Appendix J - Biovac Air Quality Assessment

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Air Quality Baseline Assessment

Proposed Vaccine Manufacturing Facility, Cape Town

The Biovac Institute (Pty) Ltd

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Making Sustainability Happen

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Executive Summary

SLR Consulting (South Africa) Proprietary Limited (SLR) was appointed by The Biovac Institute (Pty) Ltd (Biovac) to undertake a baseline air quality assessment for their proposed vaccine manufacturing facility in Pinelands, Cape Town, Western Cape.

The assessment included the collection and analysis of ambient air quality data at representative fenceline locations, characterisation of key pollutants including sulphur dioxide (SO_2), nitrogen dioxide (NO_2), ammonia (NH_3), volatile organic compounds (VOCs) specifically the BTEX suite (benzene, toluene, ethylbenzene, and xylenes), and particulate matter ($PM_{2.5}$ and PM_{10}), review of relevant meteorological conditions, and comparison of measured concentrations against applicable national standards / guideline limits, including South African National Ambient Air Quality Standards (NAAQS) and International Finance Corporation (IFC)/World Health Organization (WHO) air quality guideline limits. The purpose of the study was to establish existing baseline air quality conditions to inform appropriate management measures.

Ambient concentrations of key pollutants were generally within South African regulatory limits and relevant international (IFC/WHO) guideline values:

- Particulate matter: $PM_{2.5}$ and PM_{10} 24-hour average concentrations complied with both NAAQS and WHO AQG limits. The one-month average, conservatively compared to annual standards, complied with the annual NAAQS but exceeded the stricter WHO AQG annual guideline value.
- Gaseous pollutants: SO_2, NO_2, NH_3, and benzene concentrations were very low, well below applicable standards and guidelines.
- Other VOCs: Toluene, ethylbenzene, and xylenes were measured at very low concentrations, significantly below health-based guideline limits.

The highest ambient concentrations for all parameters assessed were recorded at FL3, downwind of the facility; however, all measured values indicate a low potential for adverse air quality impacts. Vaccine manufacturing operations are typically associated with low pollutant emissions, as most processes are enclosed and supported by engineering and operational controls. While minor releases of VOCs or particulate matter may occur during certain activities, the overall potential for significant air quality impacts is low.

This baseline assessment confirms that existing ambient air quality is within applicable regulatory and guideline limits. Provided that standard design, operational, and mitigation measures are implemented, the proposed development is not expected to result in significant adverse air quality impacts.

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Acronyms and Abbreviations

°C	Degrees celsius
µg/m^3	micrograms per cubic metre
AQG	Air quality guidelines
AQMP	Air quality management plan
BAT	Best Available Techniques
BTEX	Benzene, toluene, ethylbenzene, and xylenes
C_6H_6	Benzene
CoCT	City of Cape Town
DSP	Downstream processing facilities
ECMWF	European Centre for Medium-Range Weather Forecasts
EHS	Environmental Health and Safety
ERA 5	ECMWF Reanalysis v5
FFF	Fill and finish facility
GIIP	Good International Industry Practice
IFC	International Finance Corporation
IT 1-4	Interim Targets 1 - 4
m	Meter
m/s	Meters per second (speed)
mamsl	meters above mean sea level
mRNA	Messenger ribonucleic acid
NEM:AQA	National Environmental Management Air Quality Act
NEMA	National Environmental Management Act
NH_3	Ammonia
NO_2	Nitrogen dioxide
NO_X	Nitrogen oxides
OCV	Oral cholera vaccine
PM	Particulate matter
PM_{10}	PM less than 10 microns
$PM_{2.5}$	PM less than 2.5 microns
SAAQIS	South African Air Quality Information System
SLR	SLR Consulting (South Africa)
SO_2	Sulphur dioxide
US EPA	United States Environmental Protection Agency
VOC	Volatile organic compounds
WHO	World Health Organisation

1. Introduction

SLR Consulting (South Africa) Proprietary Limited (SLR) was appointed by The Biovac Institute (Pty) Ltd (Biovac) to undertake an Environmental Impact Assessment (EIA) process for a proposed vaccine manufacturing facility ("the Project") in Pinelands, Cape Town, Western Cape.

A specialist air quality assessment is required as input to the EIA to assess potential impacts in the Project area. The Project is also required to align with the World Bank Group's International Finance Corporation (IFC) and other international guidance for environmental best practice.

This report presents a scoping level assessment of baseline conditions and potential risks for ambient air quality associated with the proposed Project activities.

1.1 Study Purpose and Objectives

The purpose of this study is to collect baseline data and assess potential atmospheric impacts associated with the proposed Project. The objectives of this assessment are to:

- Describe the existing baseline environment and identify proximate sensitive receptors[1].
- Determine the meteorological conditions that affect air pollutant dispersion in the region.
- Assess the air quality related impacts for proximate sensitive receptors.

1.2 Scope of Work

The scope of work for this assessment is summarised as follows.

- Desktop review (using available information), including:
    - A description of the Project site and activities;
    - A summary of applicable air quality legislation and international best practices;
    - Assessment of prevailing meteorological conditions; and
    - A review of the receiving environment including identification of possible sensitive receptors, and proximate pollution sources.
- Baseline data collection surveys to measure ambient concentrations of key pollutants in the vicinity of the Project site.
- Make recommendations for impact mitigation and monitoring (as required).

1.3 Specialist Reporting Requirements

Where applicable, this baseline report meets the reporting requirements of Appendix 6 of the National Environmental Management Act, 1998 (Act 107 of 1998) (NEMA)[2] EIA Regulations[3] (GN.R 982 of 2014, as amended). A summary of Appendix 6 requirements and the associated report section in which these are addressed is provided in **Table 1-1**.

[1] Sensitive receptors are places where sensitive individuals or habitats may be impacted, such as residences, schools, medical facilities, and natural reserves.
[2] Republic of South Africa (1998): National Environmental Management Act (No. R. 107 of 1998) Government Gazette, 27 November 1998 (No. 19519)
[3] Department of Environmental Affairs (2014): Environmental Impact Assessment Regulations (GN. R982), Government Gazette, 4 December 2014, (No. 38282), as amended by GN 326 in 2017, GN 706 in 2018, GN 599 in 2020 and GN 517 in 2021.

Table 1-1: Specialist report requirements in terms of Appendix 6 of the EIA Regulations

Appendix 6 section	A specialist report prepared in terms of the EIA Regulations must contain:	Report section
(a)	Details of: (i) Details of the specialist who prepared the report (ii) The expertise of that specialist to compile a specialist report including curriculum vitae	Page i Appendix B
(b)	A declaration that the specialist is independent in a form as may be specified by the competent authority	Appendix A
(c)	An indication of the scope of, and the purpose for which, the report was prepared	Section 1
(cA)	An indication of the quality and age of base data used for the specialist report	Sections 4.3.3 and 5
(cB)	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 5
(d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	Section 5
(e)	A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Section 5
(f)	Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives	Proximity of sensitive receptors presented in Section 2 (no alternative assessed)
(g)	An identification of any areas to be avoided, including buffers	N/A
(h)	A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers	Figure 2-3
(i)	A description of any assumptions made and any uncertainties or gaps in knowledge	N/A - this report presents the baseline assessment only.
(j)	A description of the findings and potential implications of such findings on the impact of the proposed activity or activities	N/A - this report presents the baseline assessment only.
(k)	Any mitigation measures for inclusion in the Environmental Management Programme (EMPr)	Recommended management measures are presented in Section 6.
(l)	Any conditions for inclusion in the environmental authorisation	N/A- this report presents the baseline assessment only.
(m)	Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Recommended management measures are presented in Section 6.
(n)	A reasoned opinion - 1. whether the proposed activity, activities or portions thereof should be authorised; a) regarding the acceptability of the proposed activity or activities; and 2. if the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measure that should be included in the EMPr, and the closure plan in the case of a closure activity	N/A - this report presents the baseline assessment only.
(o)	A description of any consultation process that was undertaken during the course of preparing the specialist report	N/A
(p)	A summary and copies of any comments that were received during any consultation process and where applicable all responses thereto	N/A
(q)	Any other information requested by the competent authority	N/A

2. Project Background

2.1 Locality and Study Area

The proposed Project site comprises approximately two hectares of undeveloped land in Pinelands, Cape Town in the Western Cape province of South Africa (**Figure 2-1**). The site is zoned for general industrial use and falls within the jurisdiction of the City of Cape Town (CoCT) Metropolitan Municipality.

The property is situated within an established urban–industrial corridor and is surrounded by a mix of industrial, commercial, and residential land uses. Key proximate land uses and infrastructure include:

- The Pinelands railway line on the eastern boundary of the property, forming a physical buffer between the site and adjacent residential areas.
- Predominantly light industrial and commercial developments to the west and north, comprising offices, laboratories, small-scale manufacturing facilities, and associated infrastructure.
- The Ndabeni mixed use industrial area located approximately 0.4 km north of the proposed development site.
- Epping Industria, approximately 2.86 km east the proposed development site.
- Paarden Eiland, approximately 2.73 km north-northwest the proposed development site.
- The Port of Cape Town located approximately 4.51 km northwest of the proposed development site.
- Athlone Wastewater Treatment Works situated approximately 2.96 km southeast of the proposed development site.
- Several residential areas, including Pinelands (immediately east of the site), Maitland Garden Village (~0.10 km east), Oude Molen Village (~0.75 km south), Maitland (~1.3 km north), Kensington (~2.6km north-northeast), Brooklyn (~2.6km north-northwest), Thornton (~3.9 km northeast), Langa (~3.4 km east), Bridgetown (~4 km east-southeast), Kewtown (~3.4 km southeast), Athlone (~3.3km south-southeast), Sybrandpark (~2.48 km south-southeast), Rondebosch (~3.4km south-southwest), Rosebank (~2.39 km south-southwest), Mowbray (~1.86 km southwest), Observatory (~1.65 km west) and Woodstock (~3.7km west-northwest).

The proximity of nearby pollution sources is shown in **Figure 2-2**. Surrounding sensitive receptors (i.e. places where sensitive individuals or habitats may be impacted, such as residences, schools, medical facilities and places of worship) within 5 km of the site boundary are shown in **Figure 2-3**.

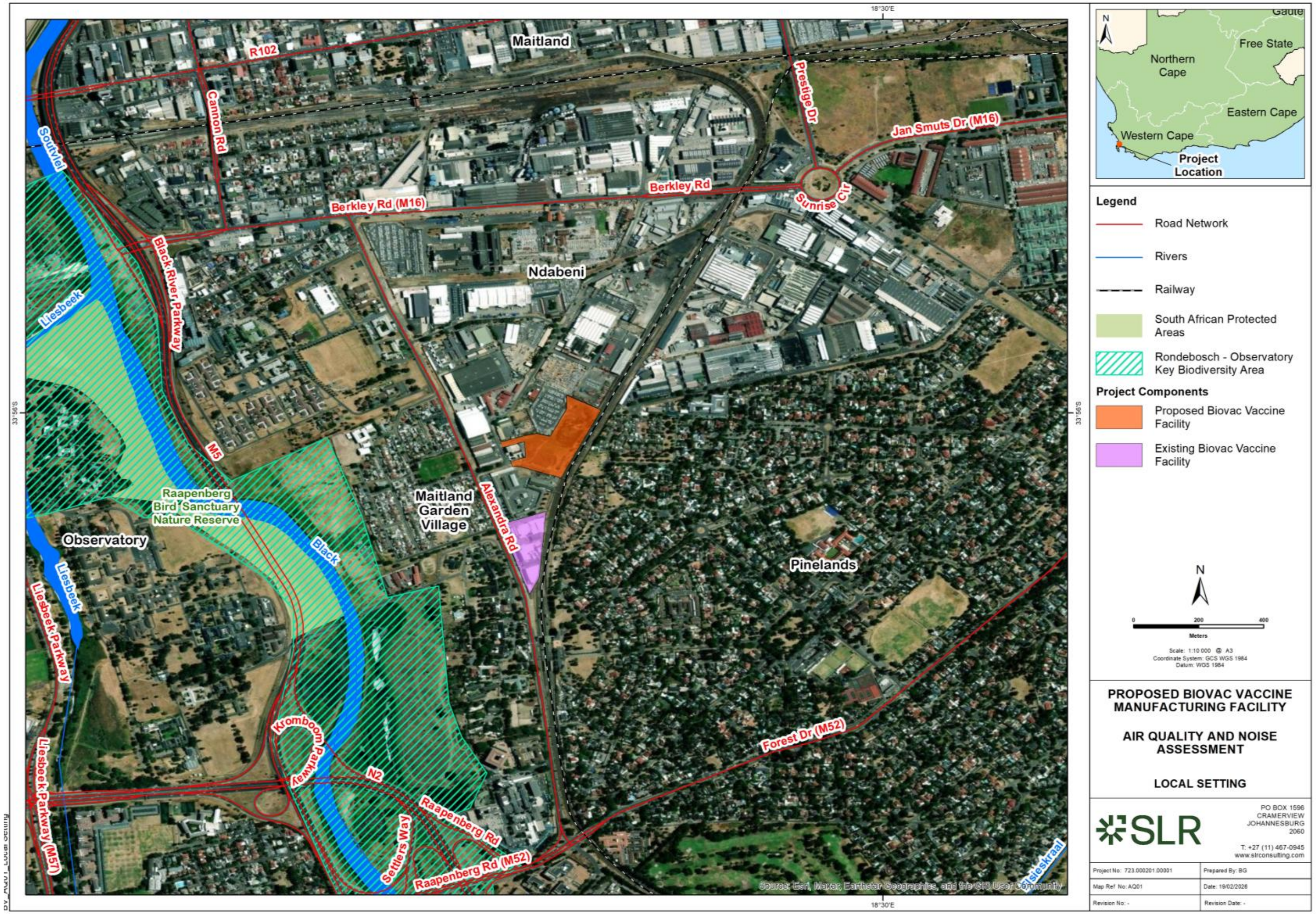


Figure 2-1: Project locality

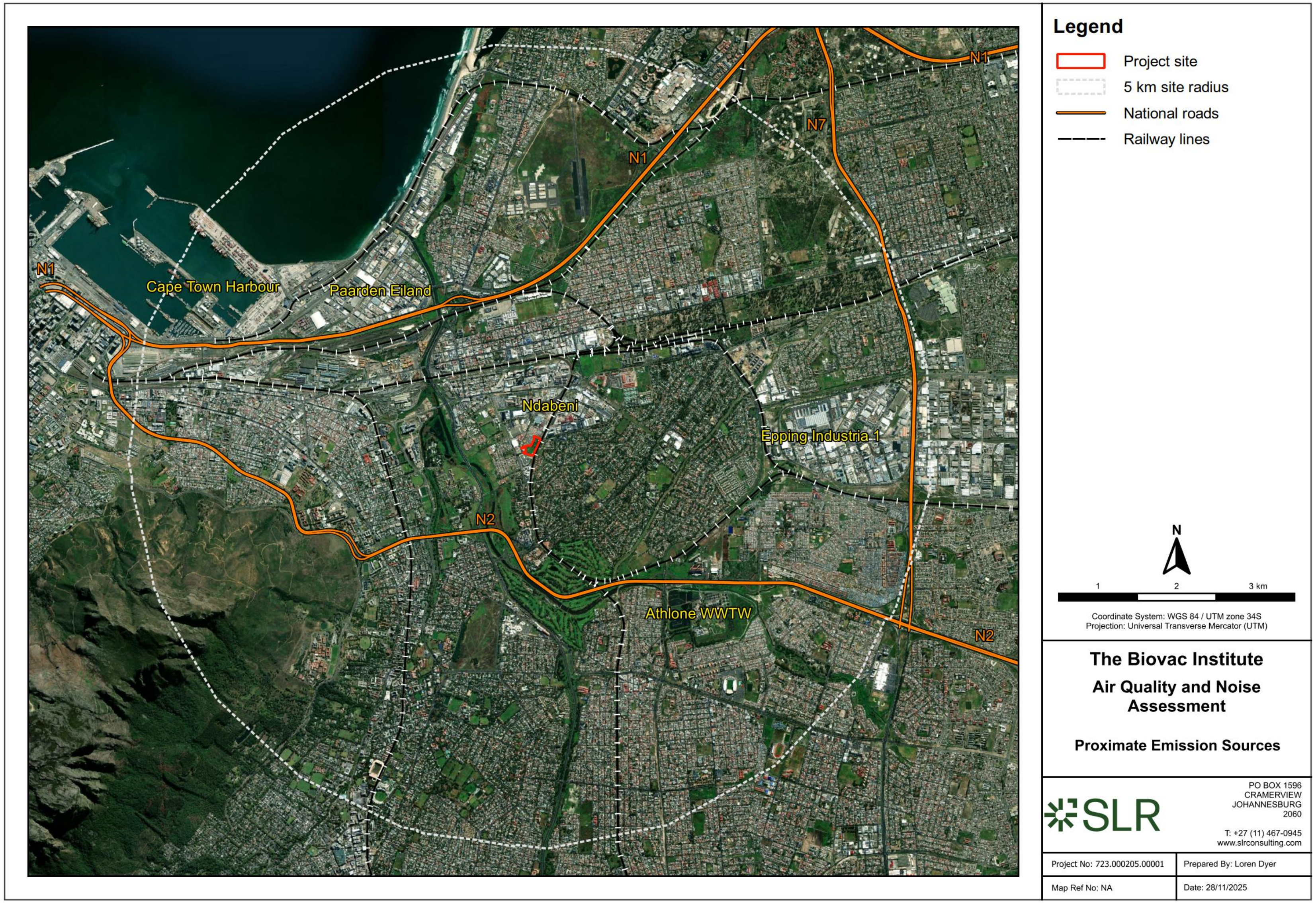


Figure 2-2: Proximity of nearby emission sources

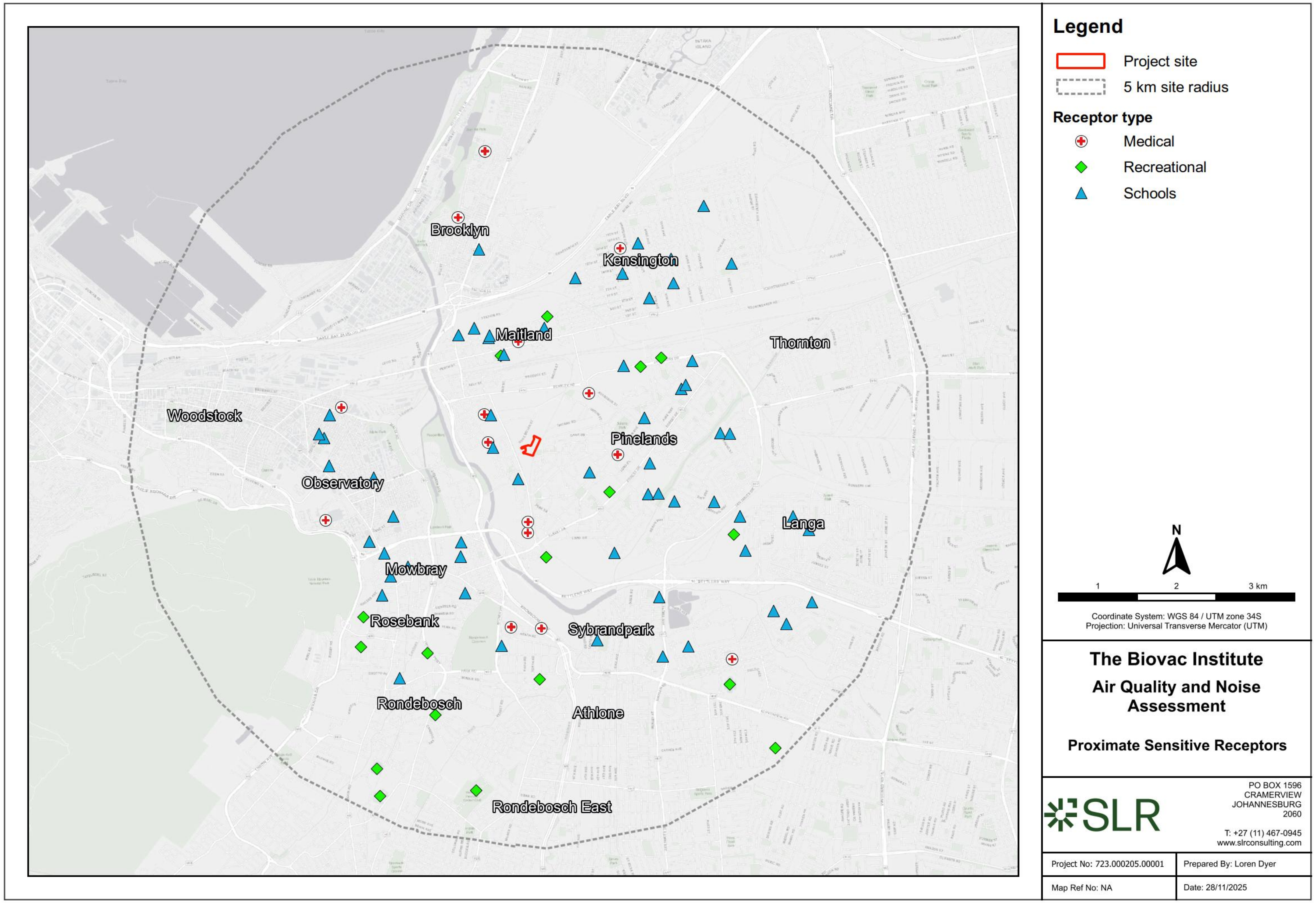


Figure 2-3: Proximity of sensitive receptors

2.2 Project Description

Biovac proposes a multi-vaccine plant with the capacity to produce ~250 million doses. The plant will be located adjacent to the existing Biovac facility in Cape Town on a site approximately two hectares in extent.

The new plant will facilitate end-to-end manufacturing of vaccines and comprise the following:

- One glass vial fill-and-finish suite, with an operational capacity of 50 million vials (~200 - 250 million doses), allowing a broad variety of vaccines to be manufactured;
- One drug substance suite, for the manufacture of up to 30 - 40 million doses of inactivated Oral Cholera Vaccine (OCV); and
- One blow-fill-seal (plastic line) for fill and finish of OCV, with an operational capacity of 60 million doses.

The Project will use solar power and other sources of renewable energy from external sources where feasible. The company's existing facility predominantly engages in filling and finishing of drug products, final product labelling, packaging, and distribution. Biovac's current product suite consists of vaccines for Tuberculosis, Measles, Pneumonia, Hepatitis B, Tetanus, and Diphtheria.

Key project components include:

- A biological production building with formulation, fill and finish (FFF) suites.
- OCV processing facilities, bio-positive and bio-negative areas.
- A central utility building, tank farm, warehouse, and technical areas.
- Further future expansions include a mRNA (messenger ribonucleic acid) workshop, downstream processing (DSP) facilities, and lyophilisation (freeze-drying) suites.

A site layout plan is shown in **Figure 2-4** and process flow in **Figure 2-5**.

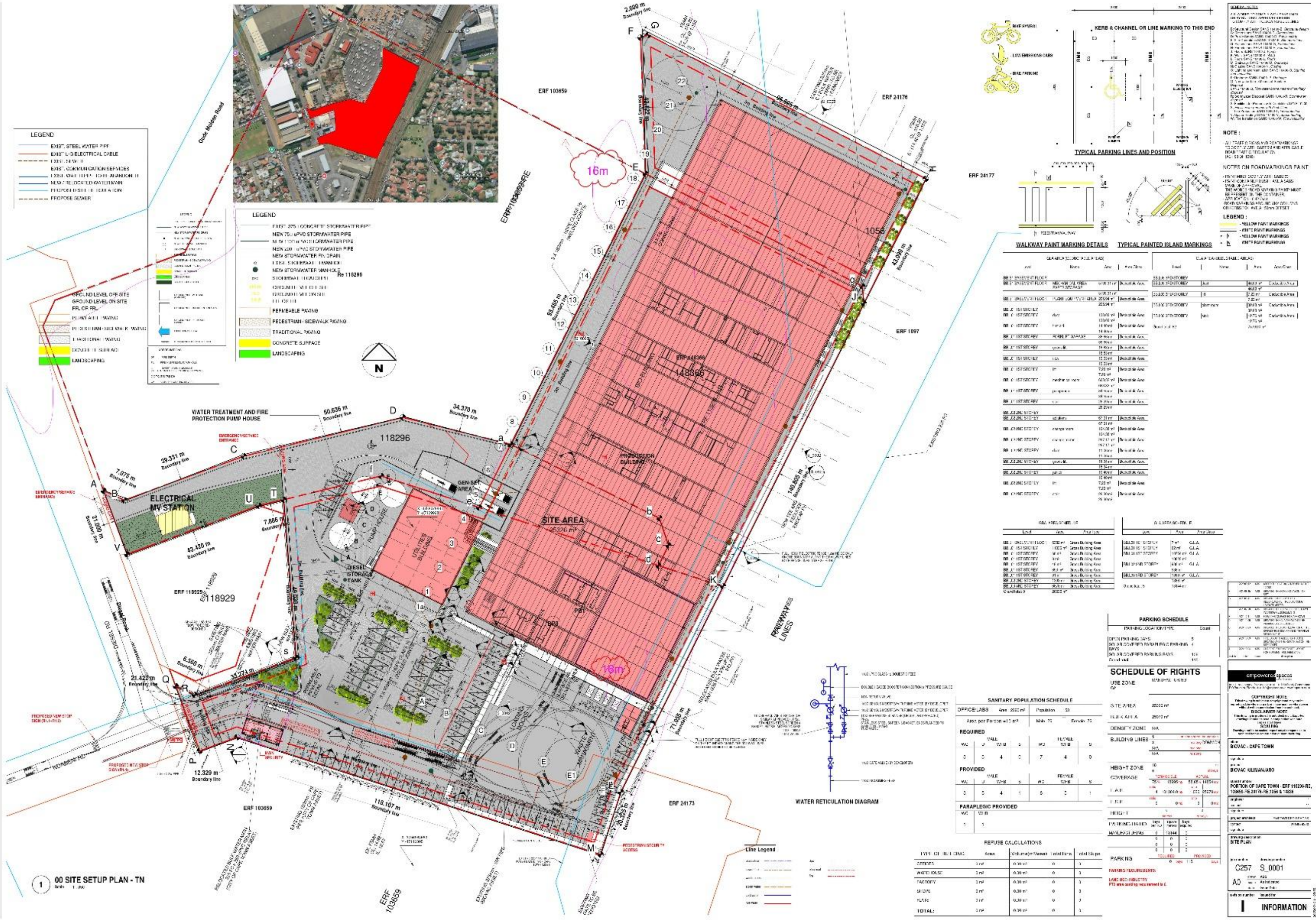
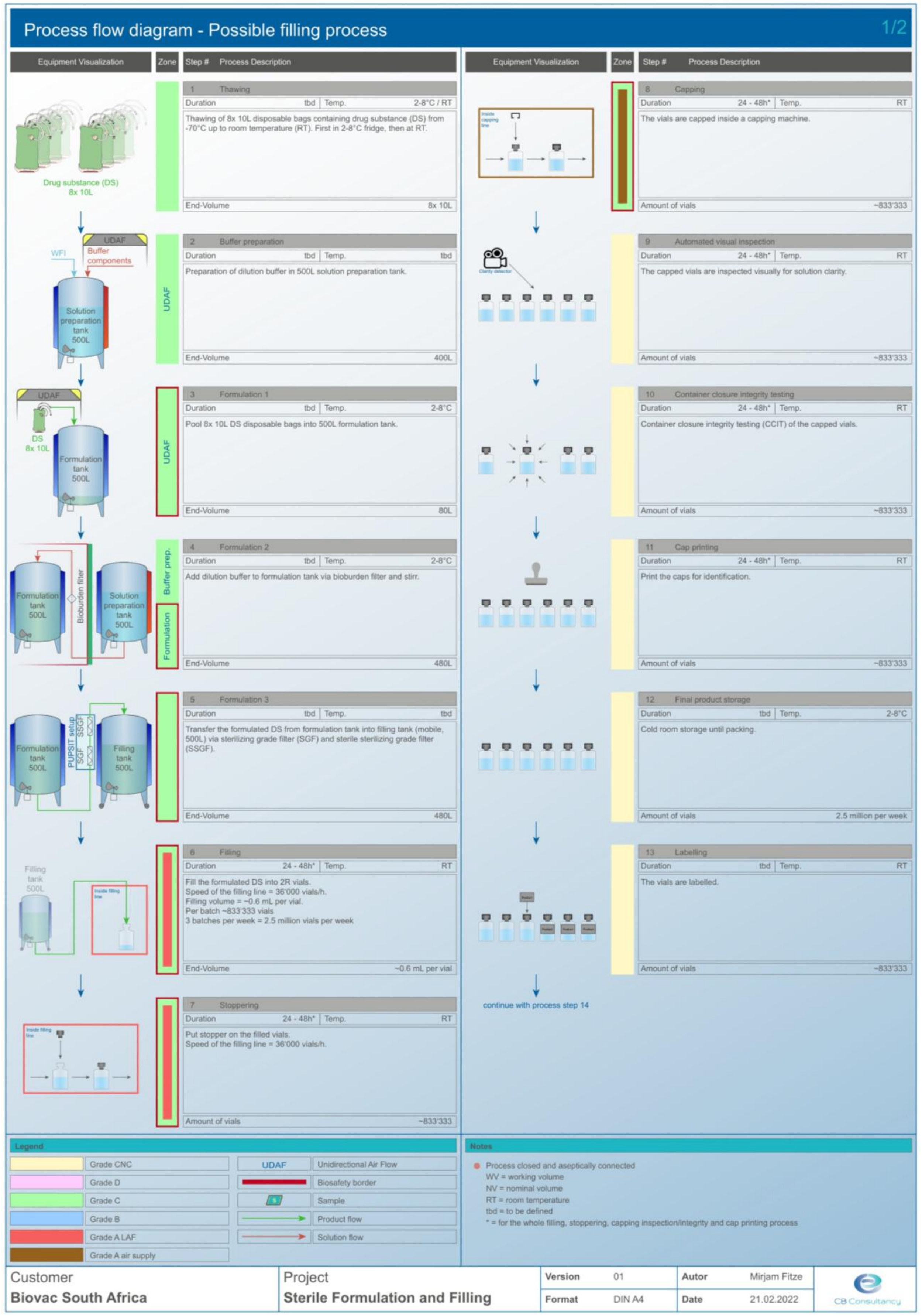


Figure 2-4: Site layout plan



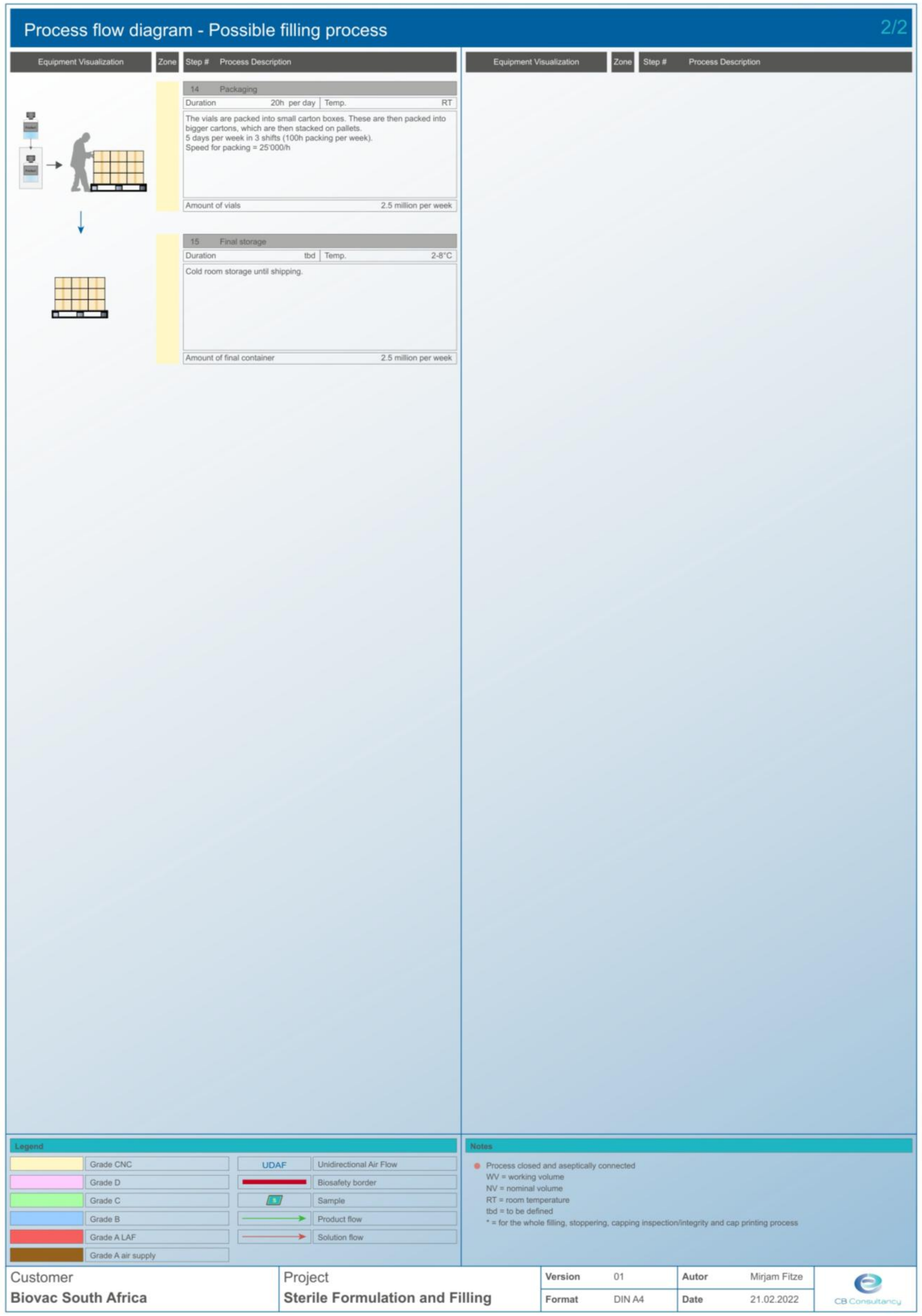


Figure 2-5: Biovac process flow

3. Legislative Requirements and International Guidelines

3.1 National Legislation

3.1.1 The Constitution of the Republic of South Africa Act, 1996 (Act No. 108 of 1996)

The overarching legislation of South Africa is the Constitution[4]. Section 24 places people and their needs at the forefront of environmental management. The Constitution provides the right to "*an environment that is not harmful to health or well-being*" and to have the environment protected, for the benefit of present and future generations, through reasonable legislative measures. These measures include the prevention of pollution and ecological degradation, the promotion of conservation, ecologically sustainable development and the utilisation of natural resources while promoting justifiable economic and social development.

3.1.2 National Environmental Management Act (No. 107 of 1998) Section 28 - Duty of Care and Remediation of Environmental Damage

Section 28 of the National Environmental Management Act (Act 107 of 1998) (NEMA)[5] (Act 107 of 1998) establishes a Duty of Care, requiring any person or organisation responsible for actual or potential environmental pollution to take reasonable measures to prevent, minimise, or rectify it. These measures include assessing environmental impacts, educating employees on risks, modifying harmful activities, eliminating pollution sources, and remedying any damage. Non-compliance constitutes a breach of Duty of Care, subject to enforcement and sanctions under NEMA.

3.1.3 National Environmental Management Air Quality Act (No 39 of 2004)

Air quality in South Africa is administered under the National Environmental Management: Air Quality Act 39 of 2004 (NEM:AQA)[6]. The objectives of NEM:AQA are to:

- Protect the environment by providing reasonable measures for the protection and enhancement of air quality, the prevention of air pollution and ecological degradation, and securing ecologically sustainable development while promoting justifiable economic and social development.
- Give effect, in terms of air quality, to the constitutional right "*to an environment that is not harmful to health and well-being*".

3.1.3.1 NEM:AQA Section 9 - National Ambient Air Quality Standards

South Africa's National Ambient Air Quality Standards (NAAQS) were promulgated in 2009[7] and 2012[8] and regulate a range of pollutants deemed to be commonly occurring yet which pose a threat to human health and the environment. Ambient air quality standards are defined as *"targets for air quality management which establish the permissible concentration of a*

[4] South Africa (1996): Constitution of the Republic of South Africa (No. 108 of 1996)
[5] Republic of South Africa (1998): National Environmental Management Act (No. R. 107 of 1998) Government Gazette, 27 November 1998 (No. 19519)
[6] South Africa (2005): National Environmental Management: Air Quality Act (No. R. 39 of 2004) Government Gazette, 24 February 2005 (No. 27318)
[7] Department of Environmental Affairs (2009): National Ambient Air Quality Standards. Government Gazette (No. R 1210 of 2009), 24 December 2009 (No. 32816)
[8] Department of Environmental Affairs (2012): National Ambient Air Quality Standard for Particulate Matter with Aerodynamic Diameter less than 2.5 Micro Metres (PM2.5). Government Gazette (No. R 486 of 2012), 29 June 2012 (No. 35463)

particular substance in, or property of, discharges to air, based on what a particular receiving environment can tolerate without significant deterioration"[9]. NAAQS relevant to the project are presented in **Table 3-1**. Each pollutant has specific averaging periods, compliance timeframes, permissible frequencies of exceedance and recognised measurement reference methods. NAAQS apply nationwide, regardless of the activity, making them relevant to the assessment of ambient air quality impacts.

Table 3-1: South African National Ambient Air Quality Standards

Pollutant	Averaging Period	Concentration ($\mu g/m^3$)	Permissible Frequency of Exceedance	Reference method
Sulphur dioxide (SO_2)	10-minute	500	526	ISO 6767
	1-hour	350	88	
	24-hour	125	4	
	1-year	50	0	
Nitrogen dioxide (NO_2)	1-hour	200	88	ISO 7996
	1-year	40	0	
Particulate matter less than 10 microns (PM_{10})	24-hour	75	4	EN 12341
	1-year	40	0	
Particulate matter less than 2.5 microns ($PM_{2.5}$)	24-hour	40	4	EN 14907
		25 [(a)]	0	
	1-year	20	4	
		15 [(a)]	0	
Benzene (C_6H_6)	1-year	5	0	EPA TO-14 A or TO-17
Carbon monoxide (CO)	1-hour	30 000	88	ISO 4224
	8-hour (average)	10 000	11	

Notes:
(a) - Effective date is 01 January 2030

3.2 Local By-laws

Section 156(2) of the Constitution permits municipalities to administer by-laws for the effective administration of matters that it has the right to administer. The management of air pollution is listed as a matter in which local government has authority, and national or provincial government may not compromise or impede a municipality's right to exercise its power or perform its functions[10].

The CoCT has promulgated an environmental health by-law (2003)[11] and an air quality management by-law (2016)[12] to regulate activities that may affect public health nuisances and air quality, complementing national and provincial legislation. These by-laws provide the municipality with a legal framework to manage air emissions, and general public nuisances to safeguard community well-being.

The overarching principles across these by-laws are to:

[9] Department of Environmental Affairs (2000): Integrated Pollution and Waste Management Policy for South Africa. Government Gazette (No. R227 of 2000), 17 March 2000 (No. 20978)

[10] Department of Environmental Affairs (2018): The 2017 National Framework for Air Quality Management in the Republic of South Africa (No.R.1144 of 2018) Government Gazette, 26 October 2018 (No. 41996).

[11] City of Cape Town (2003): Environmental Health By-Law. Western Cape Provincial Gazette 6041 on 30 June 2003

[12] City of Cape Town (2016): Air Quality Management By-Law. Western Cape Provincial Gazette 7662 on 17 August 2016

- Promote a safe and healthy environment for residents.
- Prevent or reduce public health hazards and nuisances to acceptable levels.
- Ensure that responsible parties bear the costs associated with mitigation and compliance.

The Air Quality Management By-law regulates emissions that may cause air pollution or degrade ambient air quality. The by-law enables the CoCT to control manage visible emissions such as smoke and dust and intervene where activities create localised pollution or exacerbate public health risks. It also provides for the declaration of air quality control zones, and enforcement actions where non-compliance occurs.

The by-law empowers the CoCT to issue compliance notices, undertake inspections, and enforce corrective action. Non-compliance constitutes an offence and may result in penalties, which can include fines or imprisonment, depending on severity.

3.3 International Guidance

3.3.1 Criteria Pollutants

International Finance Corporation

The World Bank Group's International Finance Corporation (IFC) Environmental, Health, and Safety (EHS)[13] guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP)[14]. The EHS guidelines contain performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs.

The EHS guidelines for air emissions and ambient air quality apply to facilities or projects that generate emissions to air at any stage of the project life cycle. This guideline provides an approach to the management of significant sources of emissions, including guidance for the assessment and monitoring of impacts.

Where possible, facilities and projects should avoid, minimize, and control adverse impacts to human health, safety and the environment from emissions to air. Where this is not possible, the generation and release of emissions of any type should be managed through a combination of:

- Energy use efficiency;
- Process modification;
- Alternative fuels or other materials which may result in less polluting emissions; and
- Application of emission control techniques.

Emission prevention and control techniques will ultimately depend on:

- Regulatory requirements of the host country;
- Significance of the source;
- Location of the emitting facility relative to other sources and sensitive receptors, existing ambient air quality and the potential for degradation of the airshed; and
- Technical feasibility and cost effectiveness of the available options.

[13] IFC (2007): Environmental Health and Safety General Guidelines (URL: www.ifc.org)
[14] GIIP is defined by the EHS as the exercise of professional skill, diligence, prudence and foresight that would be reasonably expected from skilled and experienced professionals engaged in the same type of undertaking under the same or similar circumstances globally.

Projects with “significant”[15] emission sources and potential for ambient air quality impacts should prevent or minimise impacts by ensuring that:

- Emissions do not result in pollutant concentrations that reach or exceed relevant ambient air quality standards (i.e. national legislated standards or in the absence thereof, the current World Health Organisation (WHO) air quality guidelines).
- Emissions do not contribute a significant portion to the attainment of relevant ambient air quality standards, which, as a general rule, the EHS suggests 25% of the applicable air quality standards as appropriate to allow for additional, future sustainable development in the same airshed.

These impacts should be estimated through qualitative or quantitative assessments using baseline air quality measurements and atmospheric dispersion models to assess potential ground-level concentrations. The dispersion model applied should be internationally recognised or comparable. Acceptable approaches include screening models for single source evaluations (e.g. SCREEN3 or AIRSCREEN), as well as more complex and refined models (e.g. AERMOD or CALPUFF). Model selection is dependent on the complexity and geomorphology of the project site (e.g. mountainous terrain, urban or rural areas, etc.).

World Health Organisation

The WHO provide guidelines for protecting public health from the adverse effects of air pollutants and reduce exposure to those pollutants that are known or likely to be hazardous to human health or well-being. The guidelines are based on expert evaluation of current scientific evidence and are intended to inform policy makers and to provide targets for air quality management. In establishing pollutant levels below which exposure does not constitute a significant public health risk over a specified period, the guidelines provide a basis for setting standards or limit values for air pollutants. In general, the guidelines address single pollutants whereas in reality, exposure to mixtures of chemicals occurs, with potentially additive, synergistic or antagonistic effects. In dealing with practical situations or standard-setting procedures, consideration should be given to the interrelationships between the various air pollutants. In setting legally binding standards, considerations such as prevailing exposure levels, technical feasibility, source control measures, abatement strategies, and social, economic and cultural conditions are relevant[16].

The most recent update of the WHO air quality guidelines (AQG)[17] apply to outdoor and indoor environments globally. Although they cover settings where people spend time, they do not cover an occupational context due to the potential differences in population susceptibility of the adult workforce in comparison with the general population. The WHO AQG (**Table 3-2**) are provided as recommended limits with interim targets for achieving improved health conditions.

Table 3-2: Ambient Air Quality Guidelines (µg/m^3)

Pollutant	Averaging Period	World Health Organisation [18,19,20]				
		Interim target				AQG level
		1	2	3	4	
Sulphur dioxide (SO_2)	10-minute	-	-	-	-	500

[15] “Significant” sources are defined by the EHS guideline as sources which contribute a net emission increase of PM10 > 50 tonnes per annum (tpa), NOx > 500 tpa, SO2 > 500 tpa, and/or combustion sources with an equivalent heat input of 50 MWth or greater. The significance of other pollutants, whether inorganic or organic should be established on a project-specific basis and consider the toxic properties of the pollutant.
[16] WHO (2000): Ambient air quality guidelines for Europe. 2nd ed. URL: www.who.int
[17] WHO (2021): Global air quality guidelines URL: www.who.int
[18] WHO (2000): Ambient air quality guidelines for Europe. 2nd ed. URL: www.who.int
[19] WHO (2006): Air Quality Guidelines Global Update 2005. URL: URL: www.who.int
[20] WHO (2021): Global air quality guidelines URL: www.who.int

Pollutant	Averaging Period	World Health Organisation [18,19,20]				
		Interim target				AQG level
		1	2	3	4	
	24-hour	125 (a)	50 (a)	-	-	40 (a)
	1-year	-	-	-	-	- (b)
Nitrogen dioxide (NO_2)	1-hour	-	-	-	-	200
	24-hour	120 (a)	50 (a)	-	-	25 (a)
	1-year	40	30	20	-	10
Particulate matter less than 10 microns (PM_{10})	24-hour	150 (a)	100 (a)	75 (a)	50 (a)	45 (a)
	1-year	70	50	30	20	15
Particulate matter less than 2.5 microns ($PM_{2.5}$)	24-hour	75 (a)	50 (a)	37.5 (a)	25 (a)	15 (a)
	1-year	35	25	15	10	5
Benzene (C_6H_6)	1-year	-	-	-	-	- (c)

Notes:
(a) - 99th percentile (i.e. 3-4 exceedance days per year)
(b) - According to the WHO 2005 update, an annual guideline is not needed since compliance with the 24-hour level will assure low levels for the annual average.
(c) - Benzene is carcinogenic to humans and therefore no safe levels of exposure can be recommended by the WHO. The continuous exposure concentrations of airborne benzene associated with an excess lifetime risk of 1:10 000 for leukaemia is 17 µg/m³.

The WHO AQG are based on extensive health evidence and are generally set at the lowest level of verified clinical health impact reported in peer-reviewed studies.

South Africa's NAAQS (**Section 3.1.3.1**) are informed by the WHO AQG's interim targets but adjusted by South African regulators to balance public and ecological health protection with broader sustainability needs, such as economic development, social welfare, and employment, which support overall well-being.

Compliance with both the NAAQS and the more stringent WHO AQG limits indicates that potential health implications for sensitive individuals are accounted for, and that no significant impacts on human, plant, or animal well-being is expected.

3.3.2 Non-criteria Pollutants

In the absence of NAAQS for non-criteria pollutants assessed, alternative internationally recognized benchmarks have been considered. Both short-term (1-hour) and long-term (1-year) limits are presented in **Table 3.3** with a brief discussion of each reference guideline in the sections that follow.

United Kingdom Environment Agency

The United Kingdom Environment Agency is a non-departmental public body responsible for matters relating to the protection and enhancement of the environment in England and Wales. The Environment Agency use environmental assessment levels (EALs) for emissions to judge the acceptability of emissions to air from industrial activities and their relative contribution to the ambient environment. EALs represent a pollutant in ambient air at which no appreciable risks or minimal risks to human health are expected[21].

Texas Commission on Environmental Quality

The Texas Commission on Environmental Quality (TCEQ) is the environmental agency for the state of Texas in the United States. TCEQ have developed Effects Screening Levels (ESLs) to evaluate impacts from pollutant concentrations predicted by dispersion modelling

[21] UK Environment Agency (2016): Air emissions risk assessment for your environmental permit. URL: www.gov.uk (last updated: March 2023)

simulations. ESLs, which include both short- (1-hour) and long-term (annual) limit values, are chemical-specific concentration limits set to protect human health and welfare. They are *not ambient air quality standards but rather a guideline* as to whether airborne contaminants present adverse risk. Short-term ESLs are based on data concerning acute health effects, while long-term ESLs are based on data concerning chronic health effects. Health-based ESLs are based on toxicity factors and dose responses relevant to humans[22].

California Office of Environmental Health Hazard Assessment

The California Office of Environmental Health Hazard Assessment (OEHHA) is the lead agency for the assessment of health risks posed by environmental contaminants in the state of California, United States. OEHHA have developed risk assessment guidelines with defined reference exposure levels (RELs) for airborne contaminants. An REL is the concentration level at or below which no adverse non-cancer health effects are anticipated for the specified exposure duration (i.e., acute 1-hour and chronic annual exposure). RELs are designed to protect the most sensitive individuals in the population by the inclusion of factors that account for uncertainties as well as individual differences in human susceptibility to chemical exposures. The factors used err on the side of public health protection to avoid underestimation of non-cancer hazards and as such, *exceeding the REL does not automatically indicate an adverse health impact*. Increasing concentrations above the REL value increases the likelihood that the health effect will occur[23].

Table 3.3: International health-based guidelines for measured pollutants not regulated by NAAQS

Pollutant	Averaging period	WHO [24,25,26] (µg/m³)	UK EAL[27] (µg/m³)	TCEQ ESL[28] (µg/m³)	OEHHA REL [29] (µg/m³)
Ammonia (NH_3)	1-hour	-	2500	180	-
	1-year	-	180	92	200
Toluene	1-hour	-	-	4 500	5 000
	1-week	260	-	-	-
	1-year	-	-	1 200	420
Ethylbenzene	1-hour	-	-	26 000	-
	1-year	-	4 410	570	2 000
Xylene	1-hour	-	-	2 200	22 000
	1-year	-	4 410	180	700

Notes:
Red - The most stringent of the 1-year guideline values recommended by the international bodies referenced above, are used in this study as a conservative reference threshold to assess impact.

[22] TCEQ (2006): Guidelines to develop effects screening levels, reference values and unit risk factors. RG-442
[23] California OEHHA (2015): Air toxics hot spot program risk assessment guidelines - Guidance manual for health risk assessment. URL: https://oehha.ca.gov/media/downloads/crnr/2015guidancemanual.pdf
[24] WHO (2000): Air Quality Guidelines for Europe, 2nd ed. URL: URL: www.who.int
[25] WHO (2006): Air Quality Guidelines Global Update 2005. URL: URL: www.who.int
[26] WHO (2021): Global Air Quality Guidelines. URL: URL: www.who.int
[27] UK Environment Agency (2016): Air emissions risk assessment for your environmental permit. URL: www.gov.uk
[28] TCEQ (2017): Effects Screening Levels using in the review of Air Permitting Data (URL: https://www.tceq.texas.gov/)
[29] OEHHA (undated): Toxicity criteria on chemicals evaluated by OEHHA (URL: https://oehha.ca.gov/chemicals/)

4. Geographical Context

4.1 Topography and Vegetation

Terrain can influence local wind patterns and turbulence with mountains, valleys, and urban structures either trapping or channelling airflow. Surface roughness, determined by land use, vegetation, and the presence of large water bodies, also affects how pollutants spread and settle.

The Project area is at ~15 metres above mean sea level (mamsl). Regional topography within 50 km is shown in **Figure 4-1**, however, based on the nature of the proposed activity, emissions are expected to peak nearfield. The Project site and immediate surrounds is characterised as generally flat.

According to the Köppen-Geiger Classification[30], the Project area is defined as having a warm summer Mediterranean climate (Csb) with dry summers and wet winters. The natural landcover is classified as Cape Flats Sand Fynbos, however, the CoCT is a densely populated developed region and therefore the study area is classed as predominantly urban.

[30] CSIR (undated): Köppen-Geiger Zones (URL: csir.maps.arcgis.com)

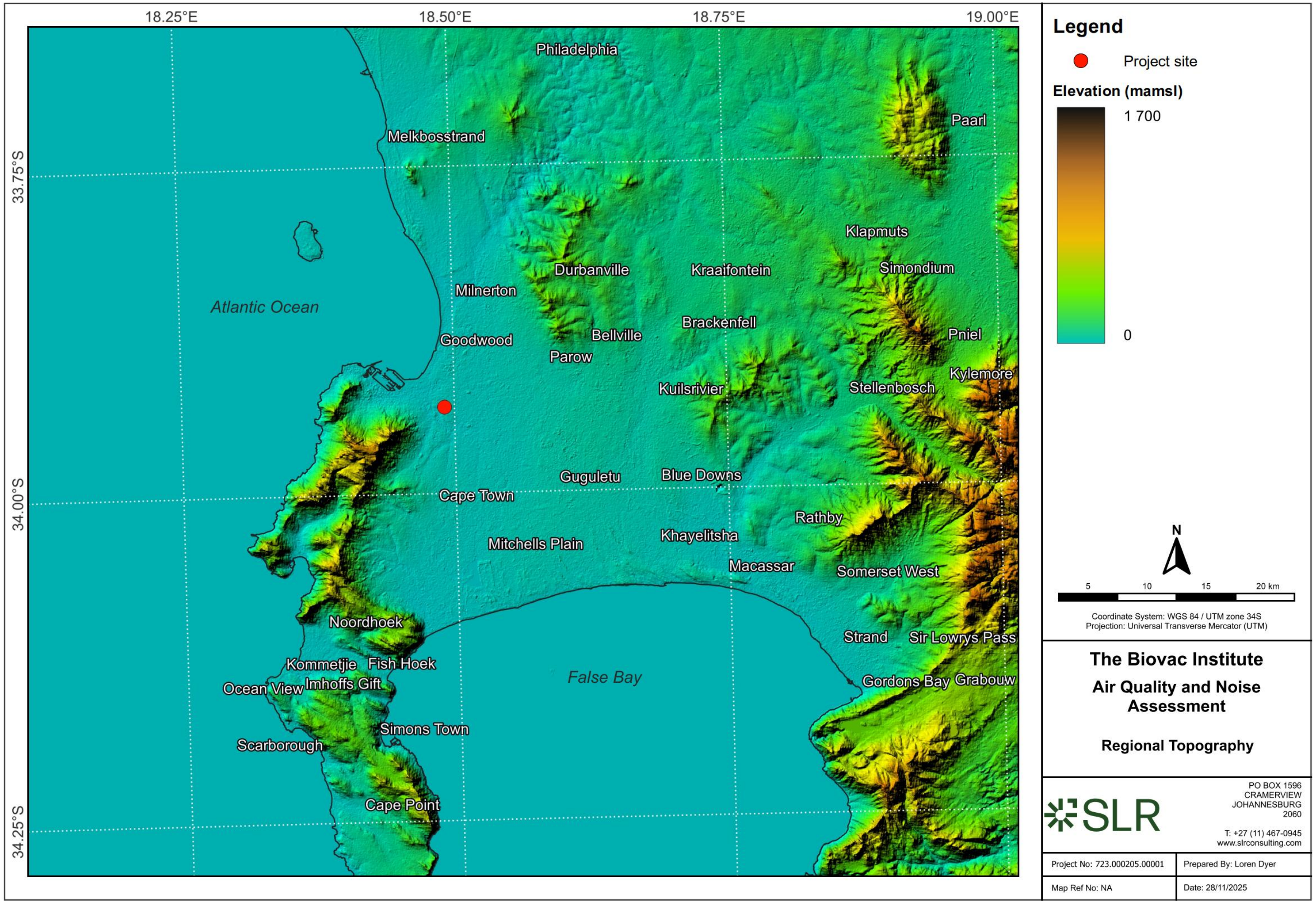


Figure 4-1: Regional topography

4.2 Climate and Meteorology

Seasonal and diurnal pollutant concentration levels fluctuate in response to the changing state of atmospheric stability, to concurrent variations in mixing depth, and to the influence of wind systems on the transport of air pollution.

4.2.1.1 Macroscale Circulation

South Africa's climate is governed by three semi-permanent high-pressure systems: the South Indian, Kalahari (continental), and South Atlantic anticyclones (**Figure 4-2**). These systems, form part of the global subtropical high-pressure belt around 30°S, and influence temperature and precipitation patterns throughout the year[31]. Their seasonal shifts interact with tropical easterly lows and westerly waves, shaping regional weather conditions. Anticyclonic systems create stable, dry conditions with inversion layers that restrict vertical pollution dispersion. Over the interior plateau, strong subsidence from the continental high-pressure system leads to persistent elevated inversions, typically forming between 300 and 700 hPa. These inversions trap pollutants close to the surface, limiting dispersion and often resulting in high pollution concentrations, particularly in winter when temperature stratification is strongest. In contrast, easterly lows, which are more prevalent in summer, bring uplift, cloud formation, and rainfall, primarily affecting eastern regions. Westerly cyclones, originating from the South Atlantic, produce berg winds ahead of the system and cooler, wetter conditions afterward. These westerly disturbances, including cut-off lows, cold fronts, and troughs, contribute to seasonal rainfall, particularly along the west coast from October to April[32]. Together, easterly and westerly systems disrupt persistent inversions, promoting pollutant dispersion and removal.

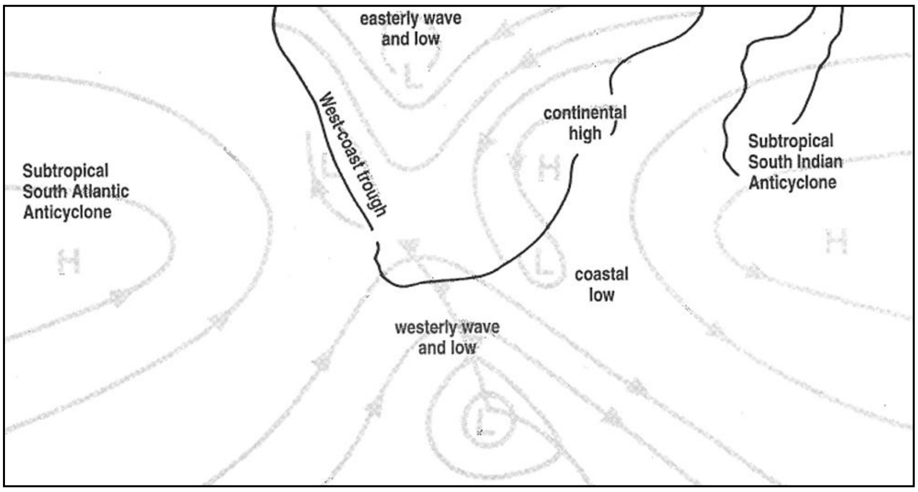


Figure 4-2: Atmospheric circulation over southern Africa (Tyson & Preston-Whyte, 2000)

4.2.1.2 Local Meteorology

Meteorology (i.e. the study of weather patterns including wind speed and direction, atmospheric temperature and pressure, humidity, cloud cover and solar insolation) is the

[31] Turner, C.R., Tosen, G.R. and Lennon S.J. (1995): Atmospheric Pollution and Climate Change Impacts in South Africa. Tytskrif vir Skoon Lug. Vol. 9 - No. 4

[32] Tyson, P.D and Preston-Whyte, R.A., 2000: The Weather and Atmosphere of Southern Africa, Oxford University Press, Cape Town.

principal factor driving the transportation, dispersion, dilution, and transformation of air pollutants in the local context[33].

This section presents an overview of local meteorological conditions for the study area. The Regulations Regarding Air Dispersion Modelling[34] (hereafter referred to as the "*Modelling Regulations*") recommend the analysis of a minimum of one year of site representative data to account for seasonal variability. In the absence of site measurements, a prognostic meteorological dataset (for temperature, rainfall, humidity, wind speed and wind direction) was sourced from the Copernicus Climate Change Service: ERA5 fifth generation European Centre for Medium-Range Weather Forecasts (ECMWF) atmospheric reanalysis model[35]. An hourly dataset was extracted for Cape Town (-34.0°S and 18.5°E) and analysed for the period January 2022 - December 2024 (i.e. the most recent three full calendar years available at the time of reporting).

Temperature, Relative Humidity and Rainfall

Ambient air temperature is relevant in the context of air pollution dispersion as it influences plume buoyancy (i.e. the higher the plume temperature is above the ambient air temperature, the higher the plume will rise), vertical stability (i.e. the formation of mixing or inversion layers) and, chemical reactions taking place in the atmosphere[36]. The frequency and intensity of precipitation affect the rate at which pollutants are scavenged and removed from the atmosphere[37] with rainfall frequency holding greater significance than precipitation intensity for aerosol removal[38].

Köppen-Geiger classifies the area as a warm summer Mediterranean climate (Csb)[39] with dry summers and wet winters. A meteorological summary is provided in **Table 4-1** and **Figure 4-3**. Annual average temperature is 16.4°C. Highest average temperatures occur in summer (December, January and February) at 19.5°C with a peak hourly temperature of 27.7°C recorded in January and February. Lowest average temperatures are in winter (June, July and August) at 13.6°C, with a minimum hourly temperature of 7.8°C measured in August. Average humidity is 94%. Annual rainfall averages at 595 mm, with most occurring in winter (59%), followed by autumn (19%) and spring (14%). Summer (8%) is the driest season.

Table 4-1: Meteorological summary for the study area (Jan 2022 - Dec 2024)

Parameter	2022	2023	2024	Period average
Maximum hourly temperature (°C)	27.7	27.4	27.7	27.6
Minimum hourly temperature (°C)	8.0	7.8	8.3	8.1
Average temperature (°C)	16.6	16.2	16.4	16.4
Total rainfall (mm)	422	691	673	595
Average humidity (%)	94	94	94	94

33 University of Cape Town (undated): Environmental Issues and Public Health - Air Pollution Chapter 5: The Influence of The Atmospheric Processes. URL: https://vula.uct.ac.za/
34 Department of Environmental Affairs (2014): Regulations Regarding Air Dispersion Modelling (No. R. 533) Government Gazette, 11 July 2014 (Notice: 37804)
35 Copernicus Climate Change Service (2025): ERA5 hourly data on single levels from 1940 to present (URL: cds.climate.copernicus.eu)
36 Piringer, M. et al (2019): Climate Change Impact on the Dispersion of Airborne Emissions and the Resulting Separation Distances to Avoid Odour Annoyance, in Atmospheric Environment: X. Vol 2: doi.org/10.1016/j.aeaoa.2019.100021
37 World Meteorological Organisation (2022): Implications of Climate Change for Air Quality. URL: www.public.wmo.int (date accessed: 09/01/2023)
38 Wang, H., Xia, W. and Zhang, G.J. (2021). What rainfall rates are most important to wet removal of different aerosol types? In Atmospheric Chemistry and Physics, Volume 21, 16797-16816
39 CSIR (undated): Köppen-Geiger Zones (URL: csir.maps.arcgis.com)

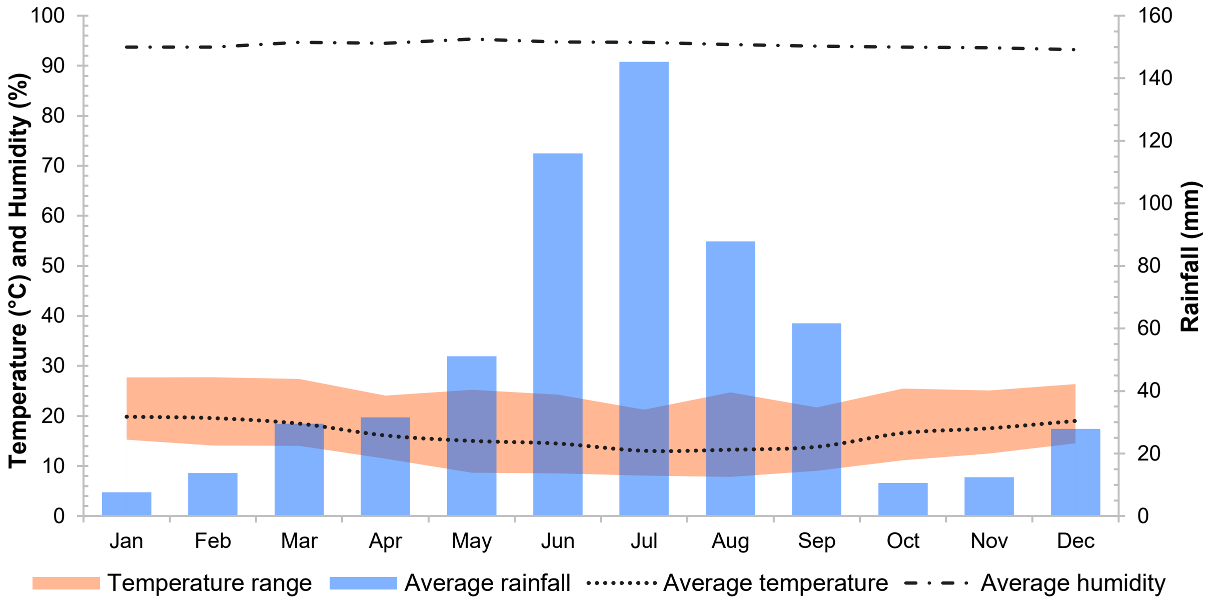


Figure 4-3: Meteorological summary for the study area (Jan 2022 - Dec 2024)

Atmospheric Stability

Dispersion model algorithms are driven by standard meteorological parameters, such as wind speed, but also atmospheric stability. Radiation balance, cloud cover, time of day, solar height and wind speed variability determine stability of the atmosphere at any given time[40].

Stability controls the vertical movement and dilution of air pollutants in the atmosphere. Turbulent, or unstable conditions disperse, and dilute pollutants more rapidly, as opposed to stable conditions that facilitate pollutant accumulation.

Radiation balance, cloud cover, time of day, solar height and wind speed variability all contribute to the stability of the atmosphere at any given time[41], however, the key factor controlling vertical mixing is the actual temperature profile relative to the dry adiabatic lapse rate (i.e. the rate of temperature decreases with height). A super adiabatic lapse rate (i.e. > 1°C decrease per 100 m) provides good dispersion conditions whereas a temperature inversion (i.e. temperature increases with height) may trap pollutants near the surface resulting in a fumigation scenario (**Figure 4-4**)[42].

[40] Piringer, M. *et al* (2019): *Climate Change Impact on the Dispersion of Airborne Emissions and the Resulting Separation Distances to Avoid Odour Annoyance*, in Atmospheric Environment: X. Vol 2: doi.org/10.1016/j.aeaoa.2019.100021

[41] Piringer, M. et al (2019): Climate Change Impact on the Dispersion of Airborne Emissions and the Resulting Separation Distances to Avoid Odour Annoyance, in Atmospheric Environment: X. Vol 2: doi.org/10.1016/j.aeaoa.2019.100021

[42] University of Cape Town (undated): Environmental Issues and Public Health - Air Pollution Chapter 5: The Influence of Atmospheric Processes. URL: https://vula.uct.ac.za/

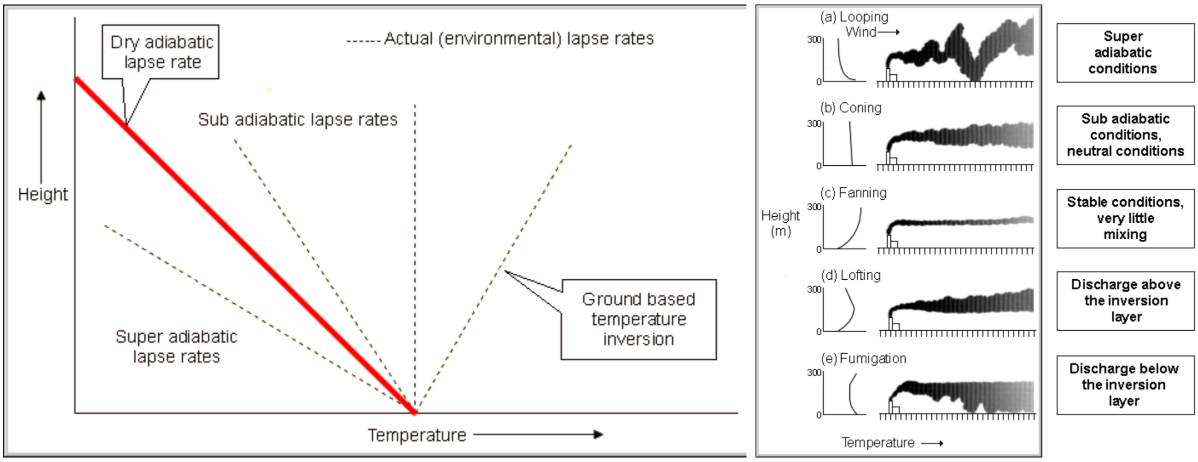


Figure 4-4: Lapse rates (left) and associated dispersion potential (right)

Wind Field

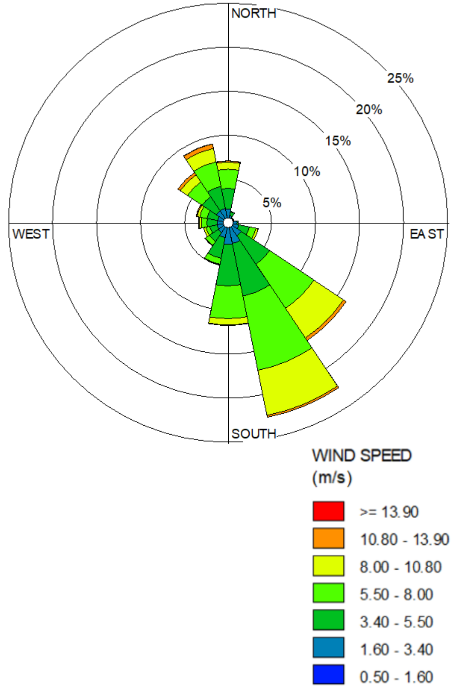
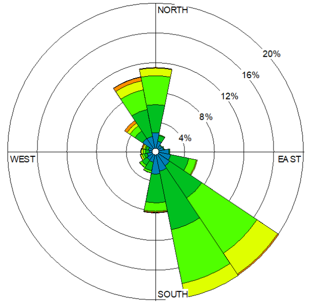
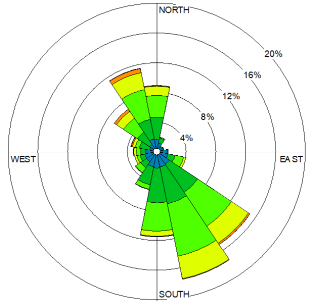
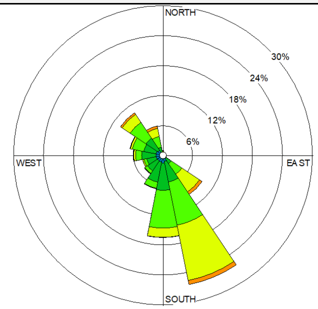
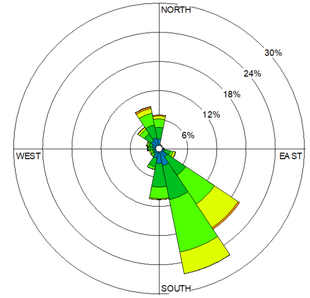
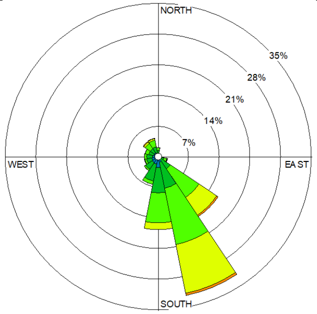
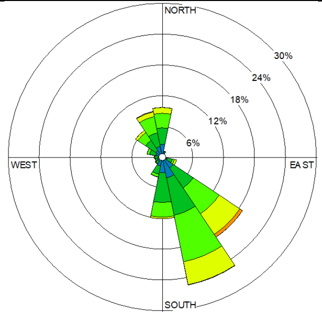
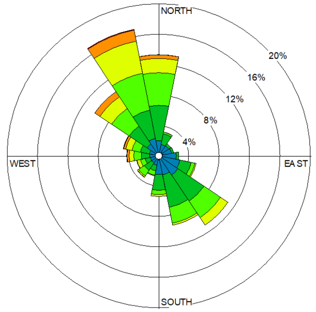
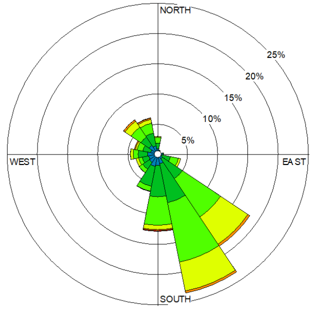
Wind speed and direction is the main mechanism for the horizontal dispersion and dilution of air pollutants downwind of a source[43]. The wind field is presented as wind rose charts that display wind speed and directional frequency. Each directional branch on a wind rose represents wind flow originating from that direction. Each directional branch is divided into segments of colour, representative of different wind speeds. The wind roses presented in **Table 4-2** were generated using Lakes Environmental WRPlot Freeware (Version 12.0.0) and the ERA5 dataset.

Temporal scales assessed include the full assessment period (January 2022 - December 2024), diurnally for early morning (00h00 - 06h00), morning (06h00 - 12h00), afternoon (12h00 - 18h00) and night (18h00 - 00h00), and seasonally for summer (December, January and February), autumn (March, April and May), winter (June, July and August) and spring (September, October and November).

Wind speed classes and the descriptions applied in this study align with the *Beaufort Wind Force Scale*[44].

[43] University of Cape Town (undated): Environmental Issues and Public Health - Air Pollution Chapter 5: The Influence of Atmospheric Processes. URL: https://vula.uct.ac.za/
[44] The Beaufort wind force scale is an empirical measure that relates to observed conditions at sea or on land.

Table 4-2: Local wind conditions

Cape Town	Early Morning	Morning	Afternoon	Night
January 2022 - December 2024	00h00 - 06h00	06h00 - 12h00	12h00 - 18h00	18h00 - 00h00
	 Calms = 0.52%	 Calms = 0.27%	 Calms = 0.09%	 Calms = 0.44%
	Summer	Autumn	Winter	Spring
	Dec, Jan & Feb	Mar, Apr & May	Jun, Jul & Aug	Sep, Oct & Nov
Calms = 0.33%	 Calms = 0.11%	 Calms = 0.387%	 Calms = 0.63%	 Calms = 0.20%

Wind field description:	
Proportion calm (<0.5 m/s) conditions	0.33 % of the time
Wind speed range	Wind speeds range from light (defined as 0.5 - 1.6 m/s) to moderate gale (defined as 13.9 - 17.2 m/s).
Prevailing wind direction	From the south-southwest
Peak hourly wind speed and direction	15.5 m/s from the north-northwest early morning (00h00-06h00) in winter.
Highest average wind speed and direction	6.4 m/s from the southeast. Wind speeds were highest on average during summer (5.8 m/s) and during the afternoon (12h00-18h00) hours (6.1 m/s).
Diurnal variation	Prevailing along south-southeasterly and north-northwesterly trajectories both day and night.
Seasonal variation	Winds from the south-southeast and southeast prevail throughout the year except during winter when winds from the north-northwest are more frequent.

4.3 Ambient Air Quality

4.3.1 Regional Context

An evaluation of the existing air pollution situation provides an understanding of the potential cumulative risk for health impacts. DFFE has identified District and Metropolitan Municipalities of concern with respect to air quality based on the prevalence of sources of emissions for each source category. The National Framework for Air Quality Management in the Republic of South Africa (hereafter referred to as “The National Framework”) has rated the CoCT, as having “poor” air quality. The metro is thus identified as being in either the upper range of one or more emission source categories or the middle range of two or more emission source categories relative to other Districts/Metros in South Africa. Municipalities that are classified as having potentially poor or poor air quality require priority attention in terms of air quality management planning.

The CoCT AQMP claims compromised air quality due to multiple emission sources and poor winter dispersion. The region experiences seasonal ‘brown haze’ (April-September), driven by emissions from traffic, industry, and domestic fuel burning. PM levels are of particular concern in low-income areas and along major transport corridors.

4.3.2 Regional Air Quality Monitoring Network

As per South Africa’s Modelling Regulations, all air quality assessments must consider the background concentration of air contaminants. The intent is to compare existing ambient air quality to the potential cumulative impact of the activity being assessed. The background concentration is the portion of the ambient concentration due to sources, both natural and anthropogenic, other than the operation being evaluated. Such background concentrations are generally obtained from a network of long-term ambient monitoring stations near the source that is adequately representative. A minimum of one year of monitoring data (to account for seasonal variability) is recommended for quantifying background pollutant concentrations.

A network of ambient air quality monitoring stations is established across South Africa with monitoring data from these stations publicly available for download from the South African Air Quality Information System (SAAQIS). Two SAAQIS reporting stations are situated within 5 km of the proposed Project site (**Figure 4-5**).

Ambient NO_2, SO_2, CO and PM data from January 2022 to December 2024 (i.e. three calendar years) was downloaded, analysed and assessed for compliance with NAAQS. Although a minimum data recovery rate of 90% is recommended for compliance assessment, this requirement was mostly not met in these datasets. The data provides some insight into background pollutant concentrations in the Project area, though the results must be considered in the context of low data recovery/availability.

Station details, data recovery, annual average concentrations, and a NAAQS/WHO AQG exceedance summary for measured pollutants is provided in **Table 4-3**. Short-term concentrations (i.e. 1-hour, 8-hour and 24-hour averages, as applicable) are presented in **Figure 4-6** to **Figure 4-16**. Key findings are as follows:

Nitrogen dioxide:

- Annual average concentrations at Maitland remained below the NAAQS limit of 40 µg/m³ but exceeded the WHO AQG of 10 µg/m³ in all years.
- The 24-hour WHO AQG of 25 µg/m³ (four exceedances permitted annually) was exceeded 36 times in 2022, 64 times in 2023 and 41 times in 2024.
- The 1-hour NAAQS/WHO AQG of 200 µg/m³ (88 exceedances permitted annually) was not exceeded in any year.

- NO_2 is not monitored at Athlone.

Sulphur dioxide:

- Annual average concentrations at Maitland and Athlone remained below the NAAQS limit of 50 µg/m³.
- The 24-hour NAAQS of 125 µg/m³ (four exceedances permitted annually) was exceeded once at Maitland and seven times at Athlone in 2023.
- The 24-hour WHO AQG of 40 µg/m³ (four exceedances permitted annually) was exceeded four times in 2022 and three times in 2023 at Maitland, and 18 times in 2023 at Athlone.
- The 1-hour NAAQS of 350 µg/m³ (88 exceedances permitted annually) was exceeded once at Maitland in 2023, and once in 2022 and three times in 2023 at Athlone.

Carbon monoxide:

- Short-term (i.e. 1-hour, 8-hour or 24-hour) ambient CO concentrations at Maitland remained below NAAQS/WHO AQG in all years.
- CO is not monitored at Athlone.

Particulate matter less than 10 microns:

- Annual average concentrations at Maitland remained below the NAAQS limit of 40 µg/m³ but exceeded the WHO annual guideline of 15 µg/m³ in all years.
- The 24-hour WHO AQG of 45 µg/m³ (four exceedances permitted annually) was exceeded 10 times in 2022, 12 times in 2023 and four times in 2024.
- The 24-hour NAAQS of 75 µg/m³ (four exceedances permitted annually) was not exceeded in any year.
- PM_{10} is not monitored at Athlone.

Particulate matter less than 2.5 microns:

- Annual average concentrations at Maitland remained below the NAAQS limit of 20 µg/m³ but exceeded the WHO annual guideline of 5 µg/m³ in 2023 and 2024.
- The 24-hour WHO AQG of 15 µg/m³ (four exceedances permitted annually) was exceeded four times in 2022, 23 times in 2023 and 23 times in 2024.
- The 24-hour NAAQS of 40 µg/m³ (four exceedances permitted annually) was not exceeded in any year.
- $PM_{2.5}$ is not monitored at Athlone.

Figure 4-5: Proximity of SAAQIS reporting ambient air quality monitoring stations

Table 4-3: SAAQIS data recovery and NAAQS exceedance summary (January 2022 - December 2024)

	SAAQIS Station	Maitland			Athlone		
	Managed by	Western Cape Province			City of Cape Town Municipality		
	Latitude (°S)	-33.920444			-33.955861		
	Longitude (°E)	18.515947			18.513111		
	Distance from Project site (km)	2.7			3.1		
	Direction from Project site	NE			SE		
Pollutant	**Year**	2022	2023	2024	2022	2023	2024
NO_2	Data recovery	83.9%	76.9%	93.6%	Not measured		
	No. of 1-hour NAAQS / WHO AQG exceedances	0	0	0			
	No. of 24-hour WHO AQG exceedances	36	64	41			
	Annual average (µg/m³)	14.1	16.7	14.0			
	Graph	**Figure 4-6** (1-hour) and **Figure 4-7** (24-hour)					
SO_2	Data recovery	69.8%	42.2%	64.3%	52.0%	31.6%	35.6%
	No. of 1-hour NAAQS exceedances	0	1	0	1	3	0
	No. of 24-hour NAAQS exceedances	0	1	0	0	7	0
	No. of 24-hour WHO AQG exceedances	4	3	0	0	18	0
	Annual average (µg/m³)	3.0	7.2	7.2	1.3	18.7	9.7
	Graph	**Figure 4-8** (1-hour) and **Figure 4-10** (24-hour)			**Figure 4-9** (1-hour) and **Figure 4-11** (24-hour)		
CO	Data recovery	64.7%	76.6%	92.5%	Not measured		
	No. of 1-hour NAAQS exceedances	0	0	0			
	No. of 1-hour WHO AQG exceedances	0	0	0			
	No. of 8-hour NAAQS / WHO AQG exceedances	0	0	0			
	No. of 24-hour WHO AQG exceedances	0	0	0			
	Graph	**Figure 4-12** (1-hour), **Figure 4-13** (8-hour) and **Figure 4-14** (24-hour)					
PM_{10}	Data recovery	76.7%	74.1%	86.3%	Not measured		
	No. of 24-hour NAAQS exceedances	0	0	0			
	No. of 24-hour WHO AQG exceedances	10	12	4			
	Annual average (µg/m³)	18.2	20.1	21.8			

	SAAQIS Station	Maitland			Athlone		
	Managed by	Western Cape Province			City of Cape Town Municipality		
	Latitude (°S)	-33.920444			-33.955861		
	Longitude (°E)	18.515947			18.513111		
	Distance from Project site (km)	2.7			3.1		
	Direction from Project site	NE			SE		
Pollutant	**Year**	2022	2023	2024	2022	2023	2024
	Graph	**Figure 4-15** (24-hour)					
$PM_{2.5}$	Data recovery	78.8%	72.4%	88.1%	Not measured		
	No. of 24-hour NAAQS exceedances	0	0	0			
	No. of 24-hour WHO AQG exceedances	4	23	23			
	Annual average (µg/m³)	3.6	6.5	6.6			
	Graph	**Figure 4-16** (24-hour)					

Notes:

Orange	-	Below SANAS 90% data recovery requirement
Red	-	Exceeds short-term NAAQS or WHO AQG permitted frequency of exceedance
Red fill	-	Exceeds annual NAAQS
Orange	-	Exceeds annual WHO AQG

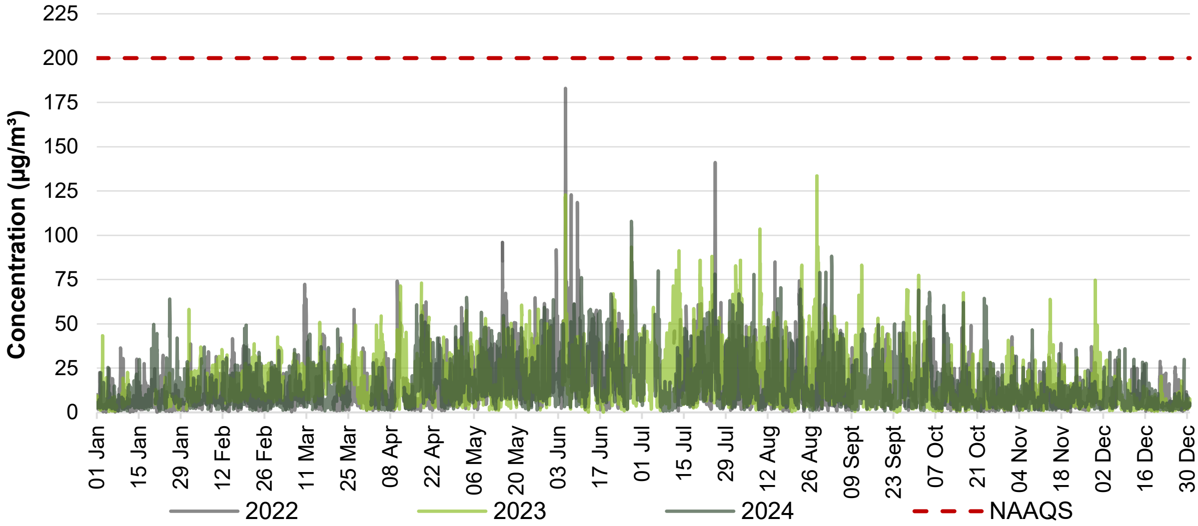


Figure 4-6: **Maitland - 1-hour average NO_2 concentrations (Jan 2022 - Dec 2024)**

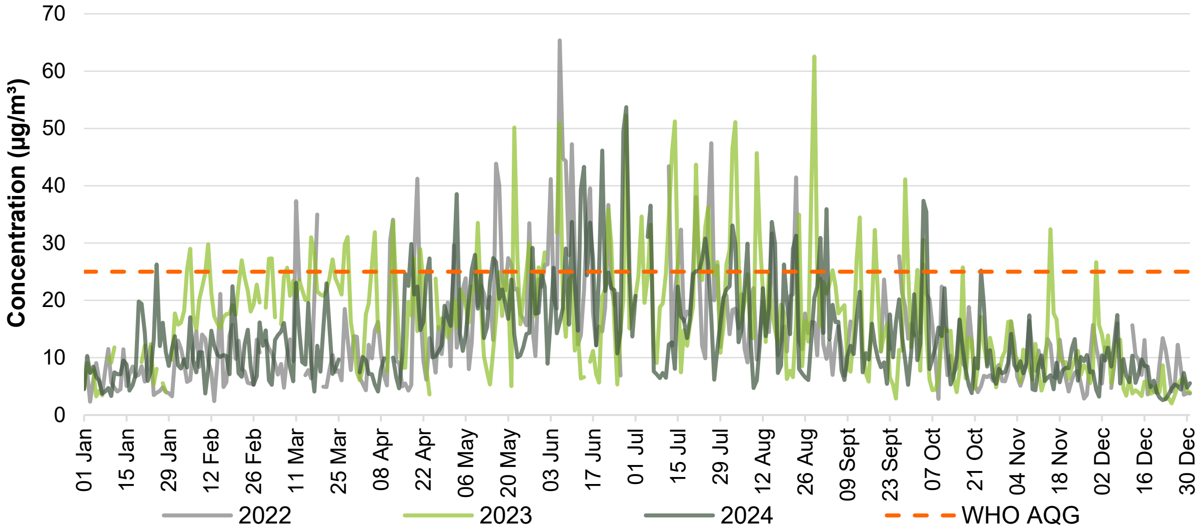


Figure 4-7: **Maitland - 24-hour average NO_2 concentrations (Jan 2022 - Dec 2024)**

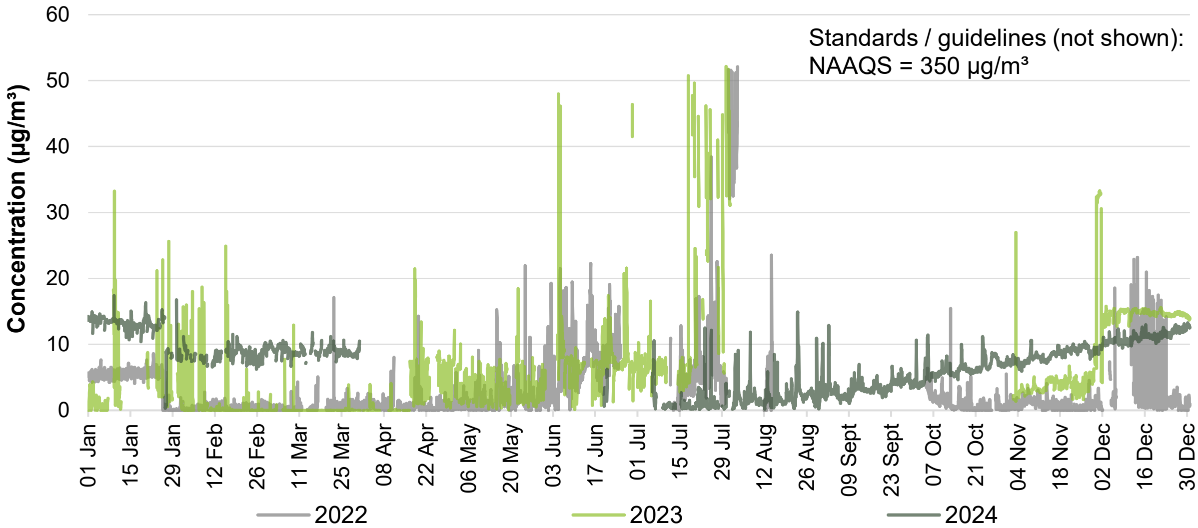


Figure 4-8: **Maitland - 1-hour average SO_2 concentrations (Jan 2022 - Dec 2024)**

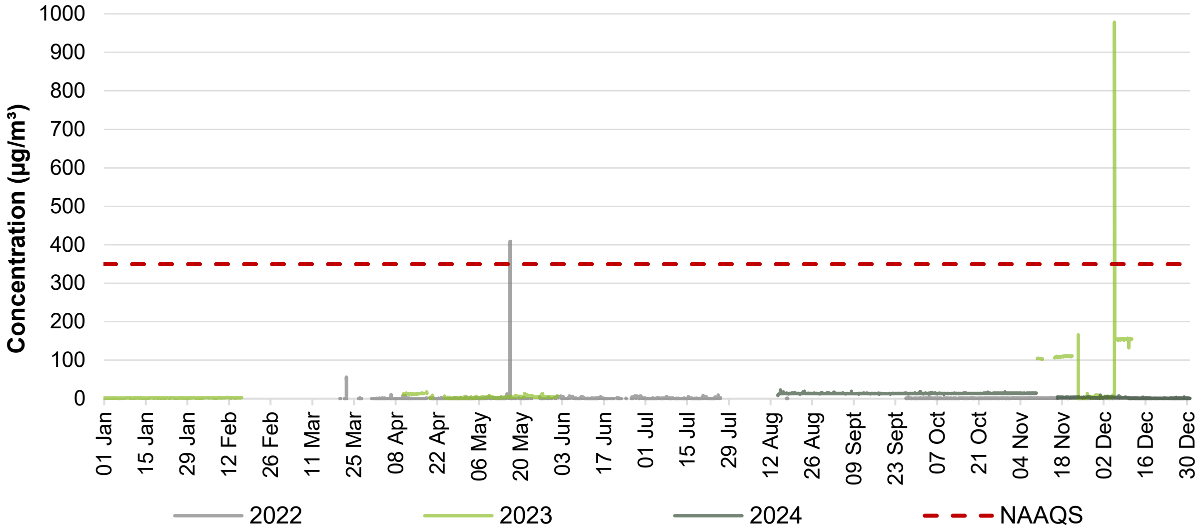


Figure 4-9: Athlone - 1-hour average SO_2 concentrations (Jan 2022 - Dec 2024)

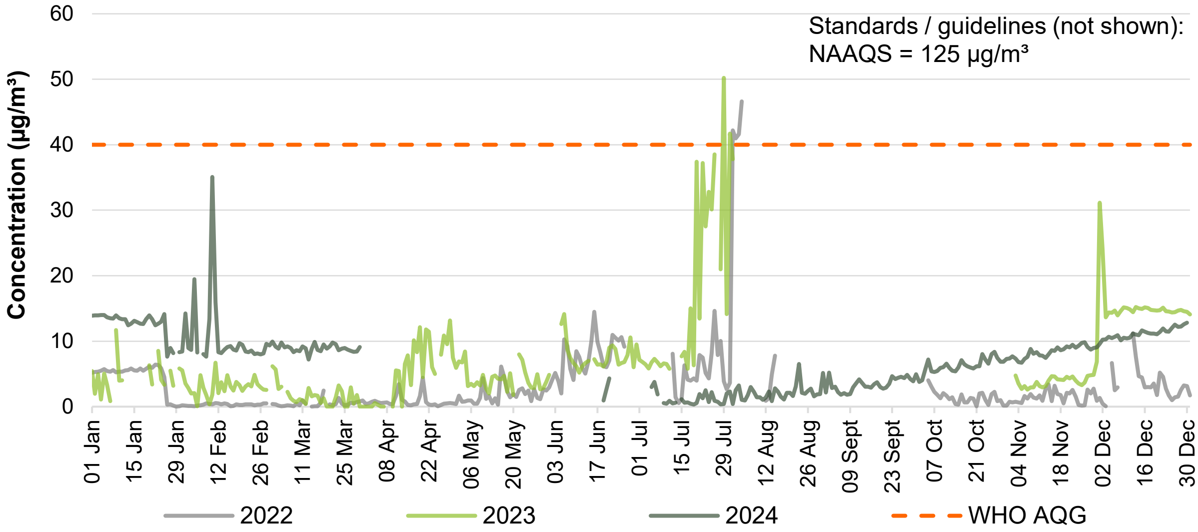


Figure 4-10: Maitland - 24-hour average SO_2 concentrations (Jan 2022 - Dec 2024)

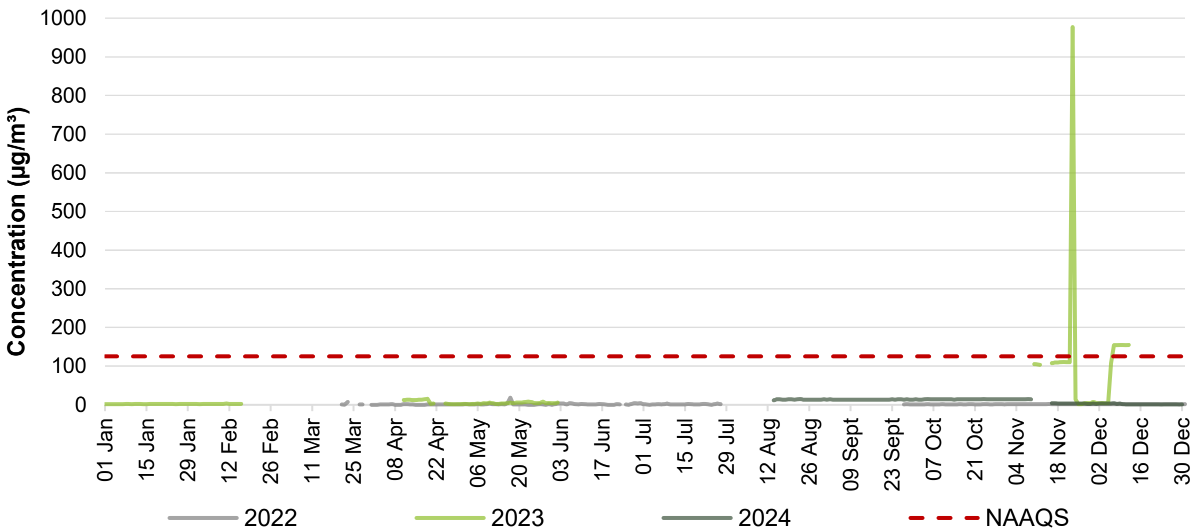


Figure 4-11: Athlone - 24-hour average SO_2 concentrations (Jan 2022 - Dec 2024)

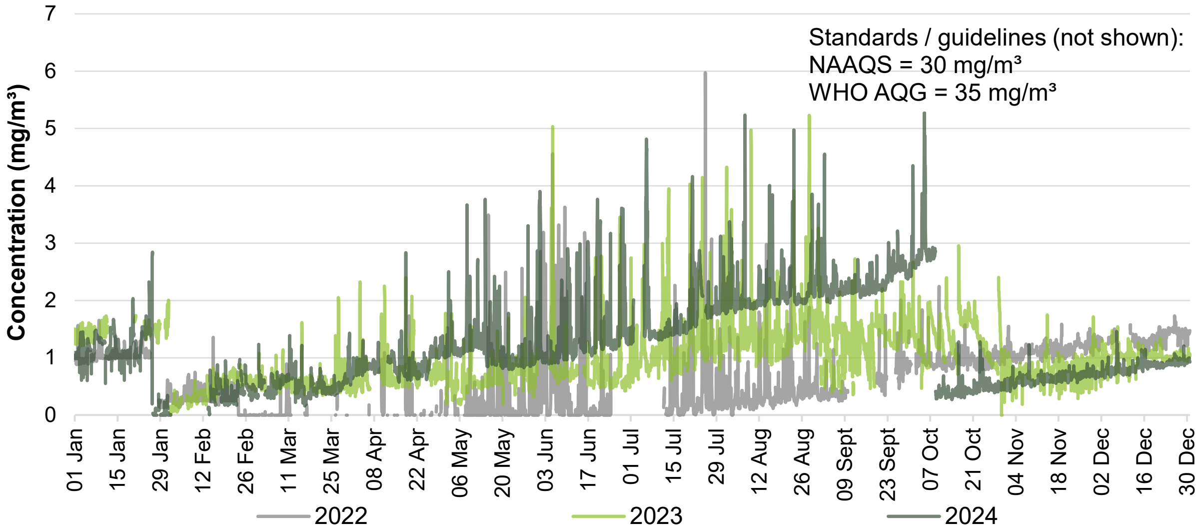


Figure 4-12: Maitland - 1-hour average CO concentrations (Jan 2022 - Dec 2024)

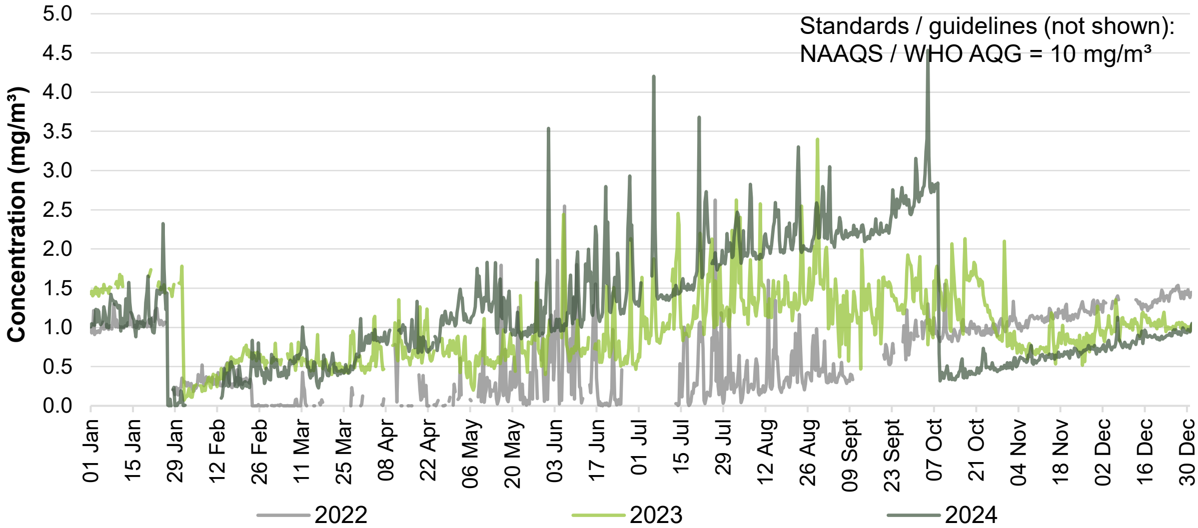


Figure 4-13: Maitland - 8-hour average CO concentrations (Jan 2022 - Dec 2024)

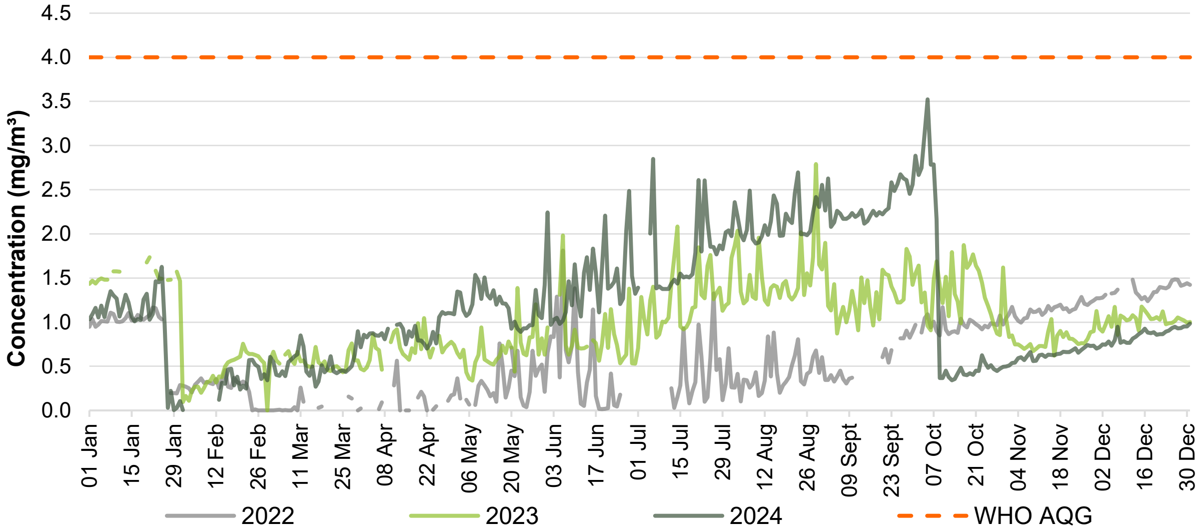


Figure 4-14: Maitland - 24-hour average CO concentrations (Jan 2022 - Dec 2024)

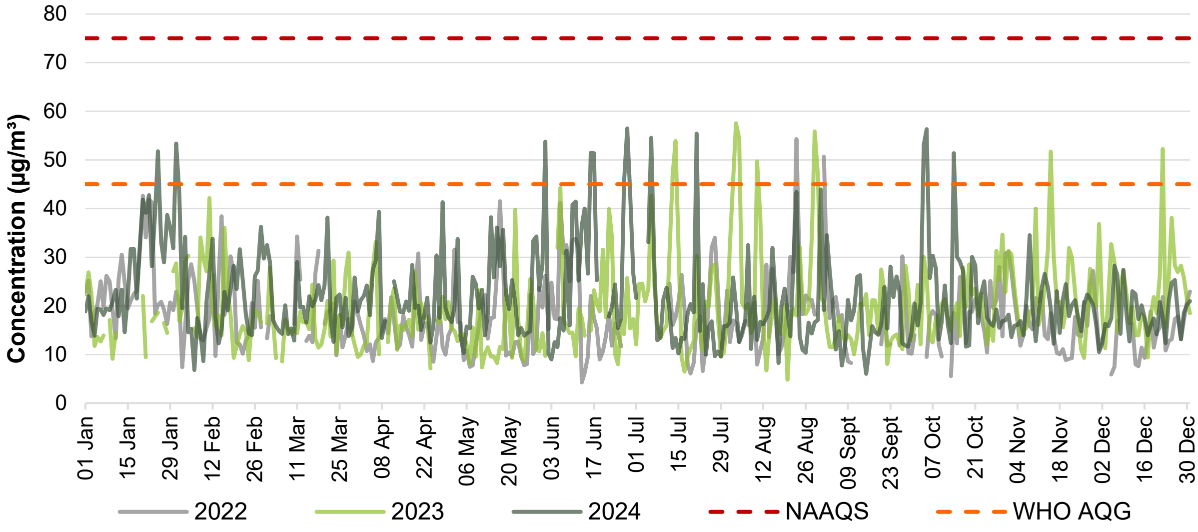


Figure 4-15: **Maitland - 24-hour average PM_{10} concentrations (Jan 2022 - Dec 2024)**

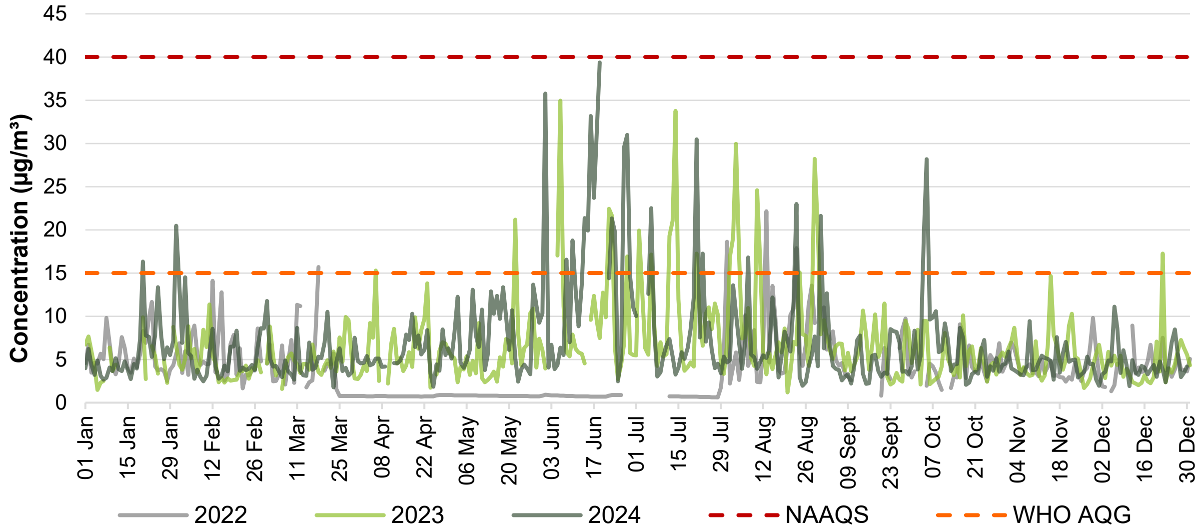


Figure 4-16: **Maitland - 24-hour average $PM_{2.5}$ concentrations (Jan 2022 - Dec 2024)**

4.3.3 Passive Gas Measurements

Biovac previously undertook passive gas monitoring at their existing facility proximate to the proposed development site, ~ 150 m south of the boundary, following complaints from nearby residents. The monitoring was undertaken by EXCO Environmental and Occupational Health Services[45] over a three-week period at five sampling locations (**Figure 4-17**), between 24th June - 7th July 2025 and focused on the measurement of VOC's including BTEX (benzene, toluene, ethylbenzene and xylenes). A summary of the monitoring results is provided in **Table 4-4**, **Figure 4-18**, **Figure 4-19** and **Figure 4-21**. Key findings include:

Benzene

- Benzene concentrations for all monitoring phases remained well below the annual NAAQS (5 µg/m³).

[45] EXCO Environmental and Occupational Health Services. 20 August 2025. Report on Ambient Air Quality Monitoring for 2025. Report No. 25-473.08BIO.

- Survey average benzene concentrations ranged from 0.97 µg/m³ to 3.06 µg/m³ across the monitoring locations.
- The highest survey average benzene concentration (3.06 µg/m³) was recorded at SP1, located northwest of the site boundary.

Toluene

- Toluene concentrations were consistently higher than other BTEX compounds but remained within the applicable guideline (refer to **Table 3.3**).
- Survey average toluene concentrations ranged from 3.21 µg/m³ to 7.80 µg/m³, with the highest levels recorded at SP1.

Ethylbenzene

- Ethylbenzene concentrations remained low across all monitoring phases and sites.
- Survey average concentrations ranged from 0.62 µg/m³ to 1.37 µg/m³, with the highest levels recorded at SP1.
- All measured values were well below relevant international health-based guideline limits (refer to **Table 3.3**).

Total Xylenes

- Total xylene concentrations (all isomers) were generally low and showed limited spatial variability.
- Survey average concentrations ranged from 3.22 µg/m³ to 6.80 µg/m³.
- Measured concentrations remained below applicable international guideline values for xylene (refer to **Table 3.3**).

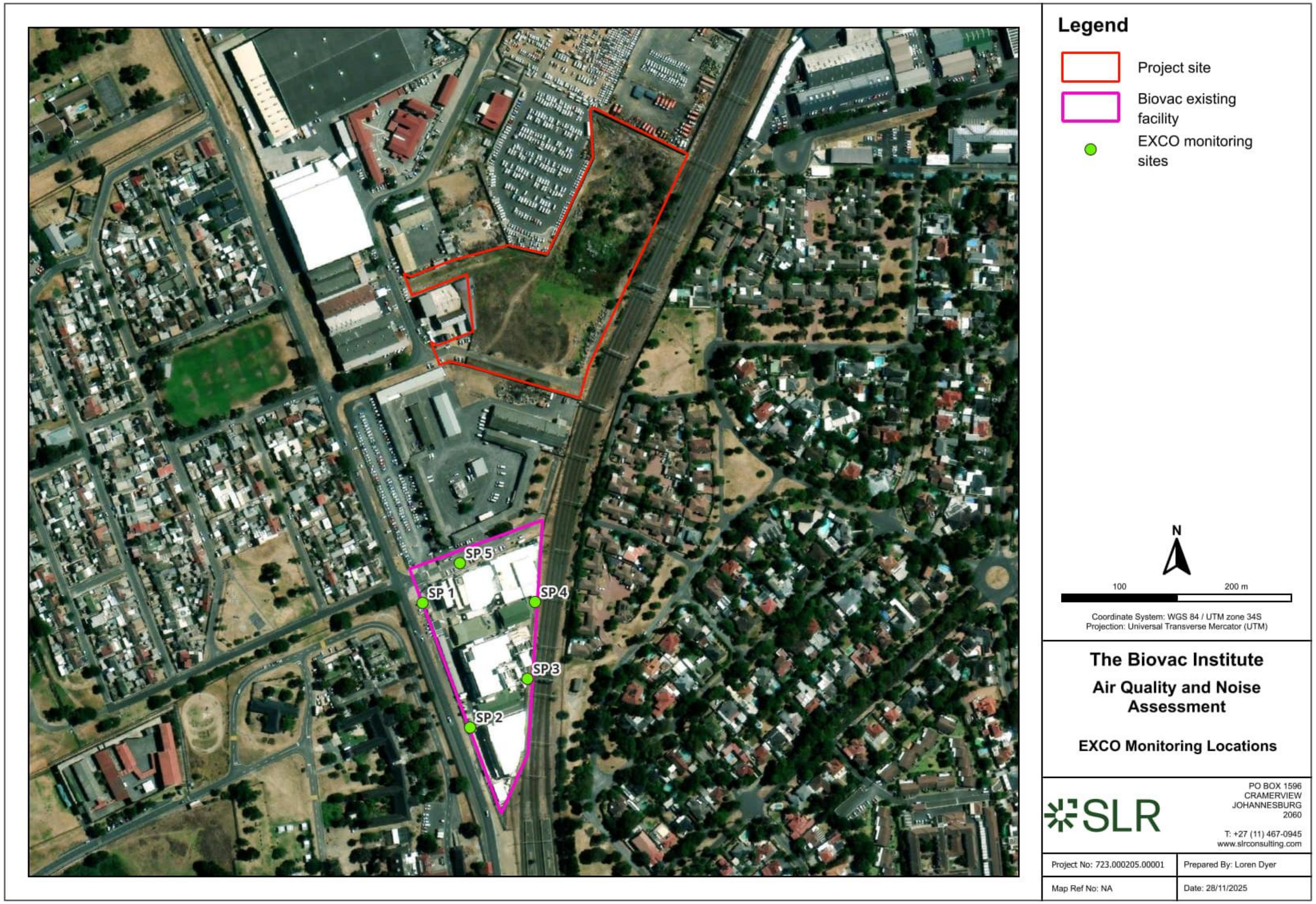


Figure 4-17: Proximity of EXCO monitoring locations to the proposed development site

Table 4-4: Measured benzene, toluene, ethylbenzene and total xylenes for the existing Biovac facility

Monitoring Period				Phase 1 (µg/m³)				Phase 2 (µg/m³)				Phase 3 (µg/m³)				Survey Average (µg/m³)			
				24/06/2025 - 01/07/2025				01/07/2025 - 08/07/2025				08/07/2025 - 15/07/2025				24/06/2025 - 15/07/2025			
Pollutant				Benzene	Toluene	Ethyl benzene	Total Xylenes	Benzene	Toluene	Ethyl benzene	Total Xylenes	Benzene	Toluene	Ethyl benzene	Total Xylenes	Benzene	Toluene	Ethyl benzene	Total Xylenes
Site ID	Direction from Boundary	Latitude (ºS)	Longitude (ºE)																
Sampling Point 1 (SP 1)	NW	-33.936683	18.489536	4.79	14.80	2.73	13.07	4.14	7.77	1.26	6.44	0.25	0.82	0.13	0.90	3.06	7.80	1.37	6.80
Sampling Point 2 (SP 2)	S	-33.937672	18.489956	3.52	6.81	1.31	5.23	2.32	6.08	1.18	5.69	0.24	0.80	0.18	0.97	2.03	4.56	0.89	3.96
Sampling Point 3 (SP3)	E	-33.9373	18.490508	2.68	6.71	0.75	3.63	2.98	8.39	1.83	8.14	0.32	0.80	0.18	0.96	1.99	5.30	0.92	4.24
Sampling Point 4 (SP 4)	NE	-33.936697	18.490597	1.78	4.90	1.45	4.62	1.54	3.77	0.90	3.97	0.33	0.97	0.06	1.08	1.22	3.21	0.80	3.22
Sampling Point 5 (SP5 5)	N	-33.936378	18.489897	1.73	4.16	0.72	3.54	0.88	4.06	1.09	6.35	0.30	2.06	0.04	2.03	0.97	3.43	0.62	3.97

Figure 4-18: Measured benzene (C_6H_6) concentrations (µg/m^3)

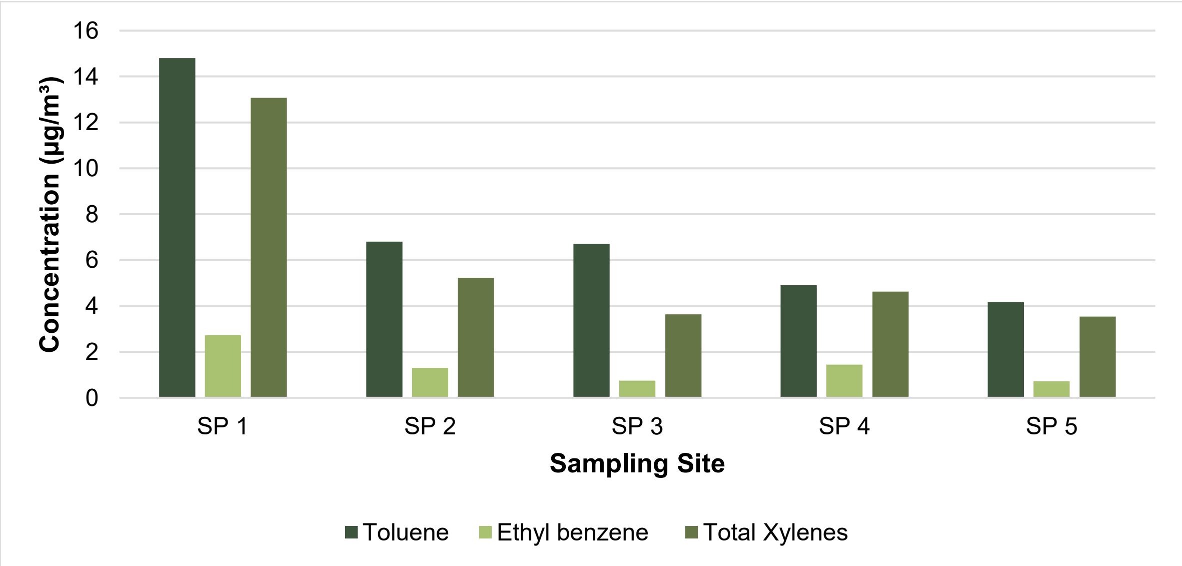


Figure 4-19: Measured toluene, ethylbenzene, and xylene concentrations (µg/m^3) - phase one (24/06/2025 - 01/07/2025)

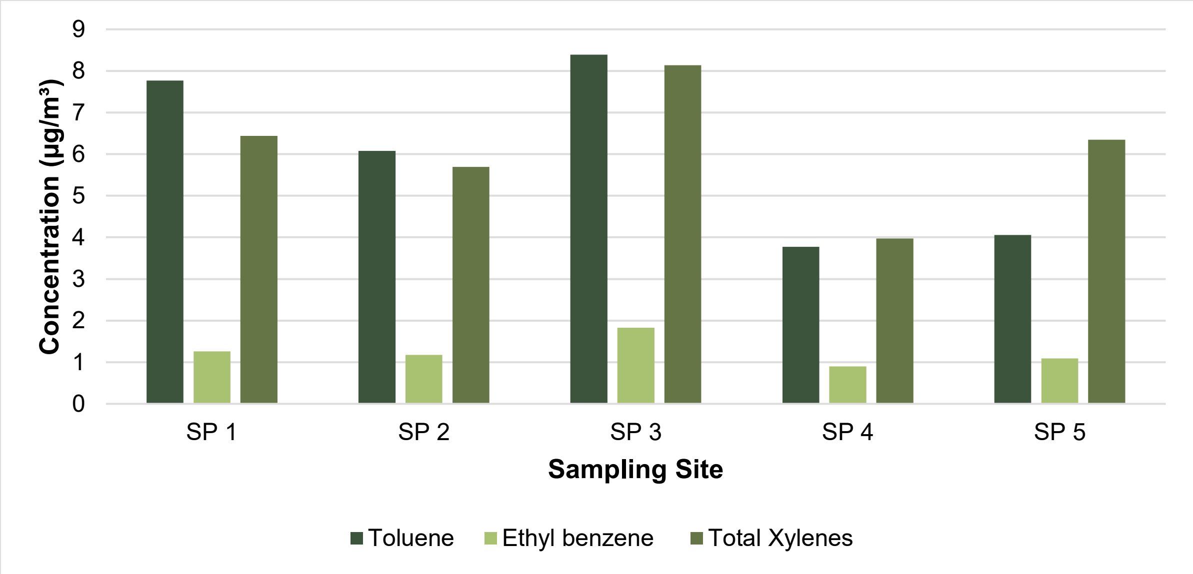


Figure 4-20: **Measured toluene, ethylbenzene, and xylene concentrations (µg/m³) - phase two (01/07/2025 - 08/07/2025)**

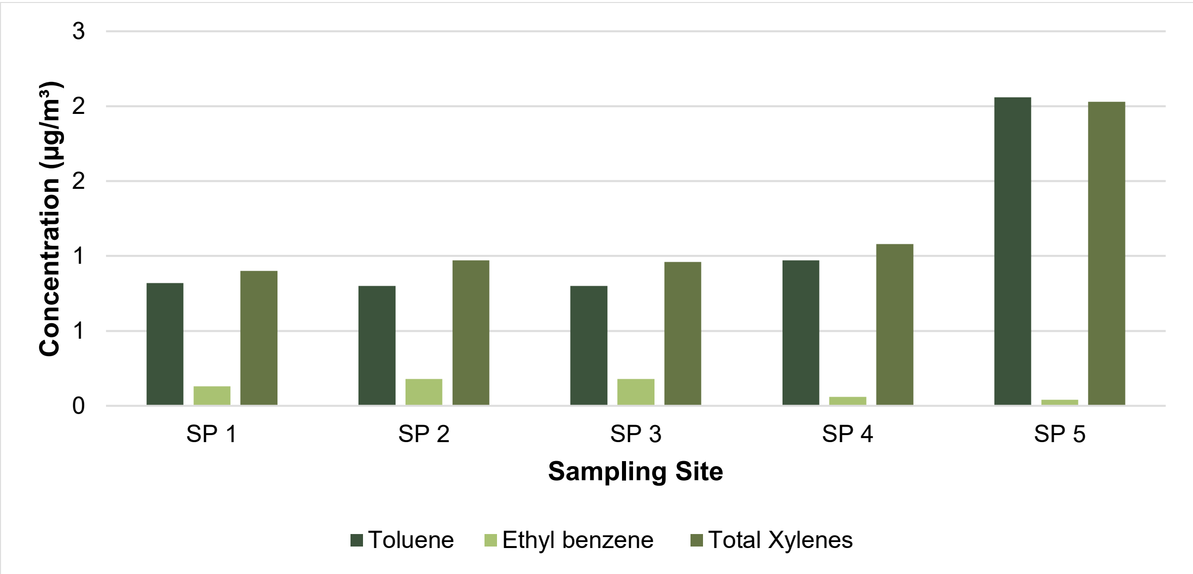


Figure 4-21: **Measured toluene, ethylbenzene, and xylene concentrations (µg/m³) - phase three (08/07/2025 - 15/07/2025)**

5. Baseline Data Collection

5.1 Monitoring Protocol

5.1.1 Monitoring Locations

Monitoring locations were selected based on site layout, prevailing meteorology, accessibility and safety considerations. are presented in **Table 5-1** and **Figure 5-1**. Fieldwork photos are provided in **Appendix C**. Field observations are presented in **Appendix D**.

Table 5-1: Monitoring locations

Unit Name / Site ID	Site Description	Latitude (°S)	Longitude (°E)	Parameter's
Fenceline 1 (FL1)	Southern corner of property	-33.935121	18.491090	NO_2, SO_2, NH_3 & BTEX
Fenceline 3 (FL3)	Northern fenceline	-33.933899	18.490432	NO_2, SO_2, NH_3, BTEX, $PM_{2.5}$ and PM_{10}

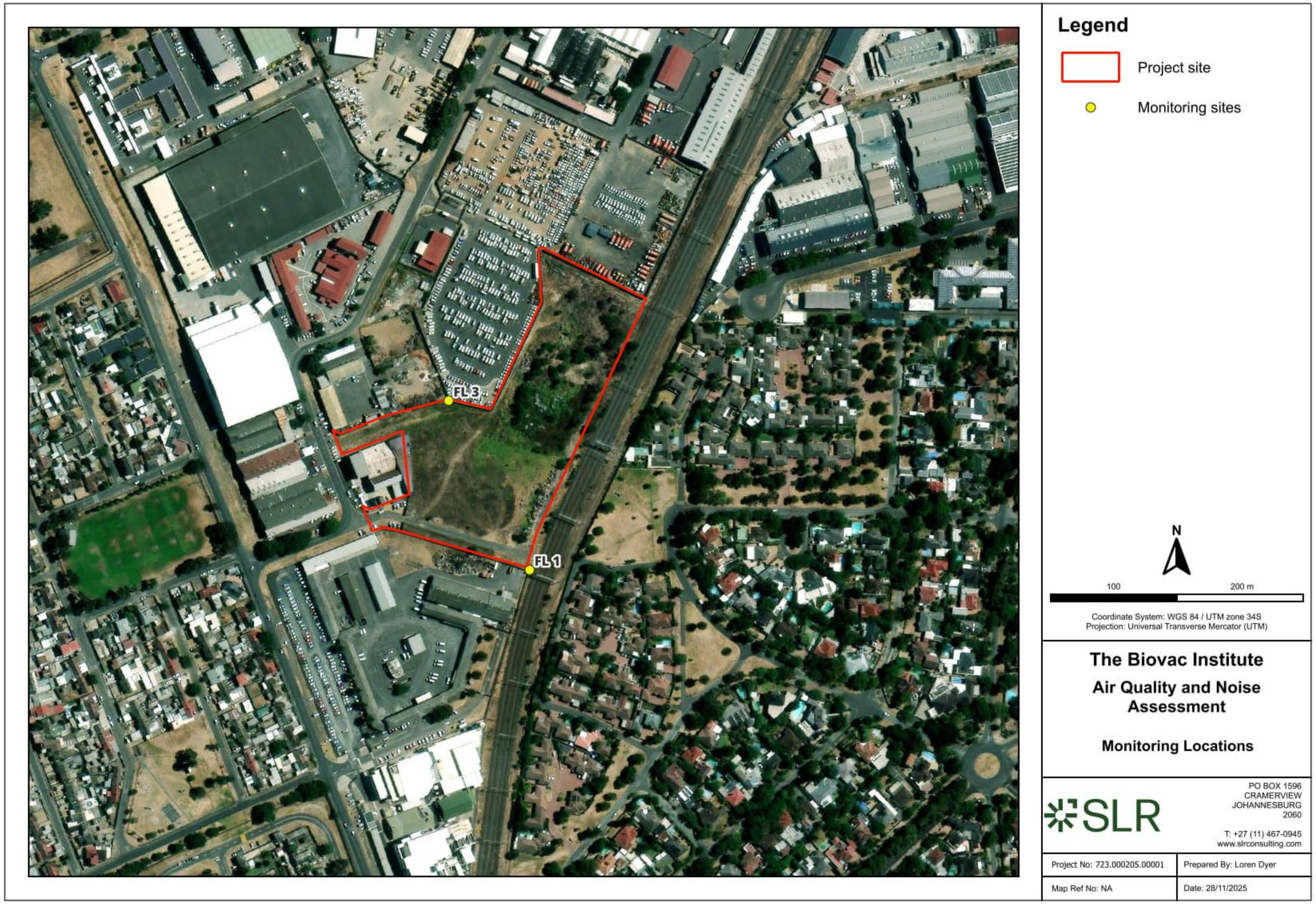


Figure 5-1: Monitoring locations

5.1.2 Equipment

5.1.2.1 Continuous Fine Particulate Monitoring

PM_{10} and $PM_{2.5}$ concentrations and meteorological parameters (temperature, rainfall, humidity, wind speed and wind direction) concentrations were measured using a Dustroid Pro continuous analyser located at FL3. The Dustroid Pro was installed on the 15th December 2025 and collected on 15th January 2026 (i.e. 32 days).

The Dustroid Pro operates on the laser scattering working principle. Dustroid comes with a heated inlet for dehumidification of air-sample for improved accuracy and stability. Site selection combined technical requirements, spatial coverage, accessibility, safety, and security aspects. The unit was installed with sufficient clearance of nearby obstacles to allow the free flow of air around the Dustroid inlet.

5.1.2.2 Passive Gas Measurement

Passive sampling is a measurement method based on the free flow of analyte molecules from a sample medium (air in this case) to a collection medium (such as activated carbon) due to the difference in chemical potentials between the two media. The net flow of analyte molecules from one medium to the other continues until equilibrium is reached or until the exposure period is terminated[46].

Passive measurements are collected using Radiello® passive diffusive samplers. A Radiello® passive sampler is a solid sorbent in an inert container into which vapours diffuse. The apparatus (**Figure 5-2**) comprises:

- The support plate.
- The diffusive body (varying in permeative properties depending on the target pollutant).
- The chemical absorbing cartridge containing a sorbent material.

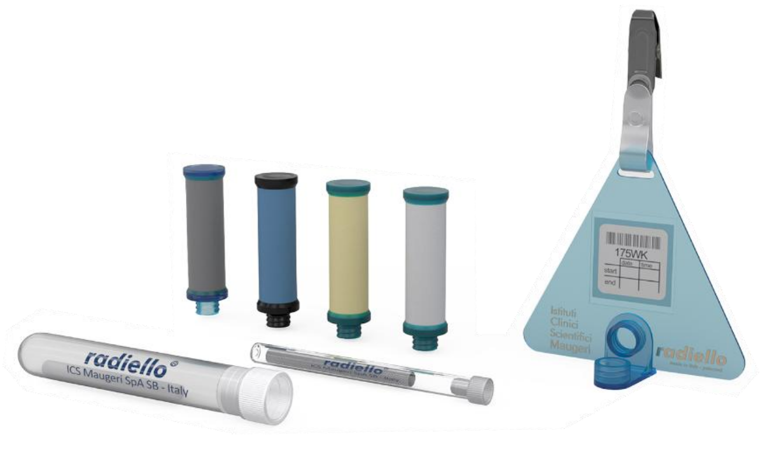


Figure 5-2: Radiello® diffusive sampling components for air quality monitoring

Samplers are assembled and deployed for a designated exposure period. The analyte compounds trapped by the sorbent are then extracted and measured in a laboratory, and a time-weighted average can be calculated. Radiello® recommend specific exposure periods depending on the application to allow for adequate adsorption of the target gases onto the sorbent material, but also to avoid saturation point or a result below the detection limit (BDL) of the analytical method.

[46] Namieśnik, J. (2002): *Passive Sampling*. Trends in Analytical Chemistry, Vol. 21, No. 4, Pg 276 - 291

The NO_2, SO_2, NH_3 and BTEX passive gas monitoring network comprised two locations, along the Project site boundary (FL1 at the southern corner of the boundary and FL3 at the northern fenceline). Samplers were deployed over two consecutive sampling phases of ±14 days to provide a full month of results. The date and time of sampler deployment and collection was recorded according to Radiello® specifications (**Table 5-2**). Field photographs and log sheets are provided in **Appendix C** and **Appendix D**, respectively. Samples were sent to a South African National Accreditation System (SANAS) accredited laboratory for analysis (**Appendix E**).

Table 5-2: Passive sample exposure periods and sample IDs

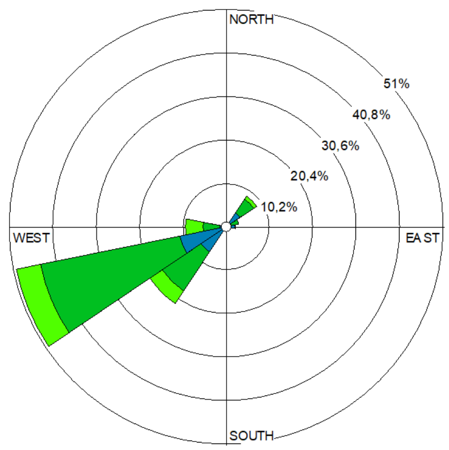
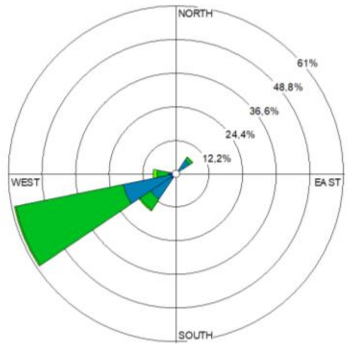
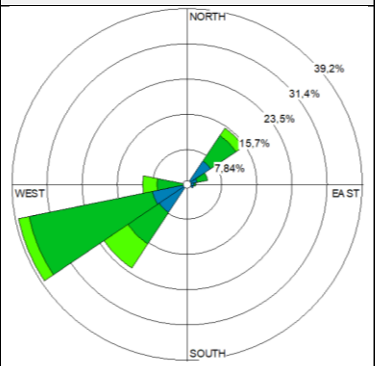
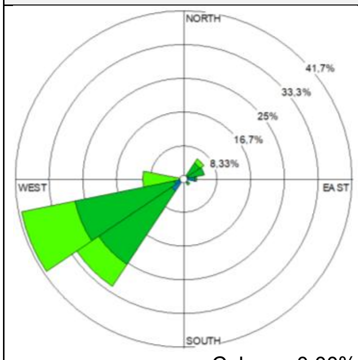
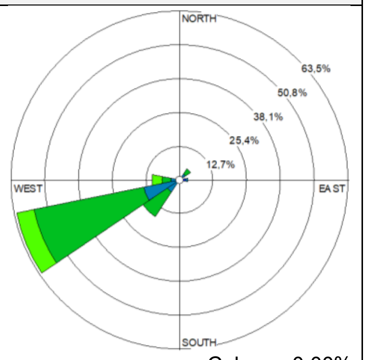
Site ID	Start Date	Start Time	End Date	End Time	Sample ID		
					SO_2/NO_2	NH_3	BTEX
Phase 1							
FL1	11/12/2025	09:02	23/12/2025	13:02	YN380	YN379	YN378
FL3					YN381	YN375	YN387
Phase 2							
FL1	23/12/2025	13:00	07/01/2026	13:00	WQ880	WQ881	WQ879
FL3					WQ885	WQ884	WQ883

5.2 Results

5.2.1 Meteorology

This section presents an overview of meteorological conditions over the monitoring survey period. The average ambient temperature was 23.4 °C. Wind speeds ranged from 0.5 m/s (light air) to 8 m/s (moderate breeze), with predominantly west–southwesterly winds recorded throughout the early morning, morning, afternoon, and nighttime periods. Only minor directional variability was observed between time periods. Wind conditions generally calmed during the late afternoon and evening hours. There was no rainfall recorded during the survey period. A wind rose was generated using Lakes Environmental WRPlot Freeware (Version 12.0.0) using wind speed and direction data collected by the Dustroid Pro continuous analyser located at FL3. The wind field is described in **Table 5-3**.

Table 5-3: Wind field description and wind rose chart for the monitoring period

Biovac	Early Morning	Morning
15/12/2025 - 15/01/2026	00h00 - 06h00	06h00 - 12h00
 Calms = 0.47% WIND SPEED (m/s) 5.50 - 8.00 3.40 - 5.50 1.60 - 3.40 0.50 - 1.60	 Calms = 1.20%	 Calms = 0.40%
	Afternoon	**Evening**
	12h00 - 18h00	18h00 - 24h00
	 Calms = 0.00%	 Calms = 0.00%

Wind field description:	
Proportion calm (<0.5 m/s) conditions	0.47% of the time
Wind speed range	Wind speeds range from light (defined as 0.5 - 1.6 m/s) to moderate breeze (defined as 5.50 - 8.00 m/s).
Prevailing wind direction	From the west-southwest
Peak hourly wind speed and direction	6.94 m/s from the west during the afternoon hours (12h00 - 18h00).
Highest average wind speed and direction	4.96 m/s from the west during the afternoon hours (12h00 - 18h00).
Diurnal variation	Prevailing along south-westerly trajectories both day and night.

5.2.2 Continuous Fine Particulate Monitoring

Continuous PM monitoring was undertaken using the Dustroid Pro over the period 15th December 2025 to 15th January 2026. The dataset was analysed for the full monitoring period and assessed for compliance with NAAQS and the IFC/WHO AQG. A minimum data recovery of 90% is required for assessing compliance with national standards[47]. Data recovery, the period average, and the number of short-term (24-hour) NAAQS or IFC/WHO AQG exceedances are presented in **Table 5-4**. 24-hour average concentrations are graphically presented in **Figure 5-3**.

There were no 24-hour NAAQS or IFC/WHO AQG exceedances recorded over the monitoring period for both $PM_{2.5}$ and PM_{10}. The period average of 12.48 µg/m^3 for $PM_{2.5}$ complies with the annual NAAQS (20 µg/m^3), while exceeding the most stringent IFC/WHO AQG annual limit of 5 µg/m^3. The period average of 23.92 µg/m^3 for PM_{10} complies with the annual NAAQS (40

[47] South African National Accreditation System (SANAS, 2012) in *TR 07-03*

µg/m³), while exceeding the most stringent IFC/WHO AQG of 15 µg/m³. We highlight the inherent conservatism in comparing a one-month average with annual guidelines.

Table 5-4: Ambient PM summary for the period 15th December 2025 - 15th January 2026

PM size fraction	Data recovery (%)	Period average concentration (µg/m³)	99th percentile 24-hour average (µg/m³)	No. of 24-hour NAAQS exceedances	No. of 24-hour IFC/WHO AQG exceedances
$PM_{2.5}$	99%	5.41	12.48	0	0
PM_{10}	99%	11.10	23.92	0	0
Notes:					
Orange	- Below SANAS 90% data recovery requirement				
Red	- Exceeds NAAQS permitted number of exceedances				

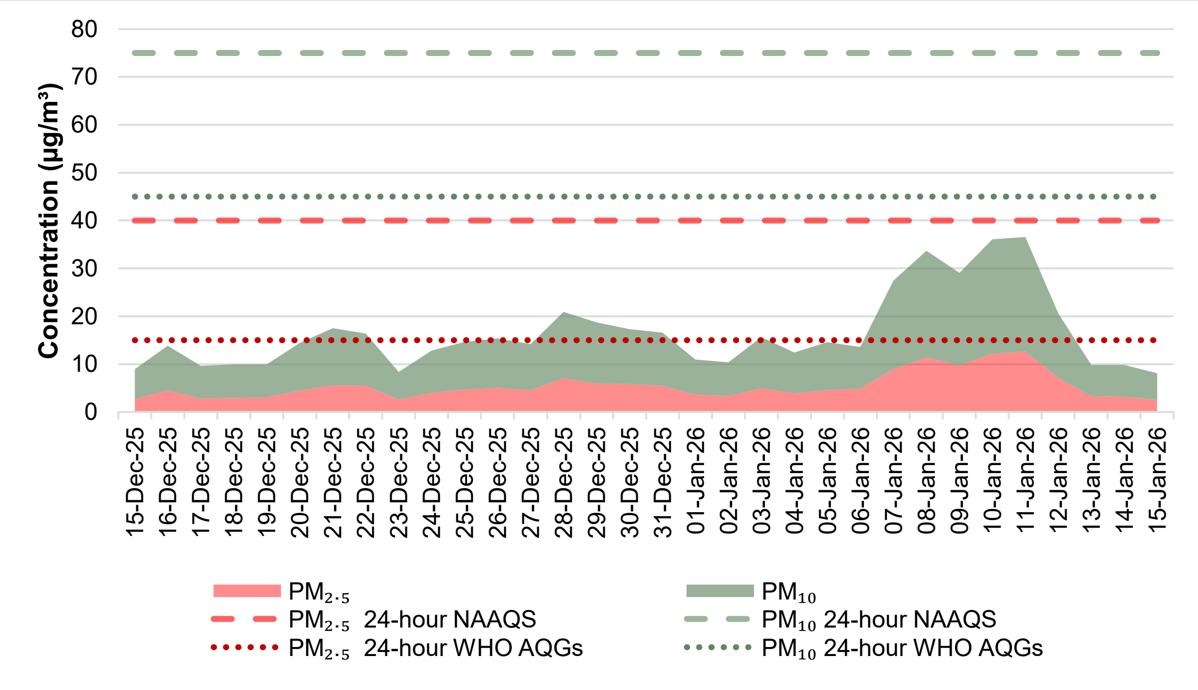


Figure 5-3: Measured $PM_{2.5}$ and PM_{10} concentrations (µg/m³)

5.2.3 Passive Gas Measurement

5.2.3.1 Sulphur dioxide

Measured SO_2 concentrations are presented in **Table 5-5** and **Figure 5-4**. Key findings are as follows:

- SO_2 concentrations during both phases remained well below the annual NAAQS (50 µg/m³). No comparable annual guideline value is provided under the WHO AQGs.
- The highest average SO_2 concentration for the survey period was recorded at FL3 (0.63 µg/m³).

Table 5-5: Measured SO_2 concentrations (µg/m³)

		Phase 1	Phase 2	Survey Average
Period		11/12/2025 - 23/12/2025	23/12/2025 - 07/01/2025	11/12/2025 - 07/01/2025
Site ID	FL1	0.31	0.66	0.49
	FL3	<0.02	0.63	0.63

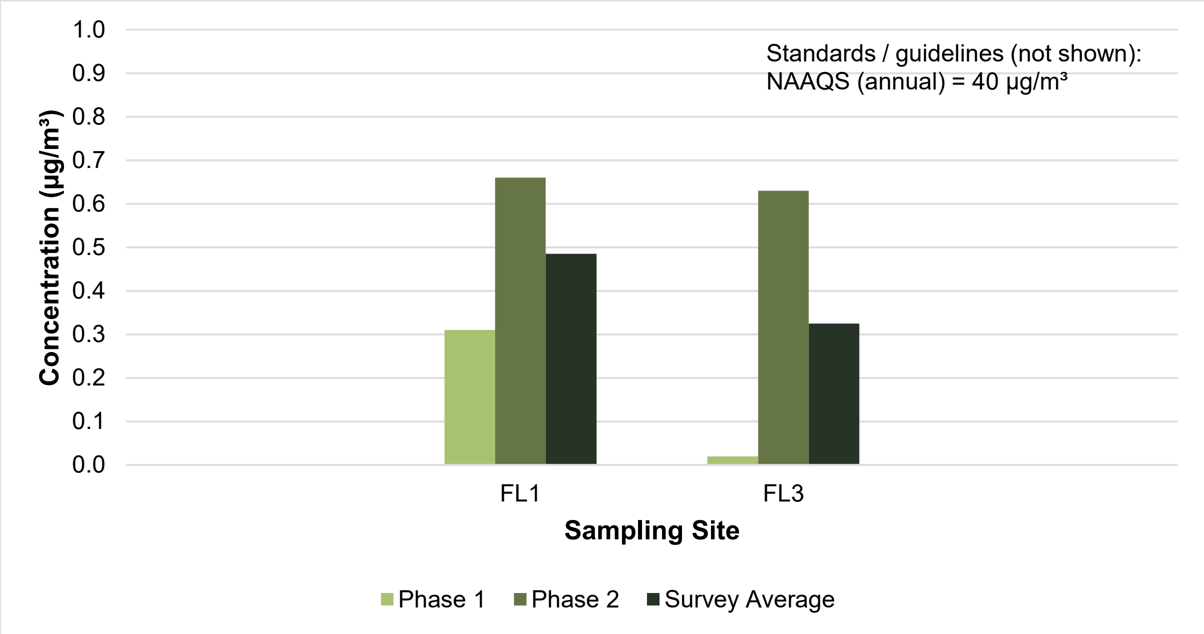


Figure 5-4: Measured SO_2 concentrations (µg/m³)

5.2.3.2 Nitrogen dioxide

Measured NO_2 concentrations are presented in **Table 5-6** and **Figure 5-5**. Key findings are as follows:

- NO_2 concentrations during both phases remained well below the annual NAAQS (40 µg/m³) and the annual WHO AQG.
- The highest average NO_2 concentration for the survey period was recorded at FL3 (5.04 µg/m³).

Table 5-6: Measured NO_2 concentrations (µg/m³)

		Phase 1	Phase 2	Survey Average
Period		11/12/2025 - 23/12/2025	23/12/2025 - 07/01/2025	11/12/2025 - 07/01/2025
Site ID	FL1	4.24	4.38	4.31
	FL3	3.96	6.11	5.04

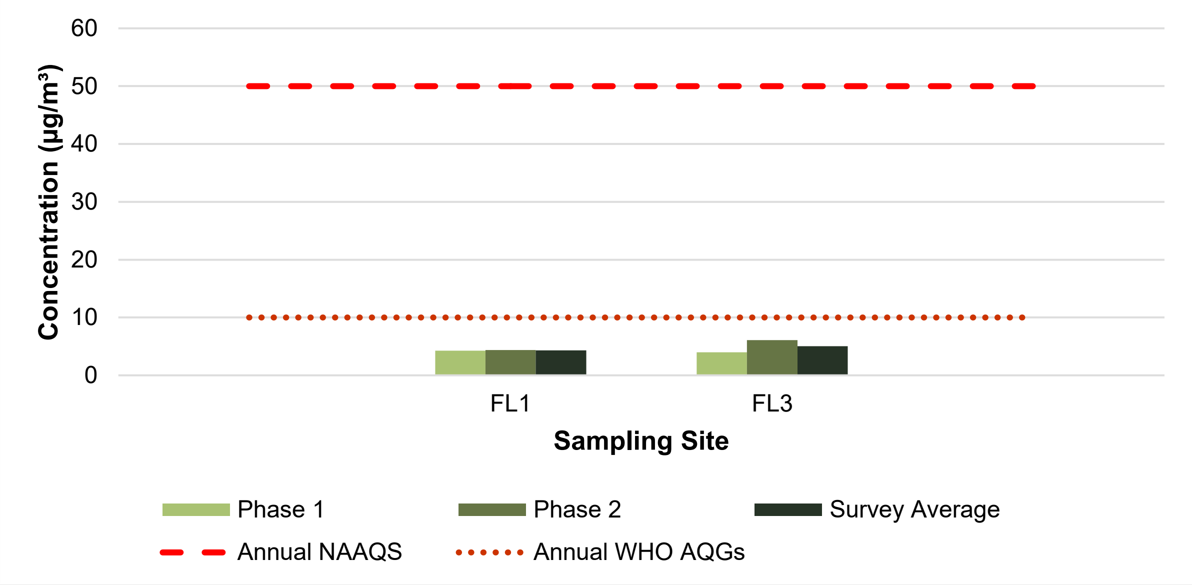


Figure 5-5: Measured NO_2 concentrations (µg/m^3)

5.2.3.3 Ammonia

Measured NH_3 concentrations are presented in **Table 5-7** and **Figure 5-6**. Key findings are as follows:

- NH_3 concentrations during both phases were overall very low and significantly below the TCEQ ESL (92 µg/m^3).
- The highest average NH_3 concentration for the survey period was recorded at FL3 (0.30 µg/m^3).

Table 5-7: Measured NH_3 concentrations (µg/m^3)

		Phase 1	Phase 2	Survey Average
Period		11/12/2025 - 23/12/2025	23/12/2025 - 07/01/2025	11/12/2025 - 07/01/2025
Site ID	FL1	0.18	0.38	0.28
	FL3	0.18	0.41	0.30

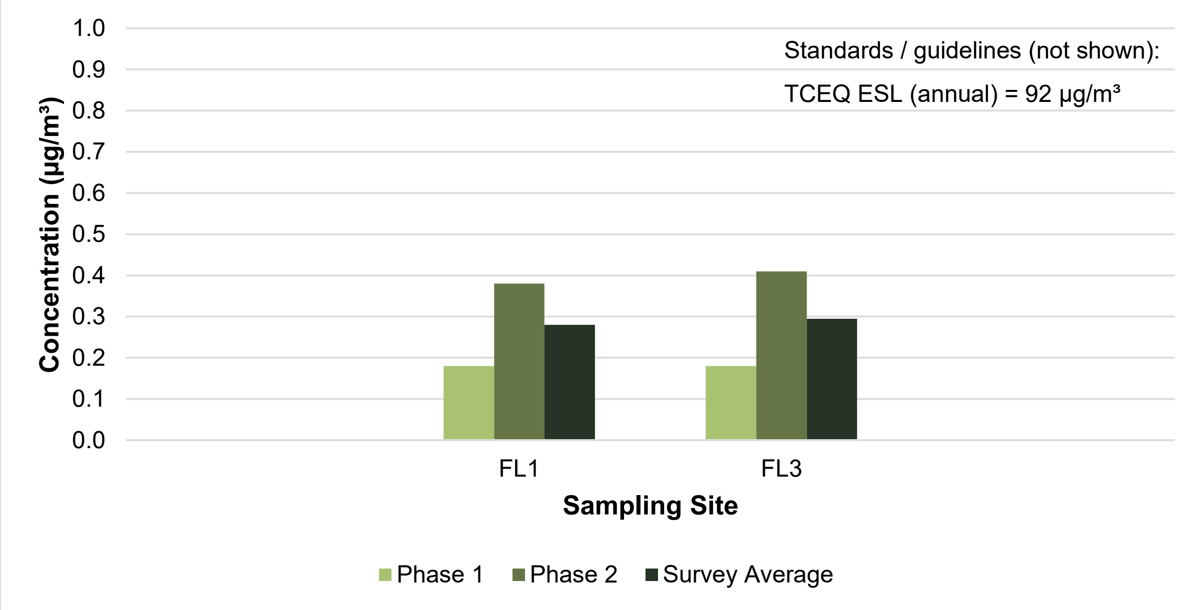


Figure 5-6: Measured NH_3 concentrations (µg/m^3)

5.2.3.4 Benzene

Measured C_6H_6 concentrations are presented in **Table 5-8** and **Figure 5-7.** Key findings are as follows:

- C_6H_6 concentrations during both phases remained well below the annual NAAQS (5 µg/m^3).
- The highest average C_6H_6 concentration was recorded at FL 3 (0.53 µg/m^3).

Table 5-8: Measured C_6H_6 concentrations (µg/m^3)

		Phase 1	Phase 2	Survey Average
Period		11/12/2025 - 23/12/2025	23/12/2025 - 07/01/2025	11/12/2025 - 07/01/2025
Site ID	FL1	0.33	0.61	0.47
	FL3	0.41	0.64	0.53

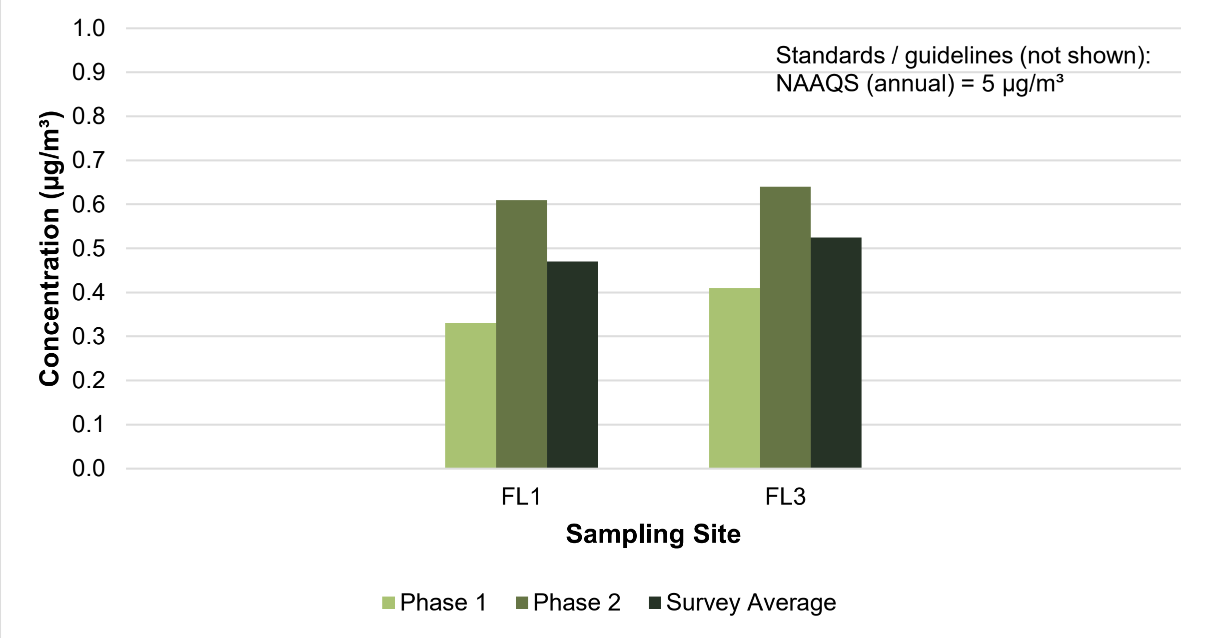


Figure 5-7: Measured C_6H_6 concentrations (µg/m^3)

5.2.3.5 Other VOCs

Measured toluene, ethylbenzene and xylene concentrations are presented in **Table 5-9**, **Figure 5-8** (phase one), and **Figure 5-9** (phase two). Key findings are as follows:

- Measured concentrations for ethylbenzene and xylene (all isomers) during both phases remained below the respective international guidelines (refer to **Table 3.3**).
- Highest average concentrations for the survey period were recorded as follows:
  - Toluene - FL3 (0.82 µg/m^3).
  - Ethylbenzene - FL1 and FL3 (<0.28 µg/m^3).
  - Xylene (all isomers) - FL3 (0.74 µg/m^3).
- All measured values were well below relevant international health-based limits (refer to **Table 3.3**).

Table 5-9: Measured toluene, ethylbenzene, and xylene concentrations (µg/m^3)

Site ID	Phase 1			Phase 2			Survey average		
	11/12/2025 - 23/12/2025			23/12/2025 - 07/01/2025			11/12/2025 - 07/01/2025		
	Toluene	Ethyl-benzene	Xylenes	Toluene	Ethyl-benzene	Xylenes	Toluene	Ethyl-benzene	Xylenes
FL1	0.68	<0.28	0.65	0.92	0.28	0.81	0.80	<0.28	0.73
FL3	0.63	<0.28	0.65	1	0.28	0.83	0.82	<0.28	0.74

Notes:
For conservative health risk screening of xylenes, concentrations reported below the laboratory detection limit were assumed to be equal to the detection limit when calculating total compound concentrations.

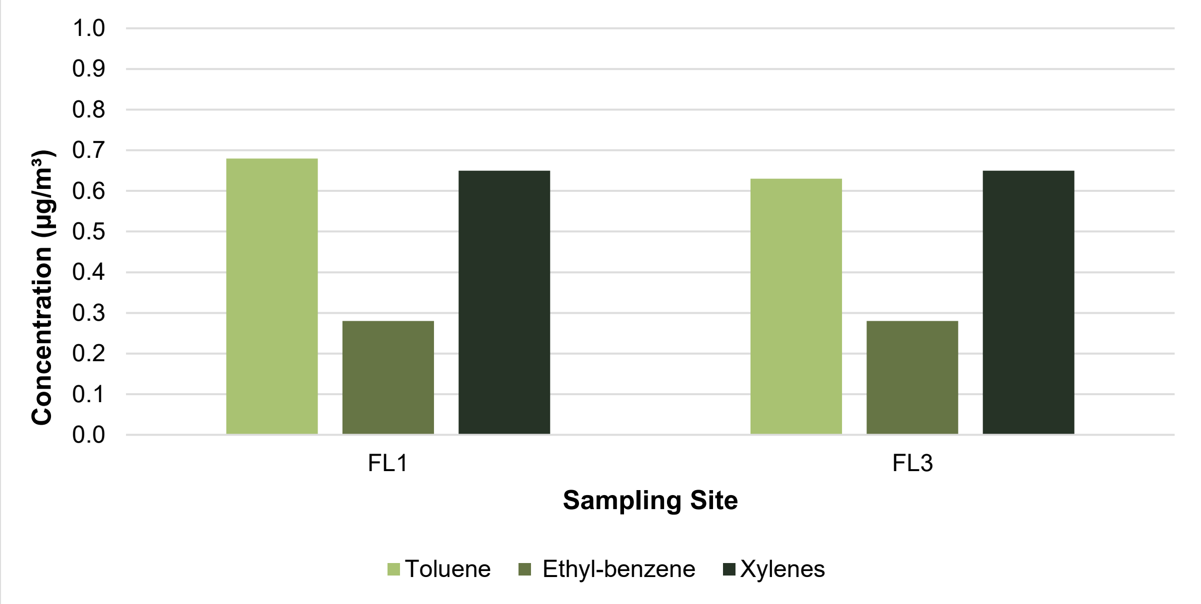


Figure 5-8: Measured toluene, ethylbenzene, and xylene concentrations (µg/m³)– phase one (11/12/2025 - 23/12/2025)

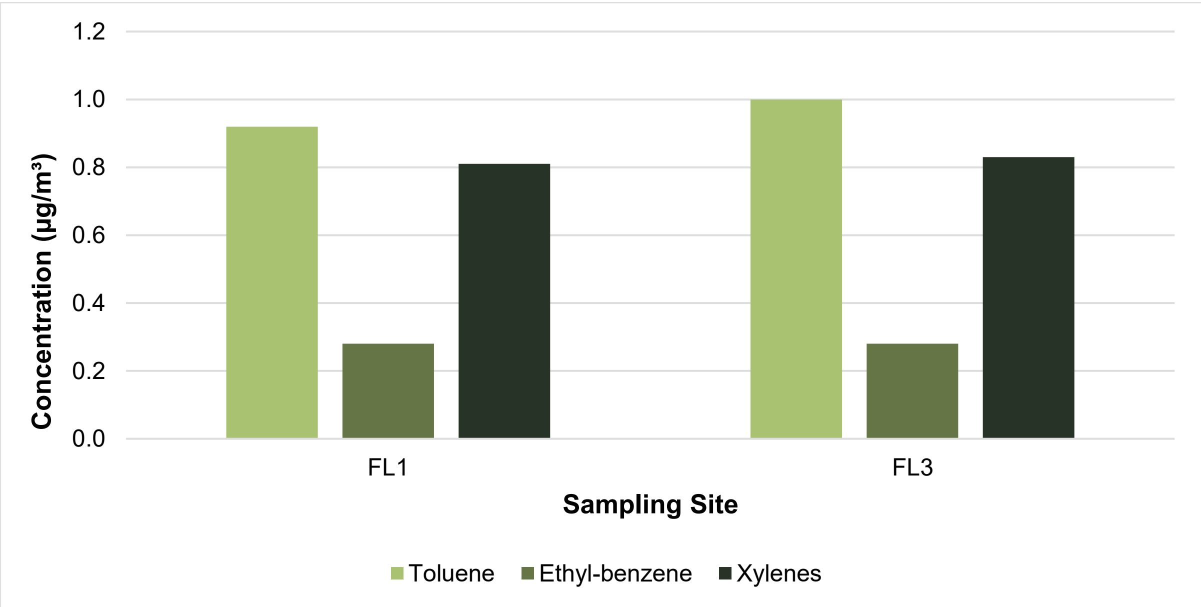


Figure 5-9: Measured toluene, ethylbenzene, and xylene concentrations (µg/m³) - phase two (23/12/2025 - 07/01/2025)

6. Recommended Management Measures

The management measures provided **Table 6-1** are intended to ensure that potential air emissions associated with construction and operational activities, including minor combustion sources, solvent use, cleaning agents, and fugitive dust, are effectively managed in line with applicable regulatory requirements, and international best practice. These measures reflect good clinical practice required for safe and compliant vaccine manufacturing and likely are already incorporated into the facility's design specifications. Given the low emission intensity typically associated with vaccine manufacturing facilities, the implementation of these measures is expected to maintain ambient air quality within acceptable limits and minimise potential impacts on surrounding receptors.

Table 6-1: Recommended management measures

Category	Management Measures
General	• Train all staff on air quality awareness, chemical handling, and operational controls, including cleanroom practices. • Integrate air quality controls into SOPs for formulation, fill-finish, cleaning, and waste handling operations. • Use high efficiency particulate air (HEPA) filtration and negative/positive pressure zones to prevent contamination and fugitive emissions. • Maintain proper plant layout to minimize cross-contamination between production, utility, and warehouse areas. • Ensure procurement of low-VOC cleaning agents, solvents, and disinfectants where feasible.
Reporting & Record-Keeping	• Maintain records of: • Fuel consumption for generators and boilers (if applicable) • Solvent and disinfectant usage • HVAC and filter maintenance • Exhaust / vent inspections • Complaints received and responses • Record incidents, deviations, and corrective actions for emissions or odour complaints.
Impact Reduction / Source Mitigation	• Install local exhaust ventilation (LEV) and HEPA filtration for particulate matter in vial FFF, blow-fill-seal, and lyophilisation areas. • Use closed transfer systems for solvents and inactivated OCV processing to reduce VOC and biological emissions. • Maintain chillers, and incinerators for minimal NO_x, SO_2, CO, and PM emissions. • Fugitive emissions control: sealed pipelines, vent hoods and secondary containment for chemical/solvent storage. • Schedule maintenance of equipment during low-production periods to reduce emissions spikes. • Use low-VOC cleaning agents where possible in bio-positive and bio-negative areas. • Use low-sulphur diesel or cleaner fuels for backup generators. • Maintain combustion equipment to minimise NO_x, SO_2, and particulate emissions. • Implement routine cleaning programmes in production, storage, and loading areas.

Category	Management Measures
	• Store solvents and disinfectants in ventilated, bunded areas. • Implement spill prevention and rapid clean-up procedures.
Complaints Management	• Establish a formal community grievance and complaints procedure. • Maintain a dedicated contact channel for environmental complaints. • Log and investigate complaints with clear response timelines. • Implement corrective measures and communicate outcomes to complainants.
Monitoring & Evaluation	• Periodically inspect exhaust outlets and ventilation systems. • Monitor indoor air quality in solvent-use and formulation areas. • Undertake targeted ambient monitoring in response to complaints or incidents.
Construction Phase, Traffic & Logistics	• Use water sprays and dust suppression during the construction phase. • Limit speed of construction vehicles; maintain haul roads to reduce dust. • Cover materials and chemicals during transport. • Schedule deliveries outside peak traffic hours. • Maintain construction equipment to minimize diesel exhaust emissions.

7. Conclusion

SLR Consulting (South Africa) Proprietary Limited (SLR) was appointed to undertake a baseline air quality assessment for the proposed Biovac vaccine manufacturing facility. This report presents an overview of prevailing baseline air quality conditions, including a summary of meteorological data, as well as the methodology applied for the collection, processing, and analysis of ambient air quality monitoring data.

The baseline air quality assessment for the proposed vaccine manufacturing facility indicates that ambient concentrations of key pollutants, including particulate matter ($PM_{2.5}$ and PM_{10}), SO_2, NO_2, NH_3, and VOCs specifically the BTEX suite (benzene, toluene, ethylbenzene, and xylenes), are generally within South African NAAQS and relevant international (IFC/WHO) guideline limits.

- Particulate matter: $PM_{2.5}$ and PM_{10} 24-hour average concentrations complied with both NAAQS and WHO AQG limits. The one-month average, conservatively compared to annual standards, complied with the annual NAAQS but exceeded the stricter WHO AQG annual guideline value.
- Gaseous pollutants: SO_2, NO_2, NH_3, and benzene concentrations were very low, well below applicable standards and guidelines.
- Other VOCs: Toluene, ethylbenzene, and xylenes were measured at very low concentrations, significantly below health-based guideline limits.

The highest pollutant concentrations for all parameters assessed were recorded at FL3, downwind of the facility; however, all measured values indicate low potential for adverse air quality impacts.

Vaccine manufacturing operations are typically associated with low atmospheric emissions, as most production processes are enclosed and supported by appropriate engineering and operational controls. Although limited releases of VOCs and particulate matter may occur during specific operational activities, the overall potential for significant adverse impacts on ambient air quality is considered low.

This assessment represents a screening-level baseline study and does not constitute a detailed air quality impact assessment or health risk assessment. Based on the results, existing ambient air quality conditions are within applicable regulatory and guideline limits. With standard design, operational, and mitigation measures in place, the proposed facility is not expected to result in significant adverse air quality impacts.

SLR Consulting (South Africa) Proprietary Limited

Sheena Muttoo
Senior Consultant - Environmental Health
HPCSA: HI 0075086

Lisa Ramsay
Service Line Director - Environmental Sciences

Appendix A Declaration of Independence - Practitioner

Air Quality Baseline Assessment

Proposed Vaccine Manufacturing Facility, Cape Town

The Biovac Institute (Pty) Ltd

SLR Project No.: 723.000205.00001

23 February 2026

DECLARATION OF INDEPENDENCE - PRACTITIONER

Name of Practitioner: Lisa Ramsay

Declaration of independence and accuracy of information provided:

I, Lisa Ramsay declare that I am independent of the applicant. I have the necessary expertise to conduct the assessments required for this report and have performed the work relating to the application in an objective manner, even if this resulted in views and findings that are not favourable to the applicant. I have disclosed to the applicant and the air quality officer/relevant authority all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the air quality officer/relevant authority. The information provided in this specialist air quality assessment 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)(f) of the National Environmental Management: Air Quality Act, 2004 (No. 39 of 2004).

Signed at Kloof, on this 23rd, day of February 2026

SIGNATURE

Service Line Director - Environmental Sciences

CAPACITY OF SIGNATORY

Appendix B Curriculum Vitae

Air Quality Baseline Assessment

Proposed Vaccine Manufacturing Facility, Cape Town

The Biovac Institute (Pty) Ltd

SLR Project No.: 723.000205.00001

23 February 2026

Lisa Frost Ramsay, PhD

Service Line Director | Environmental Sciences | South Africa

Lisa offers various environmental management services, including atmospheric dispersion modelling; compilation of atmospheric emission inventories and greenhouse gas inventories; nuisance (noise and odour) monitoring, modelling and management; health impact assessments; climate change impact assessments; and strategic air quality management plans.

With a background in meteorology, Lisa has experience using ground-based station, weather balloon, radar and satellite data for interpreting meteorological and atmospheric dispersion contexts. She is skilled in an array of emission inventory tools and dispersion modelling software packages, including TANKS, Water9, LandGEM, ADMS, AERMOD and CALPUFF. She also has experience with downscaled climate models for regional climate change assessments. She has acted as an expert witness in various fire, storm, wind and hail legal cases.

Lisa has consulting experience across Africa, including in Angola, Egypt, Ethiopia. Ghana, Guinea, Kenya, Mozambique, Namibia, Nigeria, Rwanda, South Africa, Tanzania, Zambia, Zanzibar and Zimbabwe. She also has exprerience in Europe, Asia, the Middle East and Australia. This includes air quality and health impact assessments to lender standards.

Lisa completed a PhD in 2010 at the University of Cambridge, looking at the political ecology of air pollution and environmental health in Durban, South Africa. She is currently an Associate Professor in the College of Health Sciences, University of KwaZulu-Natal, where she maintains a broad research portfolio and supervises postgraduate students researching air pollution exposure, climate change and health. She has a number of peer-reviewed publication in these fields.

Education

- Doctor of Philosophy - University of Cambridge (2010)
- Master of Philosophy - University of Cambridge (2006)
- Master of Science - Palaeoclimatology, University of KwaZulu-Natal (2005)
- Bachelor of Science (Hons) - Atmospheric Science, University of Natal (2003)
- Bachelor of Science, University of Natal (2002)

Project Experience

Advisory

Environmental and Social Policy Assessment (ESPA), The German Development Bank/ Kreditanstalt für Wiederaufbau (KfW) (2022-2023)
Appointment to compile an ESPA to support KfW's Policy Based Lending (PBL) financing agreement with the Government of South Africa (represented by the Minister of Finance) to provide support to the country's energy reforms for a Just Energy Transition.

Air Quality Impact Assessment (AQIA)

MINING

AQIA for Kabanga Mine, Tembo Nickel Corporation Limited, Tanzania **(2025)**
Compilation of emissions inventory and atmospheric dispersion modelling assessment of the proposed mining facility to support Environmental and Social Impact (ESIA) update process. Significance assessment of key emission sources, and recommendations for emission mitigation and management.

AQIA for Iduapriem Mine, AngloGold Ashanti, Ghana **(2024 – 2025)**

Appointment to develop, install and manage an air quality monitoring network (dust fallout, continuous particulate and gas monitoring) at the Iduapriem mine. The appointment also includes the compilation of an emissions inventory and atmospheric dispersion modelling of the facility.

AQIAs for Rutongo, Nyakabingo and Musha Mines, Trinity Metals, Rwanda **(2023)**
Baseline air quality monitoring (continuous particulate and passive gas monitoring) at three mines. Compilation of baseline assessment reports including emission mitigation and air quality management recommendations.

Der Brochen / Mototolo Mining Complex, Anglo American Platinum, Limpopo, South Africa **(2022 - 2025)**
Development of emission inventory and atmospheric dispersion model for the facility. Development of Air Quality Monitoring Plan, Air Quality Management Plan and compilation of Anglo Risk Register. Workshops with onsite team.

Mogalakwena Mining Complex, Anglo American Platinum, Limpopo, South Africa **(2022 - 2025)**
Development of emission inventory and atmospheric dispersion model for the facility. Development of Air Quality Monitoring Plan, Air Quality Management Plan and compilation of Anglo Risk Register. Workshops with onsite team. Three years of monthly dust fallout monitoring, and management of Polludrone continuous air quality monitoring network.

AQIA for Siguiri Mine, AngloGold Ashanti, Guinea **(2012)**
Compilation of an emissions inventory for mining processes and onsite electricity generation using United States Environmental Protection Agency AP42 and Australian National Pollution Inventory emission factors. A Level 2 dispersion model (ADMS) was used to calculate ambient concentrations of particulate matter and dust fallout in the region. Health impact and dust nuisance assessments were conducted for nearby sensitive receptors.

INFRASTRUCTURE

AQIA for Key Infrastructure Upgrades, Propav Infraestructuras Limited, Zanzibar **(2023)**
SLR was appointed to undertake air quality assessment for the proposed upgrade and rehabilitation of three road sections and an airport within the Zanzibar Archipelago. The study included a baseline ambient air quality monitoring survey and a screening level (SCREEN3) dispersion modelling assessment of the construction and operational phases of the proposed project and accounted for potential reductions in current emissions. Impacts were evaluated using IFC EHS guidelines.

POWER

Advisor to the Minister of Fisheries, Forestry and Environment (2025)
Appointment to advise the Minister of Fisheries, Forestry and Environment (Dr Dion George) on the technical aspects of the Eskom applications in terms of Section 59 of NEMA:AQA for eight coal-fired power stations.

AQIA for Thabametsi Power Plant, Eskom, Limpopo, South Africa **(2019)**
Peer review of the AQIA for Phase 1 (630 MW) of the proposed Thabametse Power Plant to support the AEL application. The study comprised a baseline assessment, emissions inventory, Level 3 (CALPUFF) atmospheric dispersion model and impact assessment. The emissions inventory compiled by the original service provider was updated for input to an atmospheric dispersion model.

AQIA for Power Generation, Saudi Electricity, Saudi Arabia **(2016)**
Peer review of an AQIA to establish whether the study aligned with international best practice and International Finance Corporation (IFC) requirements.

AQIA for Power Generation, Gigajoule Mozambique, Mozambique **(2014 & 2016)**
A Level 2 dispersion model (AERMOD) was run to assess the cumulative ambient impacts of both the natural gas-fired Gigawatt facility and one neighbouring facility. The ambient concentrations were compared with local standards and international guidelines. Recommendations for emissions reduction and ambient air quality improvement were provided. In 2016, a 40 MW expansion scenario was simulated and assessed.

RENEWABLE ENERGY

Specialist air quality opinion for Solar Photovoltaic (PV) Power Generation, Marula Platinum (Pty) Ltd, Limpopo, South Africa **(2023)**
Specialist air quality opinion describing potential air quality related risk associated with a proposed PV facility in the context of existing air pollution sources within an existing mining rights area. The opinion motivated against the need for a full AQIA, however provided recommendations for further assessment and management planning should the competent authority require it.

AQIA for Green Ammonia Production, ENERTRAG South Africa, Mpumalanga, South Africa **(2022)**
Specialist impact statement and provisional AEL application for two renewable energy complexes producing green ammonia.

AQIA for Solar Power Facilities, ACWA Power Energy Africa, Northern Cape, South Africa **(2020)**
Compiled an AQIA for 10 x 200 MW photovoltaic facilities in one of South Africa's eight renewable energy development zones. The study comprised a regulatory assessment, baseline air quality assessment, emissions assessment for the construction and operational phases of the project, with consideration of various technology options, and recommendations for minimising air quality impacts during the various phases of the project, including decommissioning.

AQIA for Solar Power Facility, Brightsource Energy, Northern Cape, South Africa **(2014)**
Compilation of an emissions inventory of 125 MW CSP for input to a Tier 2 atmospheric dispersion model (ADMS). Outputs were compared the NAAQS to assess potential impacts associated with operations of the proposed facility.

WASTE AND WASTEWATER

AEL Renewal and Transfer application for Healthcare Risk Waste Incineration, Eastern Cape Incineration Services (Pty) Ltd, Gauteng, South Africa **(2023)**
SLR was appointed by Buhle Waste to facilitate the AEL renewal and transfer of ownership application for their newly acquired ECIS facility in Roodepoort, Johannesburg. The process included engagement with both the licensing authority and the National Department of Forestry, Fisheries and the Environment (DFFE). Following a NEM:AQA compliant public participation process, the application was submitted via SAAELIP and successfully issued by City of Joburg (the licensing authority in this case).

AIR for New England Road Landfill, KZN EDTEA, KwaZulu-Natal, South Africa **(2021)**
An AIR was requested by KZN EDTEA following recurring fire incidents at the New England Road Landfill in Pietermaritzburg. The study assessed air quality impacts of the July 2020 fire on nearby receptors and to determine the long-range impact across the greater area. The Level 3 (CALPUFF) dispersion model simulated the effect of local topography and meteorology on the dispersion of over 70 pollutants emitted during the fire event. Ground-level concentrations were compared with relevant national standards and international guidelines.

AQIA for Wastewater Treatment, Metito Utilities Ltd, Serbia **(2021)**
Calculation of emissions from a proposed Wastewater Treatments plant (WWTP) in Zrenjanin, Serbia for input to a Level 2 (AERMOD) atmospheric dispersion model. Potential health impacts of emissions were assessed by comparing simulated ambient concentrations of air pollutants with international guidelines (e.g. those of the World Health Organisation). The study was conducted in line with International Finance Corporation (IFC) requirements.

AQIA for Wellington Landfill, Drakenstein Municipality, Western Cape, South Africa **(2020)**
A specialist AQIA was undertaken for the proposed height increase of the Wellington landfill. This study provided specialist input to the application for a variation of the landfill's Waste Management License (WML). The study comprised a Level 2 (AERMOD) dispersion modelling assessment to predict and assess ground level pollutant concentrations under five proposed height increase scenarios for comparison with relevant NAAQS. Lifetime cancer risk through inhalation exposure to carcinogenic compounds was also assessed.

AIR for Healthcare Risk Waste Incineration, Compass Medical Waste Services (Pty) Ltd, Gauteng, South Africa **(2019)**
Compilation of an AIR and AEL application for Compass Waste's proposed thermal desorption unit in Olifantsfontein. The assessment included a baseline assessment, emissions inventory, dispersion modelling using AERMOD and comparison of the predicted concentrations with national standards. Multiple dispersion scenarios were run to assess the existing air quality scenario (using emissions from neighbouring industries), impacts arising from the proposed development in isolation of surrounding emission sources, and cumulative impacts representative of the post-development situation, as well as a hypothetical stack height assessment to assist with the final engineering design. Lifetime cancer risk through inhalation exposure to carcinogenic compounds was also assessed.

AIR for Pet Crematoria, Legacy Pet (Pty) Ltd, Gauteng, South Africa **(2018)**
An AIR was compiled as part of an environmental authorisation and AEL application for Legacy Pet's proposed pet cremation facility. The assessment included a baseline assessment, emissions inventory, dispersion modelling using AERMOD and comparison of the predicted concentrations with national standards.

AQIA for Stellenbosch Landfill, Stellenbosch Municipality, Western Cape, South Africa **(2014)**
Compilation of an emissions inventory for an existing landfill using the United States Environmental Protection Agency's AP42 emission factors. Emission inventories for three potential end use scenarios were developed, including a gas-to-energy option. A Level 2 dispersion model (AERMOD) was applied to calculate ambient concentrations of key pollutants for a health impact assessment of nearby sensitive receptors under the various scenarios.

INDUSTRIAL

AQIA for Charcoal Manufacturing, E&C Charcoal (Pty) Ltd, KwaZulu-Natal, South Africa **(2023)**
An AQIA for an existing charcoal manufacturer near Pietermaritzburg. The study simulated atmospheric emissions from site processes using a Level 3 (CALPUFF) modelling assessment for the comparison of predicted ground-level concentrations with national standards and international guidelines. The study was conducted as part of a NEM:AQA Section 22A license rectification process. Following a NEM:AQA compliant public participation process, the license application was submitted via the South African Atmospheric Emission Licensing Portal (SAAELIP).

AQIA for Primary Aluminium Production, South32 Hillside Aluminium, KwaZulu-Natal, South Africa **(2023)**
Appointment to conduct an AQIA assessing atmospheric impacts from a primary aluminium smelter in Richards Bay, with specific focus on Casthouse operations. The study simulated pollutant dispersion using a Level 3 (CALPUFF) modelling assessment and compared impacts from Casthouse emissions with the facility's cumulative impact footprint. The assessment also provided a legal review and professional opinion regarding the applicability of additional NEM:AQA Section 21 listed activities and associated licensing requirements.

AQIA for Polyurethane Foam Production, Strandfoam Group (Pty) Ltd, Western Cape, South Africa **(2022)**
An AQIA and AEL application for Strandfoam Cape's polyurethane foam manufacturing facility in Strand. The study was conducted as part of a NEM:AQA Section 22A license rectification process. The study included the quantification and modelling of relevant pollutants using a Level 2 (AERMOD) dispersion assessment for comparison with national standards and international guidelines. Key emission sources comprised bulk chemical storage, fuel storage, fuel combustion and polyurethane foam production. This assignment required extensive engagement with the licensing authority (City

of Cape Town in this case) including the submission of a specialist opinion on the legal intention of NEM:AQA Section 21 and the potential applicability of license categories outside the ambit of the industrial process in question.

NAEIS Reporting for Foam Production, Strandfoam Group (Pty) Ltd, Western Cape, South Africa **(2021)**
Emissions inventory development for 2020 operations for annual reporting to NAEIS in line with reporting conditions for NEM:AQA Section 21 listed activities. Key emission sources include bulk liquid chemical storage, fuel storage, fuel combustion and polyurethane foam production.

AIR for Chemical Filling, Richbay Chemicals (Pty) Ltd, Gauteng, South Africa **(2020)**
Compilation of an AIR and AEL application for a proposed chemical filling plant. The applicant, Richbay Chemicals, is a manufacturer and exporter of speciality cleaning, maintenance and water treatment chemicals, including hydrochloric acid and sulphuric acid. The study assessed potential impacts to air quality from bulk chemical storage tanks, combustion installations and abatement equipment using a Level 2 (AERMOD) dispersion model. Simulated pollutant concentrations were compared with relevant national standards and international guidelines to assess degree of impact.

AEL Compliance Reporting for Safripol, Safripol (Pty) Ltd, KwaZulu-Natal, South Africa **(2019-2021)**
Contracted to provide AEL compliance support including annual compliance reporting and air quality monitoring obligations stipulated in Safripol's AEL. This comprised emissions inventory development (including emission rate modelling using TANKS), compilation of compliance reports and documents for submission to the online NAEIS and SAAELIP platforms, LDAR surveys, fenceline BTEX monitoring, and odour management planning.

AQIA for MES postponement for Paper Mill, Mondi, KwaZulu-Natal, South Africa **(2019)**
Compilation of a comprehensive emissions inventory of the Richards Bay Mill for various emission scenarios for input to a Level 3 atmospheric dispersion model (CALPUFF). Dispersion model outputs were used to assess changes in air quality impact associated with proposed site developments. Furthermore, the outputs were used to compile an application for the postponement of compliance timeframes of the 2020 Minimum Emission Standards (MES). The MES postponement process required public engagement, including presentations to community stakeholders and written responses to community comments.

AQIA for Paper Milling, Sappi Saiccor, KwaZulu-Natal, South Africa **(2019)**
Compilation of a comprehensive emissions inventory of the Umkomaas Mill for various emission scenarios for input to a Level 3 atmospheric dispersion model (CALPUFF). Dispersion model outputs were used to assess changes in air quality impact associated with proposed site developments.

NAEIS Reporting for Far Timbers, Far Timbers (Pty) Ltd, KwaZulu-Natal, South Africa **(2018, 2019)**
Emissions inventory development for 2017 and 2018 operations for annual reporting to NAEIS in line with license conditions for NEM:AQA Section 21 listed activities. Key emission sources included woodchip stockpiles, biomass combustion in boilers, drying kiln stack emissions and chemical treatment processes.

AQIA for Nut Processing, Golden Macadamias (Pty) Ltd, Mpumalanga, South Africa **(2018)**
A screening level AQIA was conducted for a macadamia nut processing facility to inform the environmental authorisation process for Golden Macadamia's proposed expansion of their existing plant onto an adjacent property. The assessment included a baseline assessment, emissions inventory, dispersion modelling using SCREEN3 and comparison of the predicted concentrations with the national ambient air quality standards.

AQIA for Lubricant Packaging, Indy Oils (Pty) Ltd, KwaZulu-Natal, South Africa **(2017)**
Compilation of an AQIA and AEL application for the proposed expansion of Indy Oil's Pietermaritzburg operations. Key activities included the storage of petroleum-based products in excess of 1000 m^3 as well as the operation of a thermic fluid oil heater. The study included a baseline assessment, emissions inventory, Level 2 dispersion modelling using AERMOD and comparison of predicted concentrations with national standards.

AQIA for Iron Ore Bulk Terminal, Transnet Port Terminals, Western Cape, South Africa **(2015)**
Compilation of an emissions inventory for the iron ore bulk storage facility at Saldanha Bay. A Level 3 atmospheric dispersion model (CALPUFF) was used to calculate ambient concentrations of particulate matter and levels of dust fallout. The study included an assessment of the red staining of surfaces in the nearby suburbs of Vredenburg, Langebaan and Bluewater Bay.

Emissions Inventory and AEL Application for Chemical Storage Facility, Island View Storage, KwaZulu-Natal, South Africa **(2013)**
Compilation of an AEL application for the largest chemical storage facility in South Africa. The study required emission estimation for more than 300 tanks (loading and breathing losses) and for the loading areas (ship and road) using the United States Environmental Protection Agency's AP42 emission factors.

OIL & GAS
Adviser to the National Environmental Consultative and Advisory (NECA) Forum (2024)
Appointment as an expert advisor to the NECA Forum to advise the Minister of Fisheries, Forestry and Environment (Barbara Creecy) on the technical aspects of two Sasol air emission appeal processes.

AQIA for Offshore Gas Exploration Drilling, Confidential Client, Namibia **(2024)**
Appointment to undertake AQIAs for two proposed exploration and appraisal projects off the coast of southern Namibia. An emissions inventory was developed for fuel combustion (by support vessels and helicopters), electricity generation and flaring of hydrocarbons during well-flow testing. A screening model (SCREEN3) of pollutant dispersion from flaring activities was undertaken to understand worst-case downwind impacts. Impacts were evaluated using IFC EHS guidelines.

Emissions Inventories for Waste Oil Recycling and Bulk Petroleum Product Storage, FFS Refiners (Pty) Ltd, South Africa **(2023, 2024)**
Emissions inventory development for eight FFS petroleum product storage and oil recovery facilities, namely, Teakwood, Pietermaritzburg, Richards Bay, Chloorkop, Evander, Cape Town Harbour and Brackenfell. Evaporative and loading losses were calculated using US EPA TANKS 4.09d and international emission estimation technique guidelines for the bulk storage and handling of products which included an array of base oils and lubricants, fuel oils, chemicals, bitumen, solvents, waste oils, vegetable oils and animal fats. These inventories were submitted to the online National Atmospheric Emissions Inventory System (NAEIS) portal, as part of FFS' annual compliance reporting obligations.

ESG DD for debt financing of an Oil Mining Lease in Nigeria, Confidential Client (2022).

ESG DD for purchase of interest in Angolan offshore oil blocks, Confidential Client (2022).

AIR for Refinery Flare Stack Upgrade, SAPREF, KwaZulu-Natal, South Africa **(2021)**
An AIR in support of an AEL variation application was undertaken for the proposed increased flare capacity and increased flare stack height at South Africa's largest crude oil refinery, SAPREF. The study assessed four emission scenarios using a Level 3 (CALPUFF) dispersion modelling assessment. Impacts from emergency and planned shutdowns as well as cumulative and long-term scenarios were compared with national standards.

AIR for Refinery Shutdown and Startup, SAPREF, KwaZulu-Natal, South Africa **(2020)**
An AIR of emergency flaring events that occurred during the shutdown and start-up of South Africa's largest crude oil refinery. A Level 3 (CALPUFF) dispersion model was run for peak hourly and 24-hourly emission scenarios. The refinery's contribution to ambient pollutant concentrations measured by three municipal air quality monitoring stations was assessed using wind trajectory analyses.

NAEIS Reporting for Bulk Storage Facility, NATREF (Pty) Ltd, KwaZulu-Natal, South Africa **(2016-2018)**
Emissions inventory development for 2016, 2017 & 2018 operations for annual reporting to NAEIS in line with license conditions for NEM:AQA Section 21 listed activities. Key emission sources include bulk fuel storage (specifically ULP, diesel and crude oil).

AQIA for Refinery Process Changes, SAPREF, KwaZulu-Natal, South Africa **(2013)**
Assessment of air quality impacts associated with process changes required to meet revised fuel specifications. Emissions from onsite stacks and tanks were calculated using a mass balance approach and use of the United States Environmental Protection Agency's TANKS model respectively. Ambient concentrations of various pollutants were calculated using a Level 2 dispersion model (ADMS). Study results were presented at contentious community meetings in the South Durban Basin.

Air Quality Management Planning and Framework Development

AQMP for iLembe District Municipality, KwaZulu-Natal, South Africa **(2022)**
Appointment by iLembe District Municipality to develop an Air Quality Management Plan (AQMP) for their jurisdiction, including a baseline assessment and the quantification and simulation of atmospheric emissions using a Level 3 (CALPUFF) dispersion model. A gap and problems analysis determined institutional capacity and identified information gaps. Based on these findings, air quality goals were developed, and practical intervention strategies designed. The study included recommendations for a customised air quality management by-law as well as a licensing guideline for the Air Quality Office (AQO).

Air Quality Management Framework for the Cape Floral Region Protected Areas, Department of Forestry, Fisheries and Environment, Western Cape, South Africa **(2020)**
Specialist air quality input to the Cape Floral Region Protected Areas (CFRPA) Environmental Management Framework (EMF). Due to high species richness and exceptional endemism, CFRPA is recognised as a globally significant centre for terrestrial biodiversity and was thus declared a World Heritage Site in 2004 by UNESCO. The study comprised a review of ambient air quality and prevailing meteorological conditions influencing regional dispersion. Recommendations were made for air quality management for CFRPA clusters. Key emission sectors included industrial development, domestic fuel burning, road traffic, waste treatment and disposal, agricultural activity (including crop spraying) and biomass burning.

AQMP for Mbombela Local Municipality, Mpumalanga, South Africa **(2020)**
Compilation of an AQMP for the City of Mbombela Local Municipality. The study comprised a baseline assessment including comprehensive emissions inventory and Level 3 dispersion modelling (CALPUFF), a feasibility assessment to determine institutional capacity, identify information gaps and analyse air pollution problems, the development of air quality goals and intervention strategies to achieve them, and an AQMP for adoption and implementation.

AQMP for Msunduzi Local Municipality, KwaZulu-Natal, South Africa **(2018 & 2019)**
Appointment to develop an AQMP in a two phased approach for the Msunduzi Local Municipality. Phase one comprised a geographical characterisation of the region, assessment of the status quo of air quality based on available ambient air quality monitoring data, an emissions inventory of identified emission sources, and an institutional capacity assessment. The emissions inventory was used in Phase Two of the AQMP as input to a Level 3 (CALPUFF) dispersion model and to develop effective air quality management strategies for the Municipality.

AQMP for Capricorn District Municipality, Limpopo, South Africa **(2017)**
Appointment to review the Capricorn District Municipality's 1st generation AQMP developed in 2009. The study comprised an appraisal of the previous AQMP and updates required. The baseline assessment included the quantification and simulation of atmospheric emissions within the District using a Level 3 dispersion model (CALPUFF). The gap and problem analysis determined institutional capacity and identified information gaps. Based on these findings, the 2009 air quality goals were realigned, and new intervention strategies designed.

Odour Impact Assessment

Nuisance Impact Assessment and Management Plan for Poultry Farming, Glen Arum Farms, KwaZulu-Natal, South Africa **(2019 & 2020)**
Compilation of a nuisance risk assessment for Glen Arum's Kemell and Impangele egg layer operations in response to a non-compliance directive from the relevant authority. The directive required the development of a corrective management plan to address odour and control vectors.

The study included a baseline assessment of the locale, prevailing meteorology, and community concerns, with an assessment of odour and vector impacts linked to waste management. The odour assessment modelled the dispersion of odours into the surrounding landscape for comparison with relevant international guidance (in the absence of local standards).

Odour Risk Assessment for Phase Two of the Pelican Park Housing Development, City of Cape Town, Western Cape, South Africa **(2018 & 2021)**
Appointment by the City of Cape Town to conduct an odour risk assessment for Phase two of the proposed Pelican Park housing development. The proposed development site is located near the Cape Flats WWTW and Coastal Park landfill site. The aim of the specialist assessment was to determine the extent of odour nuisance and the long-term suitability of the proposed site for residential activity. The study applied monitoring (dynamic olfactometry) and dispersion modelling techniques (AERMOD) to assess the impact of neighbouring land use activities on local air quality. The study recommended additional odour monitoring, and this was conducted in 2020/2021.

Air Quality and Odour Assessment for Shongweni Landholdings, Tongaat Hulett Developments, KwaZulu-Natal, South Africa **(2019)**
Investigation into nuisance odour at Tongaat Hulett's landholdings earmarked for development purposes in Shongweni, KwaZulu-Natal. The study comprised ambient air quality measurements using both instantaneous and continuous monitoring methods. Odour levels were assessed using dynamic olfactometry and electronic nose (e-nose) technology. The study included a Level 3 (CALPUFF) dispersion modelling assessment of odour.

Odour Impact Assessment for the Shongweni Landfill, Upper Highway Air NPO, KwaZulu-Natal, South Africa **(2018)**
Appointment by the Upper Highway Air non-profit organisation to undertake an assessment of potential impacts of the EnviroServ Shongweni Landfill on the Upper Highway community. Field investigations included upwind, downwind and community comparative sampling of the odour plume for source appropriation and odorous compound identification. The study included an extensive literature review as well as statistical analysis of community complaints and wind direction data. A Level 3 (CALPUFF) dispersion modelling assessment of individual gases and cumulative odour was undertaken.

Odour Assessment for Denny Mushroom Farm, Denny Mushrooms (Pty) Ltd, KwaZulu-Natal, South Africa **(2017)**
Measurement of onsite and fenceline odour levels using an e-nose and a Level 1 dispersion modelling assessment of point source emissions to delineate an odour footprint.

Odour Assessment for Pet Food Manufacturing, AVI (Pty) Ltd, KwaZulu-Natal, South Africa **(2015 & 2017)**
Odour investigation for a pet food production facility. Odour monitoring was conducted using an e-nose at the site boundary and at selected community points at various times of the day, focusing on areas from which odour complaints originated. The findings of the investigation were incorporated to a comprehensive odour management plan (OMP) in line with international best practice and requirements stipulated by the local licensing authority. Reappointment in 2017 to audit the OMP.

Odour Assessment for Maggot Protein Production, AgriProtein (Pty) Ltd, Western Cape, South Africa **(2014)**
Odour assessment and development of an odour management plan for a nutrient recycling plant in the City of Cape Town. The site proposed to process organic waste, producing maggots for drying and milling as protein feedstock. A legal compliance assessment was conducted and AEL application compiled.

Odour Assessment for Waste Compaction, Transnet Port Terminals (Pty) Ltd, KwaZulu-Natal, South Africa **(2013)**
Assessment of the potential odour impact of a proposed galley waste compacting facility at the Port of Richards Bay. An odour emissions inventory was developed for input to a Level 2 atmospheric dispersion modelling (ADMS) to calculate odour concentrations at distances away from the proposed waste compactor. Odour plume maps were generated for impact interpretation.

Noise Impact Assessments (NIA)

Der Brochen / Mototolo Mining Complex, Anglo American Platinum **(2023 - 2024)**
Development of Noise Management and Monitoring Plans. Inventory development, RFI compilation, review of all previous applicable studies, risk assessment according to Anglo risk matrix and WRAC, provision of compliance requirements, reporting of Noise Management Plan and Noise Monitoring Programme.

Mogalakwena Mining Complex, Anglo American Platinum **(2023 - 2024)**
Undertaking 2nd annual monitoring campaign as per Anglo NMP (by SLR), and review and updates of noise model and Noise Management Plan for 2nd and 3rd year.

EMPr Updates for Nyakabingo and Rutongo Mines, Trinity Metals, Rwanda**, (2023-2024)**
Tin and Tungsten mining operations involving several sites at Rutongo and Nyakabingo mines. Review of all prior studies, RFI compilation and information collation, survey planning, site sub-consultant management, assessment, reporting, and provision of mitigation recommendations including BAT.

BUA Cement Sokoto Quarry & Cement Manufacturing Plant, BUAC Plc, Nigeria **(2023 – 2024)**
7.5 Mtpa cement production plant located in Sokoto in north-west Nigeria. Thorough review of all prior studies, collating information, further survey planning, source characterization measurements, H&S compliance, engaging suppliers, sub-consultant management, highly detailed propagation modelling, assessment, provision of mitigation strategy based on hierarchy of impacts, training of personnel, and a Noise Management and Monitoring Plan report compilation.

Pemba Airport Upgrade NIA, Propav Infraestructuras, Zanzibar **(2023)**
Proposed airport upgrade project on Pemba Island, Zanzibar. Survey planning, on-site surveys, H&S compliance, sub-consultant management, assessment, comprehensive noise management recommendations, and report compilation covering pre-construction, construction and operational phases.

Zanzibar 3 Roads Upgrade NIA, Propav Infraestructuras, Zanzibar **(2023)**
Proposed 3 new/upgrade road routes on Unguja and Pemba Islands, Zanzibar. Survey planning, on-site surveys, H&S compliance, desktop calculation and assessment, and report compilation covering pre-construction, construction and operational phases.

Health Risk Assessment (HRA)

HIA for Iron Ore Mining Operations, Jindal Iron Ore Project, KwaZulu-Natal, South Africa **(2023)**
Health Impact Assessment of the proposed iron ore mining operations in Melmoth, and associated Community Health Monitoring and Management Plan to detect impacts timeously, and to avoid or mitigate potential negative impacts, while enhancing positive opportunities. This assessment was framed by a broad definition of health, moving beyond a traditional biomedical focus on the assessment of incidence and spread of disease to incorporate various aspects of physical, psychological, social and cultural well-being.

HRA for Vectors from Poultry Farming, Glen Arum Farms, KwaZulu-Natal, South Africa **(2020)**
As part of the Nuisance Management Plan conducted for Glen Arums, Balgowan (see above) an assessment of vector related health risks for neighbouring sensitive receptors arising from facility design, operational procedures, waste management and vermin control practices were also assessed. The corrective action plan made recommendations for impact mitigation, effective waste management, community engagement and complaints investigations, based on international best practice.

HRA for Healthcare Risk Waste Incineration, Compass Medical Waste Services (Pty) Ltd, Gauteng, South Africa **(2019)**
Compilation of HRA for a proposed medical waste thermal desorption unit in Olifantsfontein, Midrand. The key potential health hazards associated with the proposed development were identified as atmospheric emissions, biohazards, pests, odour, and noise. This study assessed likely health impacts from the proposed facility via multiple exposure pathways using internationally recognised methodologies for establishing distribution, likelihood, and significance of impact.

HRA for Drakenstein Waste-to-Energy Project, Interwaste (Pty) Ltd, Western Cape, South Africa **(2016)**
Compilation of a HRA (human, plant and animal health) for a proposed waste recovery, beneficiation and energy project comprising anaerobic digestion and direct combustion facilities. Potential health hazards associated with the proposed development included atmospheric emissions, water and soil contamination, biohazards and pests, and odour and noise. This study assessed likely health impacts from the proposed facility via multiple exposure pathways (including inhalation, dermal contact, and ingestion of locally produced crops and meat) using internationally recognised methodologies for establishing distribution, likelihood and significance of impact.

HRA for Healthcare Risk Waste Incineration, Sirela Trading (Pty) Ltd, KwaZulu-Natal, South Africa **(2013)**
Compilation of a HRA (human, plant and animal health) for a proposed waste recovery, beneficiation and energy project comprising anaerobic digestion and direct combustion facilities. Potential health hazards associated with the proposed development included atmospheric emissions, water and soil contamination, biohazards and pests, and odour and noise. This study assessed likely health impacts from the proposed facility via multiple exposure pathways (including inhalation, dermal contact, and ingestion of locally produced crops and meat) using internationally recognised methodologies for establishing distribution, likelihood and significance of impact.

Greenhouse Gas (GHG) Inventories and Climate Change Risk Assessment (CCRA)

Future Pollutant Dispersion Scenarios for Holfontein Landfill, Enviroserv Waste Management (Pty) Ltd, Gauteng, South Africa **(2023)**
This study reviewed the possible impacts of changing climate on local meteorology and how this changing meteorology may influence landfill gas production and dispersion of pollutants from the Holfontein landfill. The assessment included a Level 1 (SCREEN3) model to determine maximum impacts under two development pathway scenarios (i.e. best and worst case policy based outcomes) to cover a range of uncertainties in future climate projections. Outputs were presented as the relative (unitless) increase or decrease in ambient pollutant concentrations downwind of the landfill. These results can be calibrated for comparison with ambient standards using emission rates for individual gases.

GHG Emissions Inventory for iLembe District Municipality, KwaZulu-Natal, South Africa **(2022)**
A GHG emissions inventory for the iLembe District Municipality was developed as part of the District's AQMP (see above). Emissions for industrial activities, road traffic, domestic fuel burning, pre-harvest sugarcane burning, and electricity usage were calculated using IPCC emission factors and presented by emission scope in line with the *Greenhouse Gas Protocol: Global Protocol for Community-scale Greenhouse Gas Emission Inventories.*

Emissions Inventory for Port of Durban, C40 Cities, KwaZulu-Natal, South Africa **(2021)**
Compilation of an inventory of industrial, cargo handling, vehicular, rail and shipping emissions for the Port of Durban in a study funded by the C40 Cities' Empowering Cities with Data mechanism. GHG emissions were calculated using documented emission factors and presented by emission scope in line with the *Greenhouse Gas Protocol: Global Protocol for Community-scale Greenhouse Gas Emission Inventories.*

CCIA for Hydrogen Manufacturing, SAPREF, KwaZulu-Natal, South Africa **(2019)**
Review and validation of an existing GHG inventory for the SAPREF facility, calculation of GHG emissions associated with the proposed hydrogen manufacturing (HMU) using IPCC emission factors and GHG Protocol toolkits, and contextualisation of climate change implications through comparison of GHG emissions with local, national and international GHG inventories.

Climate Change Adaptation and Resilience in Africa: Recommendations for Policy Makers, funded by the Network of African Science Academies and the German National Academy of Sciences Leopoldina Interacademy Partnership, Africa **(2015)**
Editor of an advisory book, funded by Network of African Science Academies (NASAC) and German National Academy Leopoldina, to assess projected climate changes across Africa and to make

recommendations to African leaders on adaptation and resilience. The following sectors were assessed regionally: Access to Water, Food Security: Agriculture and Fisheries.

Validity of Downscale Climate Models and the Implications of Possible Future Climate Change for Lake Kariba's Kapenta Fishery, funded by IDRC/CDRI and DFID under the African Climate Change Fellowship Program 2009–2010. Zimbabwe **(2013)**
Application of downscaled global climate models to investigate the regional impacts of future emission scenarios with validation through prediction of past, observed climate. The IPCC A2 and B1 emission scenarios for the near (2046- 2065) and far (2081-2100) future. Nine models were employed and all reflected past climate (1961-2009) well. Results indicated that Kapenta fish production in Lake Kariba will continue to decline. Options and strategies for fishery management were recommended in the context of future climate changes. The study was funded by the International Development Research Centre (IDRC/CDRI) and the United Kingdom's Department for International Development (DFID), and published in a peer-reviewed journal.

Memberships and Associations

- National Association for Clean Air (NACA)
- South African Council for Natural Scientific Professions (SACNASP) (application under assessment)

Publications and Conference Papers

- Manqele, N.M., Moolla, R. and Ramsay, L.F. (2024). "A mid-tier approach to estimating Durban's Port Marine Mobile Emissions: Gauging air quality impacts in South Durban". Atmosphere, 15, 1207.
- Ashram, K., Mitku, A., Ramsay, L.F., Jeena, P.M. and Naidoo, R.N. (2024). "Environmental exposures associated with early childhood recurrent wheezing in the Mother and Child in the Environment Birth Cohort: a time-to-event study". Thorax, doi:10.1136/thorax-2023-221150
- Manqele, N.M., Moolla, R. and Ramsay, L.F. (2024). "The health and economic impacts of exposure to marine mobile emissions from ships in Durban port, South Africa". Atmospheric Environment: X, 23, 1000277.
- Benschop, N.D., Chironda-Chikanya, G., Naidoo, S., Jafta, N., Ramsay, L.F., Naidoo, R.N. (2023). "El Niño, Rainfall and Temperature Patterns Influence Perinatal Mortality in South Africa: Health Services Preparedness and Resilience in a Changing Climate". In: Akhtar, R. (eds) Climate Change and Human Health Scenarios. Global Perspectives on Health Geography. Springer, Cham.
- Procheş Ş., Watkeys M.K., Ramsay L.F. and Cowling R.M. (2023). "Why we should be looking for longitudinal patterns in biodiversity". Frontiers in Ecology and Evolution. 11: 1032827.
- Tularam, H.; Ramsay, L.; Muttoo, S; Brunekreef, B.; Meliefste, K; De Hoogh, K. and Naidoo, R.N. (2019). "A hybrid air pollution / land use regression model for predicting air pollution concentrations in Durban, South Africa". Environmental Pollution. 274: 116513.
- Tularam, H.; Ramsay, L.; Muttoo, S; Naidoo, R.N.; Brunekreef, B.; Meliefste, K and De Hoogh, K. (2019). "Harbor and intra-city drivers of air pollution: Findings from a land use regression model, Durban, South Africa". International Journal of Environmental Research and Public Health, 17(15): 5406.
- Muttoo, S.; Ramsay, L.; Brunekreef, B.; Beelen, R.; Meliefste, K. and Naidoo, R.N. (2018). "Land use regression modelling estimating nitrogen oxides exposure in industrial south Durban, South Africa". Science of the Total Environment, 610-611: 1439-1477.

- Ramsay, L. and Olago, D. (eds). (2016) "Climate Change Adaptation and Resilience in Africa: Recommendations to Policymakers", Network of African Science Academies (NASAC) and German National Academy Leopoldina.
- Pillay, K. and Ramsay, L.F. (2015). "Restructuring the Reduced Emissions from Deforestation and Forest Degradation (REDD+) mechanism for a Post Kyoto Agreement." American Journal of Climate Change 4(1): 69-76.
- Padayachee, Y.; Proches, S. and Ramsay, L.F. (2014). "Beetle assemblages of indigenous and alien decomposing fruit in subtropical Durban, South Africa." Arthropod Plant Interactions 8(2), pp. 135-142.
- Manqele, N.M. and Ramsay, L.F. "Evaluating the contribution of exhaust gas emissions to air pollution and the urban carbon footprint: A case study of the Port of Durban.", National Association for Clean Air (NACA) Annual Conference, Durban, 9-10 October 2014.
- Ndebele-Murisa, M.R.; Hill T. and Ramsay, L.F. (2013). "Validity of downscaled climate models and the implications of possible future climate change for Lake Kariba's Kapenta fishery." Environmental Development, 5: 109-130.
- Gumede, P. and Ramsay, L.F. "Community discernments of particulate matter emanating from a landfill site in Durban, KwaZulu-Natal," 16th International Union of Air Pollution Prevention and Environmental Protection Associations (IUAPPA) Clean Air Congress, Cape Town, South Africa, 29 September-4 October 2013.
- Simpson, A. and Ramsay, L.F. "Topographic control of wind field in the nearsurface boundary layer." 16th International Union of Air Pollution Prevention and Environmental Protection Associations (IUAPPA) Clean Air Congress, Cape Town, 29 September-4 October 2013.
- Ramsay, L.F. and Naidoo, R. (2012). "Carbon footprints, industrial, transparency and community engagement in a South Durban neighbourhood." South African Geographical Journal, 94 (2): 174-190.
- Ramsay, L.F. (2012). "Severe Weather Bill Warning." The Mercury, editorial, 1 February 2012, pp. 6.
- Tularam, H. and Ramsay, L.F. "Air quality in the Durban South Basin linked to synoptic events for the year 2009." National Association for Clean Air (NACA) Annual Conference, East London, 12-14 October 2011.
- Grenfell, S.E.; Ellery, W.N.; Grenfell, M.C.; Ramsay, L.F.; and Flugel, T.J. (2010). "Sedimentary facies and geomorphic evolution of a blocked-valley lake: Lake Futululu, Northern KwaZulu-Natal, South Africa." Sedimentology 57: 1159-1174.
- Ramsay, L.F. (2009). "Climate Change for the People of South Durban." Changing Tomorrow series, SDCEA and Oxfam Great Britain, pp. 34. Ellery, W.; Grenfell, M.; Grenfell, S.; Kotze, D.; McCarthy, T.; Tooth, S.; Grundling, P.-L.; Beckedahl, H.; Le Maitre, D. and Ramsay, L.F. (2008). "Controls on the distribution and dynamics of wetlands in South Africa." Wetland Management Series: WET-Origins.
- Ellery, W.; Grenfell, M.; Grenfell, S.; Kotze, D.; McCarthy, T.; Tooth, S.; Grundling, P.-L.; Beckedahl, H.; Le Maitre, D. and Ramsay, L.F. (2008). "Controls on the distribution and dynamics of wetlands in South Africa." Wetland Management Series: WET-Origins.
- Ramsay, L.F. "Asthma in the township communities of South Durban." Workshop on Chronic Disease and African Communities: Research, Practice and Policy, London School of Economics and Political Science, London, 23-24 June 2008.
- Ramsay, L.F. "Tropospheric ozone profiling for Irene, South Africa." Global Change and Regional Sustainability in South Africa, Kirstenbosch Gardens, 27-29 October 2003.

Awards

- WSP Innovation Award (2021)
- Overseas Research Studentship, University of Cambridge (2007-2009)
- Landscape Research Group Award, University of Oxford (2006)
- Commonwealth Scholarship, University of Cambridge (2005)
- Vice-Chancellor's Award, University of Natal (2000)

Appendix C Fieldwork Photographs

Air Quality Baseline Assessment

Proposed Vaccine Manufacturing Facility, Cape Town

The Biovac Institute (Pty) Ltd

SLR Project No.: 723.000205.00001

23 February 2026

Site	Monitoring methodology	Site Comments	Picture of Monitoring Station
FL1	Passive diffusive gas sampling relies on the diffusion of analytes through a diffusive surface onto an adsorbent. Measured parameters include NO_2, SO_2, NH_3 & BTEX. The monitoring period comprised two consecutive two-week sampling intervals, together representing approximately one month of monitoring. The overall sampling period extended from 11/12/2025 to 07/01/2026.	Radiello® diffusive samplers were securely mounted onto supporting plates and fixed to a vertical pole at approximately eye level (1.5–1.7 m above ground). The samplers were firmly fastened to prevent movement and fitted with a protective rain shelter to minimise the influence of precipitation and adverse weather conditions. Installation locations were selected to ensure unobstructed airflow and representative ambient sampling conditions. **Notes from site:** Monitoring units were not located near any obstruction i.e. no nearby tall shrubs or trees or walls. The monitoring locations were secure and showed no evidence of tampering or disturbance throughout the monitoring period.	 Radiello® Passive Sampler Lat:-33.935121°, Long: 18.491090°
FL3	Passive diffusive gas sampling relies on the diffusion of analytes through a diffusive surface onto an adsorbent. Measured parameters include NO_2, SO_2, NH_3 & BTEX. The monitoring period comprised two consecutive two-week sampling intervals, together representing approximately one month of monitoring. The overall sampling period extended from 11/12/2025 to 07/01/2026.	Radiello® diffusive samplers were securely mounted onto supporting plates and fixed to a vertical pole at approximately eye level (1.5–1.7 m above ground). The samplers were firmly fastened to prevent movement and fitted with a protective rain shelter to minimise the influence of precipitation and adverse weather conditions. Installation locations were selected to ensure unobstructed airflow and representative ambient sampling conditions. **Notes from site:** Monitoring units were not located near any obstruction i.e. no nearby tall shrubs or trees or walls. The monitoring locations were secure and showed no evidence of tampering or disturbance throughout the monitoring period.	 Radiello® Passive Sampler Lat:-33.935121°, Long: 18.490432°

Appendix D Field Logsheets

Air Quality Baseline Assessment

Proposed Vaccine Manufacturing Facility, Cape Town

The Biovac Institute (Pty) Ltd

SLR Project No.: 723.000205.00001

23 February 2026

SLR AIR QUALITY PASSIVE GAS MONITORING AND SAMPLING LOG SHEET								
The following sheet should be completed for passive gases using Radiello diffusion tubes								
Facility or General Locale: BioVac Ndabeni, Cape Town								Phase 1 of 2
Site Technician: Matthew Mwepu								
Site Code	Site Description	Parameter	Sample ID	Start Date	Start Time	End Date	End Time	Observations (condition of sampler components - cracking, breakage, discoloration)
FL1	Southern Corner boundary	SO2/NO2	YN380	2025/12/11	09:02	2025/12/23	13:02	Sampler removed in good order
FL1	Southern Corner boundary	BTEX	YN378	2025/12/11	09:02	2025/12/23	13:02	Sampler removed in good order
FL1	Southern Corner boundary	NH3	YN379	2025/12/11	09:02	2025/12/23	13:02	Sampler removed in good order
FL3	Eastern Corner Boundary	SO2/NO2	YN381	2025/12/11	09:02	2025/12/23	13:02	Sampler removed in good order
FL3	Eastern Corner Boundary	BTEX	YN387	2025/12/11	09:02	2025/12/23	13:02	Sampler removed in good order
FL3	Eastern Corner Boundary	NH3	YN375	2025/12/11	09:02	2025/12/23	13:02	Sampler removed in good order
General Notes: moderate weather on deployment (22°C). Hot on collection (31°C).								Take photos of passive samplers, deployment position & shelter condition

Received by:

Name ______________________ Company ______________________ Date & time ______________________

SLR AIR QUALITY PASSIVE GAS MONITORING AND SAMPLING LOG SHEET								
The following sheet should be completed for passive gases using Radiello diffusion tubes								
Facility or General Locale: BioVac Ndabeni, Cape Town								Phase 2 of 2
Site Technician: Matthew Mwepu								
Site Code	Site Description	Parameter	Sample ID	Start Date	Start Time	End Date	End Time	Observations (condition of sampler components - cracking, breakage, discoloration)
FL1	Southern Corner boundary	SO2/NO2	WQ880	2025/12/23	13:00	2026/01/07	13:00	Sampler removed in good order
FL1	Southern Corner boundary	BTEX	WQ879	2025/12/23	13:00	2026/01/07	13:00	Sampler removed in good order
FL1	Southern Corner boundary	NH3	WQ881	2025/12/23	13:00	2026/01/07	13:00	Sampler removed in good order
FL3	Northern Corner Boundary	SO2/NO2	WQ885	2025/12/23	13:00	2026/01/07	13:00	Sampler removed in good order
FL3	Northern Corner Boundary	BTEX	WQ883	2025/12/23	13:00	2026/01/07	13:00	Sampler removed in good order
FL3	Northern Corner Boundary	NH3	WQ884	2025/12/23	13:00	2026/01/07	13:00	Sampler removed in good order
FL1	Southern Corner boundary	SO2/NO2, Blank	734AR	2025/12/11	09:02	2026/01/07	13:00	Sampler in good order
FL1	Southern Corner boundary	BTEX, Blank	733AR	2025/12/11	09:02	2026/01/07	13:00	Sampler in good order
FL1	Southern Corner boundary	NH3, Blank	735AR	2025/12/11	09:02	2026/01/07	13:00	Sampler in good order
General Notes: moderate weather on deployment (22°C). Hot on collection (31°C).								Take photos of passive samplers, deployment position & shelter condition

Received by:

________________ ________________ ________________

Name Company Date & time

Appendix E Laboratory Results

Air Quality Baseline Assessment

Proposed Vaccine Manufacturing Facility, Cape Town

The Biovac Institute (Pty) Ltd

SLR Project No.: 723.000205.00001

23 February 2026

X Lab Earth Science PTY LTD
2 Samantha Street, Strydom Park, Randburg, 2169
Telephone Number: 011 590 3000
Email: info@xlab.earth

TEST REPORT

Contact	Matthew Mwepu	**Project Number**	BioVac Ndabeni
Client	**SLR Consulting (South Africa) (Pty) Ltd**	**Lab Reference**	JBX26-026399
Email	matthew.mwepu@slrconsulting.com	**Report Number**	LIM26/0166
Address		**Date Received**	20-Jan-2026
Order Number		**Date Test(s) Started**	20-Jan-2026
Samples	5	**Date Reported**	26-Jan-2026
Sample Matrix	Air		

The document is issued in accordance with SANAS's accreditation requirements. Accredited for compliance with ISO/IEC 17025. SANAS accredited laboratory T0775. Results marked "Subcontracted Test" in this report are not included in the SANAS Scope of Accreditation for this laboratory.

T0775

Dates/times as provided by the client. RAD166: The recommended maximum exposure time is 15 days (7 days when relative humidity is more than 70%).

Sample No.			JBX26-026399-01	JBX26-026399-02	JBX26-026399-03	JBX26-026399-04
Sample ID			FL1 YN380 2025/12/11 09;02 2025/12/23 13:02	FL3 YN381 2025/12/11 09:02 2025/12/23 13:02	FL1 WQ880 2025/12/23 13:00 2026/01/07 13:00	FL3 WQ885 2025/12/23 13:00 2026/01/07 13:00
Sample Comment			-	-	-	-
Analysis	**Unit**	**LOR**	**Result**	**Result**	**Result**	**Result**
Determination of inorganic Ions by IC (ME-AN-014) - LAB-QLT-MET-014						
Nitrite	µg/tube	0.3	10	9.8	11	15
Sulphate	µg/tube	0.4	2.5	<0.4	5.3	5.1
Ambient Concentration of NO_2 *	µg/m³	0.05	4.24	3.96	4.38	6.11
Ambient Concentration of SO_2 *	µg/m³	0.02	0.31	<0.02	0.66	0.63
Number of days *	days	-	12	12	12	12
Sampling Duration (Period) *	minutes	-	17520	17520	17280	17280

Sample No.			JBX26-026399-05
Sample ID			FL1 Blank 734AR 2025/12/11 09:02 2026/01/07 13:00
Sample Comment			-
Analysis	**Unit**	**LOR**	**Result**
Determination of inorganic Ions by IC (ME-AN-014) - LAB-QLT-MET-014			
Nitrite	µg/tube	0.3	<0.3
Sulphate	µg/tube	0.4	<0.4
Ambient Concentration of NO_2 *	µg/m³	0.05	<0.05
Ambient Concentration of SO_2 *	µg/m³	0.02	<0.02
Number of days *	days	-	12
Sampling Duration (Period) *	minutes	-	17518

Sasha Maistry
Technical Signatory (Approver)

Reuben Maleka
Technical Signatory (Reviewer)

IS	*Insufficient sample for analysis*	*NA*	*Not analysed*
LNR	*Sample listed but not received*	*-*	*Not applicable*
LOR	*Limit of reporting*	*UTD*	*Unable to determine*
*	*Not SANAS accredited. This result is not included in the SANAS scope of accreditation for this laboratory*	*NR*	*Not Requested*

Samples analysed as received. Solid samples expressed on a dry weight basis. *Unless otherwise indicated, samples were received in containers fit for purpose at ambient temperature.*

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Method	Method Summary
Determination of inorganic Ions by IC (ME-AN-014)	Inorganic anions (Br, Cl, F, NO3, NO2, SO4) are determined on aqueous samples by ion chromatography (IC). The method is based on Standard Methods for the Examination of Water and Wastewater Method 4110 B. For soils and wastes anions are measured on 10:1 water extracts. Sulphate, nitrite, fluoride and chloride are determined on sorbent extracts by ion chromatorgraphy (IC) and the required pollutant concentration obtained by calculation. The method is based on radiello® methods F1, J1 and K1. Dates/times as provided by the client. RAD166: The recommended maximum exposure time is 15 days (7 days when relative humidity is more than 70%).

IS	*Insufficient sample for analysis*	*NA*	*Not analysed*
LNR	*Sample listed but not received*	*-*	*Not applicable*
LOR	*Limit of reporting*	*UTD*	*Unable to determine*
*	*Not SANAS accredited. This result is not included in the SANAS scope of accreditation for this laboratory*	*NR*	*Not Requested*

Samples analysed as received. Solid samples expressed on a dry weight basis. *Unless otherwise indicated, samples were received in containers fit for purpose at ambient temperature.*

End of Report

X Lab Earth Science PTY LTD
2 Samantha Street, Strydom Park, Randburg, 2169
Telephone Number: 011 590 3000
Email: info@xlab.earth

TEST REPORT

Contact	Matthew Mwepu	**Project Number**	BioVac Ndabeni
Client	**SLR Consulting (South Africa) (Pty) Ltd**	**Lab Reference**	JBX26-026400
Email	matthew.mwepu@slrconsulting.com	**Report Number**	LIM26/0167
Address		**Date Received**	20-Jan-2026
Order Number		**Date Test(s) Started**	20-Jan-2026
Samples	5	**Date Reported**	30-Jan-2026
Sample Matrix	Air		

X-Lab is a SANAS Accredited Testing Laboratory, No. T0775. Results marked "Not SANAS Accredited" in this report are not included in the SANAS Scope of Accreditation for this laboratory.

Dates/times as provided by the client. RAD130: The maximum recommended exposure time is 14 days.

Sample No.			JBX26-026400-01	JBX26-026400-02	JBX26-026400-03	JBX26-026400-04	JBX26-026400-05
Sample ID			FL1 YN378 2025/12/11 09:02 2025/12/23 13:02	FL3 YN387 2025/12/11 09:02 2025/12/23 13:02	FL1 WQ879 2025/12/23 13:00 2026/01/07 13:00	FL3 WQ883 2025/12/23 13:00 2026/01/07 13:00	FL1 Blank 733AR 2025/12/11 09:02 2026/01/07 13:00
Sample Comment			-	-	-	-	-
Analysis	**Unit**	**LOR**	**Result**	**Result**	**Result**	**Result**	**Result**
BTEX on RAD130 - -							
Benzene *	µg/tube	1	< 1	< 1	< 1	< 1	<1
Toluene *	µg/tube	1	< 1	< 1	1.2	1.3	<1
Ethylbenzene *	µg/tube	0.75	< 0.75	< 0.75	< 0.75	< 0.75	<0.75
m/p-Xylene *	µg/tube	0.8	< 0.8	< 0.8	< 0.8	< 0.8	<0.8
o-Xylene *	µg/tube	0.75	< 0.75	< 0.75	< 0.75	< 0.75	<0.75
Ambient concentration of Benzene *	µg/m³	0.31	0.33	0.41	0.61	0.64	<0.31
Ambient concentration of Toluene *	µg/m³	0.34	0.68	0.63	0.92	1.0	<0.34
Ambient concentration of Ethylbenzene *	µg/m³	0.28	< 0.28	< 0.28	< 0.28	< 0.28	<0.28
Ambient concentration of m/p-Xylene *	µg/m³	0.29	0.36	0.36	0.52	0.54	<0.29
Ambient concentration of o-Xylene *	µg/m³	0.29	< 0.29	< 0.29	< 0.29	< 0.29	<0.29

IS	*Insufficient sample for ana lysis*	*NA*	*Not analysed*
LNR	*Sample listed but not received*	*-*	*Not applicable*
LOR	*Limit of reporting*	*UTD*	*Unable to determine*
*	*Not SANAS accredited. This result is not included in the SANAS scope of accreditation for this laboratory*	*NR*	*Not Requested*

Samples analysed as received. Solid samples expressed on a dry weight basis. *Unless otherwise indicated, samples were received in containers fit for purpose at ambient temperature.*

X Lab Earth Science PTY LTD
2 Samantha Street, Strydom Park, Randburg, 2169
Telephone Number: 011 590 3000
Email: info@xlab.earth

TEST REPORT

Report number	LIM26/0167
Client reference:	26400

Dates/times as provided by the client. RAD130: The maximum recommended exposure time is 14 days.

Sasha Maistry
Technical Signatory (Approver)

Reuben Maleka
Technical Signatory (Reviewer)

Method	Method Summary
BTEX on RAD130	Benzene, toluene, ethyl benzene, m/p-xylene, and o-xylene on Radiello 130s by GC-FID.

IS	*Insufficient sample for analysis*	*NA*	*Not analysed*
LNR	*Sample listed but not received*	*-*	*Not applicable*
LOR	*Limit of reporting*	*UTD*	*Unable to determine*
*	*Not SANAS accredited. This result is not included in the SANAS scope of accreditation for this laboratory*	*NR*	*Not Requested*

Samples analysed as received. Solid samples expressed on a dry weight basis. *Unless otherwise indicated, samples were received in containers fit for purpose at ambient temperature.*

End of Report

X Lab Earth Science PTY LTD
2 Samantha Street, Strydom Park, Randburg, 2169
Telephone Number: 011 590 3000
Email: info@xlab.earth

TEST REPORT

Contact	Matthew Mwepu	**Project Number**	BioVac Ndabeni
Client	**SLR Consulting (South Africa) (Pty) Ltd**	**Lab Reference**	JBX26-026401
Email	matthew.mwepu@slrconsulting.com	**Report Number**	LIM26/0168
Address		**Date Received**	20-Jan-2026
Order Number		**Date Test(s) Started**	20-Jan-2026
Samples	5	**Date Reported**	26-Jan-2026
Sample Matrix	Air		

The document is issued in accordance with SANAS's accreditation requirements. Accredited for compliance with ISO/IEC 17025. SANAS accredited laboratory T0775. Results marked "Subcontracted Test" in this report are not included in the SANAS Scope of Accreditation for this laboratory.

Testing Laboratory
T0775

Sample No.			JBX26-026401-01	JBX26-026401-02	JBX26-026401-03	JBX26-026401-04
Sample ID			FL1 YN379 2025/12/11 09:02 2025/12/23 13:02	FL3 YN375 2025/12/11 09:02 2025/12/23 13:02	FL1 WQ881 2025/12/23 13:00 2026/01/07 13:00	FL3 WQ884 2025/12/23 13:00 2026/01/07 13:00
Sample Comment			-	-	-	-
Analysis	**Unit**	**LOR**	**Result**	**Result**	**Result**	**Result**
Determination of Ammonia in Source Emissions (ME-AN-063) - LAB-QLT-MET-063						
Ammonia as N	µg/tube	0.008	0.60	0.60	1.3	1.4
Ammonia as NH_3	µg/tube	0.01	0.73	0.73	1.5	1.6
Ammonia (ambient)	µg/m³	0.004	0.18	0.18	0.38	0.41
Sampling Duration (Period) *	-	-	17520	17520	17280	17280

Sample No.			JBX26-026401-05
Sample ID			FL1 Blank 735AR 2025/12/11 09:02 2026/01/07 13:00
Sample Comment			-
Analysis	**Unit**	**LOR**	**Result**
Determination of Ammonia in Source Emissions (ME-AN-063) - LAB-QLT-MET-063			
Ammonia as N	µg/tube	0.008	0.013
Ammonia as NH_3	µg/tube	0.01	0.02
Ammonia (ambient)	µg/m³	0.004	< 0.004
Sampling Duration (Period) *	-	-	17518

Sasha Maistry
Technical Signatory (Approver)

Reuben Maleka
Technical Signatory (Reviewer)

Method	Method Summary
Determination of Ammonia in Source Emissions (ME-AN-063)	Analysis of ammonia captured in sulphuric acid solution in impingers by automated spectrophotometry at 660 nm using the formation of indophenol from the ammonia present.

IS	*Insufficient sample for analysis*	*NA*	*Not analysed*
LNR	*Sample listed but not received*	*-*	*Not applicable*
LOR	*Limit of reporting*	*UTD*	*Unable to determine*
***	*Not SANAS accredited. This result is not included in the SANAS scope of accreditation for this laboratory*	*NR*	*Not Requested*

Samples analysed as received. Solid samples expressed on a dry weight basis. *Unless otherwise indicated, samples were received in containers fit for purpose at ambient temperature.*

End of Report

Appendix F EXCO Monitoring Report (2025)

Air Quality Baseline Assessment

Proposed Vaccine Manufacturing Facility, Cape Town

The Biovac Institute (Pty) Ltd

SLR Project No.: 723.000205.00001

23 February 2026

EXCO
ENVIRONMENTAL & OCCUPATIONAL HEALTH
SERVICES

P.O. Box 6577
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Bellville
South Africa
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REPORT ON AMBIENT AIR QUALITY MONITORING

2025

THE BIOVAC INSTITUTE (PTY) LTD

12 ALEXANDRA ROAD, PINELANDS, CAPE TOWN, 7570

BIOVAC
science of protecting life

TABLE OF CONTENTS

STATEMENT

I, C.D. le Roux (SAIOH registration no. 0327), declare on behalf of EXCO Services, as an Approved Inspection Authority (Department of Employment and Labour certification no. OH0261- CI 011) that the results and findings of this report are a true reflection of the conditions that were encountered at the time of the survey.

Please note that only results in this report for services listed below are included in the SANAS Scope of Accreditation for this Inspection Body:

Field of Inspection:	Inspection Authority for:
The supply of services as an inspection authority for **Asbestos Abatement** Regulation, Government Notice No. R 1196 of 10 November 2020	Regulation 4(2) – Bulk sampling of a substance for identification Regulation 5(7) – Review and endorsement of the inventory of asbestos and asbestos risk assessment every six years. Regulation 13 – Duties of approved inspection authorities for asbestos work Regulation 16 – Air monitoring Regulation 22 – Asbestos clearance certificate
The supply of services as an inspection authority for **Lead** Regulation, Government Notice No. R 236 of 28 February 2002	Regulation 7 - Air monitoring Regulation 14 – Maintenance of control measures
The supply of services as an inspection authority for **Noise-Induced Hearing Loss** Regulation, Government Notice No. R 307 of 07 March 2003	Regulation 7 – Noise Monitoring
The supply of services as an inspection authority for the Regulations for **Hazardous Chemical Agents**, Government Notice No. R 280 of 29 March 2021	Regulation 6 - Air monitoring Regulation 12 – Maintenance of control measures

Items marked "☒" in this report are not included in the SANAS Scope of Accreditation for this inspection body.

All recommendations and suggestions are made in good faith and EXCO Services would make a reasonable effort to ensure that such recommendations are viable and practicable. Opinions, interpretations, background information, discussions, recommendations and conclusions expressed herein are outside the scope of SANAS accreditation. EXCO Services and its employees assume no liability or responsibility for any loss, damage, injury, cost or expense, whether of a financial or other nature, directly or consequentially incurred by the Client based on this report.

This report only pertains to the conditions found at the Biovac Institute (Pty) Ltd, 12 Alexandra Road, Pinelands during the time of the survey. The content of this document, or any part thereof, may not be reproduced or transmitted in any form or by any means, electronic, physical or otherwise, without prior written approval of the author.

APPROVAL

REPORT COMPILED BY
Andrew Molapo STACK EMISSION MONITORING TECHNICIAN Adv.Dip (Chem. Eng.)
SIGNATURE **20/08/2025** **DATE OF ISSUE**

REPORT APPROVED BY
Riaan le Roux TECHNICAL SIGNATORY (SAIOH, ROH)
SIGNATURE **20/08/2025** **DATE OF ISSUE**

ACKNOWLEDGEMENT OF RECEIPT

ON BEHALF OF THE BIOVAC INSTITUTE (PTY) LTD
Moegamat Dollie EHS OFFICER
SIGNATURE **DATE**

DISTRIBUTION LIST

Copy No.	Attention	Name and Contact Details of Concern
1.	Mr. Moegamat Dollie	The Biovac Institute (Pty) Ltd 15 Alexandra Road Pinelands 7405 Tel: 021 514 5000 E-mail: moegamatD@biovac.co.za
2.	Library	EXCO Services P.O. Box 6577 Welgemoed Bellville 7538 Tel: (021) 913-8422 Cell 083 554 1419

COMPANY INFORMATION

<table>
<tr><td>Company Name</td><td colspan="3">EXCO Environmental and Occupational Health Services</td></tr>
<tr><td>Registration Number</td><td colspan="3">2024/266967/07</td></tr>
<tr><td>Directors</td><td colspan="2">C.D. le Roux</td><td>H.J. le Roux</td></tr>
<tr><td colspan="2">Physical Address</td><td colspan="2">Postal Address</td></tr>
<tr><td colspan="2">Block 3, Oude Westhof Village Square
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<tr><td>E-mail Address</td><td colspan="3">info@excoservices.co.za riaan@excoservices.co.za</td></tr>
</table>

1 PURPOSE

Following complaints from members of the community residing near the premises of the Biovac Institute (Pty) Ltd, 15 Alexandra Road, Pinelands, Cape Town. EXCO Services was contracted by the Biovac Institute (Pty) Ltd to investigate the impact of the company's activities on the air quality of the surrounding environment and assess its potential impact on the health of the members of the surrounding community.

The monitoring programme focused primarily on volatile organic compounds (VOCs), as these pollutants are commonly associated with processes and chemical usage from pharmaceutical industry. The selection of these parameters was therefore guided by their relevance to the Biovac Institute (Pty) Ltd activities, their potential to cause odour nuisance, and their importance from a human health and regulatory compliance perspective. Benzene (C_6H_6) was included as a representative VOCs due to its regulatory significance.

To quantify possible ambient air pollutants associated with the activities of the Biovac Institute (Pty) Ltd, EXCO Services conducted air quality monitoring using passive samplers supplied by Chemtech Laboratory Services (Radiello system – Supelco analytical products). The monitoring focused on measuring airborne concentrations of volatile organic compounds (VOCs). The study was conducted under winter dispersion conditions to evaluate pollutant levels and their potential impact on air quality in the vicinity of the Biovac Institute premises.

2 INTRODUCTION

This report presents the results of ambient air quality monitoring conducted over a three-week period at the perimeter of the Biovac Institute (Pty) Ltd. The monitored pollutants are volatile organic compounds (VOCs), including Benzene, Toluene, Ethylbenzene and Xylene (BTEXs) measured at five (5) sampling points along the boundaries of the Biovac Institute (Pty) Ltd, Pinelands to conduct a passive airborne contaminant survey. These pollutants were monitored according to the current South African National Ambient Air Quality Standards, where applicable. The objective of this monitoring was to assess potential air quality impacts by comparing pollutant concentrations to legislative values and identifying any concerns regarding emissions.

The monitoring was conducted from 24 June to 15 July 2025, with weekly sample collections. The selected sampling points were as follows:

TABLE 1: LOCATION OF SAMPLING POSITIONS

Sampling Point Number	Location Description	GPS Coordinates
Sampling Point 1	North-Western Boundary	33°56'12.06"S 18°29'22.33"E
Sampling Point 2	Southern Boundary	33°56'15.62"S 18°29'23.84"E
Sampling Point 3	Eastern Boundary	33°56'14.28"S 18°29'25.83"E
Sampling Point 4	North-Eastern Boundary	33°56'12.11"S 18°29'26.15"E
Sampling Point 5	Northern Boundary	33°56'10.96"S 18°29'23.63"E

Please see the Google Earth image showing the monitoring points below:

Image 1: Satellite image of the Biovac Institute (Pty) Ltd (Pinelands), indicating passive sampling positions during the 2025 survey.

3 AMBIENT AIR QUALITY STANDARDS AND EXPOSURE LIMITS⊠

The National Environmental Management: Air Quality Act (NEMAQA) suggests standards for ambient concentrations of benzene; however, there are no standards set for toluene, xylene, and ethylbenzene in ambient air.

On the 24th of December 2009, the latest regulations emanating from NEMAQA were promulgated (see Table 2). From a legal standpoint, only standards promulgated under the National Environmental Management: Air Quality Act (Act 39 of 2004) are applicable during the relevant timeframes, as stipulated below. It should be stressed that the ambient air quality standard will not be used for prosecution but as a guide for action by the relevant local authorities.

TABLE 2: NATIONAL AMBIENT AIR QUALITY STANDARDS FOR BENZENE

Averaging Period	Concentration	Permissible Exceedances (per calendar year)	Compliance Date
Annual	5 µg/m^3 (1.6 ppb)	0	Immediate

4 SURVEY METHODOLOGY⊠

4.1 VOCs Samplers

A passive sampling technique, based on molecular diffusion, was employed to monitor the target pollutants (VOCs including BTEXs). This method, commonly referred to as "diffusive sampling" or "passive sampling", allows gas molecules to diffuse into the samplers, where they are quantitatively collected on an impregnated filter or absorbent material, providing a concentration value integrated over time. The diffusive samplers were mounted at the five (5) locations on the fence line at a height of approximately 2 metres above ground level to monitor ambient air conditions.

4.2 Methods and Exposure Times

The analytical methods and exposure times for the monitored pollutants are summarised in Table 3.

TABLE 3: RADIELLO METHODS USED TO SAMPLE AND ANALYSE POLLUTANTS

Ambient Pollutant	Method	Exposure Time
Volatile Organic Compounds (VOCs)	Radiello method D1 and analysed by gas chromatography	8 hours to a maximum of 14 days

After the exposure period, the samplers were sealed and returned for analysis to a SANAS-accredited laboratory, namely Chemtech Laboratory Services.

The following instruments and equipment were utilised:

- Diffusive Bodies;
- Vertical Adapters;
- Triangle Base Plates;
- Impregnated Thermal Desorption Tubes (Radiello); and
- Gas Chromatograph (GC-MS).

5 RESULTS

5.1 Volatile Organic Compounds (VOCs)

The results of ambient VOC monitoring obtained from the five (5) ambient air sampling sites are summarised in Table 4 and graphically presented in Graphs 1 to 4, specifically for benzene concentrations.

As mentioned previously, the only current applicable legal South African ambient standard for hydrocarbons is the annual ambient standard for benzene, set at 5 µg/m^3. This value has been plotted on the graph for comparative purposes, in the absence of a weekly standard. Ambient concentrations for Volatile Organic Compounds (VOCs) other than Benzene were also determined. These are represented in Table 5 which forms part of Appendix B.

TABLE 4: BENZENE CONCENTRATIONS DETECTED AT FIVE SAMPLING LOCATIONS DURING THE THREE-WEEK PERIOD AT THE BIOVAC INSTITUTE (PTY) LTD, PINELANDS. 24 JUNE – 15 JULY 2025.

Sampling Points (see Images 1 & 2)	Period of Sampler Exposure	Benzene Concentration (µg/m^3)	Annual Benzene Limit (µg/m^3)
Point 1: North-Western Boundary	24 June – 01 July 2025	4.79	5
	01 July – 08 July 2025	4.14	
	08 July – 15 July 2025	0.25	
Point 2: Southern Boundary	24 June – 01 July 2025	3.52	5
	01 July – 08 July 2025	2.32	
	08 July – 15 July 2025	0.14	
Point 3: Eastern Boundary	24 June – 01 July 2025	2.68	5
	01 July – 08 July 2025	2.98	
	08 July – 15 July 2025	0.32	

Sampling Points **(see Images 1 & 2)**	**Period of Sampler Exposure**	**Benzene Concentration ($\mu g/m^3$)**	**Annual Benzene Limit ($\mu g/m^3$)**
Point 4: North-Eastern Boundary	24 June – 01 July 2025	1.78	5
	01 July – 08 July 2025	1.54	
	08 July – 15 July 2025	0.33	
Point 5: Northern Boundary	24 June – 01 July 2025	1.73	5
	01 July – 08 July 2025	0.88	
	08 July – 15 July 2025	0.30	
$\mu g/m^3$ – microgram per cubic metre			

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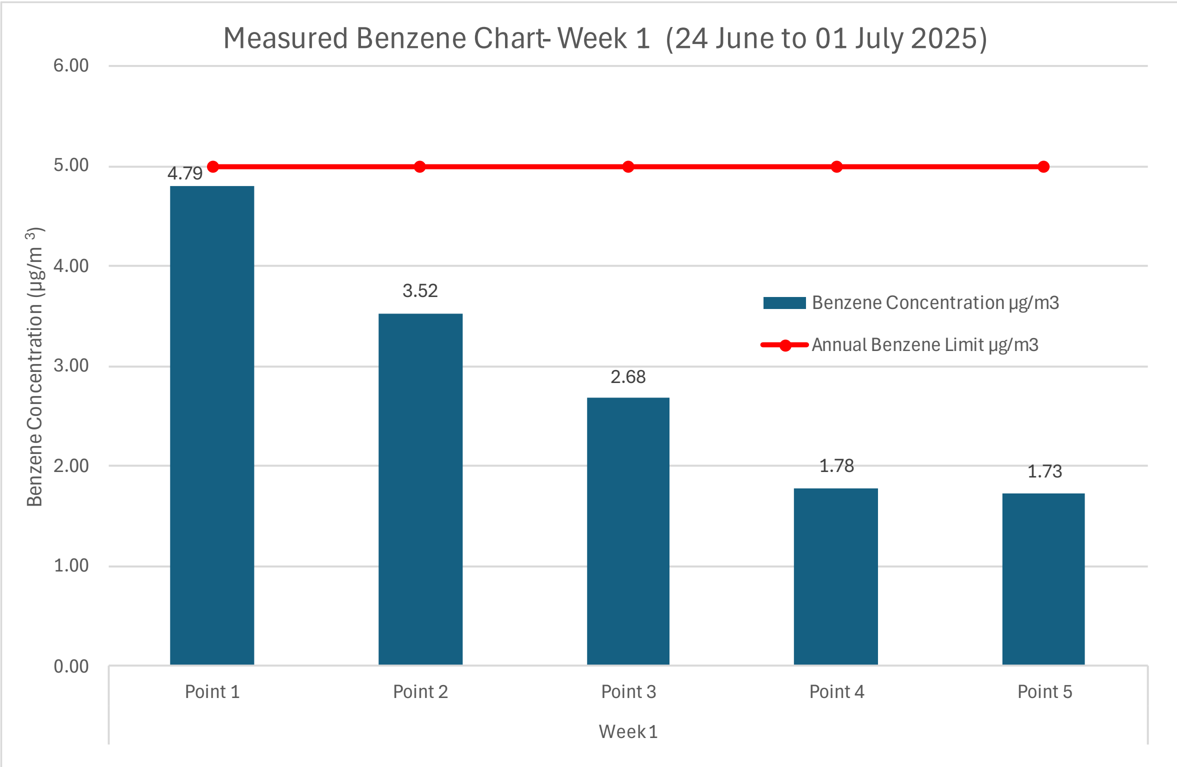
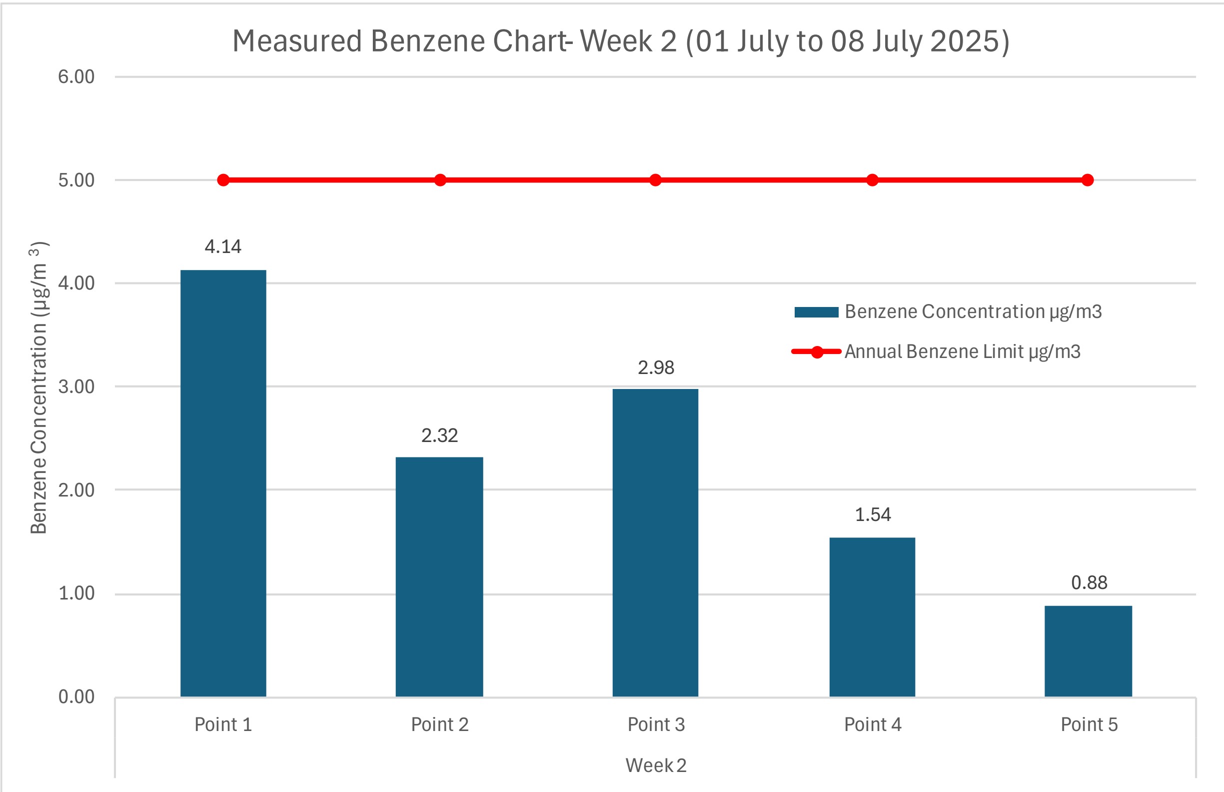
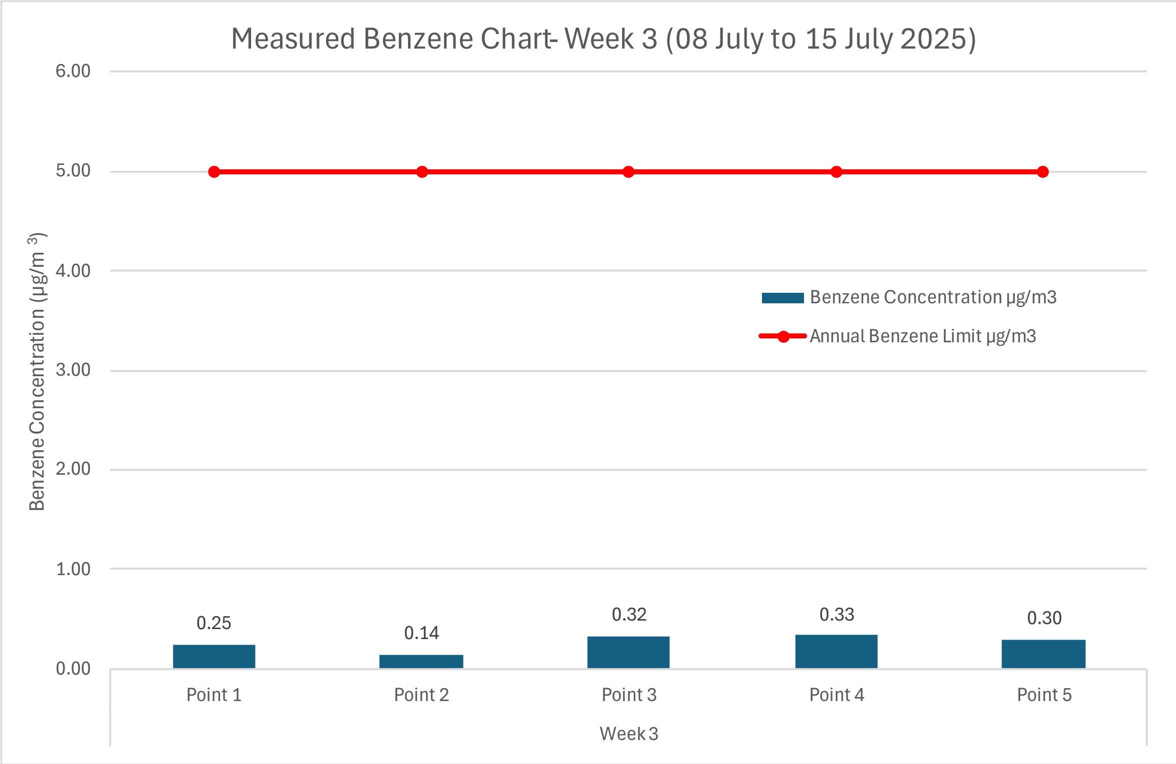


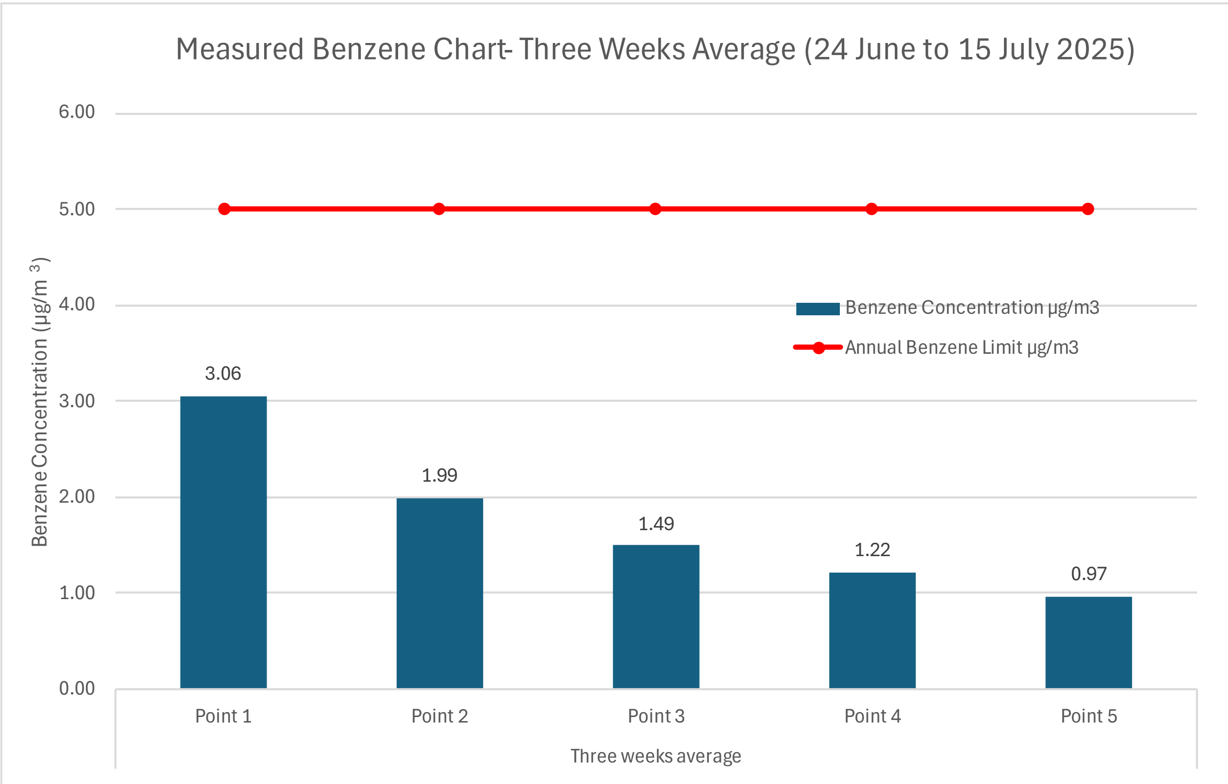
Graph 1: Measured benzene over the sample exposure period (24 June – 01 July 2025).



Graph 2: Measured benzene over the sample exposure period (01 July – 08 July 2025).



Graph 3: Measured benzene over the sample exposure period (08 July – 15 July 2025).



Graph 4: Measured benzene over the sample exposure period (24 June – 15 July 2025).

5.2 BTEX Compounds

BTEX compounds, which include benzene, toluene, ethylbenzene, and xylene, are significant environmental pollutants with various health risks and industrial applications. Monitoring these compounds is essential for protecting public health and the environment.

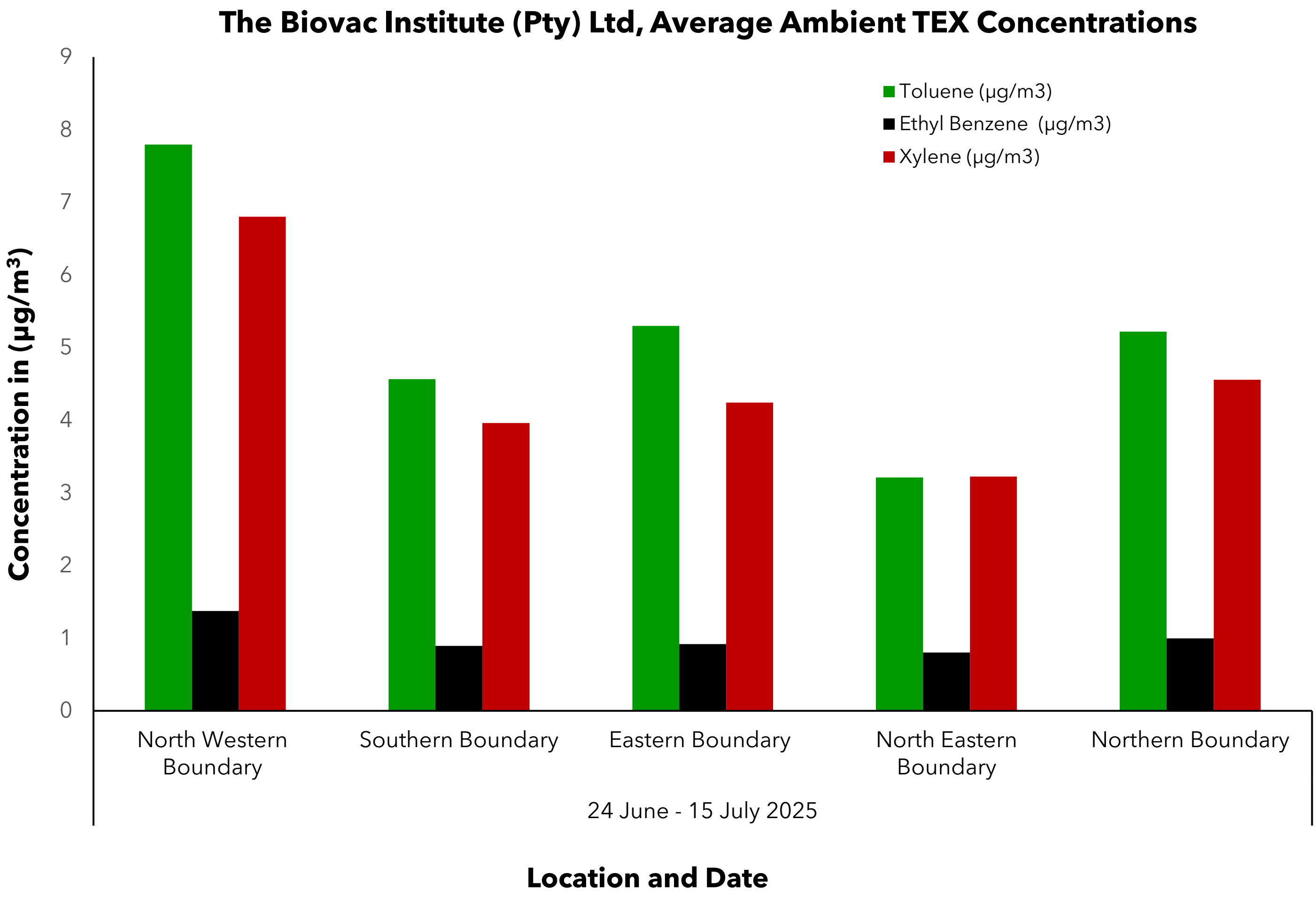
Volatile Organic Compound (VOC) concentrations, specifically BTEX, for the current sampling period are summarised in Table 5 and graphically represented in Graph 5.

TABLE 5: THE AVERAGE VOC (BTEX) CONCENTRATIONS OBTAINED OVER A THREE-WEEK PERIOD ALONG THE FENCELINE OF BIOVAC INSTITUTE (PTY) LTD, PINELANDS. 24 JUNE – 15 JULY 2025.

Sampling Points (see Image 1 & 2)	**Benzene ($\mu g/m^3$)**	**Toluene ($\mu g/m^3$)**	**Ethylbenzene ($\mu g/m^3$)**	**Xylene ($\mu g/m^3$)**
Point 1: North-Western Boundary	3.06	7.80	1.38	6.80
Point 2: Southern Boundary	1.99	4.57	0.89	3.96
Point 3: Eastern Boundary	1.99	5.30	0.92	4.24
Point 4: North-Eastern Boundary	1.22	3.21	0.80	3.23
Point 5: Northern Boundary	0.97	3.43	0.74	3.97
Three-week average (Inclusive of all weekly averages)	**1.85**	**4.86**	**0.95**	**4.44**
$\mu g/m^3$ – microgram per cubic metre				

The laboratory results above will be interpreted and assessed through comparison with the relevant standards in Section 6 (Discussion of Results) below.

Ambient concentrations for Volatile Organic Compounds (VOCs) other than the substances listed above were also determined. These are reflected in Tables 7 to 9 which forms part of Appendix B.



Graph 5: TEX parameters sampled over the entire sample exposure period (24 June – 15 July 2025).

5.3 Wind Data

Ambient weather data (used for interpretative purposes) for the duration of the monitoring period was obtained from the South African Weather Services located at the Cape Town - Royal Yacht Club, approximately 4.8 km from Biovac Institute (Pty) Ltd, Pinelands. The weather station has been measuring hourly sequential data for several years. Wind data provides insight into the transport and dispersion of air pollutants. Wind speed and direction influence how emissions from a source travel and where elevated pollutant concentrations may occur.

<u>Week 1: 24 June to 01 July 2025</u>

Figure 1 below shows that the predominant wind, during the first week of the sampling period was from the northerly direction, with an average wind speed of 3.16 m/s with calm conditions (wind speeds below 0.5 m/s) occurring approximately 15.28% of the time. The highest wind speed recorded was 13.7 m/s. The wind rose indicates the wind direction in the direction "blowing from".

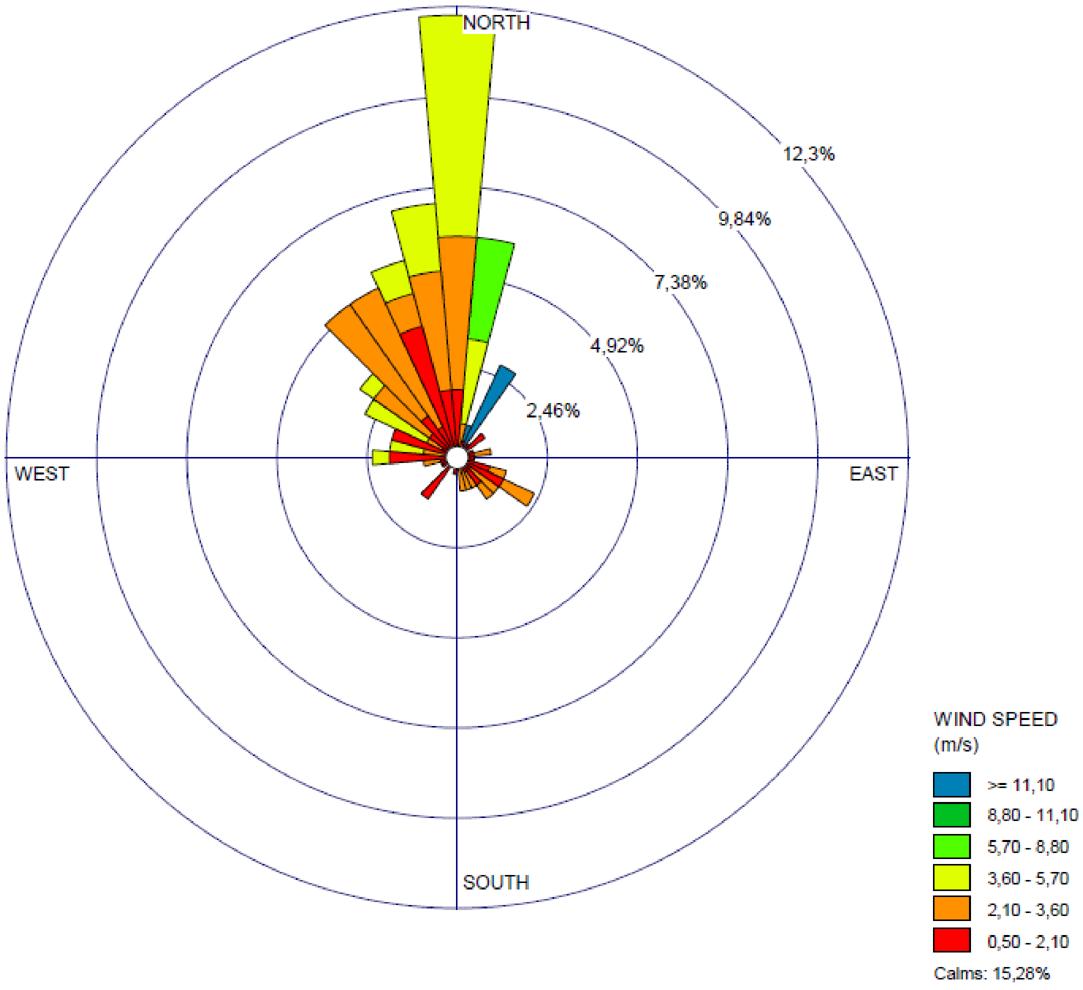


Figure 1: Wind rose depicting the wind direction and speed over the sample exposure period (24 June – 01 July 2025).

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Week 2: 01 July to 08 July 2025

Figure 2 below shows that the predominant wind, during the second week of the sampling period was from the south westerly direction, with an average wind speed of 0.43 m/s with calm conditions (wind speeds below 0.5 m/s) occurring approximately 53.7% of the time. The highest wind speed recorded was 2.6 m/s. The wind rose indicates the wind direction in the direction "blowing from".

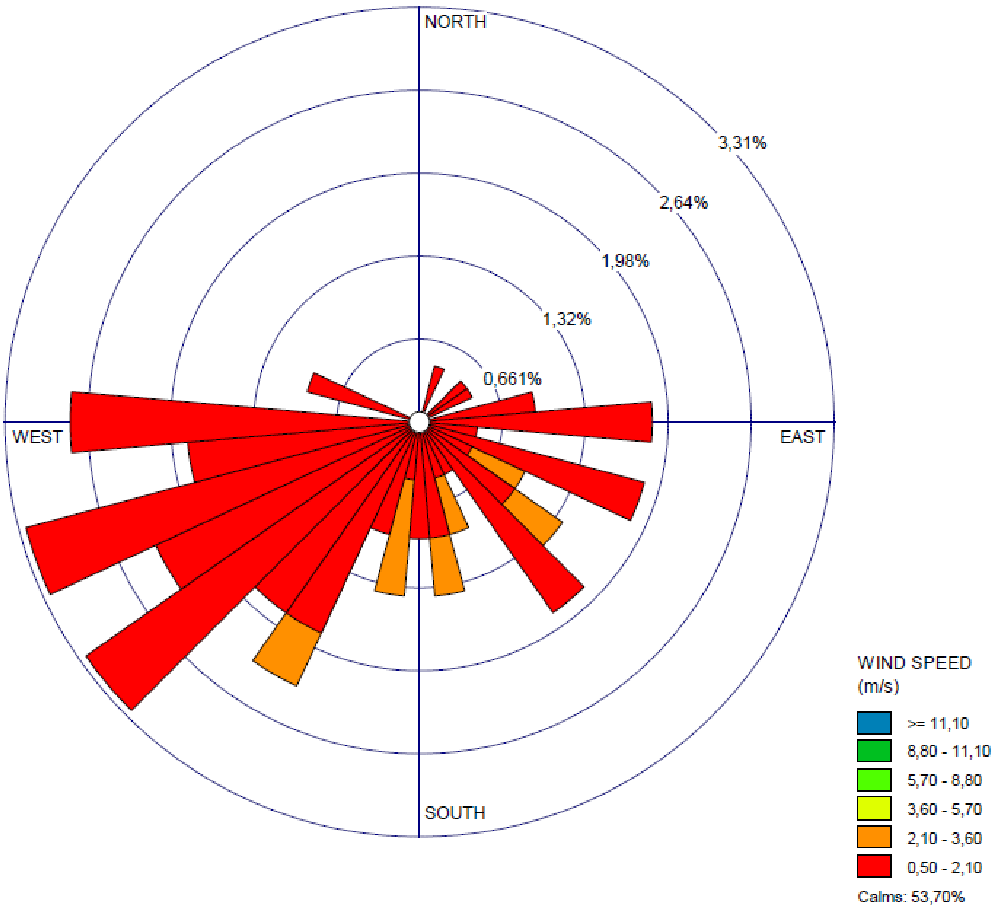

Figure 2: Wind rose depicting the wind direction and speed over the sample exposure period (01 July – 08 July 2025).

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Week 3: 08 July – 15 July 2025

Figure 3 below shows that the predominant wind, during the third week of the sampling period was from the westerly direction, with an average wind speed of 0.41 m/ with calm conditions (wind speeds below 0.5 m/s) occurring approximately 57.5% of the time. The highest wind speed recorded was 2.9 m/s. The wind rose indicates the wind direction in the direction "blowing from".

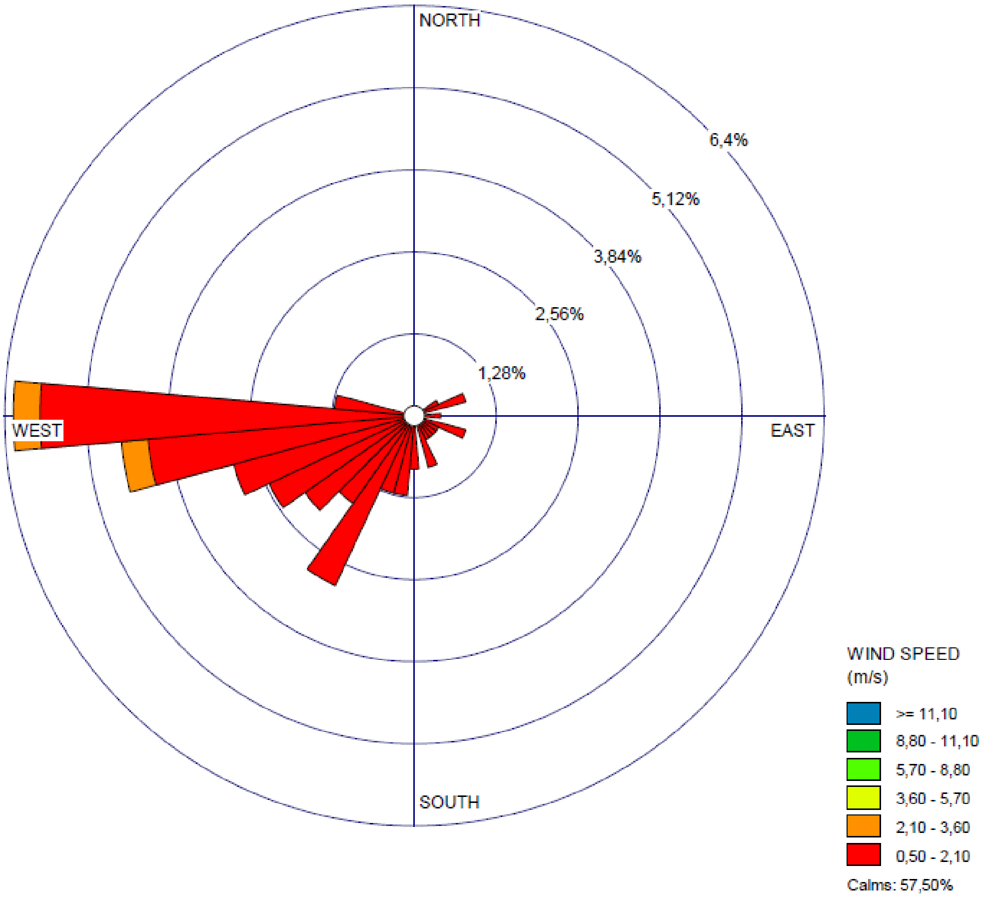

Figure 3: Wind rose depicting the wind direction and speed over the sample exposure period (08 July – 15 July 2025).

Three-Week Average: 24 June to 15 July 2025

Figure 4 below shows that the predominant wind, during the entire three-week sampling period, was from both the northerly and westerly direction, with an average wind speed of 1.42 m/s with calm conditions (wind speeds below 0.5 m/s) occurring approximately 44.02% of the times. The highest wind speed recorded was 13.7 m/s. The wind rose indicates the wind direction in the direction "blowing from".

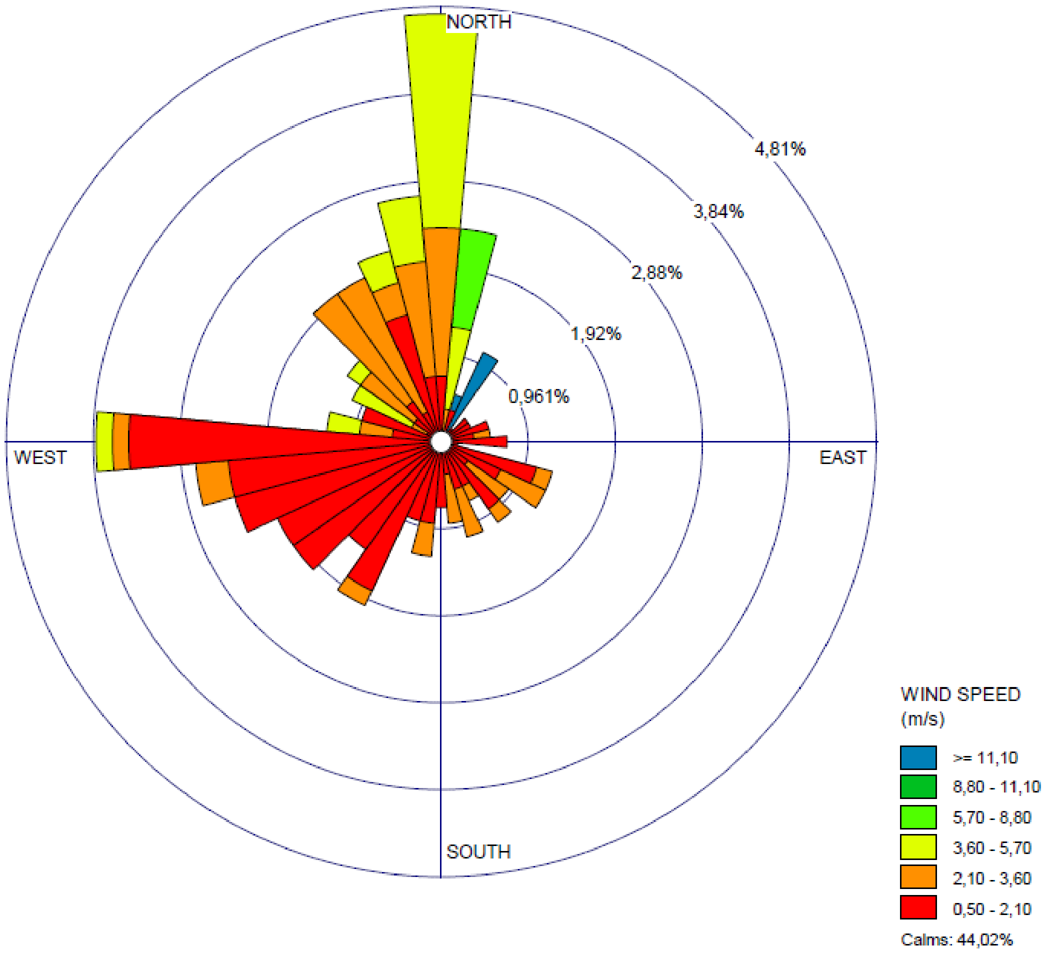

Figure 4: Wind rose depicting the wind direction and speed over the sample exposure period (24 June – 15 July 2025).

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Image 2: Satellite Image of Biovac Institute (Pty) Ltd, Pinelands with the wind rose visible an overlay (24 June – 15 July 2025).

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6 DISCUSSION OF RESULTS

6.1 Volatile Organic Compounds (Benzene)

Benzene concentrations measured over the three-week monitoring period ranged from 0.14 µg/m³ to 4.79 µg/m³ across the five (5) sampling points (see Table 4). The highest benzene concentrations were recorded at Sampling Point 1 (North-Western boundary) during Week 1 and 2, with concentrations of 4.79 µg/m³ and 4.14 µg/m³, respectively. The elevated benzene levels observed at this sampling point are likely influenced by both off-site emission sources and localised operational activities occurring near the sampling point. Notably, pollutant concentrations recorded at the five (5) sampling points were comparatively low during Week 3 of the monitoring period. These reduced benzene levels are consistent with the observed meteorological conditions, which indicated limited dispersion conditions during that week. Wind speeds were relatively low, with a high percentage of calm conditions (see Figure 3).

The three-week average benzene concentrations measured at Sampling Points 1, 2, 3, 4 and 5 were 3.06 µg/m³, 1.99 µg/m³, 1.99 µg/m³, 1.22 µg/m³ and 0.97 µg/m³, respectively (see Table 5). This translates to the overall average benzene concentration of 1.85 µg/m³ measured over the three-week period across five sampling points. The results indicate that benzene concentrations were relatively consistent across the sampling points, with minor variations likely influenced by proximity to emission sources and meteorological conditions during the sampling periods.

All measured benzene concentrations were lower than the National Ambient Air Quality Standard (NAAQS) for benzene, which specifies an annual average limit of 5 µg/m³. The results therefore indicate that ambient benzene concentrations in the monitoring area were within acceptable limits throughout the monitoring period. No exceedances of the applicable legislative limit were recorded.

6.2 TEX Concentrations

Monitoring results for TEX (toluene, ethylbenzene, and xylene) over the three-week sampling period show that average toluene concentrations ranged from 3.21 µg/m³ to 7.80 µg/m³ across the five sampling locations. Average ethylbenzene concentrations ranged from 0.74 µg/m³ to 1.38 µg/m³, while xylene concentrations varied between 3.23 µg/m³ and 6.80 µg/m³.

The results indicate that toluene and xylene were dominant TEX pollutants, the highest average concentrations of 7.80 µg/m³ and 6.80 µg/m³ respectively, recorded at Sampling Point 1 (see Tables 5 and Graph 5). The predominant wind directions during the three-week period were from the northerly and westerly directions (see Figure 4), indicating that sources outside the boundary of the Biovac Institute (Pty) Ltd likely contributed to the elevated concentrations of organic vapours at these locations.

However, meteorological data indicate that wind patterns varied throughout the three-week monitoring period, with occasional winds blowing from the south-easterly directions (see Figure 4). As a result, potential contributions from sources within the Biovac Institute premises cannot be excluded, particularly regarding the elevated concentrations observed at Sampling Points 1 and 2 (See Image 2).

6.3 Other VOCs

In addition to BTEX compounds, other VOCs were detected during the monitoring period, including amongst others hexane group compounds, Methyl Ethyl Ketone (MEK), *n*-Decane, and *d*-Limonene, which were present at slightly higher concentrations relative to other detected compounds (see Appendix B). It is important to note that there are no applicable South African ambient air quality standards for hydrocarbons other than benzene. As such, the detected VOCs cannot be assessed against any established benchmark limits or regulatory thresholds.

7 CONCLUSION

Ambient air quality monitoring was undertaken over a three-week period to assess concentrations of various organic compounds (VOCs), including benzene, toluene, ethylbenzene and xylene (BTEX compounds) along the boundary of the Biovac Institute (Pty) Ltd, Pinelands. The monitoring was initiated in response to air quality-related complaints from nearby community situated northwest to the Biovac Institute premises. The results of the monitoring survey indicate that the concentrations of all pollutants measured were below the applicable South African ambient air quality limits.

Benzene was detected at all sampling points, with concentrations ranging from 0.14 µg/m³ to 4.79 µg/m³, and an average concentration of 1.85 µg/m³. These values are well below the annual ambient air quality standard of 5 µg/m³. Although benzene concentrations were below the applicable legislative limit, elevated levels were consistently observed during the first two weeks, with Sampling Point 1 recording the highest concentration in Week 1.

While the measured pollutant concentrations do not exceed the regulatory limit, benzene remains a concern in this context due to its consistent elevated presence at the specified sampling point. However, from a regulatory perspective, enforcement action based solely on ambient concentration exceedances would not be applicable given that the results remain within prescribed limits.

The wind analysis included in this report show that wind patterns at the Biovac Institute during the three-week monitoring period were predominantly from the northerly and westerly directions. These wind patterns indicate that majority of pollutants recorded were likely influenced by the sources mostly outside the perimeter of the Biovac Institute premises. Given that the complainant's premises are located to the north-west of the Biovac Institute, the prevailing wind directions during winter were less favourable for pollutant transport from the Biovac Institute premises towards the complainant.

It is recommended that the Biovac Institute conduct a repeat of the ambient air monitoring during the summer season, which is typically characterised by prevailing winds from the southern and south-eastern directions. Including an off-site sampling point as part of future surveys, preferably situated in the vicinity of the complainant's community will be essential to serve as a control point for comparative analysis. This approach will help assessing potential worst-case emission impacts on the complainant, if any, assess seasonal variations in air quality, and confirm the Biovac Institute's environmental commitments.

APPENDIX A: IMAGES

Image 3: Point 1, North-Western boundary next to the main entrance.

Image 4: Point 2, Southern boundary next to the second gate.

Image 5: Point 3, Eastern boundary, along the railway line next to the boilers area.

Image 6: Point 4, North-Eastern boundary, along the railway lines.

Image 7: Point 5, Northern boundary, adjacent reception building.

APPENDIX B: LABORATORY RESULTS

TABLE 6: VOC CONCENTRATIONS DETECTED AT FIVE SAMPLING LOCATIONS. ON THE FENCELINE OF THE BIOVAC INSTITUTE, PINELANDS. 24 JUNE – 01 JULY 2025.

	Point 1	Point 2	Point 3	Point 4	Point 5
Compound	**SMIS 594**	**SMIS 595**	**SMIS 596**	**SMIS 597**	**SMIS 598**
Unit	**µg/m³**	**µg/m³**	**µg/m³**	**µg/m³**	**µg/m³**
n-Pentane	1.14	0.35	0.71	0.16	0.35
Ethanol	2.77	0.26	0.04	0.42	< 0.01
Acetone	0.39	0.13	0.07	< 0.01	0.05
Isohexane	3.09	1.39	1.32	0.21	1.17
1-Hexene	2.95	0.64	1.07	< 0.01	< 0.01
n-Hexane	2.88	0.61	0.97	0.32	0.40
MEK	7.40	0.25	< 0.01	0.06	0.03
Ethyl acetate	2.40	1.78	1.77	< 0.01	0.21
Chloroform	< 0.01	< 0.01	< 0.01	1.53	< 0.01
2-Methylhexane	0.85	0.41	0.32	0.08	< 0.01
3-Methylhexane	0.81	0.72	0.36	0.20	< 0.01
Benzene	4.79	3.52	2.68	1.78	1.73
1-Heptene	0.45	< 0.01	< 0.01	< 0.01	< 0.01
n-Heptane	1.39	0.46	0.36	0.63	0.02
Propyl acetate	0.76	1.45	0.18	< 0.01	0.20
Toluene	14.80	6.81	6.71	4.90	4.16
n-Octane	0.79	0.53	< 0.01	< 0.01	< 0.01
Perchloroethylene	0.57	0.45	0.24	0.04	0.08
Ethyl benzene	2.73	1.31	0.75	1.45	0.72
Xylene	13.07	5.23	3.63	4.62	3.54
1-Nonene	< 0.01	0.53	0.31	0.86	0.12
n-Nonane	0.23	0.89	0.73	1.91	0.59
Propyl benzene	0.53	0.10	0.15	0.22	0.12
1,2,3-Trimethylbenzene	0.78	0.30	0.20	0.26	0.18
n-Decane	4.92	1.33	1.49	5.42	0.70
1,2,4-Trimethylbenzene	2.86	0.65	0.62	0.95	0.55
d-Limonene	9.86	1.63	1.08	3.72	0.44
1,3,5-Trimethylbenzene	0.74	0.19	0.20	0.23	0.17
µg/m³ – microgram per cubic meter					

TABLE 7: VOC CONCENTRATIONS DETECTED AT FIVE SAMPLING LOCATIONS. ON THE FENCELINE OF THE BIOVAC INSTITUTE, PINELANDS. 01 JULY – 08 JULY 2025.

	Point 1	Point 2	Point 3	Point 4	Point 5
Compound	**SMIS 599**	**SMIS 600**	**SMIS 601**	**SMIS 602**	**SMIS 603**
Unit	**µg/m³**	**µg/m³**	**µg/m³**	**µg/m³**	**µg/m³**
n-Pentane	1.19	0.61	0.52	0.05	0.06
Ethanol	0.04	0.04	1.29	0.10	< 0.01
Acetone	0.27	0.15	< 0.01	0.03	0.11
Isohexane	2.63	1.52	1.60	0.63	0.34
1-Hexene	0.69	0.86	< 0.01	0.06	< 0.01
n-Hexane	1.53	1.26	2.77	0.56	0.43
MEK	0.09	0.66	9.70	0.33	0.03
Ethyl acetate	10.01	4.63	< 0.01	1.98	0.13
2-Methylhexane	0.67	0.43	0.60	0.27	0.29
3-Methylhexane	0.75	0.35	0.70	0.17	0.07
Benzene	4.14	2.32	2.98	1.54	0.88
1-Heptene	0.18	0.23	< 0.01	0.06	< 0.01
n-Heptane	0.40	0.83	< 0.01	0.31	< 0.01
Propyl acetate	5.21	3.36	0.52	1.13	< 0.01
Toluene	7.77	6.08	8.39	3.77	4.06
1-Octene	0.45	0.31	< 0.01	< 0.01	< 0.01
n-Octane	0.51	0.41	< 0.01	0.41	0.28
Perchloroethylene	< 0.01	< 0.01	< 0.01	0.14	< 0.01
Ethyl benzene	1.26	1.18	1.83	0.90	1.09
Xylene, all isomers	6.44	5.69	8.14	3.97	6.35
n-Nonane	0.70	0.83	1.67	0.20	< 0.01
Propyl benzene	0.19	0.17	0.24	0.12	0.23
1,2,3-Trimethylbenzene	0.30	0.28	0.36	0.15	0.34
n-Decane	0.55	0.64	1.50	0.35	0.59
1,2,4-Trimethylbenzene	1.03	0.93	1.31	0.55	1.31
d-Limonene	0.20	0.41	1.25	< 0.01	0.66
1,3,5-Trimethylbenzene	0.23	0.23	0.35	0.10	0.26
µg/m³ – microgram per cubic meter					

TABLE 8: VOC CONCENTRATIONS DETECTED AT FIVE SAMPLING LOCATIONS. ON THE FENCELINE OF THE BIOVAC INSTITUTE, PINELANDS. 08 JULY – 15 JULY 2025.

	Point 1	Point 2	Point 3	Point 4	Point 5
Compound	**SMIS 604**	**SMIS 605**	**SMIS 606**	**SMIS 607**	**SMIS 608**
Unit	**µg/m³**	**µg/m³**	**µg/m³**	**µg/m³**	**µg/m³**
n-Pentane	0.01	0.01	0.02	0.08	0.05
Ethanol	0.02	0.05	0.02	0.02	< 0.01
Isohexane	0.04	0.04	0.11	0.07	0.05
n-Hexane	0.04	0.03	0.12	< 0.01	0.02
Cyclohexane	0.17	0.09	0.06	< 0.01	0.06
MEK	0.05	0.04	0.11	0.06	< 0.01
Ethyl acetate	< 0.01	< 0.01	< 0.01	0.06	0.02
2-Methylhexane	0.05	0.02	0.09	0.04	0.01
3-Methylhexane	0.13	0.01	0.02	0.03	0.01
Benzene	0.25	0.14	0.32	0.33	0.30
1-Heptene	< 0.01	< 0.01	< 0.01	0.04	< 0.01
n-Heptane	0.03	0.01	0.05	0.05	0.01
Toluene	0.82	0.80	0.80	0.97	2.06
n-Octane	0.03	0.05	0.07	< 0.01	0.02
Perchloroethylene	< 0.01	< 0.01	< 0.01	< 0.01	0.02
Ethyl benzene	0.13	0.18	0.18	0.06	0.40
Xylene, all isomers	0.90	0.97	0.96	1.08	2.03
1-Nonene	0.03	0.07	< 0.01	< 0.01	0.02
n-Nonane	0.05	0.06	0.06	0.03	0.20
Propyl benzene	0.01	0.02	< 0.01	< 0.01	0.01
1,2,3-Trimethylbenzene	0.05	0.04	0.05	< 0.01	0.01
n-Decane	0.05	0.11	0.20	0.03	0.20
1,2,4-Trimethylbenzene	0.13	0.15	0.15	0.13	0.31
d-Limonene	< 0.01	0.11	0.02	0.02	0.13
1,3,5-Trimethylbenzene	0.02	0.03	0.04	0.05	0.09

µg/m³ – microgram per cubic meter

APPENDIX C: CERTIFICATES

sanas
South African National
Accreditation System

CERTIFICATE OF ACCREDITATION

In terms of section 22(2) (b) of the Accreditation for Conformity Assessment, Calibration and Good Laboratory Practice Act, 2006 (Act 19 of 2006), read with sections 23(1), (2) and (3) of the said Act, I hereby certify that:-

CHEMTECH LABORATORY SERVICES CC

Co. Reg. No.: 1998/037710/23

Facility Accreditation Number: **T0361**

is a South African National Accreditation System accredited facility
provided that all conditions and requirements are complied with

This certificate is valid as per the scope as stated in the accompanying schedule of accreditation, Annexure "A", bearing the above accreditation number for

CHEMICAL ANALYSIS

The facility is accredited in accordance with the recognised International Standard

ISO/IEC 17025:2017

The accreditation demonstrates technical competency for a defined scope and the operation of a quality management system

While this certificate remains valid, the Accredited Facility named above is authorised to use the relevant accreditation symbol to issue facility reports and/or certificates

Baleni

Mr T Baleni
Acting Chief Executive Officer

Effective Date: 02 November 2022
Certificate Expires: 01 November 2027

Environmental: Stationary Emission Sources	Ammonia by Ion Chromatography	EPA Method CTM 27
	Hydrogen Halides and Halogens by Ion Chromatography	EPA Method 26, BS EN 1911:2010
	Metals by Inductively Coupled Plasma - Atomic Emission Spectroscopy (ICP-AES)	EPA Method 29, BS EN 14385
	Nitrogen Oxide by Ion Chromatography	EPA Method 7, BS EN 14792
	Particulate Matter (Gravimetrical Weighing)	EPA Method 5, EPA Method 17, BS EN 13284:2002, ISO 9096:2003
	Poly Aromatic Hydrocarbons by Gas Chromatography Mass Spectrometry	EPA Method 0010, ISO 11338-2
	Sulphur Dioxide by Ion Chromatography	EPA Method 6, BS EN 14791
	Sulphuric Acid & Sulphur Dioxide by Ion Chromatography	EPA Method 8, BS EN 14791
	Volatile Organic Compounds by Gas Chromatography Mass Spectrometry (GC-MS)	EPA Method 18, EPA Method - T014, EN BS 13649:2002

Original Date of Accreditation: 02 November 2007

ISSUED BY THE SOUTH AFRICAN NATIONAL ACCREDITATION SYSTEM

Accreditation Manager

NATIONAL LABORATORY ASSOCIATION · SOUTH AFRICA

This is to certify that

EXCO Stack Monitoring CC

is a member of the

NATIONAL LABORATORY ASSOCIATION

SOUTH AFRICA

for

2025

31 December 2025

EXPIRY DATE

CHAIRMAN

NLA-A-C-2259

employment & labour

Department:
Employment and Labour
REPUBLIC OF SOUTH AFRICA

APPROVED INSPECTION AUTHORITY

Registered in accordance with the provisions of the Occupational Health and Safety Act, Act 85 of 1993, as amended.

This is to certify that:

EXCO ENVIRONMENTAL & OCCUPATIONAL HEALTH SERVICES (PTY) LTD

has been approved by the Department of Employment & Labour as a Type C, Approved Inspection Authority: Occupational Health and Hygiene under the following regulations:

- Asbestos Abatement Regulations 4(2), 5(7), 13, 15(2)(c), 16 & 22
- Regulations for Hazardous Chemical Agents 6 & 12.
- Lead Regulations 7 & 14.
- Noise Induced Hearing Loss Regulation 7

CHIEF INSPECTOR

Valid from: **05 June 2025**
Expires: **28 September 2026**
Certificate Number: **OH0261 – CI 011**

DEPARTMENT OF EMPLOYMENT & LABOUR

Making Sustainability Happen