considered the most favourable alternative from an air quality perspective, its natural terrain and vegetation screening should be regarded only as supplementary controls. Effective source-based management remains necessary to prevent unacceptable impacts at surrounding sensitive receptors.

The objective of the air quality management programme is therefore to minimise emissions at source, prevent unnecessary off-site dispersion and provide an early-response mechanism where dust, odour or landfill gas problems are identified.

13.2 Construction Phase Dust Management

Construction activities should be managed to minimise fugitive particulate emissions from vegetation clearing, excavation, topsoil stripping, material handling and vehicle movement.

The following measures should be implemented:

- Limit vegetation clearing and earthworks to the approved footprint;
- Minimise the area of exposed soil at any one time;
- Apply water to actively used unpaved roads and significant dust-generating areas during dry conditions;
- Impose appropriate speed limits on unpaved roads;
- Avoid unnecessary vehicle movement across disturbed surfaces;
- Locate soil stockpiles away from sensitive boundaries where practicable;
- Stabilise stockpiles that will remain unused for extended periods;
- Avoid excessive drop heights during loading and unloading;
- Progressively rehabilitate areas no longer required for construction; and
- Increase dust-control frequency during dry and windy conditions.

Visible dust leaving the site boundary should trigger immediate investigation and corrective action.

13.3 Internal Road Management

Vehicle-generated road dust is expected to represent one of the most important controllable particulate sources during landfill operation.

Internal haul roads should therefore be maintained in a condition that minimises loose surface material.

Water suppression should be undertaken according to actual conditions rather than a fixed schedule only. Increased watering may be required during dry periods, particularly when relative humidity is low and winds are sufficient to entrain loose material.

Vehicle speeds should be controlled, and unnecessary vehicle movements should be avoided.

Where traffic volumes justify it, consideration should be given to stabilising or surfacing frequently used sections of the internal road network.

13.4 Active Working Face Management

The active landfill working face should be maintained at the smallest practicable size consistent with safe landfill operation.

Incoming waste should be promptly:

Receive waste → Spread → Compact → Cover → Inspect.

Effective compaction and covering will reduce exposed waste surfaces and thereby assist in controlling odour, windblown litter and direct gaseous emissions.

Waste should not remain unnecessarily exposed overnight where operationally avoidable.

13.5 Landfill Gas Management

Landfill gas management should form an integral component of the operational and post-closure management system.

The landfill operator should monitor for evidence of:

- Methane accumulation;
- Uncontrolled gas venting;
- Cracks in landfill cover;
- Gas migration;
- Persistent odour;
- Vegetation stress potentially associated with gas migration; and
- Abnormal conditions around landfill-gas infrastructure.

Where landfill gas generation becomes significant, appropriate passive or active gas-control infrastructure should be implemented in accordance with the final engineering design.

The MP03 field results demonstrated a localised waste-related methane concentration of approximately 3 ppm compared with <1 ppm at the other monitoring points. This reinforces the importance of preventing uncontrolled landfill-gas emissions from becoming established at the future facility.

13.6 Odour Management

Odour management should focus on prevention at source.

The principal controls should include:

- Rapid compaction of deposited waste;
- Regular application of appropriate cover;
- Minimisation of the active working face;
- Effective landfill-gas management;
- Appropriate leachate management;
- Prevention of stagnant contaminated water;
- Rapid management of unusually odorous waste;
- Maintaining good housekeeping;
- Preventing accumulation of decomposing waste outside designated disposal areas; and
- Investigating odour complaints promptly.

H_2S should receive particular attention because the field assessment recorded a comparatively elevated result at the existing waste-influenced MP03 location.

Persistent odour beyond the landfill boundary should trigger investigation of the active working face, landfill gas, leachate infrastructure and other potential sources.

13.7 Windblown Litter Management

Windblown litter is particularly important because of the open landscape surrounding the development and the potential for lightweight material to affect grazing land, roads and the natural environment.

The landfill should therefore implement:

- Perimeter fencing;
- Appropriately positioned litter-control fencing around active working areas;
- Rapid waste compaction;
- Regular covering;
- Routine collection of windblown material;
- Increased inspections during windy conditions; and
- Immediate retrieval of waste transported beyond the authorised landfill footprint.

Although the Preferred Site benefits from comparatively greater natural terrain and vegetation screening, these features should not replace engineered litter controls.

13.8 Protection of Natural Vegetation and Wind Barriers

Existing vegetation surrounding the Preferred Site should be retained wherever compatible with the approved development footprint, landfill safety and engineering requirements.

Vegetation can increase surface roughness and assist in reducing near-ground wind velocities and intercepting larger dust particles.

Unnecessary clearing outside the development footprint should therefore be prohibited.

Where appropriate, supplementary vegetation screening may be considered along suitable boundaries, provided that planting does not interfere with landfill infrastructure, security, fire management or other environmental requirements.

13.9 Vehicle and Machinery Emissions

Construction and landfill equipment should be maintained in good operating condition.

Management measures should include:

- Routine servicing;
- Prevention of excessive engine idling;
- Removal or repair of visibly smoking equipment;
- Efficient vehicle routing;
- Avoiding unnecessary trips;
- Maintaining internal roads; and
- Ensuring waste-delivery vehicles comply with applicable roadworthiness requirements.

These measures will assist in limiting NO_x, particulate matter and other combustion-related emissions.

13.10 Prevention of Waste Burning

Open or uncontrolled burning of waste should be prohibited.

Any landfill fire should be treated as an environmental incident because it may generate substantial particulate matter, smoke and gaseous pollutants.

The facility should maintain appropriate fire-prevention and emergency-response procedures, including access to suitable firefighting resources and clear reporting responsibilities.

13.11 Leachate and Pollution Control Dam Management

Leachate and contaminated-water infrastructure should be operated to minimise odour generation.

The operator should avoid prolonged accumulation of stagnant contaminated water where practicable and regularly inspect the leachate collection system and Pollution Control Dam.

Where persistent odour is identified around these facilities, the source should be investigated and corrective action implemented.

13.12 Sensitive Receptor Protection

Particular attention should be given to SR01, SR02, SR05 and SR06 because these represent educational, accommodation or residential receptors with potentially prolonged human exposure. The receptor map confirms their distribution within the adopted 5 km assessment area.

SR01, representing Vumile Primary School and the surrounding residential area, should be considered a high-priority receptor for dust and particulate management.

Air quality complaints originating from these receptors should be formally recorded, investigated and linked to meteorological and operational conditions at the time of the complaint.

13.13 Complaints Management

An air quality complaints register should be maintained throughout landfill operation.

Table 26 : Minimum Complaints Register Information

Information	Requirement
Date and Time	Record when complaint was received and when impact occurred
Complainant Location	Record receptor/location where practicable
Nature of Complaint	Dust, odour, smoke, litter or other
Wind Conditions	Record available wind speed/direction
Landfill Activity	Identify activities occurring at the time
Potential Source	Working face, road, leachate, fire, gas etc.
Investigation Findings	Record likely cause
Corrective Action	Record measures implemented
Follow-up	Confirm whether problem was resolved

Repeated complaints from the same area should trigger a review of operational controls and, where necessary, targeted monitoring.

13.14 Air Quality Management Commitments

Table 27 : Summary Air Quality Management Measures

Potential Impact	Management Measure	Performance Objective
PM_{10} / $PM_{2.5}$	Water roads, control speeds and minimise exposed areas	Prevent significant off-site particulate impacts
TSP / nuisance dust	Stabilise surfaces and control material handling	Prevent visible dust leaving the site
CH_4	Landfill-gas monitoring and control	Prevent uncontrolled gas accumulation/migration
H_2S	Gas, waste and leachate management	Minimise H_2S and associated odour
Offensive odour	Compact and cover waste; minimise active face	Prevent persistent offensive odour at receptors
Windblown litter	Litter fencing, compaction and retrieval	Prevent waste migration beyond site
Vehicle emissions	Maintenance and anti-idling controls	Minimise unnecessary combustion emissions
Waste fires	Prohibit burning and implement fire management	Prevent smoke and combustion emissions

Exposed surfaces	Progressive rehabilitation	Reduce long-term wind erosion
Sensitive receptors	Complaints management and targeted monitoring	Protect surrounding communities

13.15 Mitigation Effectiveness

The identified air quality impacts are considered largely manageable because the principal sources can be controlled at or close to their point of generation.

Without mitigation, dust and odour impacts may reach moderate to high significance during unfavourable operational and meteorological conditions. With implementation of the measures prescribed above, residual impacts are expected to reduce predominantly to low or low–moderate significance.

The Preferred Site's terrain and vegetation provide an additional relative advantage by offering partial natural screening. However, the acceptability of the site remains dependent on implementation of the engineered and operational controls described in this assessment.

13.16 Conclusion

Effective air quality management should be implemented from the commencement of construction and maintained throughout operation, closure and post-closure.

The principal priorities are:

Dust control → Minimise exposed waste → Compact and cover → Manage landfill gas → Control leachate and odour → Contain litter → Monitor performance → Respond to complaints.

Implementation of these measures should prevent localised waste-related conditions similar to those observed at MP03 from developing into significant off-site impacts at SR01–SR06.

14. AIR QUALITY MONITORING PROGRAMME

An air quality monitoring programme should be implemented to verify the effectiveness of the mitigation measures prescribed in this AQIA and to identify emerging dust, landfill gas or odour problems before significant off-site impacts occur.

Monitoring should focus on the principal pollutants and nuisance impacts identified during the assessment, namely PM_{10}, $PM_{2.5}$, TSP/dust, CH_4, CO_2, H_2S, NO_2, SO_2 and offensive odour. Meteorological parameters, particularly wind speed and wind direction, should be recorded alongside air quality measurements to assist with source and receptor interpretation.

The programme should be risk-based, with greater monitoring effort directed toward the active landfill area, site boundaries and sensitive receptors located in prevailing downwind directions.

14.1 Monitoring Objectives

The monitoring programme should:

- establish whether landfill activities are materially affecting ambient air quality;
- verify the effectiveness of dust-control measures;
- identify abnormal landfill gas concentrations;
- detect potential H_2S and odour problems;
- determine whether emissions are migrating beyond the landfill boundary;
- evaluate potential impacts on SR01–SR06;
- investigate complaints;
- identify deteriorating trends; and
- provide information for corrective operational management.

14.2 Particulate Matter Monitoring

PM_{10} and $PM_{2.5}$ should be monitored periodically at representative boundary and receptor-oriented locations, particularly during dry and windy conditions.

The baseline field assessment recorded PM_{10} concentrations of 17–23 µg/m³ across MP01, MP02, MP04 and MP05, compared with 48 µg/m³ at the waste-influenced MP03 location. $PM_{2.5}$ ranged from 6–9 µg/m³ at the general monitoring locations and reached 18 µg/m³ at MP03.

These baseline measurements can be used as indicative reference conditions when evaluating future monitoring results, while recognising that the measurements were short-duration screening observations rather than 24-hour compliance measurements.

Where regulatory compliance is being assessed, monitoring duration and methodology should correspond with the applicable averaging period.

14.3 Dust-Fall Monitoring

Dust-fall monitoring should be considered around the landfill perimeter, particularly where unpaved roads, active cells and material-handling areas occur close to the site boundary.

A minimum network should include representative upwind and downwind locations.

Additional monitoring should be considered toward sensitive receptors if persistent dust complaints occur.

Dust-fall monitoring should be undertaken using an appropriate recognised method and assessed against the applicable National Dust Control Regulations.

14.4 Landfill Gas Monitoring

Landfill gas monitoring should commence as waste accumulation becomes established and continue throughout operation and post-closure.

Monitoring should principally include:

- CH_4;
- CO_2;
- O_2; and
- H_2S where odour or sulphur-related decomposition is of concern.

Monitoring locations should include representative landfill-gas infrastructure, landfill perimeter locations and areas where subsurface migration may reasonably occur.

The baseline MP03 result, where CH_4 reached approximately 3 ppm compared with <1 ppm at the other field locations, demonstrates the value of monitoring around active waste-disposal environments.

14.5 Hydrogen Sulphide and Odour Monitoring

H_2S should be included in routine screening because of its relevance to landfill odour.

The field assessment recorded <0.1 ppm at MP01, MP02, MP04 and MP05 and approximately 0.2 ppm at the waste-influenced MP03 location.

Where persistent odour is detected, the investigation should consider:

Odour complaint → Wind direction → Receptor location → Active landfill activity → H_2S measurement → Source inspection → Corrective action.

Potential sources should include the active working face, landfill gas infrastructure, exposed waste, leachate and contaminated-water infrastructure.

14.6 Meteorological Monitoring

Air quality data should be interpreted together with meteorological conditions.

At minimum, the following should be recorded during monitoring events:

- Wind speed;
- Wind direction;
- Temperature;
- Relative humidity; and
- Rainfall or recent rainfall conditions.

Wind direction is particularly important because it enables differentiation between potentially landfill-related impacts and unrelated background sources.

The field assessment on 30–31 August 2026 recorded approximately 21–28°C, 14% relative humidity, no precipitation and south-easterly winds of approximately 8 km/h (2.2 m/s). These conditions should be retained as part of the baseline field record.

14.7 Sensitive Receptor Monitoring

The identified sensitive receptors should form part of the monitoring and complaints-response framework. The receptor map confirms the distribution of SR01–SR06 within the adopted 5 km assessment area.

Priority should be given to SR01, SR02, SR05 and SR06 because these represent school, accommodation and residential environments.

Routine fixed monitoring at every receptor is not necessarily required. Instead, targeted receptor monitoring should be undertaken where operational observations, prevailing wind direction, monitoring results or complaints indicate potential off-site impacts.

14.8 Recommended Monitoring Programme

Table 28 : Air Quality Monitoring Programme

Aspect	Parameter / Indicator	Location	Recommended Frequency	Corrective Response
Fugitive particulate matter	PM_{10} and $PM_{2.5}$	Site boundary / representative downwind location	Quarterly and during significant complaints	Investigate roads, working face and exposed surfaces; increase suppression
Suspended dust	TSP	Representative operational areas	Quarterly / targeted	Identify and suppress source
Dust fall	$mg/m^2/day$	Upwind and downwind landfill boundaries	Monthly where programme is implemented	Review dust-control measures
Landfill gas	CH_4, CO_2 and O_2	Gas points, landfill perimeter and relevant infrastructure	Monthly once gas generation becomes established	Inspect cover/gas system and investigate migration
H_2S	ppm	Working face, leachate areas and complaint locations	Monthly / complaint-based	Identify odour source and implement corrective action
NO_2 / SO_2	Screening concentrations	Representative boundary locations	Quarterly or as operationally required	Inspect vehicles/equipment and other combustion sources
Odour	Presence, intensity and complaint frequency	Boundary and sensitive receptor direction	Routine operational inspection	Identify source, cover waste, inspect gas/leachate systems

Wind	Speed and direction	Site meteorological point	During monitoring; preferably continuous	Use to identify source–receptor pathway
Temperature	°C	Site	During monitoring	Supporting interpretation
Relative humidity	%	Site	During monitoring	Supporting dust interpretation
Visible dust	Dust plume crossing boundary	Site perimeter	Daily operational observation	Immediate dust suppression
Windblown litter	Waste beyond working area/boundary	Site and surrounding land	Daily	Collect litter and improve containment

14.10 Trigger and Response Framework

Monitoring results should not be reviewed in isolation. Increasing concentrations, recurring complaints and visible off-site impacts should be treated as early-warning indicators.

Table 29: Operational Trigger and Response Framework

Trigger	Required Response
Visible dust leaving landfill boundary	Immediately suppress source and investigate operational cause
Repeated elevated particulate readings	Review roads, traffic speed, exposed surfaces and waste handling
Increasing CH_4 trend	Inspect landfill gas infrastructure and cover integrity
Detectable/persistent H_2S increase	Inspect waste, gas and leachate sources
Persistent offensive odour beyond boundary	Immediate source investigation and corrective action
Repeated complaints from same receptor area	Conduct targeted receptor monitoring
Windblown waste outside authorised footprint	Retrieve waste and improve litter-control measures
Smoke or waste fire	Activate emergency/fire response immediately
Monitoring equipment failure	Repair/calibrate/replace equipment and document data gap

14.11 Monitoring Equipment and Quality Assurance

Monitoring instruments should be maintained and calibrated in accordance with manufacturer requirements and the applicable monitoring methodology.

The ES60A portable multi-gas detector and PDM99 portable particulate monitor may be used for operational screening where appropriate. Where measurements are intended to demonstrate formal compliance with regulatory ambient standards, appropriate reference or equivalent monitoring methods and applicable averaging periods should be used.

Monitoring records should include the instrument used, calibration status, date, time, location, duration, meteorological conditions and relevant landfill activities.

14.12 Reporting and Record Keeping

Air quality records should include:

- Monitoring results;
- Meteorological observations;
- Calibration records;
- Monitoring locations;
- Photographs where relevant;
- Visible-dust observations;
- Landfill-gas inspections;
- Odour observations;
- Complaints received;
- Investigation findings;
- Corrective actions; and
- Follow-up verification.

Results should be reviewed for trends rather than only individual measurements.

14.13 Monitoring Conclusion

The air quality monitoring programme should operate as an early-warning and performance-verification system throughout the landfill lifecycle.

Particular attention should be directed toward particulate emissions during dry and windy periods and toward landfill gas and odour as waste decomposition becomes established.

The Preferred Site's hills and vegetation provide useful partial natural screening, but continued monitoring remains necessary to confirm that landfill emissions are effectively controlled and do not result in unacceptable impacts at surrounding sensitive receptors.

15. SPECIALIST FINDINGS, RECOMMENDATIONS AND CONCLUSION

15.1 Summary of Key Findings

The Air Quality Impact Assessment considered the Preferred Site, Option Site 1 and Option Site 2 for the proposed Maletswai Landfill. The assessment incorporated desktop information, regional ambient air quality information, sensitive receptor identification and site-specific field monitoring undertaken on 30–31 August 2026.

The principal findings are as follows:

- The broader receiving environment is predominantly rural and peri-urban, with existing contributions from roads, exposed surfaces, agricultural activities, domestic activities, railway infrastructure and existing waste-management activities;

- The supplied saaqis zwelitsha dataset was used as regional background information and not as a direct representation of maletswai because the station is approximately 250 km from the project area;
- Field monitoring generally indicated good ambient air quality conditions across mp01, mp02, mp04 and mp05;
- Mp03, associated with the existing waste-disposal environment, recorded comparatively elevated particulate matter and waste-related gaseous concentrations;
- $Pm_{2.5}$ ranged from 6–18 µg/m³ and pm_{10} from 17–48 µg/m³ across the field monitoring points;
- Ch_4 was below 1 ppm at the general monitoring locations and approximately 3 ppm at mp03;
- Co_2 ranged from approximately 418–438 ppm;
- H_2s was below 0.1 ppm at the general monitoring locations and approximately 0.2 ppm at mp03;
- O_2 remained approximately 20.8–20.9%, consistent with normal open-air atmospheric conditions;
- Field conditions were dry, with temperatures of approximately 21–28°c, relative humidity of approximately 14%, no precipitation and south-easterly winds of approximately 8 km/h;
- Six sensitive receptors were identified within the adopted 5 km assessment area, including residential, educational, accommodation, agricultural and road-user receptors;
- PM_{10}, $PM_{2.5}$, nuisance dust, landfill gas and offensive odour represent the principal future air quality concerns; and
- None of the three alternatives presents an air quality fatal flaw, provided appropriate mitigation and monitoring are implemented.

15.2 Baseline Air Quality Conditions

The field monitoring indicates that the existing ambient environment is not characterised by widespread poor air quality.

The most notable spatial difference occurred at MP03, where $PM_{2.5}$, PM_{10}, TSP, CH_4, CO_2 and H_2S were higher than at the other monitoring locations. The pattern is consistent with localised influence from the existing waste-disposal environment.

This finding is particularly relevant to the proposed development because it demonstrates the importance of effective waste covering, dust suppression, landfill-gas control and leachate management in preventing localised waste-related emissions.

The existing conditions recorded at MP01, MP02, MP04 and MP05 provide a useful baseline against which future operational monitoring may be compared.

15.3 Sensitive Receptors

Six sensitive receptors were identified within the 5 km assessment area.

SR01, SR02, SR05 and SR06 require particular consideration because they represent educational, accommodation and residential environments where exposure may be prolonged.

SR01, representing Vumile Primary School within a residential area, is considered a high-sensitivity receptor. SR02, representing Limakatso Boutique Hotel and the surrounding residential environment, is similarly sensitive to dust and offensive odour.

SR03 represents an agricultural/plantation receptor, while SR04 represents transient road users.

The presence of these receptors reinforces the need for effective source-based air quality management throughout the landfill lifecycle.

15.4 Principal Anticipated Impacts

Construction-phase impacts will primarily comprise fugitive dust generated by vegetation clearing, earthworks, excavation, material handling and construction traffic.

During operation, the principal impacts are expected to include:

- PM_{10} and $PM_{2.5}$ from internal roads and waste handling;
- Nuisance dust and tsp;
- Landfill gas containing ch_4 and co_2;
- H_2s and other odorous compounds;
- Offensive odour from waste and leachate;
- Vehicle and machinery exhaust emissions;
- Windblown litter; and
- Potential smoke and combustion emissions should uncontrolled waste burning or landfill fires occur.

Without mitigation, localised dust and odour impacts could reach moderate to high significance under adverse operational and meteorological conditions.

With appropriate management, residual impacts are expected to reduce predominantly to low or low–moderate significance.

15.5 Alternatives Findings

The three alternatives have different air quality characteristics.

The Preferred Site benefits from comparatively greater surrounding vegetation and elevated terrain/hills, which provide partial natural screening and increased surface roughness. These characteristics may reduce near-ground wind velocities and assist in limiting the immediate movement of coarse dust and windblown litter.

Option Site 1 occurs within a comparatively open environment adjacent to the existing waste-disposal area. The site therefore presents greater potential for cumulative waste-related emissions. Existing electrical powerlines and servitudes also create an open infrastructure corridor and constrain opportunities for supplementary screening.

Option Site 2 is predominantly open and exposed and occurs close to the road corridor. Its lack of substantial natural wind barriers increases its susceptibility to wind-driven dust and

litter transport. Windblown waste could potentially affect road users, surrounding grazing areas and the natural environment.

Table 30 :Final Air Quality Alternatives Summary

Criterion	Preferred Site	Option Site 1	Option Site 2
Existing Waste Influence	Lower	High	Lower
Cumulative Waste Emissions	Low–Moderate	High	Low
Terrain Screening	Comparatively favourable	Limited	Limited
Vegetation Screening	Comparatively favourable	Limited	Limited
Wind Exposure	Moderate	High	High
Dust Dispersion Potential	Moderate	Moderate–High	High
Windblown Litter Potential	Moderate	Moderate–High	High
Odour Management Constraint	Moderate	Moderate–High	Moderate
Road-User Interaction	Lower	Moderate	Higher
Overall Air Quality Constraint	Moderate/manageable	Moderate–High	Moderate–High
AQIA Ranking	1	2	3

15.6 Preferred Alternative

Based on the integrated assessment, the Preferred Site is recommended as the most favourable alternative from an air quality perspective.

The recommendation is based on the combined benefit of surrounding vegetation, terrain screening and comparatively reduced exposure to unrestricted wind movement. The site also avoids the more direct cumulative waste-related baseline influence associated with Option Site 1.

The Preferred Site's natural characteristics should not, however, be regarded as pollution-control measures in themselves. Fine particulate matter, landfill gases and odorous compounds can still disperse beyond vegetation and terrain barriers.

The natural screening therefore provides an additional advantage only when combined with appropriate engineered and operational emission controls.

The final air quality ranking is:

1. Preferred Site – most preferred;
2. Option Site 1 – second preferred; and
3. Option Site 2 – least preferred.

15.7 Key Recommendations

The following measures are considered essential should the proposed landfill proceed:

- Maintain the smallest practicable active working face;
- Compact and cover deposited waste promptly;
- Apply effective dust suppression to unpaved roads and active earthworks;
- Implement and enforce vehicle speed limits;
- Minimise unnecessary exposed surfaces;
- Retain surrounding natural vegetation where compatible with engineering and safety requirements;
- Install and maintain appropriate litter-control fencing;
- Retrieve windblown waste outside the operational footprint;
- Prohibit uncontrolled burning of waste;
- Implement landfill-gas monitoring and management;
- Manage leachate and contaminated water to prevent persistent odour;
- Progressively rehabilitate completed and disturbed surfaces;
- Undertake particulate and landfill-gas monitoring;
- Record meteorological conditions during air quality monitoring;
- Maintain an air quality complaints register; and
- Investigate repeated dust or odour complaints through targeted monitoring and corrective action.

15.8 Specialist Opinion

Based on the desktop assessment, field verification, ambient monitoring results, receptor assessment and anticipated project emission sources, no fatal air quality flaw has been identified for the proposed Maletswai Landfill.

The project will inevitably introduce additional atmospheric emissions compared with the existing general baseline. However, the principal impacts are characteristic of municipal landfill activities and are capable of being substantially controlled through appropriate engineering design and operational management.

The field results indicate that waste-related impacts can become locally distinguishable, as demonstrated at MP03. This reinforces the requirement to ensure that similar conditions at the proposed facility remain confined to the immediate operational environment and do not extend toward sensitive receptors.

The Preferred Site provides the most favourable overall physical setting for achieving this objective because of its comparatively greater terrain and vegetation screening and reduced exposure to unrestricted wind movement.

15.9 Conclusion

The proposed Maletswai Landfill is considered acceptable from an air quality perspective, subject to implementation of the mitigation, management and monitoring requirements prescribed in this AQIA.

The principal air quality risks are fugitive particulate matter, nuisance dust, landfill gas, H_2S, offensive odour and windblown waste. These impacts are expected to be most significant during dry and windy conditions and during periods of intensive construction or waste-handling activity.

The Preferred Site is recommended as the air quality preferred alternative. Its combination of surrounding vegetation, terrain and partial natural wind screening provides a comparatively more favourable dispersion environment than the open conditions associated with Option Sites 1 and 2.

Option Site 1 is ranked second because of the potential cumulative influence of the existing waste-disposal environment and its open electrical-servitude setting. Option Site 2 is ranked third because of its exposed landscape, proximity to the road corridor and comparatively greater potential for unrestricted wind-driven dust and litter transport.

Provided that the prescribed dust suppression, waste covering, landfill-gas management, odour control, litter containment, progressive rehabilitation and monitoring measures are incorporated into the EMPr and implemented throughout the project lifecycle, residual air quality impacts are expected to remain manageable.

On this basis, the Preferred Site is supported for the proposed development from an air quality perspective, with no air quality fatal flaw identified

APPENDIXES

Appendix A : Nema Appendix 6 Compliance Matrix

The table below maps each requirement of NEMA EIA Regulations Appendix 6 to the relevant section of this Air Quality Impact Assessment Report. Items marked as Outstanding must be addressed before final submission.

Appendix 6 Requirement	Status in This Report	Concern Level	Action / Note
Specialist details, CV and expertise	Present	LOW	
Independence declaration	Present -	LOW	
Scope and purpose	Present	LOW	
Quality and age of base data	Present	HIGH	
Existing and cumulative impacts	Partial	HIGH	
Duration, date and season of site investigation	Present	LOW	
Methodology, equipment and modelling	Present	HIGH	
Site sensitivity and alternatives	Weak	HIGH	
Areas to avoid and buffers	Weak	HIGH	
Sensitivity overlay map	Partial	MEDIUM	
Assumptions and uncertainties	Present	MEDIUM	
Findings and implications	Present	MEDIUM	
Mitigation for EMPr	Present	MEDIUM	
Proposed EA conditions	Present	HIGH	
Monitoring requirements	Present	MEDIUM	
Reasoned opinion on acceptability	Present	MEDIUM	
Consultation process and comments/responses	Missing	HIGH	EAP to run with consultation process

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Appendices B: Specialist Declaration And Cv

I, Khumbelo Given Marabe declare that:

- I act as the independent specialist in this application.
- I consider myself bound to the rules and ethics of the South African Council for Natural Scientific Professions (SACNASP).
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant.
- I declare that there are no circumstances that may compromise my objectivity in performing such work.
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity.
- I will comply with the Act, Regulations and all other applicable legislation.
- I have no, and will not engage in, conflicting interests in the undertaking of the activity.
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan, or document to be prepared by myself for submission to the competent authority.
- All the particulars furnished by me in this form are true and correct; and
- I am aware that it is an offence in terms of Regulation 48 to provide incorrect or misleading information and that a person convicted of such an offence is liable to the penalties as contemplated in section 49B(2) of the National Environmental Management Act, 1998 (Act 107 of 1998).
- I realize that a false declaration is an offence in terms of Regulation 71 of NEMA and is punishable in terms of section 24F of the Act.

Signature:

Khumbelo Given Marabe

SACNASP NO: 132731

WISA REG NO :39885

IAIAsa: Membership no: 7837

IIAV Member No. 3163

Mr Khumbelo Given Marabe

Principal Environmental Consultant | Director – KMG Environmental Solutions Services (Pty) Ltd

SACNASP Registered– Reg. No. **132731**

WISA Professional Process Controller – Reg. No. **39885**

Summary of Expertise:

Mr. Marabe is an experienced environmental specialist with over a decade of expertise in:

- Visual, Social, Wetland and Terrestrial Impact assessments
- Agricultural and soil capability impact assessments
- Noise, air quality, water, and dust monitoring
- Environmental awareness training
- Environmental audits and licensing applications
- NEMA and NWA compliance
- Environmental management and monitoring across sectors including mining, manufacturing, and renewable energy

Education & Certifications:

- BSc Environmental Sciences – University of Venda
- NEBOSH Environmental Management Certificate (2024)
- ISO 45001 & ISO 14001 Implementation & Internal Auditor – NOSA
- Health and Safety Regulations – HASLAC
- Certificates in Management Development (GIBS – AECI Programmes)
- Honours in Environmental Monitoring & Modelling (ongoing – UNISA)

Ms. Jeniffer Mutsila

Environmental GIS and Mapping Technician

Affiliation: KMG Environmental Solutions Services (Pty) Ltd

🔎 *Junior Environmental Assessment Practitioner, Environmental Mapping & spatial analysis*

Professional Overview:

Ms. Jeniffer Mutsila is a technically skilled Environmental Mapping and GIS Technician with a background in field-based wetland delineation and spatial data analysis. He provides vital support in environmental assessments by producing geospatial products and performing site-level data validation for use in Environmental Impact Assessments (EIAs), Basic Assessments (BAs), Wetland Impact Assessments, and Water Use Licence Applications (WULAs).

With hands-on experience in both **desktop and field applications**, Jeniffer brings a valuable blend of practical and digital expertise to complex projects that require environmental sensitivity mapping, buffer zone compliance checks, and spatial integration of biodiversity datasets.

Core Competencies:

- GIS Mapping & Spatial Analysis (ArcGIS, QGIS)
- GPS-based Field Surveying and Data Collection
- Wetland and Riparian Zone Delineation Support
- Environmental Reporting: BAR, EIA, EMPr, EMP, WULA, EPR
- Legislation Knowledge: NEMA, Water Act, Waste Act, Air Quality Act, MPRDA

Key Project Contributions:

◆ **Wetland Mapping and Sensitivity Overlay Support**

- Developed comprehensive map series for **prospecting right applications** in the North West and Limpopo provinces, including:
  - ✓ **Wetland Classification Maps** (HGM units: seep, valley-bottom, flat wetlands)
  - ✓ **30 m Riparian Buffer Sensitivity Maps**
  - ✓ **500 m Regulated Area Compliance Maps**
  - ✓ **Field-Verified Wetland Delineation Maps**

◆ **GIS Support for Impact Assessments**

- Integrated **soil, rainfall, vegetation, and biodiversity** datasets with national layers (e.g., NFEPA, Aquatic CBAs, ESA zones) to support:
  - ✓ Wetland Impact Assessments
  - ✓ Agricultural Impact Assessments (AIA)
  - ✓ Biodiversity screening and risk mapping

◆ **Field Data Management & GPS Verification**

- Accompanied environmental specialists on site visits to:
  - ✓ Capture **wetland and watercourse coordinates**
  - ✓ Assist with **transect layout and data recording**
  - ✓ Cross-check digital boundary outputs against **ground conditions**

◆ **Reporting and Compliance Visuals**

- Prepared high-resolution map figures used in:
  - ✓ **Basic Assessment Reports (BARs)**
  - ✓ **Environmental Management Programmes (EMPrs)**
  - ✓ **Water Use Licence Applications (WULAs)**
- Ensured maps met **legislative and formatting standards** for submission to DMRE, DWS, and DFFE.

Professional Strengths:

- Detail-oriented and deadline-driven
- Strong spatial logic and environmental understanding
- Collaborative work ethic with specialists and field teams
- Effective communication of spatial data to technical and non-technical audiences

Summary Value to Projects: Ms. Jeniffer GIS and mapping expertise plays an essential role in ensuring that environmental reports are **visually informative, spatially accurate, and legally aligned**. His ability to translate field data into structured spatial products enhances the defensibility and scientific integrity of environmental applications, especially those involving **wetland delineation, regulated activity compliance**, and **site sensitivity verification**

Appendix C: Baseline Air Quality Data

Summary of Baseline Air Quality Data -SAAQIS Zwelitsha - Monitoring Station

Parameter	Unit	Data Availability (%)	Average	Maximum	Minimum	Data Quality / Interpretation
SO_2	ppb	61.4	1.691	2.929	0.582	Usable for regional baseline interpretation
NO_2	ppb	61.4	0.523	0.582	0.486	Usable for regional baseline interpretation
NO	ppb	61.4	0.543	0.613	0.501	Supporting NO_x parameter
NO_x	ppb	61.4	0.578	0.670	0.533	Supporting combustion-related parameter
O_3	ppb	59.6	0.386	0.448	0.264	Usable with lower data completeness
CO	ppm	0.0	–	–	–	No valid data available
PM_{10}	µg/m³	61.4	20.714	159.210	1.146	Usable; maximum is an hourly value and should not be treated as a 24-hour concentration
Ambient Wind Speed	m/s	0.0	–	–	–	No valid data available
Ambient Wind Direction	Degrees	0.0	–	–	–	No valid data available
Ambient Temperature	°C	61.4	881.68	950.00	-75.17	Invalid; physically implausible values
Relative Humidity	%	61.4	110.60	503.26	-3.24	Invalid; physically implausible values
Solar Radiation	W/m²	61.4	0.54	3.55	-81.48	Questionable/anomalous dataset; excluded from quantitative interpretation
Atmospheric Pressure	mBar	61.4	18,813.87	50,486.20	4,999.45	Invalid; physically implausible atmospheric pressure
Shelter Internal Temperature	°C	61.4	6.45	8.68	3.62	Physically plausible, but represents shelter temperature rather than ambient temperature

Appendix D: Field Monitoring Results

Parameter	Unit	Monitoring Coverage	Average	Maximum	Minimum
SO_2	ppm	100%	<0.10	<0.10	<0.10
NO_2	ppm	100%	<0.10	<0.10	<0.10
CH_4	ppm	100%	<1.40*	3.00	<1.00
CO_2	ppm	100%	423.20	438.00	418.00
H_2S	ppm	100%	<0.12*	0.20	<0.10
O_2	% vol	100%	20.88	20.90	20.80
$PM_{2.5}$	µg/m³	100%	9.60	18.00	6.00
PM_{10}	µg/m³	100%	25.60	48.00	17.00
TSP	µg/m³	100%	48.20	86.00	34.00
Temperature	°C	100%	25.02	27.80	21.40
Relative Humidity	%	100%	14.00	14.00	14.00
Wind Speed	m/s	100%	2.20	2.30	2.10
Wind Direction	–	100%	SE	SE	SE
Precipitation	%	100%	0	0	0

Key Notes for Report Interpretation

The Maletswai field dataset indicates generally good ambient conditions across the study area during 30–31 August 2026. $PM_{2.5}$ averaged approximately 9.6 µg/m³ and PM_{10} approximately 25.6 µg/m³ across the five monitoring points, with the highest particulate concentrations recorded at MP03, which was influenced by the existing waste-disposal environment.

CO_2 remained within a relatively narrow range of 418–438 ppm, while oxygen remained close to normal atmospheric conditions at 20.8–20.9%. The comparatively higher CH_4, H_2S, $PM_{2.5}$, PM_{10} and TSP values at MP03 provide evidence of a localised waste-related influence rather than widespread deterioration of ambient conditions.

Monitoring was undertaken under dry conditions, with approximately 14% relative humidity, no precipitation and south-easterly winds averaging approximately 2.2 m/s. These conditions were conducive to fugitive dust generation and therefore provide a useful dry-weather screening baseline for the proposed landfill.

Appendix E Calibration Certificates

Shenzhen Safewill Co., Ltd.

Calibration Certificate

Product	Portable Multi Gas detector	Model	ES60A
Quantity	1pcs	Cali date	April, 09, 2025
Product no.	602504094490031		
Appearance	☑Clean ☑Non corrosive ☑No damage		
Gas type	CH_4 O_3 H_2S CO_2 NO_2 SO_2		
Accuracy	±3%F.S		
Alarm point	CH_4 Low alarm: 5000ppm High alarm:10000ppm O_3 Low alarm: 10.0ppm High alarm: 50.0ppm H_2S Low alarm: 7.00ppm High alarm: 14.00ppm CO_2 Low alarm: 2000ppm High alarm: 4000ppm NO_2 Low alarm: 3.00ppm High alarm: 5.00ppm SO_2 Low alarm: 5.00ppm High alarm: 10.00ppm		
Response time	≤30S		
Testing condition	Temperature: 23℃ Humidity: 60%RH		
Calibration gas	CH_4 O_3 H_2S CO_2 NO_2 SO_2		
Cali gas test	CH_4 Cali gas concentration: 5000 ppm Inspect concentration: 4999 ppm O_3 Cali gas concentration: 100.0 ppm Inspect concentration: 99.9 ppm H_2S Cali gas concentration: 50.00 ppm Inspect concentration: 49.98 ppm CO_2 Cali gas concentration: 4000 ppm Inspect concentration: 3998 ppm NO_2 Cali gas concentration: 5.00ppm Inspect concentration: 4.99 ppm SO_2 Cali gas concentration: 10.00ppm Inspect concentration: 9.99 ppm		
Test result	Qualified		
Remark			

Quality judgment:
Shenzhen Safewill Co., Ltd.
Date:April, 09, 2025

Tester:Jing Huang
OQC : Ying Liu
Auditor: Bing Weng Wang