Air Quality Impact Assessment for the Ammonia Pipeline from Farm 58 to the Ammonia Terminal to Port, Close to Walvis Bay

Project done for **Environmental Compliance Consultancy (ECC)**

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Revision Record

Version	Date	Comments
Rev 0	October 2024	For internal review
Rev 1	October 2024	For client review
Rev 2	October 2024	Incorporation of client's comments

Abbreviations

AERMIC	AMS/EPA Regulatory Model Improvement Committee
AQG	Air Quality Guidelines
AQIA	Air Quality Impact Assessment
AQMP	Air Quality Management Plan
AQO	Air Quality Objectives
AQSR	Air Quality Sensitive Receptors
CO	Carbon monoxide
CO_2	Carbon dioxide
EC	European Community
ECC	Environmental Compliance Consultancy
EHS	Environmental, Health and Safety
EPA	Environmental Protection Agency
ESL	Effect Screening Level
GG	Government gazette
GIIP	Good International Industry Practice
HC	Hydrocarbon
IFC	International Finance Corporation
IT	Interim target
LMo	Obukhov length
NAAQS	National Ambient Air Quality Standards (South Africa)
NACA	National Association for Clean Air
NDCR	National Dust Control Regulations (South Africa)
NO_2	Nitrogen dioxide
NOx	Oxides of nitrogen
NPI	Australian National Pollutant Inventory
O_3	Ozone
PAH	Polycyclic aromatic hydrocarbons
Pb	Lead
PM	Particulate Matter
PM_{10}	Particulate matter with an aerodynamic diameter of less than 2.5 µm (thoracic particles)
$PM_{2.5}$	Particulate matter with an aerodynamic diameter of less than 10 µm (respirable particles)
ROW	Right-of-way
SA	South African
SACNASP	South African Council for Natural Scientific Professions
SEMP	Strategic Environmental Management Plan
SO_2	Sulfur dioxide
TCEQ	Texas Commission on Environmental Quality
TSP	Total Suspended Particulates
US	United States
VOC	Volatile organic compound
WBG	World Bank Group
WHO	World Health Organisation
WRF	The Weather Research and Forecasting (WRF) Model

Units

°C	degree Celsius
g	gram
g/s/m²	grams per second per metre squared
kg	kilogram
km	kilometre
km/hr	kilometres per hour
kW	kilowatt
kWh	kilowatt hour
µm	micrometre
m	metres
m²	metres squared
m³	cubic metre
mm	millimetre
mg/m²/day	milligram per metre squared per day
m/s	metres per second
Pa	pascal
tph	tons per hour
µg/m³	microgram per cubic metre
%	percent

Glossary

Air pollution: means any change in the composition of the air caused by smoke, soot, dust (including fly ash), cinders, solid particles of any kind, gases, fumes, aerosols and odorous substances.

Atmospheric emission: means any emission or entrainment process emanating from a point, non-point or mobile sources that result in air pollution.

Averaging period: This implies a period of time over which an average value is determined.

Dust: Solid materials suspended in the atmosphere in the form of small irregular particles, many of which are microscopic in size.

Frequency of Exceedance: A frequency (number/time) related to a limit value representing the tolerated exceedance of that limit value, i.e. if exceedances of limit value are within the tolerances, then there is still compliance with the standard.

Particulate Matter (PM): These comprise a mixture of organic and inorganic substances, ranging in size and shape and can be divided into coarse and fine particulate matter. The former is called Total Suspended Particulates (TSP), whilst PM_{10} and $PM_{2.5}$ fall in the finer fraction referred to as Inhalable particulate matter.

TSP: Total suspended particulates refer to all airborne particles and may have particle sizes as large as 150 µm, depending on the ability of the air to carry such particles. Generally, suspended particles larger than 75 to 100 micrometre (µm) do not travel far and deposit close to the source of emission.

PM_{10}: Thoracic particulate matter is that fraction of inhalable coarse particulate matter that can penetrate the head airways and enter the airways of the lung. PM_{10} consists of particles with a mean aerodynamic diameter of 10 µm or smaller, and deposit efficiently along the airways. Particles larger than a mean size of 10 µm are generally not inhalable into the lungs. These PM_{10} particles are typically found near roadways and dusty industries.

$PM_{2.5}$: Respirable particulate fraction is that fraction of inhaled airborne particles that can penetrate beyond the terminal bronchioles into the gas-exchange region of the lungs. Also known as fine particulate matter, it consists of particles with a mean aerodynamic diameter equal to or less than 2.5 µm ($PM_{2.5}$) that can be inhaled deeply into the lungs. These particles can be directly emitted from sources such as forest fires, or they can form when gases emitted from power plants, industries and automobiles react in the air.

Point sources: are discrete, stationary, identifiable sources of emissions that release pollutants to the atmosphere (International Finance Corporation (IFC), 2007).

Vehicle entrainment: This is the lifting and dropping of particles by the rolling wheels leaving the road surface exposed to strong air current in turbulent shear with the surface. The turbulent wake behind the vehicle continues to act on the road surface after the vehicle has passed.

Executive Summary

Cleanergy Solutions Namibia Pty Ltd is intending on becoming a driving force in the growth of the Namibia's hydrogen economy, while contributing to the global shift for industrial decarbonisation. To this end, Cleanergy Solutions intends to use the abundant sun to produce hydrogen and then combine the hydrogen with nitrogen to produce ammonia for exportation purposes. The proposed activities consist of a hydrogen pipeline starting near Arandis to the ammonia facility on Farm 58, close to Walvis Bay. Three routes have been proposed. From the ammonia facility, ammonia is transported to an ammonia tank located north of Walvis Bay. From this ammonia storage tank, ammonia will be exported via a ship.

Separate environmental authorizations have been applied for the hydrogen pipeline and the ammonia plant and terminal. This assessment focuses on the ammonia pipeline and its associated impacts.

Airshed Planning Professionals (Pty) Ltd was commissioned by Environmental Compliance Consultancy (ECC) to undertake an Air Quality Impact Assessment for the proposed ammonia pipeline (hereafter referred to as "the pipeline").

The main objective of the investigation was to quantify the potential air quality impacts resulting from the pipeline construction activities on the surrounding environment and human health. Impacts due to operational phase are expected to be insignificant. As part of the air quality assessment, a good understanding of the regional climate and local dispersion potential of the site is necessary and subsequently an understanding of existing sources of air pollution in the region and the pipeline construction activities resulting in air quality related impacts.

The scope of work (SoW) included the review of technical information and legislative context relevant to Namibia. A baseline assessment was required to get an understanding of the receiving environment, looking at existing sources of air pollution and the status of air quality within the region, as well as sensitive receptors in the form of human settlements. Modelled meteorological data for a three-year period (2021 to 2023) was used to determine the dispersion potential of the site, which influences the spreading and removal of air pollution. To determine the potential impacts from the pipeline construction, an emissions inventory had to be established accounting for all sources of air pollution associated with the construction activities. Emissions were based on the process description and equipment list provided. The AERMOD dispersion model was used to simulate the expected impacts from these emission sources, with the simulated ground level concentrations and dustfall rates screened against the applicable air quality objectives (AQOs) to determine the significance of the proposed pipeline construction on the receiving environment. Once the significance of these impacts has been established, mitigation measures can be defined to ensure reduced impacts from these activities.

Baseline Assessment

The main findings from the baseline assessment can be summarised as follows:

- The main baseline sources (i.e. non pipeline construction sources) likely to contribute to cumulative particulate impact are vehicle entrainment on unpaved road surfaces, wind erosion of open areas and mining activities within the vicinity of the pipeline.

- The closest potential air quality sensitive receptors (AQSR) to the pipeline are the residential areas of Green Valley and Walvis Bay.
- Measured daily thoracic particulate matter of 10 µm diameter (PM_{10}) concentrations in the vicinity of the pipeline (Site 1) was 25.5 µg/m³ and daily inhalable particulate matter of 2.5 µm in diameter ($PM_{2.5}$) concentrations was 5.2 µg/m³. This is based on a single grab sample taken in July 2024.
- The main pollutant of concern in the region is particulate matter (PM) (including total suspended particulates (TSP); PM_{10} and $PM_{2.5}$) resulting from vehicle entrainment on the roads (paved, unpaved and treated surfaces), windblown dust and mining activities. Gaseous pollutants such as sulfur dioxide (SO_2), oxides of nitrogen (NOx), carbon monoxide (CO) and carbon dioxide (CO_2) would result from vehicles and combustion sources, but these are expected to be at low concentrations due to the few sources along the pipeline.

Impact Assessment

The findings from the impact assessment can be summarised as follows:

- The air quality impact assessment considered the construction due to the proposed pipeline only.
- Activities were specified to take place 24 hours per day.
- CO AQO were not exceeded.
- Nitrogen dioxide (NO_2) AQO were exceeded up to a distance of 220 m from the pipeline centreline.
- SO_2 AQO were not exceeded.
- VOC AQO were exceeded up to a distance of 20 m from the pipeline centreline.
- PM_{10} AQO were exceeded up to a distance of 140 m from the pipeline centreline.
- $PM_{2.5}$ AQO were exceeded up to a distance of 80 m from the pipeline centreline.
- The dust deposition AQO were exceeded up to a distance of 140 m from the pipeline centreline.
- The closest AQSR to the pipeline is 300 m. The AQO are, thus, not expected to be exceeded at any AQSR within the study area.

Conclusion

Given that the AQO are not exceeded at AQSR along the pipeline due to construction activities, it is the specialist's opinion that the pipeline be authorised.

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1 INTRODUCTION

Cleanergy Solutions Namibia Pty Ltd is intending on becoming a driving force in the growth of the Namibia's hydrogen economy, while contributing to the global shift for industrial decarbonisation. To this end, Cleanergy Solutions intends to use the abundant sun to produce hydrogen and then combine the hydrogen with nitrogen to produce ammonia for exportation purposes. The proposed activities consist of a hydrogen pipeline starting near Arandis to the ammonia facility on Farm 58, close to Walvis Bay. Three routes have been proposed, as indicated in Figure 1-1. From the ammonia facility, ammonia is transported to an ammonia tank located north of Walvis Bay. From this ammonia storage tank, ammonia will be exported via a ship.

Separate environmental authorizations have been applied for the hydrogen pipeline and the ammonia plant and terminal. This assessment focuses on the ammonia pipeline and its associated impacts.

Airshed Planning Professionals (Pty) Ltd was commissioned by Environmental Compliance Consultancy (ECC) to undertake an Air Quality Impact Assessment (AQIA) for the proposed ammonia pipeline (hereafter referred to as the pipeline).

1.1 Purpose/Objective

The main objective of the investigation is to quantify the potential impacts resulting due the construction activities on the pipeline on the surrounding environment and human health. Impacts due to operational activities will be negligible. As part of the air quality assessment, a good understanding of the regional climate and local dispersion potential of the site is necessary and subsequently an understanding of existing sources of air pollution in the region.

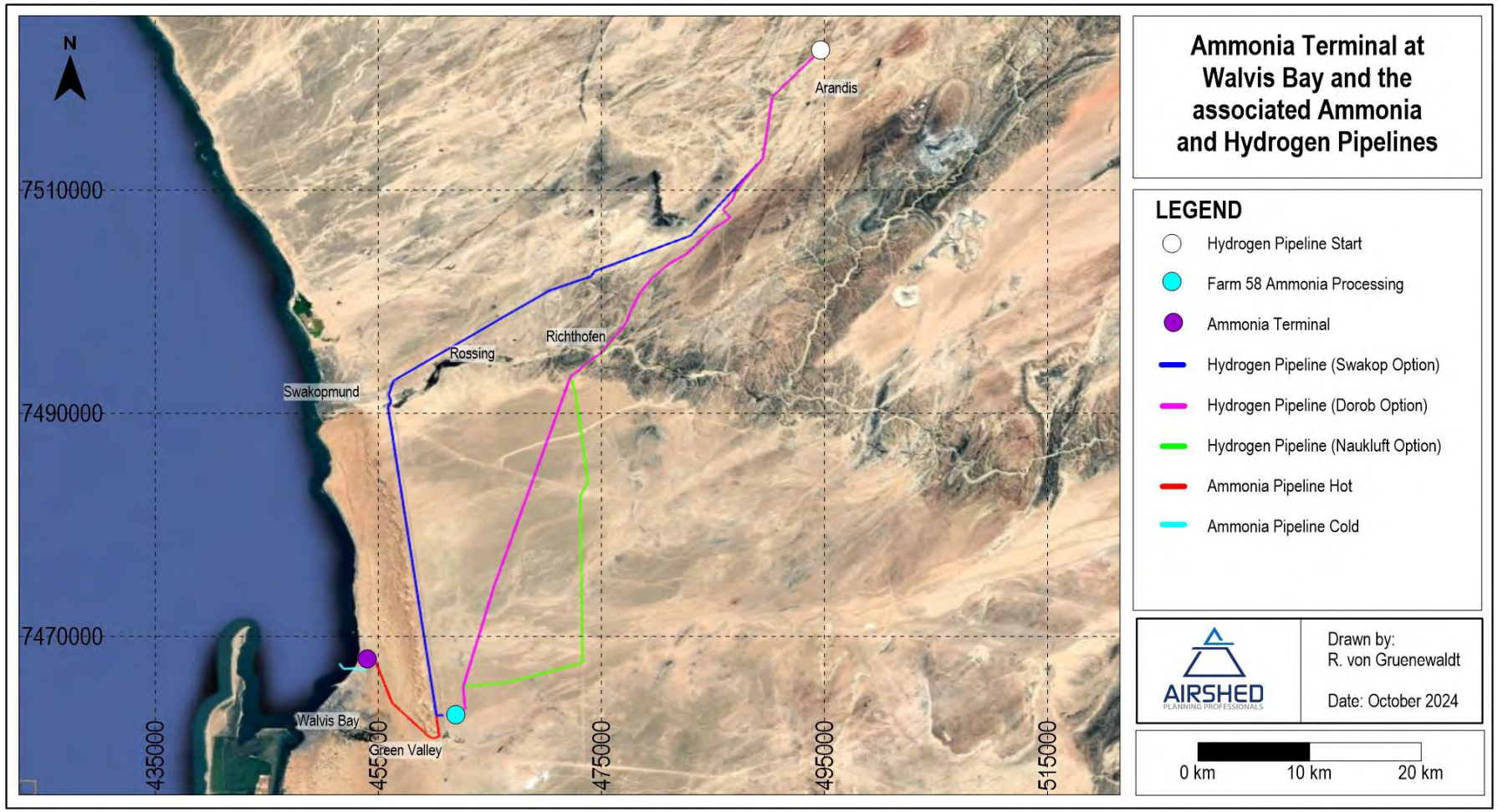

Figure 1-1: The proposed ammonia plant, ammonia terminal, and ammonia and hydrogen pipelines

1.2 Terms of Reference/ Scope of Work

The baseline assessment includes a study of the receiving environment by referring to:

- A study of legal requirements pertaining to air quality – applicable international legal guidelines and limits and dust control regulations.
- Desktop review of all available information for the pipeline and associated data.
- A study of atmospheric dispersion potential by referring to available on-site weather records for a period of at least one year (required for dispersion modelling) or modelled weather data where on-site data is not available.
    - Details on the physical environment i.e., meteorology (atmospheric dispersion potential).
    - Identification of existing air pollution sources.
    - Identification of air quality sensitive receptors (AQSR), including any nearby residential dwellings in the vicinity of the pipeline.
    - Any freely available ambient air quality data.
- An impact assessment, including:
    - Identify all current sources of air pollution in the area.
    - The compilation of a comprehensive emissions inventory including the identification and quantification of all emissions associated with the construction of the pipeline.
    - Atmospheric dispersion modelling to simulate ambient air pollutant concentrations and dustfall rates from the pipeline construction activities.
    - The screening of simulated ambient pollutant concentration levels and dust fallout against ambient air quality guidelines and standards.
- Assessment of the potential air quality impacts on human health and the environment.
- The identification and recommendation of suitable mitigation measures.
- The preparation of a comprehensive specialist AQIA report.

1.3 Deliverables

At the core of the study is the provision of a mathematical tool (i.e., the dispersion model) that credibly describes the fluxes and dispersion of air emissions from the pipeline construction through the incorporation of meteorological and emission configuration complexities.

The final deliverables are simulated ground level air concentrations and total dust deposition rates provided as graphs.

1.4 Specialist Details

1.4.1 Statement of Independence

Airshed is an independent consulting firm with no interest in the pipeline construction other than to fulfil the contract between the client and the consultant for delivery of specialised services as stipulated in the terms of reference.

1.4.2 Competency Profiles

RG von Gruenewaldt (MSc (Meteorology), BSc, Pr. Sci Nat.)

Reneé von Gruenewaldt is a Registered Professional Natural Scientist (Registration Number 400304/07) with the South African Council for Natural Scientific Professions (SACNASP) and a member of the National Association for Clean Air (NACA).

Following the completion of her bachelor's degree in atmospheric sciences in 2000 and honours degree (with distinction) with specialisation in Environmental Analysis and Management in 2001 at the University of Pretoria, her experience in air pollution started when she joined Environmental Management Services (now Airshed Planning Professionals) in 2002. Reneé von Gruenewaldt later completed her master's degree (with distinction) in Meteorology at the University of Pretoria in 2009.

Reneé von Gruenewaldt became partner of Airshed Planning Professionals in September 2006. Airshed Planning Professionals is a technical and scientific consultancy providing scientific, engineering and strategic air pollution impact assessment and management services and policy support to assist clients in addressing a wide variety of air pollution related risks and air quality management challenges.

She has extensive experience on the various components of air quality management including emissions quantification for a range of source types, simulations using a range of dispersion models, impacts assessment and health risk screening assessments. Reneé has been the principal air quality specialist and manager on several Air Quality Impact Assessments and Environmental Noise Impact Assessments between 2006 to present and her project experience range over various countries in Africa, providing her with an inclusive knowledge base of international legislation and requirements pertaining to air quality.

A comprehensive curriculum vitae of Reneé von Gruenewaldt is provided in Appendix A.

The declaration of independence for Reneé von Gruenewaldt is provided in Appendix B.

1.5 Pipeline Description

The ammonia pipeline from the ammonia plant to the ammonia terminal will consist of a carbon steel pipe which is approximately 6-inch, with a 75 mm insulation layer. Ammonia from the bulk storage tank (ammonia terminal) will

be transported, approximately 6.7 km via an 18-inch pipeline to the port and loaded onto a ship with a capacity of 25 000 metric tonnes. The ammonia pipeline will be underground.

The construction activities were provided to take place 24 hours per day.

Air quality impacts due to the operation of the pipeline are negligible.

1.6 Assessment Approach and Methodology

The approach to, and methodology followed in the completion of tasks as part of the scope of work, are provided in Table 1-1.

An information requirements list was sent to ECC at the onset of the AQIA. In response to the request, the following information was supplied:

- Layout maps;
- Process description; and,
- List of equipment.

Table 1-1: Assessment Approach and Methodology

Task	Activity	Description	Report Section
Legal Review	A study of legal requirements pertaining to air quality in Namibia –ambient air quality standards and guidelines; dust control regulations and emission limits and guidelines.	Namibian Atmospheric Pollution Prevention Ordinance (No. 11 of 1976) International air quality criteria referenced, include: • World Health Organisation; • World Bank Group; • International Finance Corporation; and • South Africa air quality legislation.	Section 2
Baseline Assessment	Physical environmental parameters that influence the dispersion of pollutants in the atmosphere include: • land cover, and • meteorology.	Modelled meteorological data for the period 2021 to 2023 was used for the assessment.	Section 3.2
	Identification of existing air pollution sources.	Likely sources of potential air quality pollution include, but are not limited to, windblown dust and vehicle emissions.	Section 3.4
	Identification of AQSR, including any nearby residential dwellings.	A map of all the potential air quality sensitive receptors is provided.	Section 3.1
Impact Assessment	The compilation of an emissions inventory incl. the identification and quantification of all emissions associated with the pipeline construction activities.	Pollutants quantified are limited to particulate matter and gaseous emissions (sulfur dioxide, nitrogen dioxide, carbon monoxide, and volatile organic compounds). Use is made of process descriptions and layout maps to quantify activity emissions through the application of emissions factors and emission equations as published by the United States Environmental Protection Agency (US EPA) and Australian National Pollutant Inventory.	Section 4.1
	Atmospheric dispersion simulations of all pollutants for pipeline construction activities.	Use was made of US EPA AERMOD atmospheric dispersion modelling suite.	Section 4.2

Task	Activity	Description	Report Section
	Dispersion modelling results and compliance evaluation for the different construction steps.	Compliance is assessed by comparing modelled ambient concentrations and dustfall rates to the relevant national and international ambient air quality standards and dustfall regulations.	Section 4.3
	Air quality impact assessment	The impact significance is evaluated against the adopted Air Quality Objectives.	Section 4.3
	The identification of air quality management measures based on the findings of the compliance and impact assessment.	Practical mitigation and optimisation measures that can be implemented effectively to reduce the significance of impacts were identified.	Section 5

1.7 Assumptions, Exclusions and Limitations

The main assumptions, exclusions and limitations are summarised below:

- Meteorological and Ambient Data:
  - Modelled meteorological data for a point just north of Walvis Bay for the period 2021 to 2023 was used for the assessment. Although this meteorological data is not representative of the entire pipeline route, it provides an indication of the meteorological conditions at the terminal point of the pipeline. The ambient temperatures would be higher further from the coast. The sources, however, are low level and unlikely to be influenced significantly by temperature. The short-term simulations will also use the worst-case meteorological conditions and is likely to be similar, in terms of distance of impact, along the pipeline route.
  - Ambient measured particulate matter (PM) for the area was a single grab sample over a day. These ambient concentrations will provide an indication of the baseline levels but cannot be used to determine cumulative impacts as variability in concentrations have not been taken into account.
- Emissions:
  - The quantification of sources of emission was restricted to the pipeline construction activities only. Although other background sources were identified, these could not be quantified and did not form part of the scope of work.
  - Emissions were based on the process description of the pipeline construction activities.
  - The load factor for the construction equipment was assumed to be 50%.
  - Pipeline construction would progress by 500 m per day. It was assumed that the active working area would be 10 m from the pipeline centreline.
- Impact Assessment:
  - Impacts due to the construction phase were assessed quantitatively. Impacts due to operation of the pipeline is negligible.
  - The impact assessment was limited to airborne particulate (including total suspended particulates (TSP), thoracic particulate matter of less than 10 µm in diameter (PM_{10}) and inhalable particulate matter of less than 2.5 µm in diameter ($PM_{2.5}$)) and gaseous emissions from vehicle exhaust.
  - Dust deposition rates were calculated using the estimated TSP concentrations and a deposition velocity of 3.62 cm/s as reported by Zhu et al (2016) for dry daytime conditions. It should be noted that this referenced deposition velocity is for PM_{10}. It is thus assumed that the PM_{10} deposition velocity is an average and that larger particles would fall out faster and finer particles would take longer to fallout.
  - There will always be some degree of uncertainty in any geophysical model, but it is desirable to structure the model in such a way to minimize the total error. A model represents the most likely outcome of an ensemble of experimental results. The total uncertainty can be thought of as the sum of three components: the uncertainty due to errors in the model physics; the uncertainty due to data errors; and the uncertainty due to stochastic processes (turbulence) in the atmosphere. Nevertheless, dispersion modelling is generally accepted as a necessary and valuable tool in air quality management.

2 LEGAL OVERVIEW

Air quality guidelines and standards are fundamental to effective air quality management, providing the link between the source of atmospheric emissions and the user of that air at the downstream receptor site. Air quality guidelines and standards are based on benchmark concentrations that normally indicate safe daily exposure levels for the majority of the population, including the very young and the elderly, throughout an individual's lifetime. Benchmark concentrations could therefore be based on health effects, such as sulfur dioxide (SO_2) or carcinogenic consequences, such as benzene.

Air quality guidelines and standards are normally given for specific averaging or exposure periods and are evaluated as the observed air concentration expressed as a fraction of a benchmark concentration. A standard, as opposed to a benchmark concentration only, is a set of instructions which include a limit value and may contain a set of conditions to meet this limit value. Standards are normally associated with a legal requirement as implemented by the country's relevant authority; however, organisations such as the World Bank Group (WBG) International Finance Corporation (IFC) and private companies also issue standards for internal compliance. The benchmark concentrations issued by the World Health Organisation (WHO), on the other hand, are not standards, but rather guidelines that may be considered for use as limit values in standards.

A common condition included in a standard is the allowable frequency of exceedances of the limit value. The frequency of exceedances recognises the potential for unexpected meteorological conditions coupled with emission variations that may result in outlier air concentrations and would normally be based on a percentile, typically the 99th percentile.

Standards are normally issued for criteria pollutants, i.e., those most commonly emitted by industry including SO_2, nitrogen dioxide (NO_2), carbon monoxide (CO), PM_{10}, and $PM_{2.5}$, but may also include secondary pollutants such as ozone (O_3). Some countries include other pollutants, specifically when these are considered to be problematic emissions.

In addition to ambient air quality standards or guidelines, emission limits aim to control the amount of pollution from a point source[1]. Emissions to air should be avoided or controlled according to Good International Industry Practice (GIIP) applicable to the specific industry sector (IFC, 2007a).

Namibia does not have air quality guidelines or limits, and reference is usually made to international ambient air quality guidelines and standards. The WHO is widely referenced, as well as countries in the region who have air quality standards. As part of the Air Quality Management Plan (AQMP) developed for the Strategic Environmental Management Plan (SEMP) update, ambient guidelines for PM_{10} and $PM_{2.5}$ were determined to provide the necessary performance indicators for mines and industries within the Erongo Region.

[1] Point sources are discrete, stationary, identifiable sources of emissions that release pollutants to the atmosphere (IFC, 2007).

2.1 Namibian Legislation

The Atmospheric Pollution Prevention Ordinance (No. 11 of 1976) deals with the following:

Part I	:	Appointment and powers of officers;
Part II	:	Control of noxious or offensive gases;
Part III	:	Atmospheric pollution by smoke;
Part IV	:	Dust control;
Part V	:	Pollution of the atmosphere by gases emitted by vehicles;
Part IV	:	General provisions; and
Schedule 2:		Scheduled processes.

The Ordinance does not include any ambient air standards with which to comply, but opacity guidelines for smoke are provided under Part III. It is implied that the Director[2] provides air quality guidelines for consideration during the issuing of Registration Certificates, where Registration Certificates may be issued for "Scheduled Processes" which are processes resulting in noxious or offensive gases and typically pertain to point source emissions. To our knowledge no Registration Certificates have been issued in Namibia. However, an Environmental Clearance Certificate is required for any activity entailing a scheduled process as referred to in the Atmospheric Pollution Prevention Ordinance, 1976.

Also, the Ordinance defines a range of pollutants as noxious and offensive gases, but no ambient air quality guidelines or standards or emission limits are provided for Namibia.

Part II of the Ordinance pertains to the regulation of noxious or offensive gases. The Executive Committee may declare any area a *controlled area* for the purpose of this Ordinance by notice in the Official Gazette. Any scheduled process carried out in a *controlled area* must have a current registration certificate authorising that person to carry on that process in or on that premises.

The published Public and Environmental Health Act 1 of 2015 provides "a framework for a structured uniform public and environmental health system in Namibia; and to provide for incidental matters". The act identifies health nuisances, such as chimneys sending out smoke in quantities that can be offensive, injurious, or dangerous to health and liable to be dealt with.

2.2 International Criteria

Typically, when no local ambient air quality criteria exist, or are in the process of being developed, international criteria are referenced. This serves to provide an indication of the severity of the potential impacts from proposed activities. The most widely referenced international air quality criteria are those published by the WBG, the WHO, and the European Community (EC). The South African (SA) National Ambient Air Quality Standards (NAAQS) are also referenced since it is regarded representative indicators for Namibia due to the similar environmental and socio-economic characteristics between the two countries.

[2] *Director* means the Director of Health Services of the Administration, and, where applicable, includes any person who, in terms of any authority granted to him under section 2(2) or (3) of the Ordinance.

2.2.1 WHO Air Quality Guidelines

Air Quality Guidelines (AQG) were published by the WHO in 1987 and revised in 1997. Since the completion of the second edition of the AQG for Europe, which included new research from low-and middle-income countries where air pollution levels are at their highest, the WHO has undertaken to review the accumulated scientific evidence and to consider its implications for its AQG. The result of this work is documented in *'Air Quality Guidelines – Global Update 2005'* in the form of revised guideline values for selected criteria air pollutants, which are applicable across all WHO regions (WHO, 2005). The ITs and WHO AQG have been updated recently (WHO, 2021) following a much stronger body of evidence to show how air pollution affects different aspects of health at even lower concentrations than previously understood.

Given that air pollution levels in developing countries frequently far exceed the recommended WHO AQG, interim target (IT) levels were included in the updates. These are more lenient than the WHO AQG with the purpose to promote steady progress towards meeting the WHO AQG (WHO, 2005) (WHO, 2021). There are two to four interim targets depending on the pollutant, starting at WHO interim target-1 (IT-1) as the most lenient and IT-3 or IT-4 as more stringent targets before reaching the AQG. The 24-hour SA NAAQS are, for instance, in line with IT-1 for SO_2 and IT-3 for PM_{10} and IT-4 for $PM_{2.5}$. It should be noted that the WHO permits a frequency of exceedance of 1% per year (3 to 4 days per year) for 24-hour average PM_{10} and $PM_{2.5}$ concentrations. These are provided in Table 2-1 for pollutants considered in this study.

2.2.2 SA National Ambient Air Quality Standards

NAAQS for SA were determined based on international best practice for SO_2, NO_2, $PM_{2.5}$, PM_{10}, O_3, CO, lead (Pb) and benzene. These standards were published in the Government Gazette on 24 of December 2009 and included a margin of tolerance (i.e. frequency of exceedance) and with implementation timelines linked to it. SA NAAQS for $PM_{2.5}$ were published on 29 July 2012. As mentioned previously, SA NAAQS closely follow WHO interim targets, which are targets for developing countries, for $PM_{2.5}$, PM_{10} and SO_2. The SA NAAQS for ambient NO_2 concentrations is equivalent to the WHO AQG. SA NAAQS referred to in this study are also given in Table 2-1.

Table 2-1: International assessment criteria for criteria pollutants

Pollutant	Averaging Period	WHO Guideline Value (µg/m³) (i)	South Africa NAAQS (µg/m³)
Carbon monoxide (CO)	24-hour 1-hour	7 000 (IT 1) 4 000 (AQ level)	 30 000
Sulfur Dioxide (SO_2)	1-year 24-hour 1-hour 10-minute	- 125 (IT1) 50 (IT2) (a) 40 (AQ level) - -	50 125 (b) 350 (c) 500 (d)
Nitrogen Dioxide (NO_2)	1-year	40 (IT1) 30 (IT2)	40

Pollutant	Averaging Period	WHO Guideline Value (µg/m³) (i)	South Africa NAAQS (µg/m³)
		20 (IT3) 10 (AQ level)	
	24-hour	120 (IT1) 50 (IT2) 25 (AQ level)	
	1-hour		200 (c)
Particulate Matter (PM_{10})	1-year	70 (IT1) 50 (IT2) 30 (IT3) 20 (IT4) 15(AQ level)	40 (e) (b)
	24-hour	150 (IT1) 100 (IT2) 75 (IT3) 50 (IT4) 45 (AQ level)	75 (e)
Particulate Matter ($PM_{2.5}$)	1-year	35 (IT1) 25 (IT2) 15 (IT3) 10 (IT4) 5 (AQ level)	25 (f) 20 (g) 15 (h)
	24-hour	75 (IT1) 50 (IT2) 37.5 (IT3) 25 (IT4) 15 (AQ level)	65 (f) 40 (g) 25 (h)

Notes:

(a) Intermediate goal based on controlling motor vehicle emissions; industrial emissions and/or emissions from power production. This would be a reasonable and feasible goal to be achieved within a few years for some developing countries and lead to significant health improvement.
(b) 4 permissible frequencies of exceedance per year
(c) 88 permissible frequencies of exceedance per year
(d) 526 permissible frequencies of exceedance per year
(e) Applicable from 1 January 2015.
(f) Applicable immediately to 31 December 2015.
(g) Applicable 1 January 2016 to 31 December 2029.
(h) Applicable 1 January 2030.
(i) WHO (2021) for 24-hour averages 99th percentile (i.e., 3-4 exceedance days per year).

2.2.3 Dustfall Limits

Air quality standards are not defined by all countries for dust deposition, although some countries may make reference to annual average dust fall thresholds above which a 'loss of amenity' may occur. In the southern African context, widespread dust deposition impacts occur as a result of windblown dust from mining operations, other fugitive dust sources and natural sources.

South Africa has published the National Dust Control Regulations (NDCR) on the 1st of November 2013 (Government Gazette (GG) 36974) with an updated NDCR gazetted on 8 March 2024 (GG 50272). The purpose

of the regulations is to prescribe general measures for the control of dust in all areas including residential and non-residential areas. Similarly, Botswana published dust deposition evaluation criteria (BOS 498:2013). According to these limits, an enterprise may submit a request to the authorities to operate within the Band 3 (action band) for a limited period, providing that this is essential in terms of the practical operation of the enterprise (for example the final removal of a tailings deposit) and provided that the best available control technology is applied for the duration. No margin of tolerance will be granted for operations that result in dustfall rates in the Band 4 (alert band). This four-band scale is presented in Table 2-2.

Table 2-2: Bands of dustfall rates

Band Number	Band Description	30 Day Average Dustfall Rate (mg/m²-day)	Comment
1	Residential	Dustfall rate < 600	Permissible for residential and light commercial
2	Industrial	600 < Dustfall rate < 1 200	Permissible for heavy commercial and industrial
3	Action	1 200 < Dustfall rate < 2 400	Requires investigation and remediation if two sequential months lie in this band, or more than three occur in a year.
4	Alert	2 400 < Dustfall rate	Immediate action and remediation required following the first exceedance. Incident report to be submitted to relevant authority.

2.2.4 Inhalation Health Criteria for Volatile Organic Compounds

Chronic effect screening levels for volatile organic compounds (VOCs) emitted from combustion sources are published by the Texas Commission on Environmental Quality (TCEQ) - Effects Screening Levels (ESLs) (TCEQ, 2013) (Table 2-3).

Table 2-3: Chronic inhalation screening criteria for volatile organic compounds

Pollutant	Acute/Short term Screening Criteria (µg/m³)	Chronic/Long term Screening Criteria (µg/m³)	Reference
VOC (*Diesel fuel* used as indicator)	1000	100	TCEQ

2.3 International Conventions

The technical reference documents published in the IFC Environmental, Health and Safety (EHS) Guidelines provide general and industry specific examples of GIIP. The General EHS Guidelines are designed to be used together with the relevant Industry Sector EHS Guidelines (IFC, 2007).

The IFC EHS Guidelines provide a general approach to air quality management for a facility, including the following:

- Identifying possible risks and hazards associated with the project as early on as possible and understanding the magnitude of the risks, based on:
    - the nature of the project activities; and,

    - the potential consequences to workers, communities, or the environment if these hazards are not adequately managed or controlled.
- Preparing project- or activity-specific plans and procedures incorporating technical recommendations relevant to the project or facility;
- Prioritising the risk management strategies with the objective of achieving an overall reduction of risk to human health and the environment, focusing on the prevention of irreversible and / or significant impacts;
- When impact avoidance is not feasible, implementing engineering and management controls to reduce or minimise the possibility and magnitude of undesired consequence; and,
- Continuously improving performance through a combination of ongoing monitoring of facility performance and effective accountability.

Significant impacts to air quality should be prevented or minimised by ensuring that:

- Emissions to air do not result in pollutant concentrations exceeding the relevant ambient air quality guidelines or standards. These guidelines or standards can be national guidelines or standards or in their absence WHO AQG or any other international recognised sources.
- Emissions do not contribute significantly to the relevant ambient air quality guidelines or standards. It is recommended that 25% of the applicable air quality standards are allowed to enable future development in a given airshed. Thus, any new development should not result in ground level concentrations exceeding 25% of the guideline value.
- The EHS recognises the use of dispersion models to assess potential ground level concentrations. The models used should be internationally recognised or comparable.

2.3.1 Degraded Airsheds or Ecological Sensitive Areas

The IFC provides further guidance on projects located in degraded airsheds (IFC, 2007), i.e., areas where the national/ WHO/ other recognised international Air Quality Guidelines are significantly exceeded or where the project is located next to areas regarded as ecological sensitive such as national parks. The project is not located in an ecologically sensitive area, and the airshed is not regarded to be degraded.

2.3.2 Fugitive Source Emissions

According to the IFC (IFC, 2007), fugitive source emissions refer to emissions that are distributed spatially over a wide area and confined to a specific discharge point. These sources have the potential to result in more significant ground level impacts per unit release than point sources. It is therefore necessary to assess this through ambient quality assessment and monitoring practices.

2.4 Recommended Guidelines and Objectives

The IFC references the WHO guidelines but indicates that any other internationally recognized criteria can be used such as the United States (US) Environmental Protection agency (EPA) or the EC. It was, however, found that merely adopting the WHO guidelines would result in exceedances of these guidelines in many areas due to the arid environment in the country, and specifically in Namibia. The WHO states that these AQG and interim targets should be used to guide standard-setting processes and should aim to achieve the lowest concentrations possible in the context of local constraints, capabilities, and public health priorities. These guidelines are also aimed at urban environments within developed countries (WHO, 2005). For this reason, the South African NAAQS are also referenced since these were developed after a thorough review of all international criteria and selected based on the socio, economic and ecological conditions of the country.

In the absence of guidelines on ambient air concentrations for Namibia, reference is made to the AQO. These objectives are based on the WHO interim targets and SA NAAQS (Table 2-1). The criteria were selected on the following basis:

- The WHO IT3 was selected for particulates since these limits are in line with the SA NAAQS, and the latter are regarded feasible limits for the arid environment of Namibia.
- Even though $PM_{2.5}$ emissions are mainly associated with combustion sources and mainly a concern in urban environments, it is regarded good practice to include as health screening criteria given the acute adverse health effects associated with this fine fraction. Also, studies found that desert dust with an aerodynamic diameter 2.5 µm cause premature mortality.
- For SO_2, there is no IT3, and the IT2 was selected since the WHO states: "This would be a reasonable and feasible goal for some developing countries (it could be achieved within a few years) which would lead to significant health improvements that, in turn, would justify further improvements (such as aiming for the AQG value)".
- The WHO provides no interim targets for NOx. The AQG are in line with the SA NAAQS and therefore regarded as achievable limits.
- For CO, hourly guideline is only available for the SA NAAQS and therefore selected. The WHO provides a IT1 daily guideline. These guidelines were regarded as applicable.
- For VOC, health effect screening levels as published by the TCEQ are referenced.
- The Botswana and South African criteria for dust fallout are the same and with limited international criteria for dust fallout, these were regarded applicable.

The proposed Air Quality Objectives (AQO) as set out in Table 2-4 are intended to be used as indicators during the impact assessment.

Table 2-4: Proposed Air Quality Objectives for the pipeline construction

Pollutant	Averaging Period	Criteria	Reference
CO	1-hour average (µg/m³)	30 000[(a)]	SA NAAQS
	24-hour average (µg/m³)	7 000[(b)]	WHO IT1
NO_2	1-hour average (µg/m³)	200[(a)]	WHO AQG & EC & SA NAAQS
	Annual average (µg/m³)	40	WHO AQG & EC & SA NAAQS
SO_2	1-hour average (µg/m³)	350[(a)]	EC Limit & SA NAAQS (no WHO guideline)
	24-hour average (µg/m³)	50[(b)]	WHO IT2 (seen as a per 40% of the SA and EC limits)
	Annual average (µg/m³)	50	SA NAAQS (no WHO guideline)
VOC	1-hour average (µg/m³)	1 000	TCEQ
	Annual average (µg/m³)	100	TCEQ
Particulate matter (PM_{10})	24-hour average (µg/m³)	75[(b)]	WHO IT3 & SA NAAQS (as per SEMP AQMP)
	Annual average (µg/m³)	40	SA NAAQS (as per SEMP AQMP)
Particulate matter ($PM_{2.5}$)	24-hour average (µg/m³)	37.5[(b)]	WHO IT (as per SEMP AQMP)
	Annual average (µg/m³)	15	WHO IT3 & SA NAAQS (as per SEMP AQMP)
Dustfall	30-day average (mg/m²/day)	600[(c)]	SA NDCR & Botswana residential limit
		1 200[(c)]	SA NDCR & Botswana industrial limit
		2 400	Botswana Alert Threshold

Notes: [(a)] Not to be exceeded more than 88 hours per year (SA)

[(b)] Not to be exceeded more than 4 times per year (SA)

[(c)] Not to be exceeded more than 3 times per year or 2 consecutive months

3 DESCRIPTION OF THE BASELINE ENVIRONMENT

This chapter provides details of the receiving environment which is described in terms of:

- Local AQSR;
- The local atmospheric dispersion potential; and,
- Ambient air quality and the existing sources of air pollution in the area.

3.1 Sensitive Receptors

The evaluation criteria are based on human exposure to specific criteria pollutants and as such, possible AQSR were identified where the public is likely to be unwittingly exposed.

Potential AQSR sensitive receptors within the study area (Figure 3-1) include residential areas of Green Valley and Walvis Bay.

3.2 Atmospheric Dispersion Potential

Meteorological mechanisms govern the dispersion, transformation and eventual removal of pollutants from the atmosphere. The extent to which pollution will accumulate or disperse in the atmosphere is dependent on the degree of thermal and mechanical turbulence within the earth's boundary layer. Dispersion comprises vertical and horizontal components of motion. The stability of the atmosphere and the depth of the surface-mixing layer define the vertical component. The horizontal dispersion of pollution in the boundary layer is primarily a function of the wind field. The wind speed determines both the distance of downwind transport and the rate of dilution as a result of plume 'stretching'. The generation of mechanical turbulence is similarly a function of the wind speed, in combination with the surface roughness. Pollution concentration levels therefore fluctuate in response to changes in atmospheric stability, to concurrent variations in the mixing depth, and to shifts in the wind field.

A description of the wind field, temperature, precipitation, and atmospheric stability is provided in the following section. Modelled Weather Research and Forecasting (WRF)[3] meteorological data for a point located just north of Walvis Bay for the period 2021 to 2023 was utilised which include wind speed (km/hr), wind direction (degrees), temperature (°C), humidity (%), barometric pressure (Pa) and rainfall (mm).

[3] The Weather Research and Forecasting (WRF) Model is a state-of-the-art mesoscale numerical weather prediction system designed for both atmospheric research and operational forecasting applications. It features two dynamical cores, a data assimilation system, and a software architecture supporting parallel computation and system extensibility.

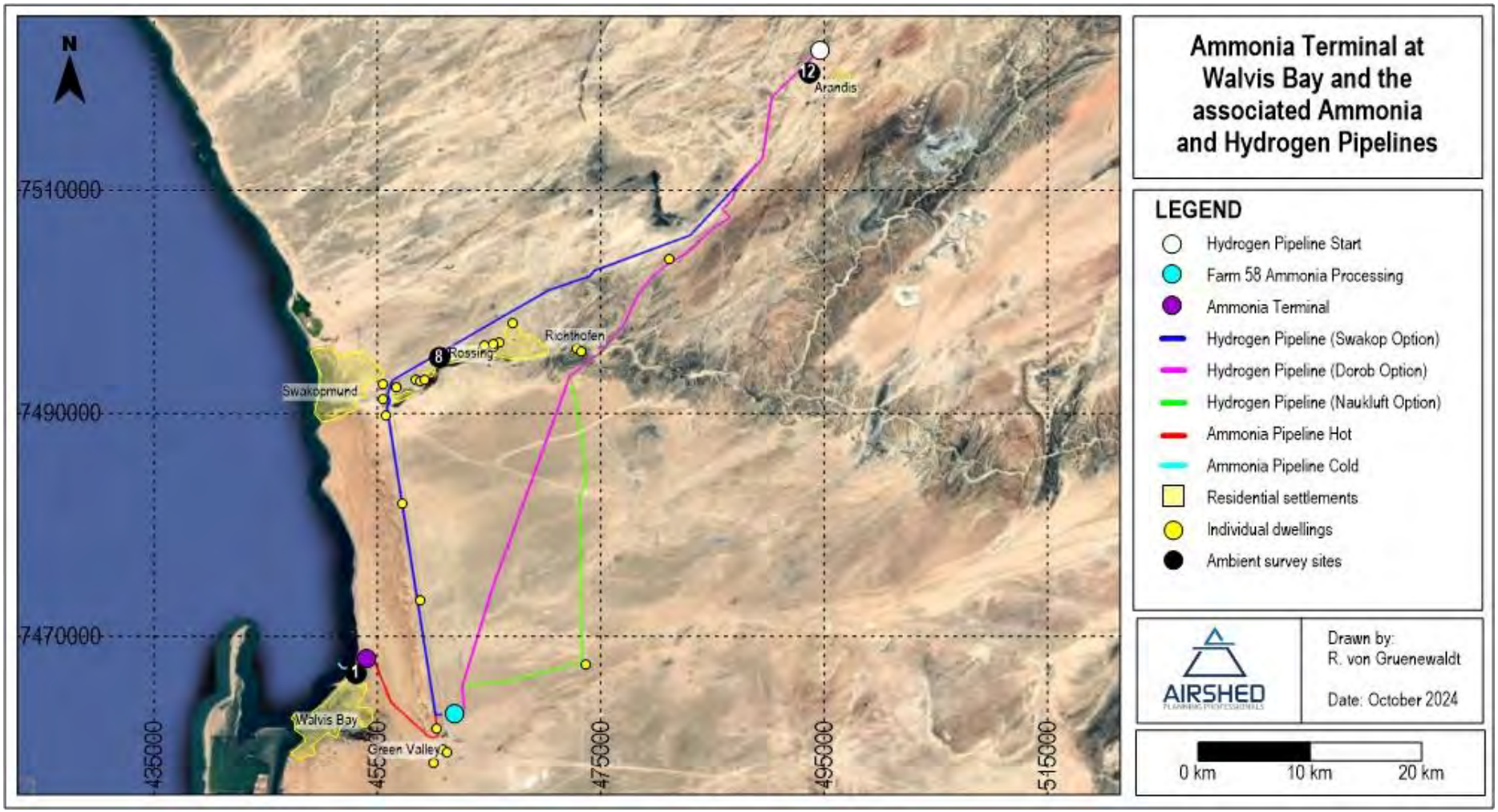

Figure 3-1: Identified AQSR within the study area

3.2.1 Surface Wind Field

The wind direction, and the variability in wind direction, determines the general path that air pollutants will follow, and the extent of crosswind spreading. Wind roses comprise 16 spokes, which represent the directions from which winds blew during the period. The colours used in the wind roses below, reflect the different categories of wind speeds; the red area, for example, representing winds higher than 6 m/s. The dotted circles provide information regarding the frequency of occurrence of wind speed and direction categories. The frequency with which calms occurred refers to periods during which the wind speed was below 1 m/s.

Period, daytime and night-time wind roses for the study area, based on the modelled WRF meteorological data for three-year period: 2021 to 2023 are depicted in Figure 3-2.

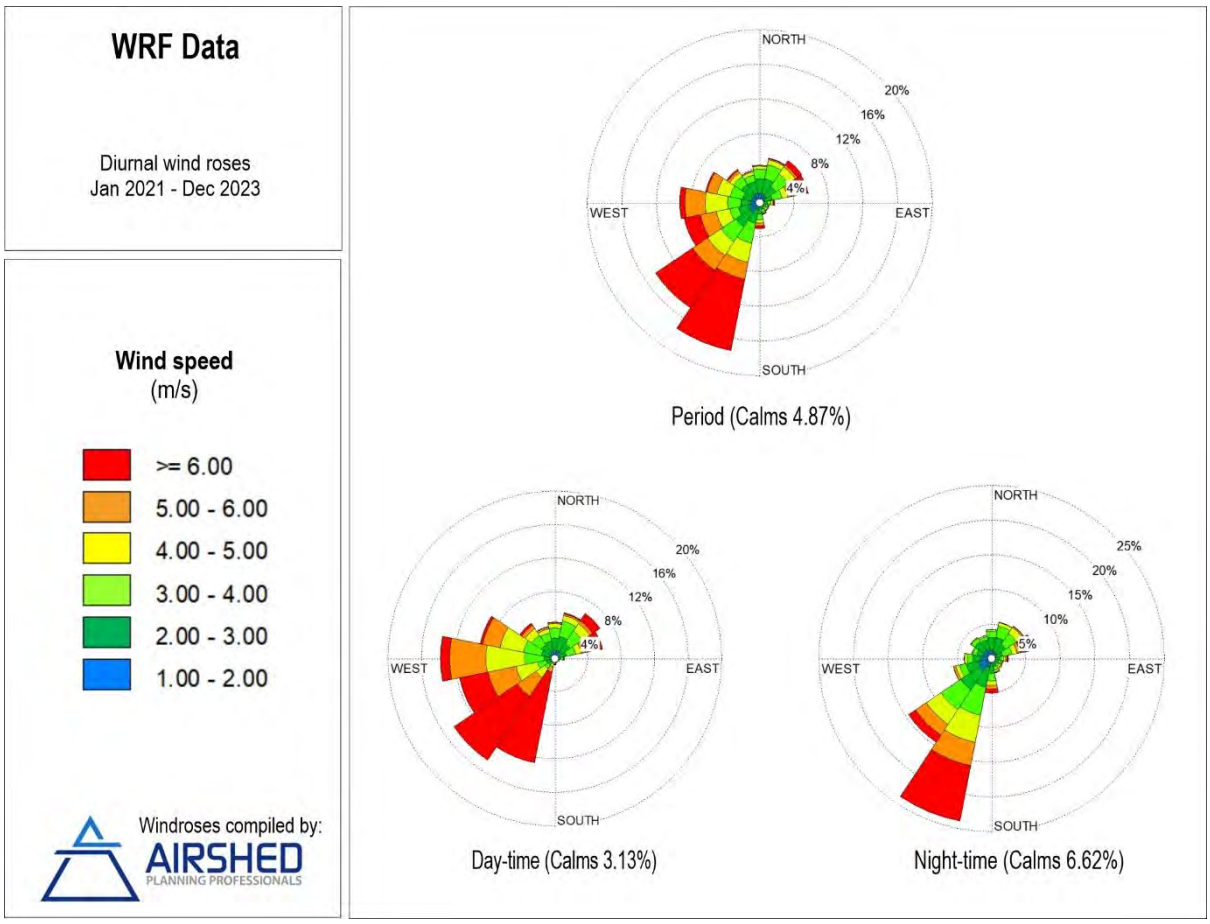

Figure 3-2: Period, day- and night-time wind roses based on modelled WRF data for a point just north of Walvis Bay (2021 to 2023)

The predominant wind direction for the study area (point just north of Walvis Bay) is from the south-southwest and southwest which is evident in the day- and night-time wind roses as well. Calm conditions (i.e., wind speeds of less than 1 m/s) occurred for 4.87% of the period.

3.2.2 Temperature

Air temperature is important, both for determining the effect of plume buoyancy (the larger the temperature difference between the emission plume and the ambient air, the higher the plume is able to rise), and determining the development of the mixing and inversion layers.

Monthly mean, maximum and minimum temperatures are given in Table 3-1. Diurnal temperature variability is presented in Figure 3-3. Average monthly temperatures ranged between 14.5°C and 20.1°C. During the day, temperatures increase to reach maximum at about 15:00 to 16:00 in the late afternoon. Ambient air temperature decreases to reach a minimum at between 06:00 and 07:00.

Table 3-1: Monthly temperature summary (WRF data for a point just north of Walvis Bay, 2021 to 2023)

Monthly Minimum, Maximum and Average Temperatures (°C)												
Parameter	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Minimum	17.0	17.5	15.4	16.4	13.6	12.7	11.3	8.9	8.7	11.1	12.3	13.1
Average	19.9	20.1	19.4	21.3	18.6	17.5	16.8	14.6	14.5	15.5	17.5	17.8
Maximum	22.9	23.3	24.3	26.7	24.4	23.5	23.4	21.2	21.0	20.9	22.6	22.7

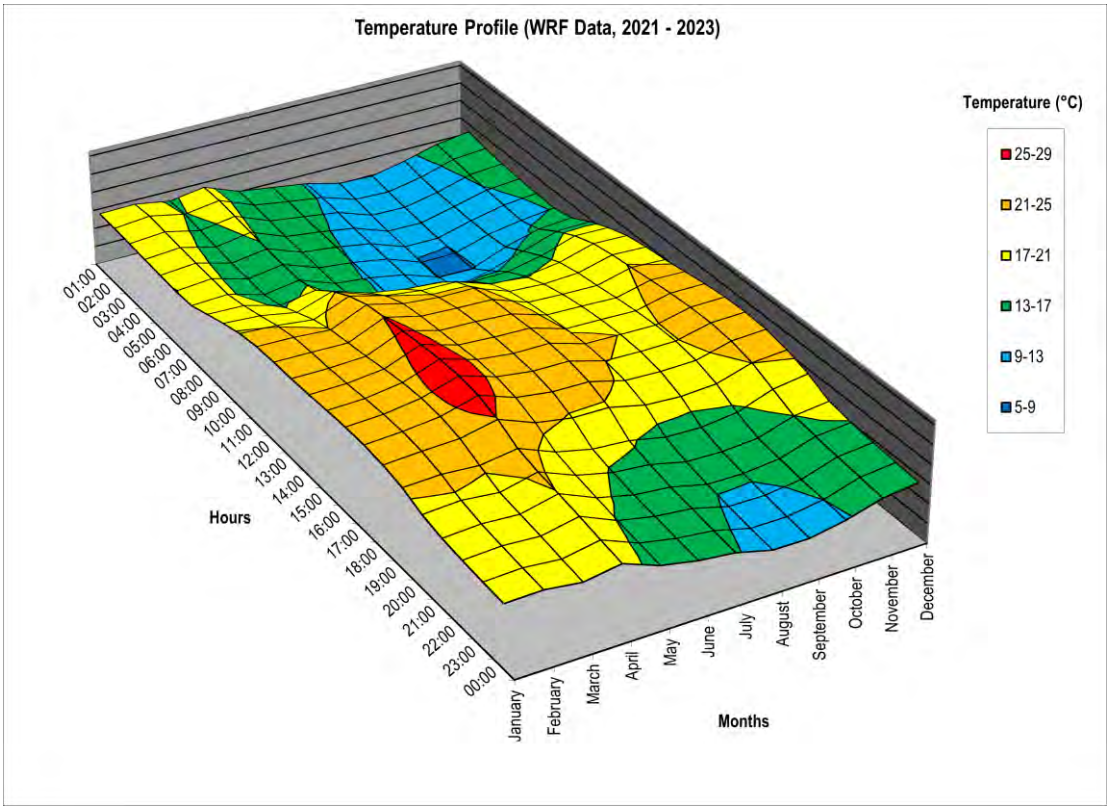

Figure 3-3: Diurnal temperature profile (WRF data for a point just north of Walvis Bay, 2021 to 2023)

3.2.3 Atmospheric Stability

The new generation air dispersion models differ from the models traditionally used in a number of aspects, the most important of which are the description of atmospheric stability as a continuum rather than discrete classes. The atmospheric boundary layer properties are therefore described by two parameters: the boundary layer depth and the Monin-Obukhov length, rather than in terms of the single parameter Pasquill Class. The Monin-Obukhov length (LMo) provides a measure of the importance of buoyancy generated by the heating of the ground and mechanical mixing generated by the frictional effect of the earth's surface. Physically, it can be thought of as representing the depth of the boundary layer within which mechanical mixing is the dominant form of turbulence generation (CERC, 2004). The atmospheric boundary layer constitutes the first few hundred metres of the atmosphere. During the daytime, the atmospheric boundary layer is characterised by thermal turbulence due to the heating of the earth's surface. Night times are characterised by weak vertical mixing and the predominance of a stable layer. These conditions are normally associated with low wind speeds and less dilution potential. During windy and/or cloudy conditions, the atmosphere is normally neutral. For low level releases, the highest ground level concentrations would occur during weak wind speeds and stable (night-time) atmospheric conditions. The atmospheric stability for the site is provided in Figure 3-4.

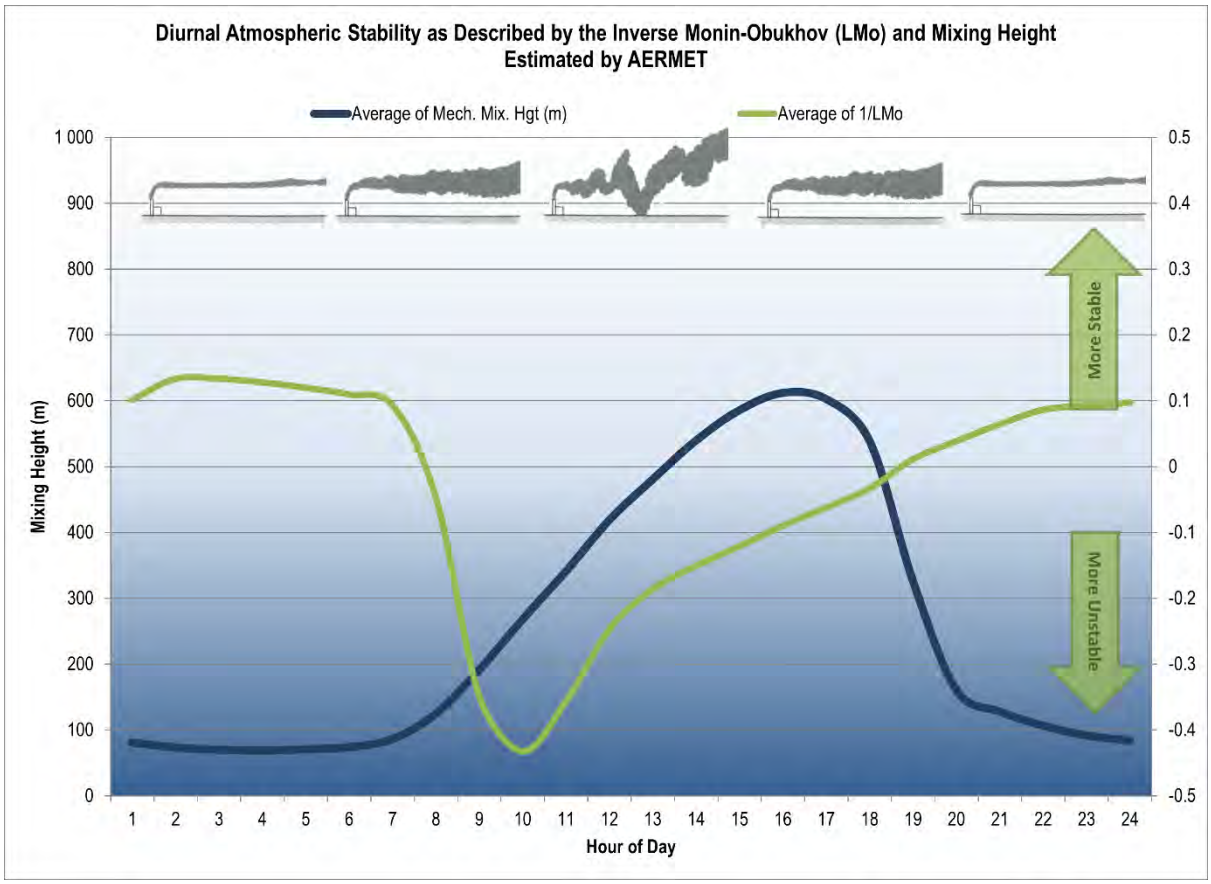

Figure 3-4: The diurnal atmospheric stability for the site (point just north of Walvis Bay) as estimated with AERMET

3.3 Current Ambient Air Quality

Three survey sites were selected (i.e. Site 1, Site 8 and Site 12) to take PM_{10} and $PM_{2.5}$ grab samples (Figure 3-1). The measured PM data is provided in Table 3-2. The measured daily PM_{10} concentrations ranged between 24.4 µg/m³ and 27.1 µg/m³ the daily $PM_{2.5}$ concentrations ranged between 3.2 µg/m³ and 5.6 µg/m³. it should be noted that the measured concentrations were only over a single day and only provide an indication of concentration levels in the area.

Table 3-2: Measured daily average PM_{10} and $PM_{2.5}$ for the 2024 survey

Survey site	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	Start measurement	End measurement
Site 1	25.5	5.2	25/07/2024 09:36	26/07/2024 01:00
Site 8	24.4	3.2	24/07/2024 09:14	24/07/2024 23:57
Site 12	27.1	5.6	23/07/2024 08:32	23/07/2024 23:58

The site of interest for the pipeline is Site 1.

3.4 Existing Air Quality within the Study Area

Sources identified as possibly impacting on air quality in the region include, but are not limited to:

- Fugitive emissions from surrounding mining operations;
- Vehicle tailpipe emissions from national and main roads; and,
- Various miscellaneous fugitive dust sources (wind erosion of open areas, vehicle-entrainment of dust along paved and unpaved roads).

3.4.1 Vehicle Tailpipe Emissions

Air pollution from vehicle emissions may be grouped into primary and secondary pollutants. Primary pollutants are those emitted directly into the atmosphere, and secondary, those pollutants formed in the atmosphere as a result of chemical reactions, such as hydrolysis, oxidation, or photochemical reactions. The significant primary pollutants emitted by vehicles include carbon dioxide (CO_2), CO, hydrocarbons (HCs), SO_2, oxides of nitrogen (NO_x), particulates and lead. Secondary pollutants include NO_2, photochemical oxidants (e.g., ozone), HCs, sulphur acid, sulphates, nitric acid, nitric acid and nitrate aerosols. Toxic hydrocarbons emitted include benzene, 1.2-butadiene, aldehydes and polycyclic aromatic hydrocarbons (PAH). Benzene represents an aromatic HC present in petrol, with 85% to 90% of benzene emissions emanating from the exhaust and the remainder from evaporative losses. Vehicle tailpipe emissions are localised sources and unlikely to impact far-field.

3.4.2 Mining Operations in the Region

Fugitive dust sources associated with mining activities include drilling and blasting operations, materials handling activities, vehicle-entrainment by haul vehicles and wind-blown dust from stockpiles. Mining operations represent

potentially the most significant sources of fugitive dust emissions ($PM_{2.5}$, PM_{10} and TSP) with small amounts of NO_x, CO, SO_2, methane, and CO_2 being released during blasting operations and from mine trucks.

Experience has shown that fugitive dust emissions due to on-site operations are typically only of concern within 3 km of the mine boundary, depending on the location of the mine boundary and extent of the mining operations. This is the reason for the current manner in which atmospheric emissions are treated for mining operations. Dust suppression methods that are most frequently used in local mining operations include wet suppression and chemical stabilisation of haul roads and storage piles, and the vegetation or rock cladding of tailings impoundments.

There are no mining activities in the immediate vicinity of the pipeline but mining activities are located further (more than 20 km) to the north-norhteast and northeast of the site.

3.4.3 Fugitive Dust Sources

Fugitive dust emissions may occur as a result of vehicle entrained dust from local paved and unpaved roads, and wind erosion from open areas. The extent of particulate emissions from the main roads will depend on the number of vehicles using the roads and the silt loading on the roadways. The extent, nature and duration of agricultural activities and the moisture and silt content of soils are required to be known in order to quantify fugitive emissions from this source. The quantity of wind-blown dust is similarly a function of the wind speed, the extent of exposed areas and the moisture and silt content of such areas.

4 IMPACT ASSESSMENT

The emissions inventory, dispersion modelling and results are discussed in Section 4.1, 4.2 and Section 4.3 respectively.

4.1 Atmospheric Emissions

The establishment of a comprehensive emission inventory formed the basis for the assessment of the air quality impacts from the pipeline construction activities on the receiving environment.

Construction activities are a source of primarily criteria pollutants, including CO, SO_2, NO_X and particulate matter (PM_{10} and $PM_{2.5}$). Nuisance effects are caused by the total suspended particulate fraction resulting in soiling of materials and visibility reductions.

The proposed construction steps for the pipeline are as follows:

- Step 1: Construction staging areas and storage yards.
- Step 2: Clear cutting the right-of-way (ROW).
- Step 3: Excavating the trench (track hoes with jack hammers are brought in to create the trench).
- Step 4: Pipe transport, stringing, and assembly (segments of pipe transported from stockpiles, welded together and sandblasted).
- Step 5: Obstacles: roads and streams (constructed underneath these obstacles by either boring for shallow depth or using horizontal directional drilling for deeper placement).
- Step 6: Testing and restoration.

4.1.1 General Infrastructure Construction

Each of the construction steps has their own duration and potential for dust generation. It is therefore often necessary to estimate area wide construction emissions, without regard to the actual plans of any individual construction process. It should also be noted that all activities per construction step will not occur concurrently at all portions of the site.

The US EPA documents emission factors which aim to provide a general rule-of-thumb as to the magnitude of emissions which may be anticipated from construction operations (US EPA, 2006). The quantity of dust emissions is assumed to be proportional to the area of land being worked and the level of construction activity. The approximate emission factors for general construction activity operations are given as:

E = 2.69 Mg/hectare/month of activity (269 g/m^2/month)

The PM_{10} and $PM_{2.5}$ fraction is assumed to be 30% and 3% of the US EPA total suspended particulate factor respectively. These emission factors are most applicable to construction operations with (i) medium activity levels, (ii) moderate silt contents, and (iii) semiarid climates. The emission factor for TSP considers 42 hours of work per

week of construction activity. Test data were not sufficient to derive the specific dependence of dust emissions on correction parameters, and because the above emission factor is referenced to TSP, use of this factor to estimate PM_{10} emissions will result in conservatively high estimates. Also, because derivation of the factor assumes that construction activity occurs 30 days per month, the above estimate is somewhat conservatively high for TSP as well.

A construction area of 500 m by 20 m (10 m from the pipeline centreline on either side of the pipeline) was assumed as the expected active area at any given time and used in the model.

The total particulate emissions due to infrastructure construction is provided in Table 4-1.

Table 4-1: Estimated particulate matter emissions due to infrastructure construction

Pollutant	Emissions (g/s/m²)
TSP	1.02E-04
PM_{10}	3.07E-05
$PM_{2.5}$	3.07E-06

4.1.2 Engine Exhaust Emissions

Engine exhaust emissions cover a wide variety of industrial applications of both gasoline and diesel internal combustion engines, including mobile (road sources, i.e. buses, trucks, etc. and non-road sources, such as forklifts, backhoes, etc.) and non-mobile sources (such as power generators and pumps). The Australian National Pollution Inventory (NPi) (2008) manual for combustion engines were used to estimate emission rates for the pipeline construction equipment.

The list of construction equipment was provided for the current assessment (Table 4-2). The NPi emission factors for diesel industrial engine exhaust emissions is provided in Table 4-3 with the estimated average emissions provided in Table 4-4.

Table 4-2: List of equipment provided for the pipeline construction

Equipment List	No. of units	Assumed construction step where equipment is used	Assumed Power Rating (kW)	Assumed load factor
Trenchers	1	Step 3	186.5	50%
Skid steer loaders	1	Step 2	43	50%
Rock grinders	1	Step 5	399	50%
Backhoe loaders	1	Step 3	55	50%
Dozers	1	Step 2	185	50%
Excavators	1	Step 3	125	50%
Articulated trucks	1	Step 2	236	50%
Track hoe with Jackhammer	1	Step 3	45.6	50%
Trucks (transportation)	1	All steps	280	50%
Trucks (carry pipes to location)	1	Step 4	280	50%

Table 4-3: Emission factors for diesel industrial engine exhaust

Substance	Emission factor (kg/kWh)
CO	0.0062
NOx	0.015
$PM_{2.5}$	0.0011
PM_{10}	0.0012
SO_2	0.000008
VOC	0.0014

Table 4-4: Estimated emissions due to vehicle exhaust

Equipment List	Emissions (g/s/m²)					
	CO	NOx	$PM_{2.5}$	PM_{10}	SO_2	VOC
Trenchers	1.61E-05	3.89E-05	2.85E-06	3.11E-06	2.07E-08	3.63E-06
Skid steer loaders	3.70E-06	8.96E-06	6.57E-07	7.17E-07	4.78E-09	8.36E-07
Rock grinders	3.44E-05	8.31E-05	6.10E-06	6.65E-06	4.43E-08	7.76E-06
Backhoe loaders	4.74E-06	1.15E-05	8.40E-07	9.17E-07	6.11E-09	1.07E-06
Dozers	1.59E-05	3.85E-05	2.83E-06	3.08E-06	2.06E-08	3.60E-06
Excavators	1.08E-05	2.60E-05	1.91E-06	2.08E-06	1.39E-08	2.43E-06
Articulated trucks	2.03E-05	4.92E-05	3.61E-06	3.93E-06	2.62E-08	4.59E-06
Track hoe with Jackhammer	3.93E-06	9.50E-06	6.97E-07	7.60E-07	5.07E-09	8.87E-07
Trucks (transportation)	2.41E-05	5.83E-05	4.28E-06	4.67E-06	3.11E-08	5.44E-06
Trucks (carry pipes to location)	2.41E-05	5.83E-05	4.28E-06	4.67E-06	3.11E-08	5.44E-06

4.1.3 Summary of Estimated Emissions due to Construction Activities

A summary of emissions quantified per construction step due to general construction activities and vehicle exhaust is provided in Table 4-5.

Table 4-5: Estimated emissions due to general infrastructure construction and vehicle exhaust

Construction Activity	Emissions (g/s/m²)						
	CO	NOx	TSP	$PM_{2.5}$	PM_{10}	SO_2	VOC
Step 2	6.41E-05	1.55E-04	1.15E-04	1.44E-05	4.31E-05	8.27E-08	1.45E-05
Step 3	5.96E-05	1.44E-04	1.02E-04	1.36E-05	3.07E-05	7.69E-08	1.35E-05
Step 4	4.82E-05	1.17E-04	1.12E-04	1.16E-05	4.00E-05	6.22E-08	1.09E-05
Step 5	5.85E-05	1.41E-04	1.14E-04	1.34E-05	4.20E-05	7.54E-08	1.32E-05

4.2 Atmospheric Dispersion Modelling

To assess impact on human health and the environment the following important aspects need to be considered:

- The criteria against which impacts are assessed (Section 2.4);
- The potential of the atmosphere to disperse and dilute pollutants emitted by the project (Section 3.2); and
- The AQSR in the vicinity of the pipeline (Section 3.1).

The impact of pipeline construction on the atmospheric environment was determined through the simulation of ambient pollutant concentrations. Dispersion models simulate ambient pollutant concentrations as a function of source configurations, emission strengths and meteorological characteristics, thus providing a useful tool to ascertain the spatial and temporal patterns in the ground level concentrations arising from the emissions of various sources. Increasing reliance has been placed on concentration estimates from models as the primary basis for environmental and health impact assessments, risk assessments and emission control requirements. It is therefore important to carefully select a dispersion model for the purpose.

4.2.1 Dispersion Model Selection

In the calculation of ambient air pollutant concentrations and dustfall rates use was made of the US EPA AERMOD atmospheric dispersion modelling suite. AERMOD is a Gaussian plume model best used for near-field applications where the steady-state meteorology assumption is most likely to apply. AERMOD is a model developed with the support of the AMS/EPA Regulatory Model Improvement Committee (AERMIC), whose objective has been to include state-of the-art science in regulatory models (Hanna, Egan, Purdum, & Wagler, 1999). AERMOD is a dispersion modelling system with three components, namely: AERMOD (AERMIC Dispersion Model), AERMAP (AERMOD terrain pre-processor), and AERMET (AERMOD meteorological pre-processor). AERMET version 22112 and AERMOD version 22112 were used for the assessment.

4.2.2 Meteorological Requirements

Modelled hourly WRF meteorological data for 2021 to 2023 was utilised for the dispersion simulations.

4.2.3 Source Data Requirements

The US EPA AERMOD model is able to model point, jet, area, line and volume sources. The construction area was modelled as an area source.

4.2.4 Simulation of NO/NO_2 Transformation

Nitrogen monoxide (NO) emissions are rapidly converted in the atmosphere into the more toxic NO_2. The rate of this conversion process is determined by the rate of the physical processes of dispersion and mixing of the plume and the chemical reaction rates as well as the local atmospheric ozone concentration. In the absence of accurate O_3 data required to estimate the conversion ratio, 20% of all NOx was assumed to be NO_2 as per literature (Howard, 1988).

4.2.5 Modelling Domain

The dispersion of pollutants expected to arise from pipeline construction activities was modelled for an area covering 2 km (east-west) by 2 km (north-south). The area was divided into a grid matrix with a resolution of 20 m by 20 m, with the construction area (500 m x 20 m) located centrally. AERMOD calculates ground-level (1.5 m above ground level) concentrations and dustfall rates at each grid and discrete receptor point.

4.3 Dispersion Modelling Results

Dispersion modelling was undertaken to determine the 99th percentile hourly, 99th percentile daily, highest hourly (for VOC), highest daily (for dust deposition) and annual average ground level concentrations. Averaging periods were selected to facilitate the comparison of predicted pollutant concentrations to relevant ambient air quality and inhalation health criteria as well as dustfall regulations.

Pollutants with the potential to result in human health impacts which are assessed in this study include CO, NO_2, $PM_{2.5}$, PM_{10}, SO_2 and VOC. Dustfall is assessed for its nuisance potential. It should be noted that construction Step 1 was not simulated as the exact location of the staging areas and storage yards were not provided. The distance of impacts from the staging areas and storage yards however are expected to be similar to impacts due to construction Step 2.

4.3.1 Carbon Monoxide (CO)

A profile of the simulated hourly and daily CO ground level concentrations due to pipeline construction activities for the various steps (i.e. Step 2 to Step 5), is provided in Figure 4-1 and Figure 4-2 respectively. AQO for CO was not exceeded due to the pipeline construction.

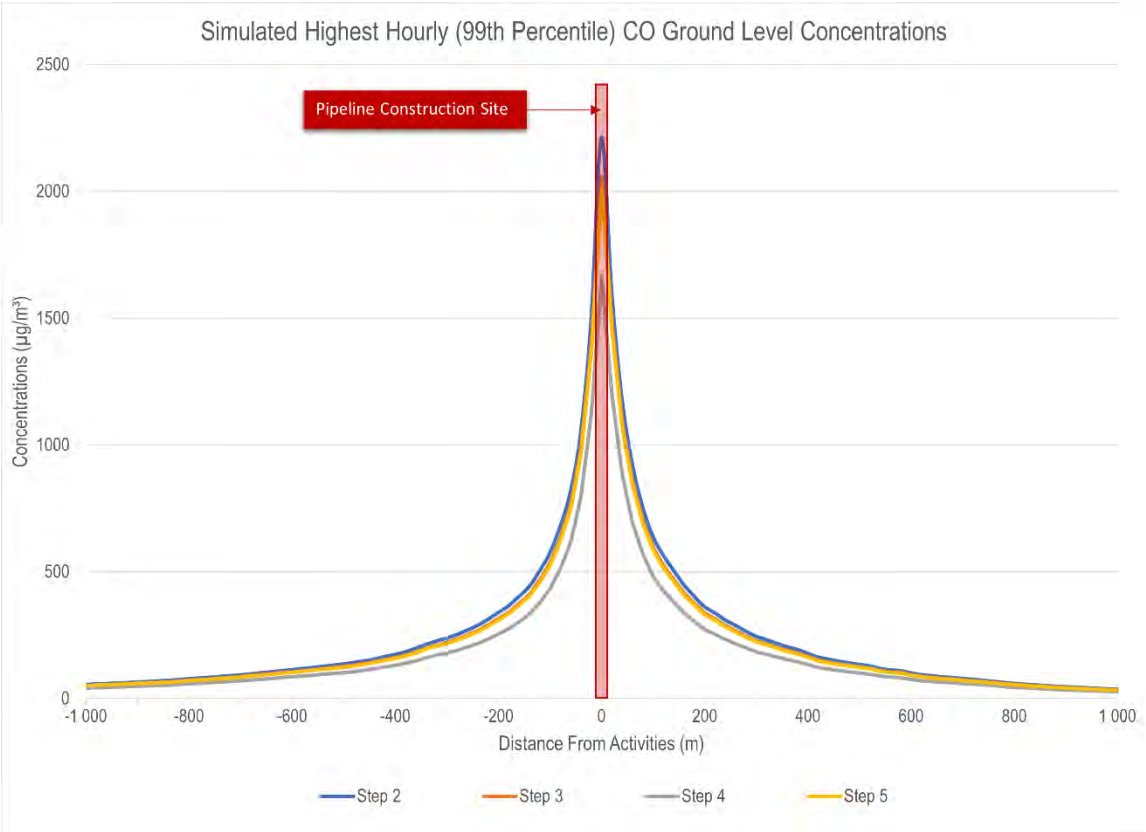

Figure 4-1: Simulate hourly (99th percentile) CO ground level concentrations due to pipeline construction activities

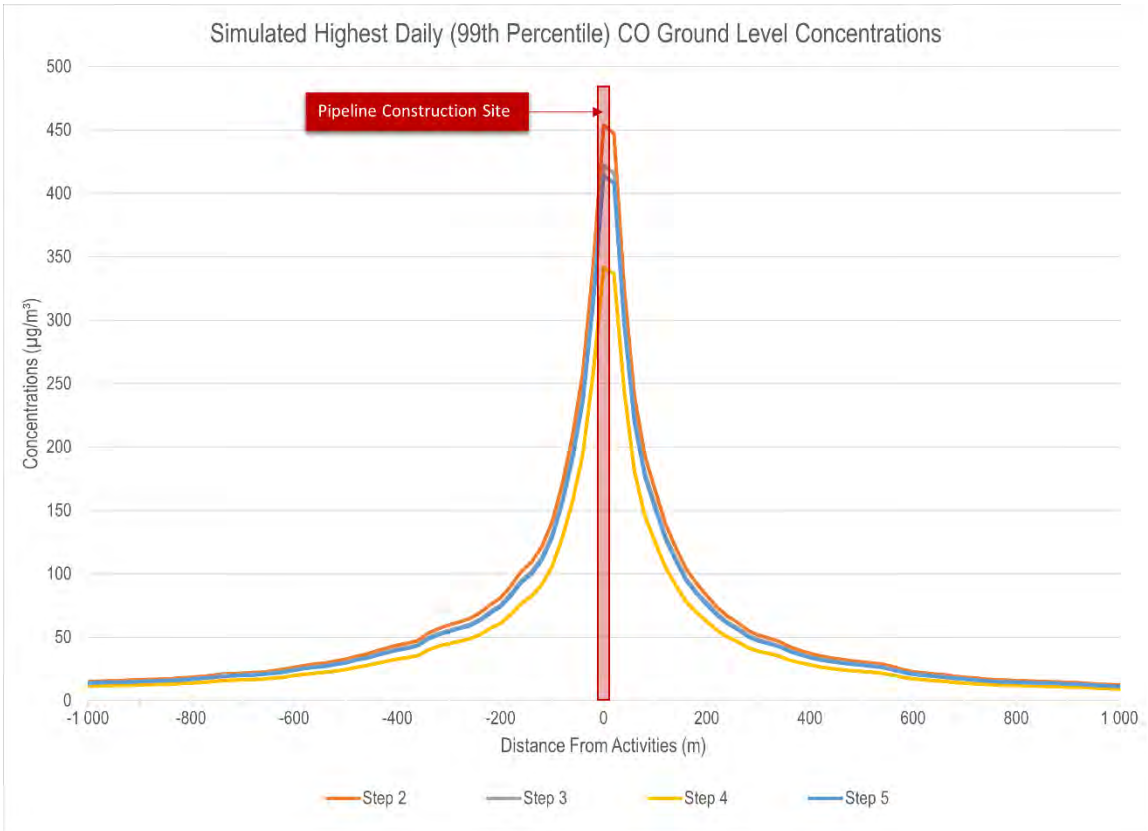

Figure 4-2: Simulate daily (99th percentile) CO ground level concentrations due to pipeline construction activities

4.3.2 Nitrogen Dioxide (NO_2)

A profile of the simulated hourly and annual NO_2 ground level concentrations due to pipeline construction activities, is provided in Figure 4-3 and Figure 4-4 respectively. Simulated hourly (99th percentile) and annual NO_2 ground level concentrations due to pipeline construction exceeded the NO_2 AQO up to 220 m from the pipeline centreline. It should be noted, however, that the closest AQSR to the pipeline centreline is ~300 m, so NO_2 AQO are not expected to be exceeded at AQSR.

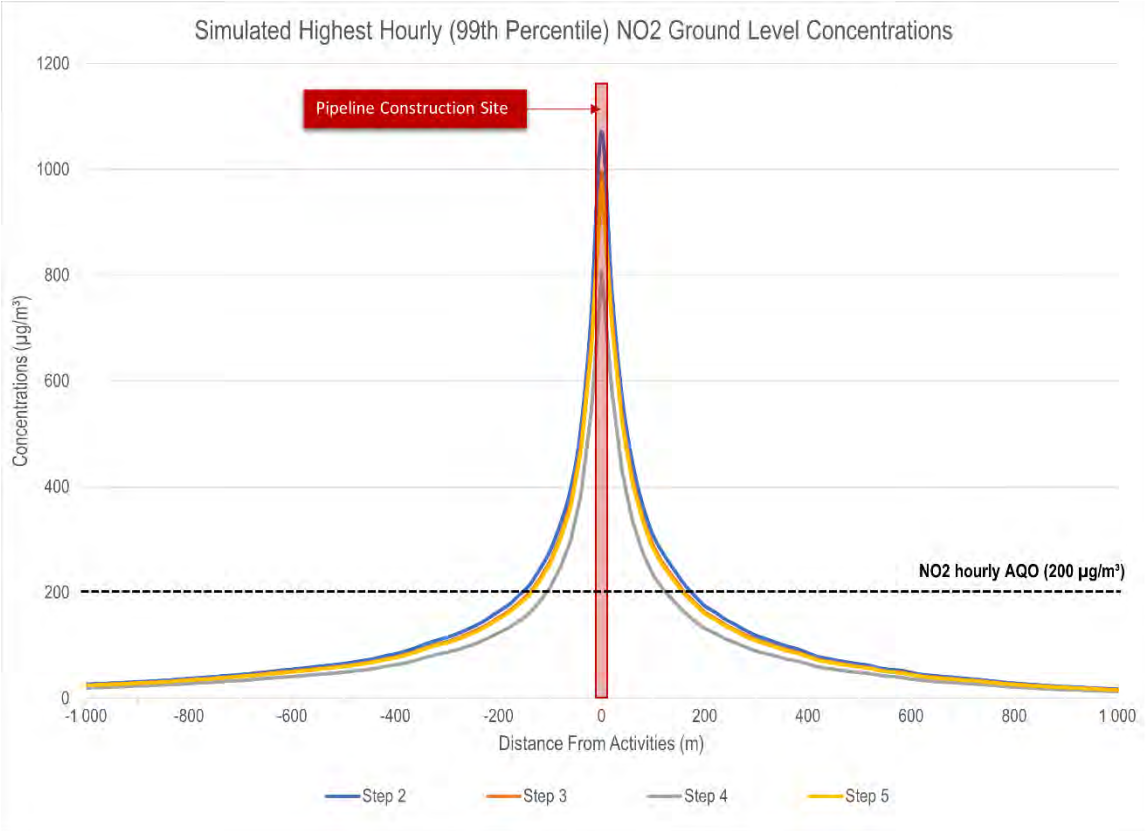

Figure 4-3: Simulate hourly (99th percentile) NO_2 ground level concentrations due to pipeline construction activities

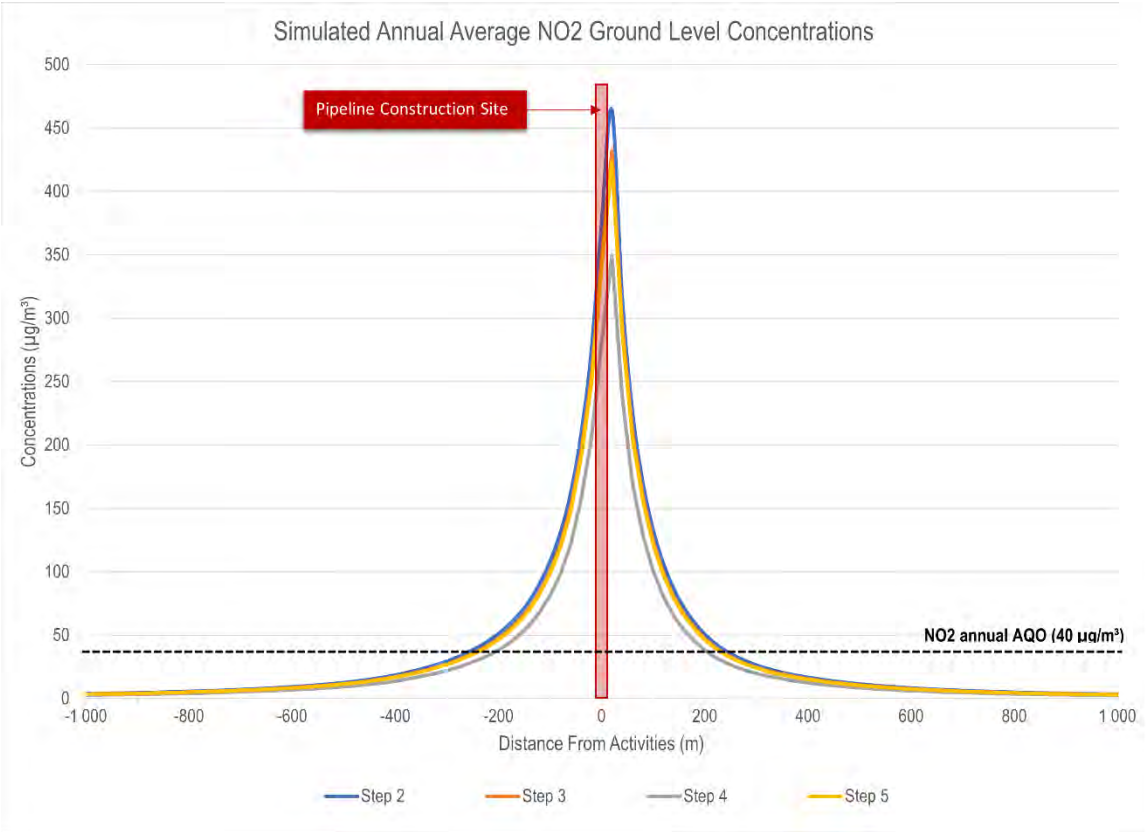

Figure 4-4: Simulate annual average NO_2 ground level concentrations due to pipeline construction activities

4.3.3 Sulfur Dioxide (SO_2)

A profile of the simulated hourly, daily and annual SO_2 ground level concentrations due to pipeline construction activities, is provided in Figure 4-5, Figure 4-6 and Figure 4-7 respectively. AQO for SO_2 was not exceeded due to the pipeline construction.

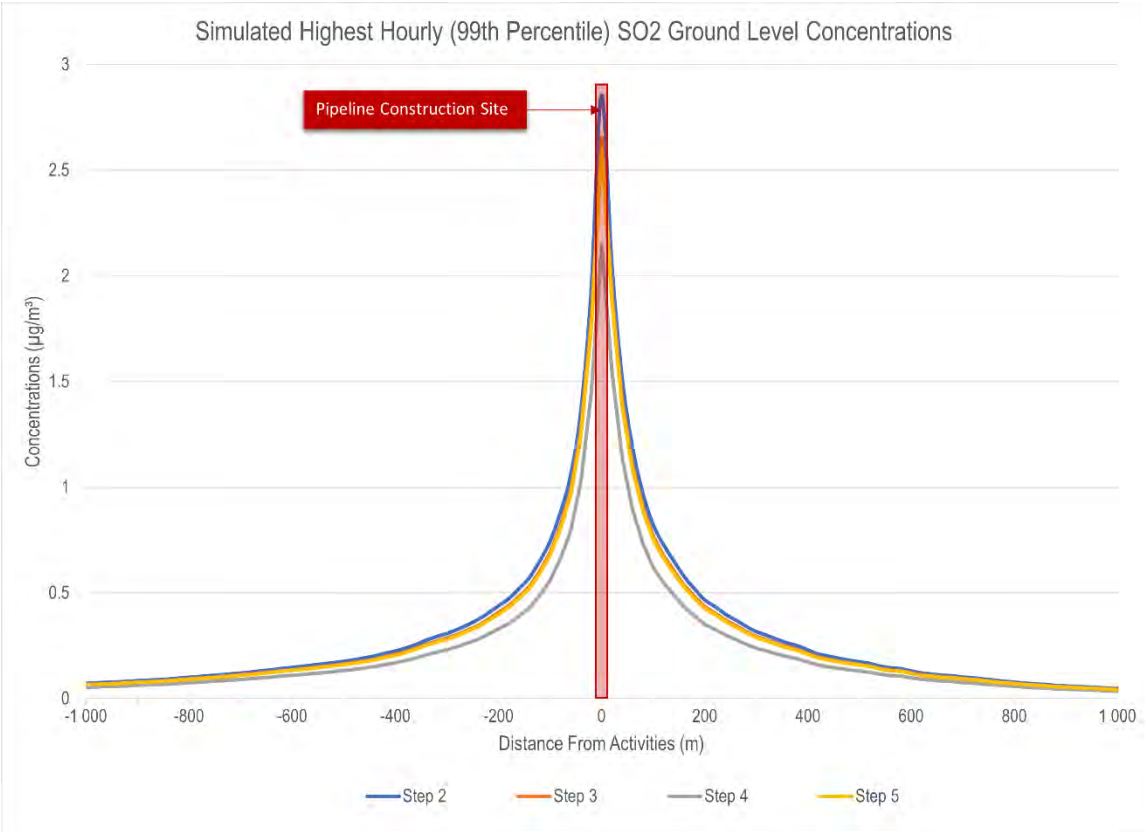

Figure 4-5: Simulate hourly (99th percentile) SO_2 ground level concentrations due to pipeline construction activities

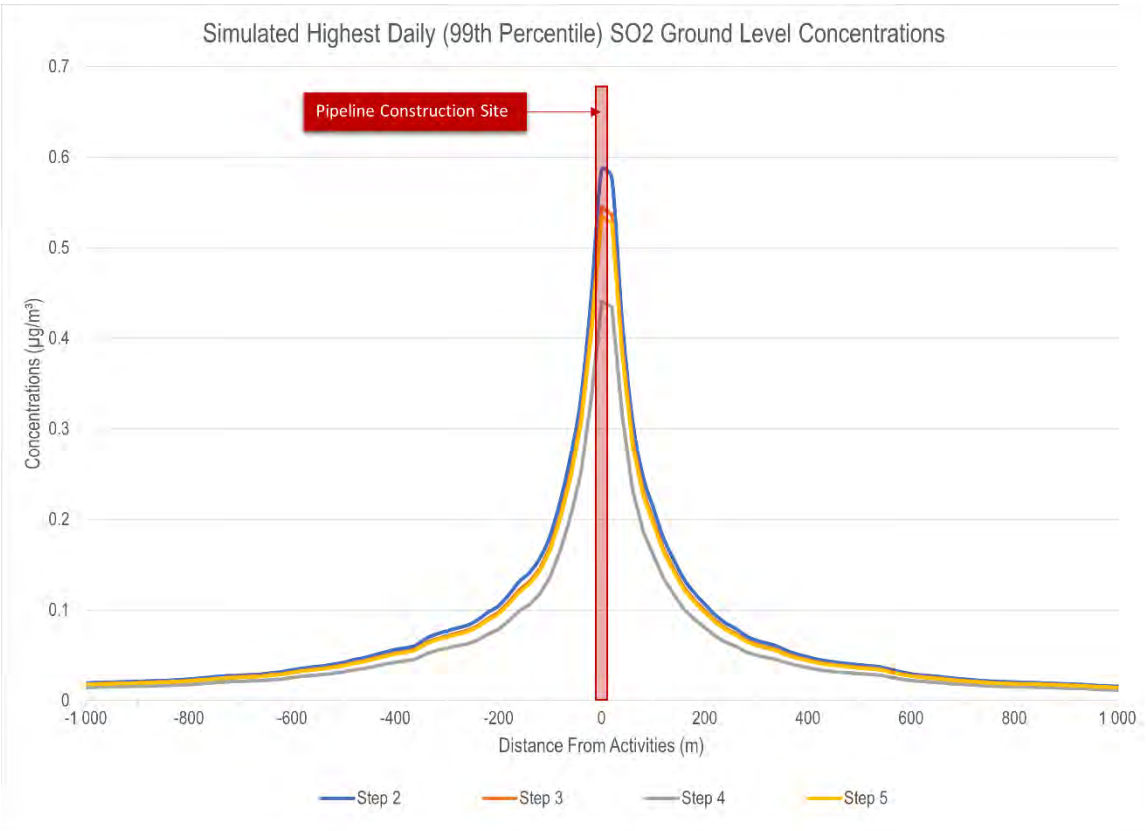

Figure 4-6: Simulate daily (99th percentile) SO_2 ground level concentrations due to pipeline construction activities

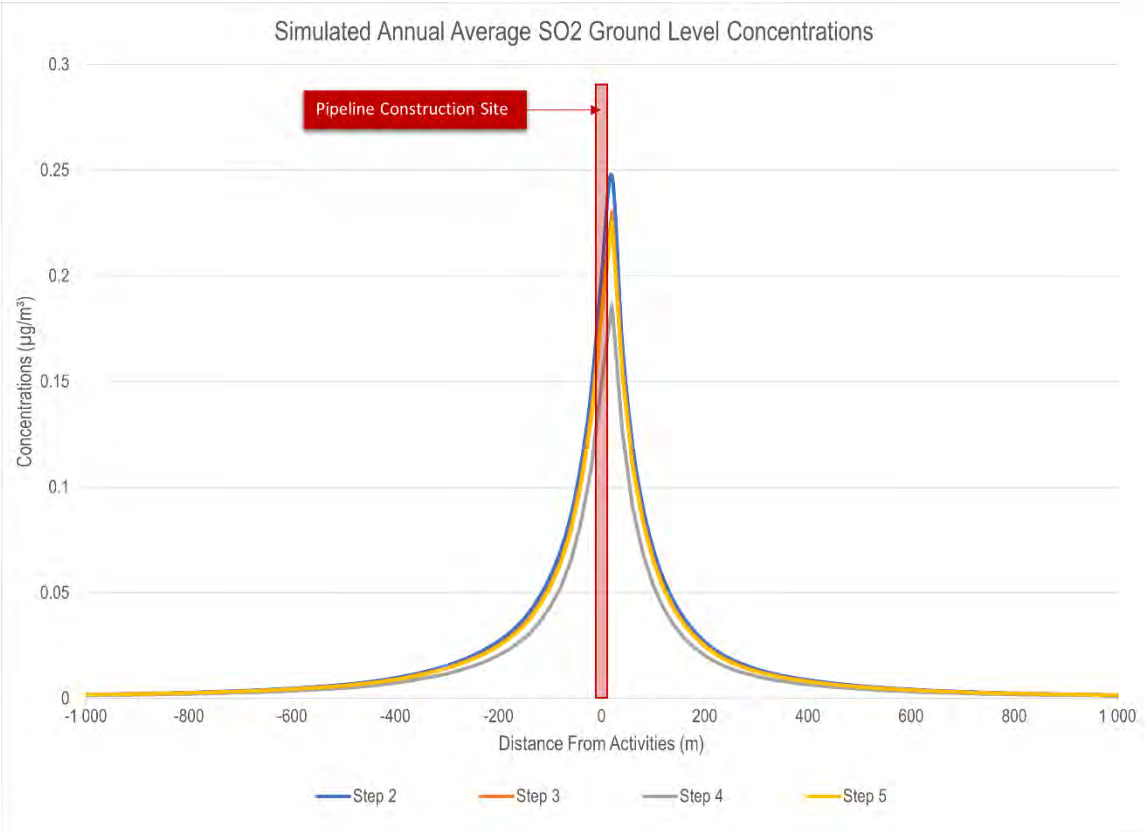

Figure 4-7: Simulate annual average SO_2 ground level concentrations due to pipeline construction activities

4.3.4 Volatile Organic Compounds (VOC)

A profile of the simulated hourly and annual VOC ground level concentrations due to pipeline construction activities, is provided in Figure 4-8 and Figure 4-9 respectively. Simulated highest hourly VOC ground level concentrations due to pipeline construction exceeded the AQO up to 20 m from the pipeline centreline. The closest AQSR is ~300 m from the pipeline and thus unlikely to be in exceedance of the AQO.

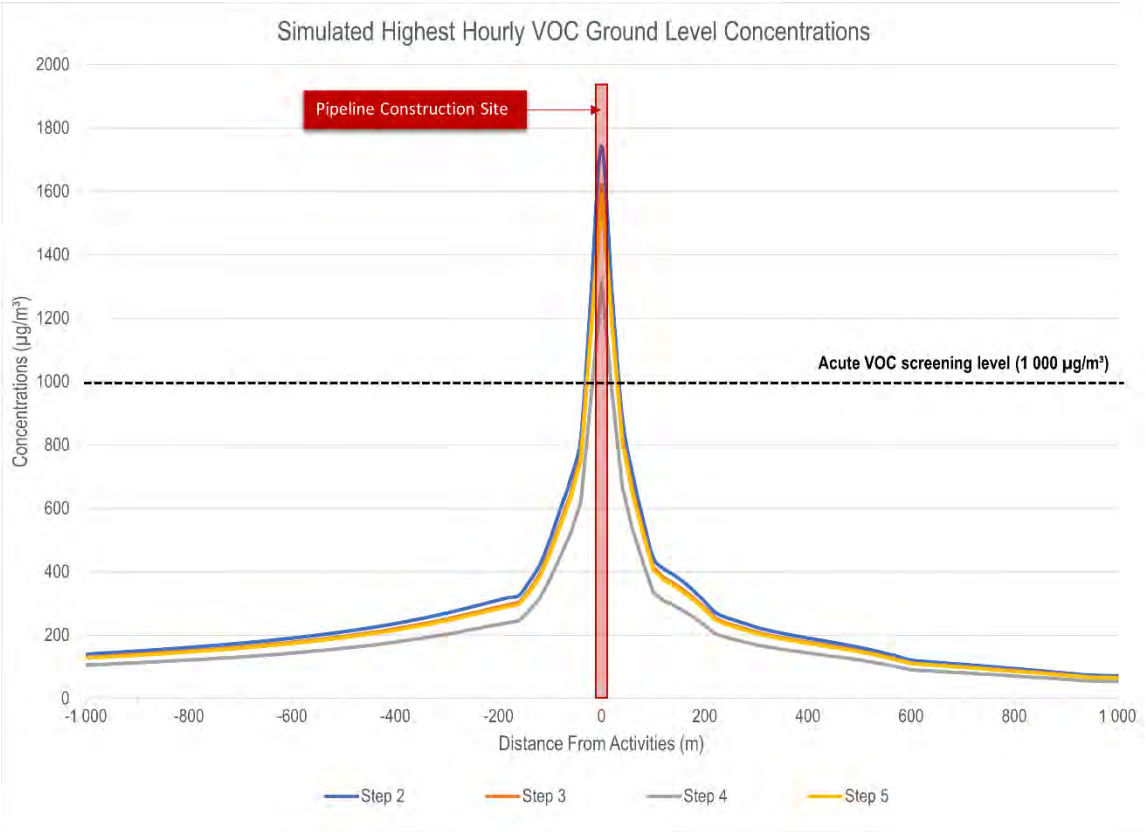

Figure 4-8: Simulate highest hourly VOC ground level concentrations due to pipeline construction activities

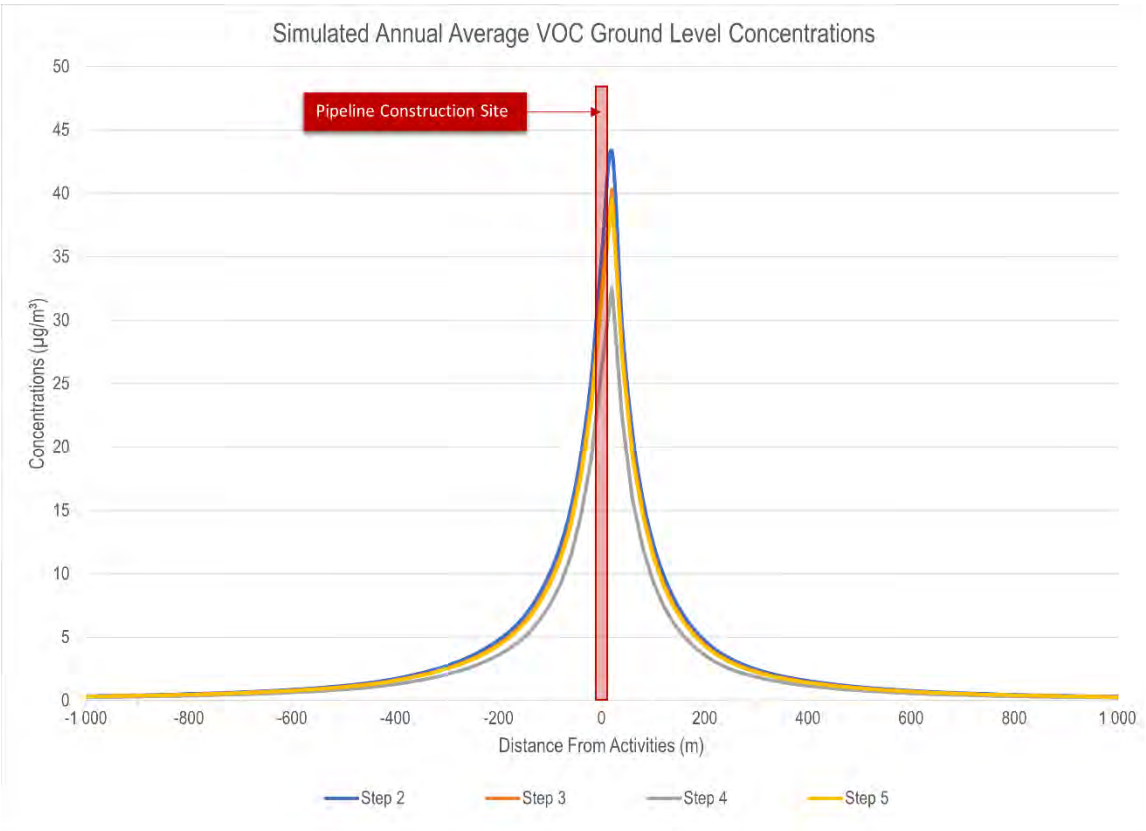

Figure 4-9: Simulate annual average VOC ground level concentrations due to pipeline construction activities

4.3.5 Thoracic Particulate Matter (PM_{10})

A profile of the simulated daily (99th percentile) and annual PM_{10} ground level concentrations due to pipeline construction activities, is provided in Figure 4-10 and Figure 4-11 respectively. Simulated daily PM_{10} ground level concentrations due to pipeline construction exceed the AQO up to 140 m from the pipeline centreline and annual average PM_{10} ground level concentrations exceed the AQO up to 80 m. The closest AQSR is ~300 m from the pipeline and thus unlikely to be in exceedance of the AQO.

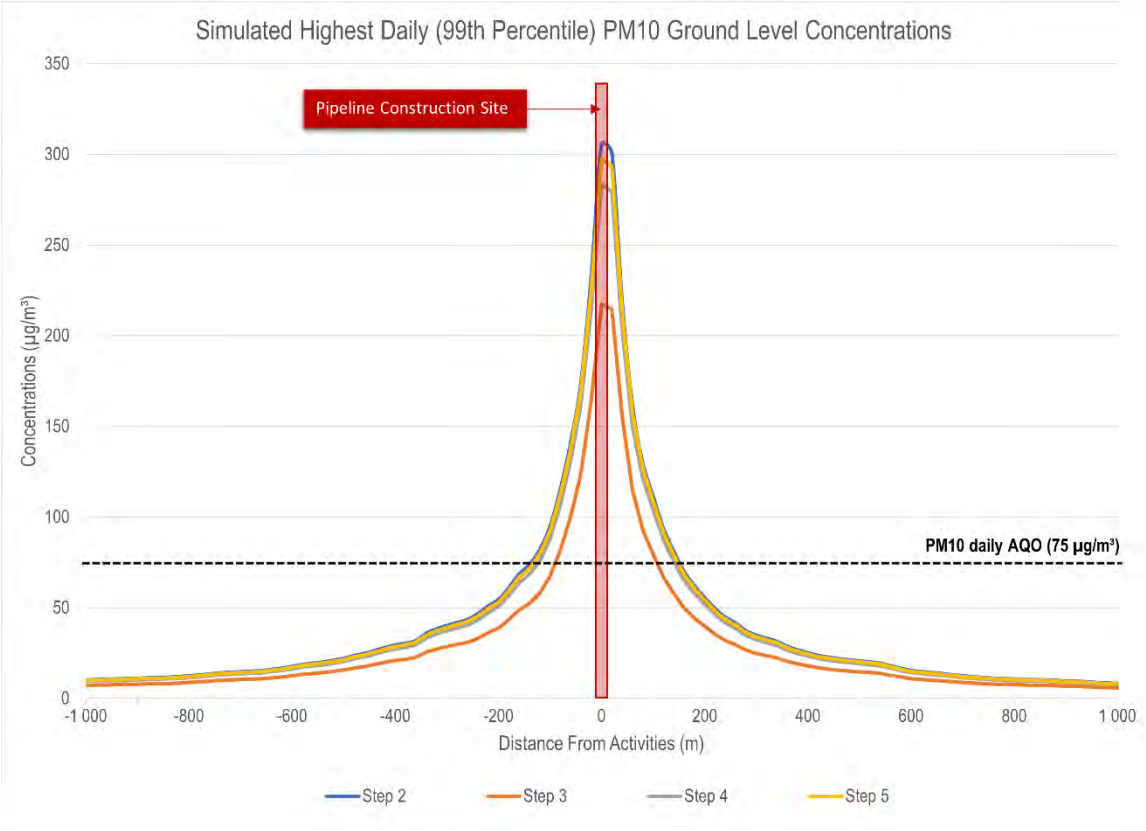

Figure 4-10: Simulate daily (99th percentile) PM_{10} ground level concentrations due to pipeline construction activities

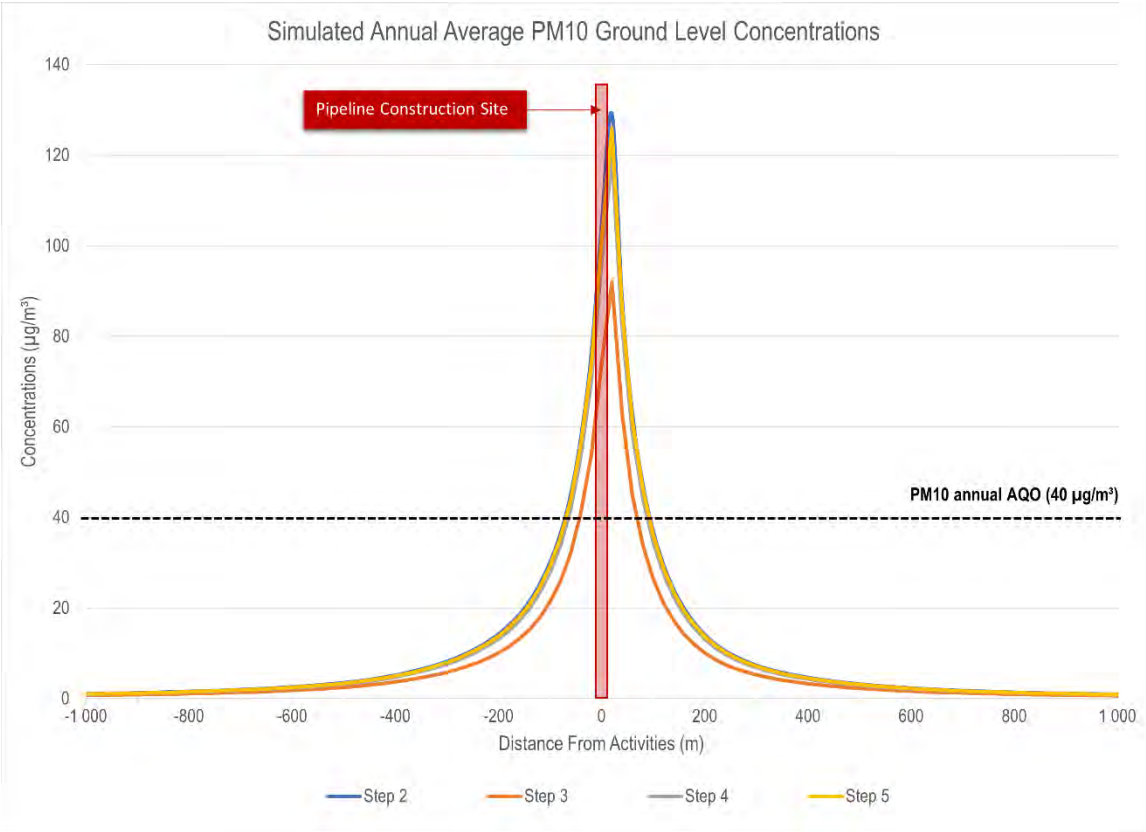

Figure 4-11: Simulate annual average PM_{10} ground level concentrations due to pipeline construction activities

4.3.6 Inhalable Particulate Matter ($PM_{2.5}$)

A profile of the simulated daily (99th percentile) and annual $PM_{2.5}$ ground level concentrations due to pipeline construction activities, is provided in Figure 4-12 and Figure 4-13 respectively. Simulated daily (99th percentile) and annual average $PM_{2.5}$ ground level concentrations due to pipeline construction exceed the AQO up to 80 m from the pipeline centreline. The closest AQSR is ~300 m from the pipeline and thus unlikely to be in exceedance of the AQO.

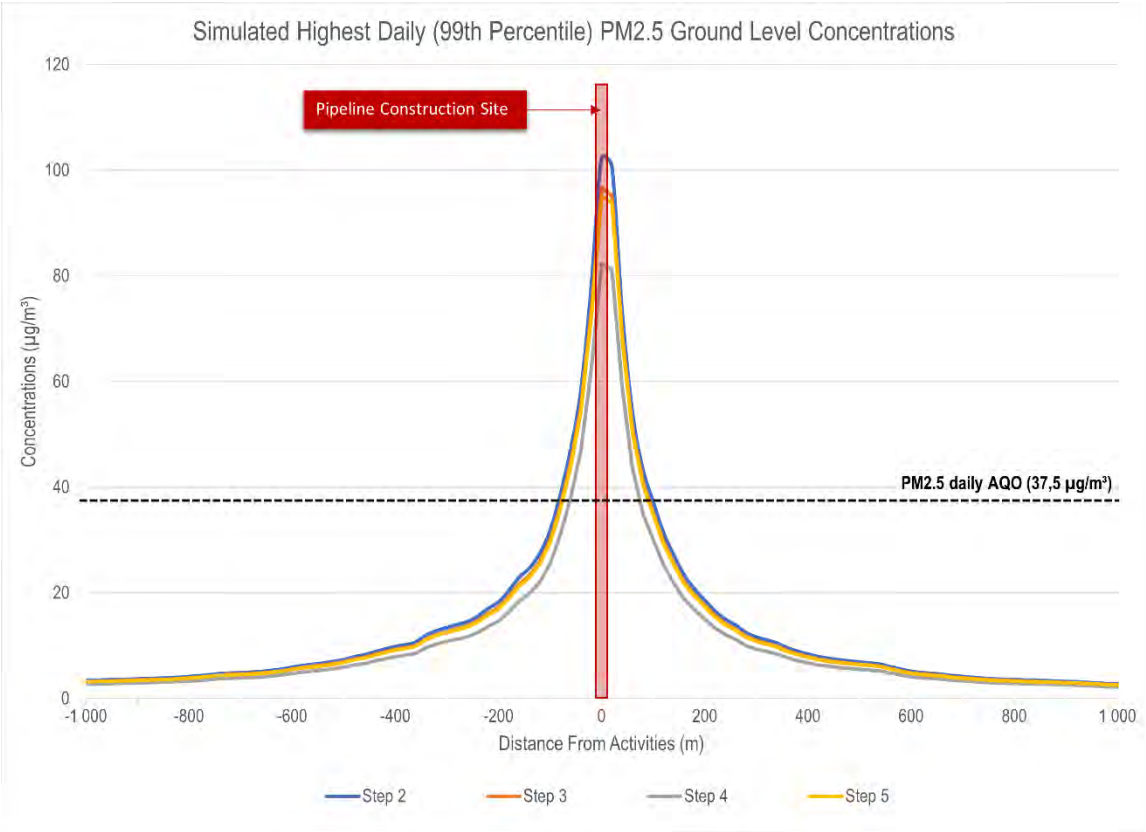

Figure 4-12: Simulate daily (99th percentile) $PM_{2.5}$ ground level concentrations due to pipeline construction activities

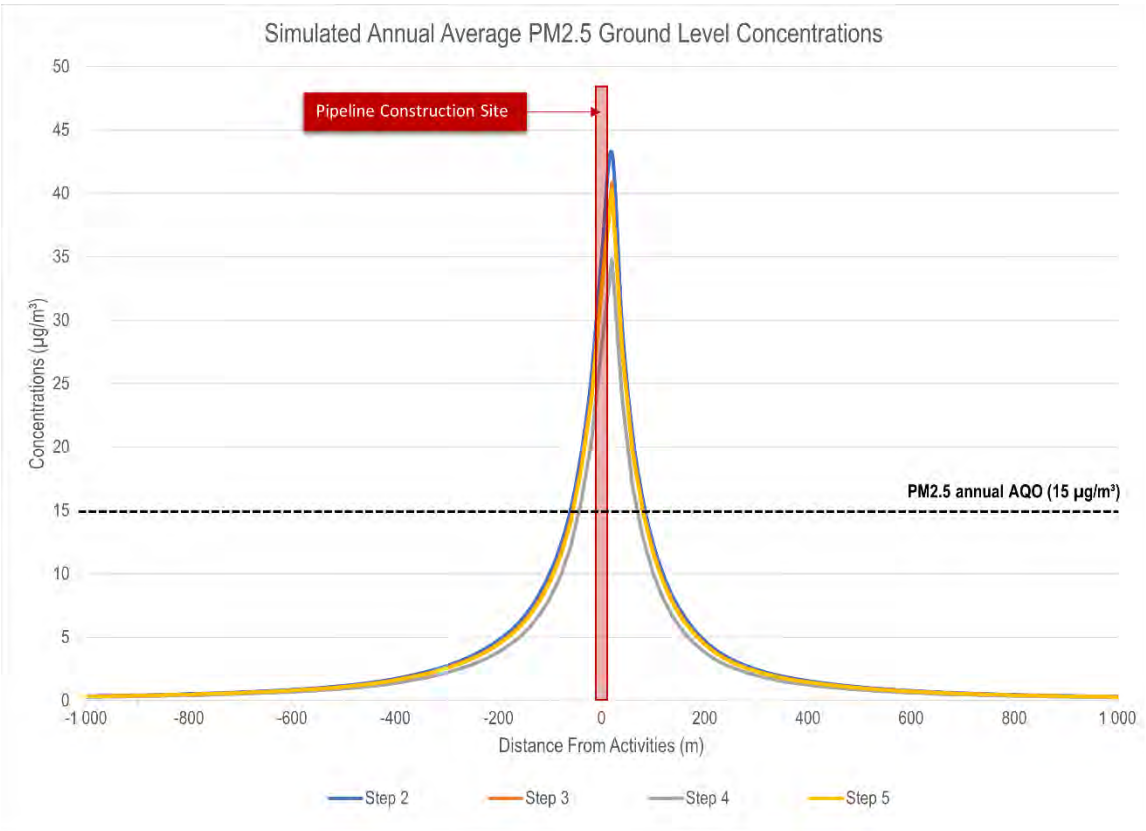

Figure 4-13: Simulate annual average $PM_{2.5}$ ground level concentrations due to pipeline construction activities

4.3.7 Dust Deposition

A profile of the simulated maximum daily dust deposition rates due to pipeline construction activities, is provided in Figure 4-14. Simulated daily dust deposition exceeds to the AQO for residential areas up to 140 m from the pipeline centreline and thus unlikely to exceed AQO at the closest AQSR.

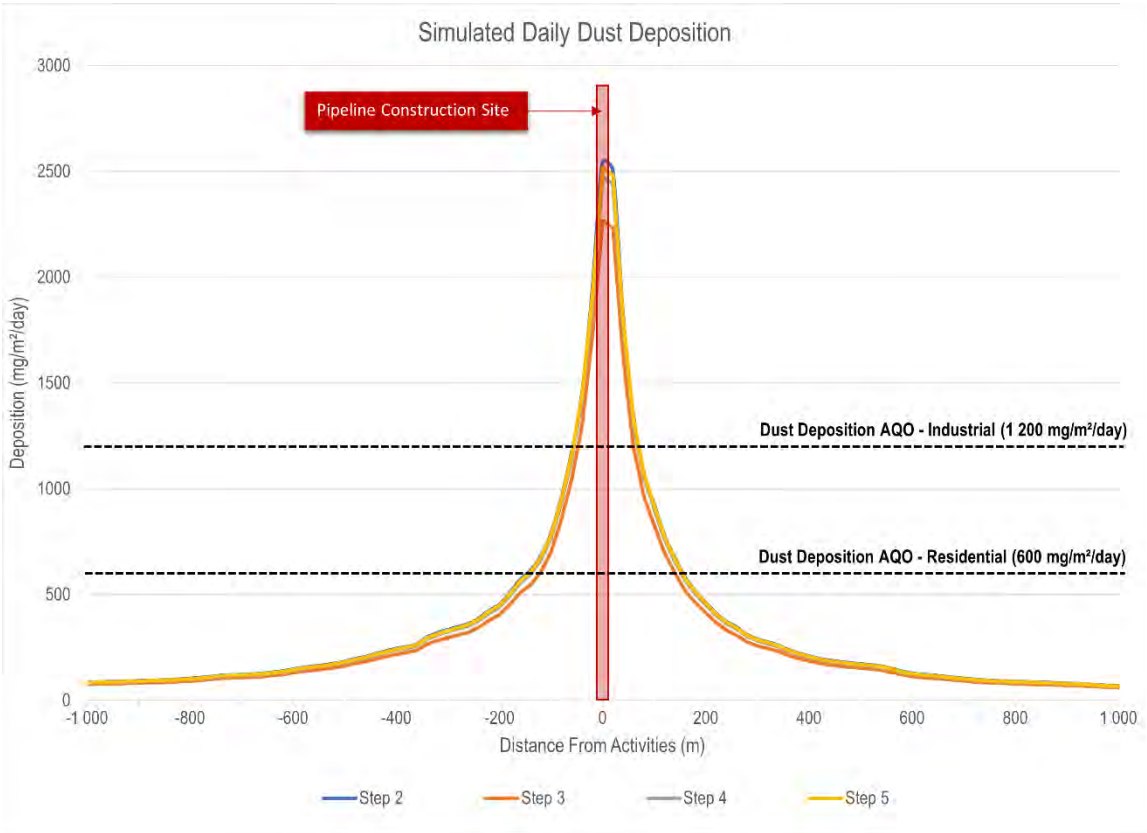

Figure 4-14: Simulate maximum daily dust deposition due to pipeline construction activities

4.3.8 Summary of Exceedance Distances of the AQO

A summary of the exceedance distances of the AQO due to pipeline construction activities is provided in Table 4-6.

Table 4-6: Exceedance distances from the pipeline centreline of the AQO due to pipeline construction activities

AQO	Construction activity			
	Step 2	**Step 3**	**Step 4**	**Step 5**
CO AQO - 1-hourly (30 000 µg/m³)	0 m	0 m	0 m	0 m
CO AQO - 24-hourly (7 000 µg/m³)	0 m	0 m	0 m	0 m
NO_2 AQO - 1-hourly (200 µg/m³)	160 m	160 m	120 m	140 m
NO_2 AQO - annual (40 µg/m³)	220 m	220 m	180 m	220 m
SO_2 AQO - 1-hourly (350 µg/m³)	0 m	0 m	0 m	0 m
SO_2 AQO - 24-hourly (50 µg/m³)	0 m	0 m	0 m	0 m
SO_2 AQO - annual (50 µg/m³)	0 m	0 m	0 m	0 m
VOC AQO - 1-hourly (1 000 µg/m³)	20 m	20 m	10 m	20 m
VOC AQO - annual (100 µg/m³)	0 m	0 m	0 m	0 m
PM_{10} AQO - 24-hourly (75 µg/m³)	140 m	100 m	140 m	140 m
PM_{10} AQO - annual (40 µg/m³)	80 m	60 m	80 m	80 m
$PM_{2.5}$ AQO - 24-hourly (37.5 µg/m³)	80 m	80 m	60 m	80 m
$PM_{2.5}$ AQO - annual (15 µg/m³)	80 m	80 m	60 m	60 m
PM Deposition - daily (residential: 600 mg/m²/day)	140 m	140 m	140 m	140 m

5 AIR QUALITY MANAGEMENT MEASURES

In the quantification of air emissions and simulation of impacts as a result of the pipeline construction, it was found that environmental air quality evaluation criteria for residential receptors will be met at all off-site AQSR.

The measures discussed in this section are measures typically applicable to industrial sites and are considered good practice. It should be noted that not all mitigation measures are to be implemented, but should the need arise the mitigation measures as discussed in this section can be considered.

5.1 Proposed Mitigation Measures and/or Target Control Efficiencies

The following air quality measures are recommended during construction of the pipeline:

- Maintenance and repair of diesel engines should be carried out as prescribed by manufacturer in order to maximize combustion and reduce gaseous emissions.
- Fuel efficient driving practices on site, during construction, may also help lower exhaust emissions from vehicles and machinery and reduce vehicle entrainment, such as stipulating a maximum speed on all unpaved roads. In addition, other fuel-efficient practices that may lower exhaust emissions include limiting idling of machinery, driving in an upper gear rather than a lower gear as much as possible, ensuring tire pressure are always adequate etc.
- Products, liquid fuels, and chemicals should be stored in areas where there are provisions for containment of spills.
- Reduce the area of construction (i.e. distance from the pipeline centreline) where it is close to receptors.
- Apply water sprays or chemical suppressants on regularly travelled, unpaved road sections. This would result in a control efficiency of between 50% and 90%.

5.2 Periodic Inspections and Audits

Periodic inspections and external audits are essential for progress measurement, evaluation and reporting purposes. It is recommended that site inspections and progress reporting be undertaken at regular intervals (at least quarterly), with annual environmental audits being conducted. Annual environmental audits should be continued at least until construction is complete. Progress should be reported to all interested and affected parties, including authorities and persons affected by pollution.

The criteria to be taken into account in the inspections and audits must be made transparent by way of minimum requirement checklists included in the management plan. Corrective action or the implementation of contingency measures must be proposed to the stakeholder forum in the event that progress towards targets is indicated by the quarterly/annual reviews to be unsatisfactory.

5.3 Impact Zones

The impact zones include distances for air quality impacts, due to various construction steps, as indicated in Table 4-6 (Section 4.3.8). These are buffer zones in consideration of air quality impacts due to pipeline construction. Therefore, these are seen as management zones where the potential for air quality impacts can be mitigated and managed. Based on the impact distances, the management zone would be 220 m from the pipeline centreline based on the potential NO_2 ground level concentrations due to equipment exhaust.

6 FINDINGS AND CONCLUSION

A quantitative air quality impact assessment was conducted for the construction of the pipeline. The assessment included an estimation of atmospheric emissions, the simulation of pollutant concentrations and determination of the significance of impacts. The main concern is the potential air quality impacts from the proposed pipeline construction on the receiving environment and human health.

6.1 Main Findings

6.1.1 Baseline Assessment

The main findings from the baseline assessment can be summarised as follows:

- The main baseline sources (i.e. non pipeline construction sources) likely to contribute to cumulative particulate impact are vehicle entrainment on unpaved road surfaces, wind erosion of open areas and mining activities.
- The closest potential AQSR to the pipeline are the residential areas of Green Valley and Walvis Bay.
- Measured daily PM_{10} concentrations in the vicinity of the pipeline (Site 1) was 25.5 µg/m³ and daily $PM_{2.5}$ concentrations was 5.2 µg/m³. This is based on a single grab sample taken in July 2024.
- The main pollutant of concern in the region is PM (including TSP; PM_{10} and $PM_{2.5}$) resulting from vehicle entrainment on the roads (paved, unpaved and treated surfaces), windblown dust and mining activities. Gaseous pollutants such as SO_2, NOx, CO and CO_2 would result from vehicles and combustion sources, but these are expected to be at low concentrations due to the few sources along the pipeline.

6.1.2 Impact Assessment

The findings from the impact assessment can be summarised as follows:

- The air quality impact assessment considered the construction due to the proposed pipeline only.
- Activities were specified to take place 24 hours per day.
- CO AQO were not exceeded.
- NO_2 AQO were exceeded up to a distance of 220 m from the pipeline centreline.
- SO_2 AQO were not exceeded.
- VOC AQO were exceeded up to a distance of 20 m from the pipeline centreline.
- PM_{10} AQO were exceeded up to a distance of 140 m from the pipeline centreline.
- $PM_{2.5}$ AQO were exceeded up to a distance of 80 m from the pipeline centreline.
- The dust deposition AQO were exceeded up to a distance of 140 m from the pipeline centreline.
- The closest AQSR to the pipeline is 300 m. The AQO are, thus, not expected to be exceeded at any AQSR within the study area.

6.2 Conclusion

Given that the AQO are not exceeded at AQSR along the pipeline due to construction activities, it is the specialist's opinion that the pipeline be authorised.

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APPENDIX A – SPECIALIST CURRICULUM VITAE

FULL CURRICULUM VITAE

Name of Firm	Airshed Planning Professionals (Pty) Ltd
Name of Staff	Reneé von Gruenewaldt (*nee* Thomas)
Profession	Air Quality and Environmental Noise Scientist
Position	Principal consultant
Date of Birth	13 May 1978
Years with Firm	Since January 2002
Nationalities	South African

MEMBERSHIP OF PROFESSIONAL SOCIETIES

- Registered Professional Natural Scientist (Registration Number 400304/07) with the South African Council for Natural Scientific Professions (SACNASP)
- Member of the National Association for Clean Air (NACA)

KEY QUALIFICATIONS

Reneé von Gruenewaldt (Air Quality Scientist): Reneé joined Airshed Planning Professionals (Pty) Ltd (previously known as Environmental Management Services cc) in 2002. She has, as a Specialist, attained over twenty (20) years of experience in the Earth and Natural Sciences sector in the field of Air Quality and nine (9) years of experience in the field of environmental noise assessments. As an environmental practitioner, she has provided solutions to both large-scale and smaller projects within the mining, minerals, and process industries.

She has developed technical and specialist skills in various air quality modelling packages including the AMS/EPA Regulatory Models (AERMOD and AERMET), UK Gaussian plume model (ADMS), EPA Regulatory puff-based model (CALPUFF and CALMET), puff-based HAWK model and line-based models, Lagrangian GRAL model. Her experience with air emission models includes Tanks 4.0 (for the quantification of tank emissions), WATER9 (for the quantification of wastewater treatment works) and GasSim (for the quantification of landfill emissions). Noise propagation modelling proficiency includes CONCAWE, South African National Standards (SANS 10210) for calculating and predicting road traffic noise and CadnaA for propagation of industrial, road and rail noise sources.

Having worked on projects throughout Africa (i.e., South Africa, Mozambique, Malawi, Kenya, Angola, Democratic Republic of Congo, Namibia, Madagascar and Egypt for Air Quality Impact Assessments and Mozambique, Namibia, Botswana, Kenya, Ghana, Suriname and Afghanistan for Environmental Noise Impact Assessments) Reneé has developed a broad experience base. She has a good understanding of the laws and regulations associated with ambient air quality and emission limits in South Africa and various other African countries, as well as the World Bank Guidelines, European Community Limits and World Health Organisation.

RELEVANT EXPERIENCE (AIR QUALITY)

Mining and Ore Handling

Reneé has undertaken numerous air quality impact assessments and management plans for coal, platinum, uranium, copper, cobalt, chromium, fluorspar, bauxite, manganese and mineral sands mines. These include: compilation of emissions databases for Landau and New Vaal coal collieries (SA), impact assessments and management plans for numerous mines over Mpumalanga (viz. Schoonoord, Belfast, Goedgevonden, Mbila, Evander South, Driefontein, Hartogshoop, Belfast, New Largo, Geluk, etc.), Mmamabula Coal Colliery (Botswana), Moatize Coal Colliery (Mozambique), Revuboe Coal Colliery (Mozambique), Toliera Sands Heavy Minerals Mine and Processing (Madagascar), Corridor Sands Heavy Minerals Mine monitoring assessment, El Burullus Heavy Minerals Mine and processing (Egypt), Namakwa Sands Heavy Minerals Mine (SA), Tenke Copper Mine and Processing Plant (DRC), Rössing Uranium (Namibia), Lonmin platinum mines including operations at Marikana, Baobab, Dwaalkop and Doornvlei (SA), Impala Platinum (SA), Pilannesburg Platinum (SA), Aquarius Platinum, Hoogland Platinum Mine (SA), Tamboti PGM Mine (SA), Sari Gunay Gold Mine (Iran), chrome mines in the Steelpoort Valley (SA), Mecklenburg Chrome Mine (SA), Naboom Chrome Mine (SA), Kinsenda Copper Mine (DRC), Kassinga Mine (Angola) and Nokeng Flourspar Mine (SA), etc.

Mining monitoring reviews have also been undertaken for Optimum Colliery's operations near Hendrina Power Station and Impunzi Coal Colliery with a detailed management plan undertaken for Morupule (Botswana) and Glencor (previously known as Xstrata Coal South Africa).

Air quality assessments have also been undertaken for mechanical appliances including the Durban Coal Terminal and Nacala Port (Mozambique) as well as rail transport assessments including BHP-Billiton Bauxite transport (Suriname), Nacala Rail Corridor (Mozambique and Malawi), Kusile Rail (SA) and WCL Rail (Liberia).

Metal Recovery

Air quality impact assessments have been carried out for Highveld Steel, Scaw Metals, Lonmin's Marikana Smelter operations, Saldanha Steel, Tata Steel, Afro Asia Steel and Exxaro's Manganese Pilot Plant Smelter (Pretoria).

Chemical Industry

Comprehensive air quality impact assessments have been completed for NCP (including Chloorkop Expansion Project, Contaminated soils recovery, C3 Project and the 200T Receiver Project), Revertex Chemicals (Durban), Stoppani Chromium Chemicals, Foskor (Richards Bay), Straits Chemicals (Coega), Tenke Acid Plant (DRC), and Omnia (Sasolburg).

Petrochemical Industry

Numerous air quality impact assessments have been completed for Sasol (including the postponement/exemption application for Synfuels, Infrachem, Natref, MIBK2 Project, Wax Project, GTL Project, re-commissioning of boilers at Sasol Sasolburg and Ekandustria), Engen Emission Inventory Functional Specification (Durban), Sapref refinery (Durban), Sasol (at Elrode) and Island View (in Durban) tanks quantification, Petro SA and Chevron (including the postponement/exemption application).

Pulp and Paper Industry

Air quality studies have been undertaken or the expansion of Mondi Richards Bay, Multi-Boiler Project for Mondi Merebank (Durban), impact assessments for Sappi Stanger, Sappi Enstra (Springs), Sappi Ngodwana (Nelspruit) and Pulp United (Richards Bay).

Power Generation

Air quality impact assessments have been completed for numerous Eskom coal fired power station studies including the ash expansion projects at Kusile, Kendal, Hendrina, Kriel and Arnot; Fabric Filter Plants at Komati, Grootvlei, Tutuka, Lethabo and Kriel Power Stations; the proposed Kusile, Medupi (including the impact assessment for the Flue Gas Desulphurization) and Vaal South Power Stations. Reneé was also involved and the cumulative assessment of the existing and return to service Eskom power stations assessment and the optimization of Eskom's ambient air quality monitoring network over the Highveld.

In addition to Eskom's coal fired power stations, various Eskom nuclear power supply projects have been completed including the air quality assessment of Pebble Bed Modular Reactor and nuclear plants at Duynefontein, Bantamsklip and Thyspunt.

Apart from Eskom projects, power station assessments have also been completed in Kenya (Rabai Power Station) and Namibia (Paratus Power Plant).

Waste Disposal

Air quality impact assessments, including odour and carcinogenic and non-carcinogenic pollutants were undertaken for the Waste Water Treatment Works in Magaliesburg, proposed Waterval Landfill (near Rustenburg), Tutuka Landfill, Mogale General Waste Landfill (adjacent to the Leipardsvlei Landfill), Cape Winelands District Municipality Landfill, the Tsoeneng Landfill (Lesotho) and the FG Landfill (near the Midstream Estate). Air quality impact assessments have also been completed for the BCL incinerator (Cape Town), the Ergo Rubber Incinerator and the Ecorevert Pyrolysis Plant.

Cement Manufacturing

Impact assessments for ambient air quality have been completed for the Holcim Alternative Fuels Project (which included the assessment of the cement manufacturing plants at Ulco and Dudfield as well as a proposed blending platform in Roodepoort).

Management Plans

Reneé undertook the quantification of the baseline air quality for the first declared Vaal Triangle Airshed Priority Area. This included the establishment of a comprehensive air pollution emissions inventory, atmospheric dispersion modelling, focusing on impact area "hotspots" and quantifying emission reduction strategies. The management plan was published in 2009 (Government Gazette 32263).

Reneé has also been involved in the Provincial Air Quality Management Plan for the Limpopo Province.

RELEVANT EXPERIENCE (GREENHOUSE GAS EMISSION FOOT-PRINTING AND CLIMATE CHANGE IMPACT STATEMENTS)

Mining and Tailings Storage Facilities

Reneé has quantified the direct and indirect (Scope 2 and Scope 3) emissions for numerous mines over the highveld of South Africa and the Democratic Republic of Congo. She has also assessed the climate risks and vulnerabilities of the project and surrounding communities due to increasing ambient temperatures, water scarcity, risk of intense storms.

Gas to Power Plants

Reneé has quantified the direct and indirect (Scope 2 and Scope 3) emissions for gas to power plants proposed for South Africa. She has also assessed the climate risks and vulnerabilities of the project and surrounding communities due to increasing ambient temperatures, water scarcity, risk of intense storms.

RELEVANT EXPERIENCE (NOISE)

Mining

Reneé has undertaken numerous environmental noise assessments for mining operations. These include environmental noise impact assessments including baseline noise surveys for numerous coal, platinum, manganese, tin and zinc mines. Projects include, but are not limited to, Balama (Mozambique), Masama Coal (Botswana), Lodestone (Namibia), Osino (Namibia), Kurmuk (Ethiopia), Gamsberg (SA), Prieska (SA), Kolomela (SA), Heuningkranz (SA), Syferfontein (SA), South 32 (SA), Mamatwan (SA), Alexander (SA) and Marula Platinum Mine (SA), etc.

Power Generation

Environmental noise assessments have been completed for numerous Eskom coal fired power station studies in SA including the Kriel Fabric Filter Plant, Kendal ash facility, Medupi ash facility. Apart from Eskom projects, power plant assessments have also been completed in Botswana (Morupule), Kenya (Or Power geothermal power plants), Suriname (EBS power plant) and SA (Richards Bay combined cycle power plant).

Process Operations

Environmental noise assessments have been undertaken for various process operations including waste disposal facilities (Bon Accord in Gauteng), bottling and drink facilities (Imali and Isanti Project in Gauteng) and Smelter (Gamsberg in Northern Cape).

Transport

An environmental noise assessment was completed for the Obetsebi road expansion and flyover project in Ghana, the Scorpion Zinc Mine transport route in Namibia and the Sisian-Kajaran (North-South Corridor) Road Project in Armenia.

Gas Pipelines

An environmental noise assessment was completed for the Sheberghan gas pipeline in Afghanistan.

Baseline Noise Surveys

Baseline noise surveys have been undertaken for numerous mining and process operation activities (including Raumix quarries, Kolomela and Sibanye Stillwater Platinum Mines (SA)) in support of onsite Environmental Management Programmes.

OTHER EXPERIENCE (2001)

Research for B.Sc Honours degree was part of the "Highveld Boundary Layer Wind" research group and was based on the identification of faulty data from the Majuba Sodar. The project was THRIP funded and was a joint venture with the University of Pretoria, Eskom and Sasol (2001).

EDUCATION

M.Sc Earth Sciences	University of Pretoria, RSA, Cum Laude (2009) Title: *An Air Quality Baseline Assessment for the Vaal Airshed in South Africa*
B.Sc Hons. Earth Sciences	University of Pretoria, RSA, Cum Laude (2001) Environmental Management and Impact Assessments
B.Sc Earth Sciences	University of Pretoria, RSA, (2000) Atmospheric Sciences: Meteorology

ADDITIONAL COURSES

CALMET/CALPUFF	Presented by the University of Johannesburg, RSA (March 2008)
Air Quality Management	Presented by the University of Johannesburg, RSA (March 2006)

COUNTRIES OF WORK EXPERIENCE

South Africa, Mozambique, Botswana, Ghana, Suriname, Afghanistan, Malawi, Liberia, Kenya, Angola, Democratic Republic of Congo, Ethiopia, Afghanistan, Lesotho, Namibia, Madagascar, Egypt, Suriname and Iran.

EMPLOYMENT RECORD

January 2002 - Present

Airshed Planning Professionals (Pty) Ltd, (previously known as Environmental Management Services cc until March 2003), Principal Air Quality and Environmental Noise Scientist, Midrand, South Africa.

2001

University of Pretoria, Demi for the Geography and Geoinformatics department and a research assistant for the Atmospheric Science department, Pretoria, South Africa.

Department of Environmental Affairs and Tourism, assisted in the editing of the Agenda 21 document for the world summit (July 2001), Pretoria, South Africa.

1999 - 2000

The South African Weather Services, vacation work in the research department, Pretoria, South Africa.

CONFERENCE AND WORKSHOP PRESENTATIONS AND PAPERS

- Understanding the Synoptic Systems that lead to Strong Easterly Wind Conditions and High Particulate Matter Concentrations on The West Coast of Namibia, H Liebenberg-Enslin, R von Gruenewaldt, H Rauntenbach and L Burger. National Association for Clean Air (NACA) conference, October 2017.
- Topographical Effects on Predicted Ground Level Concentrations using AERMOD, R.G. von Gruenewaldt. National Association for Clean Air (NACA) conference, October 2011.
- Emission Factor Performance Assessment for Blasting Operations, R.G. von Gruenewaldt. National Association for Clean Air (NACA) conference, October 2009.
- Vaal Triangle Priority Area Air Quality Management Plan – Baseline Characterisation, R.G. Thomas, H Liebenberg-Enslin, N Walton and M van Nierop. National Association for Clean Air (NACA) conference, October 2007.
- A High-Resolution Diagnostic Wind Field Model for Mesoscale Air Pollution Forecasting, R.G. Thomas, L.W. Burger, and H Rautenbach. National Association for Clean Air (NACA) conference, September 2005.
- Emissions Based Management Tool for Mining Operations, R.G. Thomas and L.W. Burger. National Association for Clean Air (NACA) conference, October 2004.
- An Investigation into the Accuracy of the Majuba Sodar Mixing Layer Heights, R.G. Thomas. Highveld Boundary Layer Wind Conference, November 2002.

LANGUAGES

	Speak	Read	Write
English	Excellent	Excellent	Excellent
Afrikaans	Fair	Fair	Fair

CERTIFICATION

I, the undersigned, certify that to the best of my knowledge and belief, these data correctly describe me, my qualifications, and my experience.

Signature of staff member

29/07/2024

Date (Day / Month / Year)

Full name of staff member: Reneé Georgeinna von Gruenewaldt

APPENDIX B – DECLARATION OF INDEPENDENCE

DECLARATION OF INDEPENDENCE - PRACTITIONER

Name of Practitioner: Reneé von Gruenewaldt
Name of Registration Body: South African Council for Natural Scientific Professions
Professional Registration No.: 400304/07

Declaration of independence and accuracy of information provided:
Air Quality Impact Assessment for the Ammonia Pipeline from Farm 58 to the Ammonia Terminal to Port, Close to Walvis Bay

I, René von Gruenewaldt, declare that I am independent of the applicant. I have the necessary expertise to conduct the assessments required for the report and will perform the work relating the application in an objective manner, even if this results in views and findings that are not favourable to the applicant. I will disclose to the applicant and the air quality officer 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 air quality officer. The additional information provided in this atmospheric impact report is, to the best of my knowledge, in all respects factually true and correct. I am aware that the supply of false or misleading information to an air quality officer is a criminal offence in terms of section 51(1)(g) of this Act.

Signed at Pretoria on this 18th of October 2024.

SIGNATURE
Principal Noise Scientist
CAPACITY OF SIGNATORY