APPENDIX E: AIR QUALITY STUDY (AIRSHED, 2020)

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PLANNING PROFESSIONALS

Air Quality Specialist Report for the Proposed Increase of the Flash Dryer Capacity and Associated Feed Circuit Modifications at the Impala Rustenburg Smelter Complex

Project done for **SLR Consulting (Africa) (Pty) Ltd**

Report Compiled by
N Shackleton

Project Reviewed by
T Bird

Report No: 20SLR05 | **Version:** Final v4 | **Date:** March 2021

Address: 480 Smuts Drive, Halfway Gardens | **Postal:** P O Box 5260, Halfway House, 1685
Tel: +27 (0)11 805 1940 | **Fax:** +27 (0)11 805 7010
www.airshed.co.za

Report Details

Reference	20SLR05
Status	Final v4
Report Title	Air Quality Specialist Report for the Proposed Increase of the Flash Dryer Capacity and Associated Feed Circuit Modifications at the Impala Rustenburg Smelter Complex
Date	March 2021
Client	SLR Consulting (Africa) (Pty) Ltd
Prepared by	Natasha Shackleton, Pr. Sci. Nat., BSc Hons (Meteorology) (University of Pretoria)
Reviewed by	Theresa (Terri) Bird, Pr. Sci. Nat., PhD (University of the Witwatersrand)
Notice	Airshed Planning Professionals (Pty) Ltd is a consulting company located in Midrand, South Africa, specialising in all aspects of air quality, ranging from nearby neighbourhood concerns to regional air pollution impacts as well as noise impact assessments. The company originated in 1990 as Environmental Management Services, which amalgamated with its sister company, Matrix Environmental Consultants, in 2003.
Declaration	Airshed is an independent consulting firm with no interest in the project other than to fulfil the contract between the client and the consultant for delivery of specialised services as stipulated in the terms of reference. I, Natasha Anne Shackleton as the appointed independent air quality specialist for the “Air Quality Specialist Report for the Proposed Increase of the Flash Dryer Capacity and Associated Feed Circuit Modifications at the Impala Rustenburg Smelter Complex”, hereby declare that I: • acted as the independent specialist in this scoping assessment; • performed the work relating to the study in an objective manner; • regard the information contained in this report as it relates to my specialist input/study to be true and correct, • do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the Environmental Impact Assessment; • declare that there are no circumstances that may compromise my objectivity in performing such work; • have expertise in conducting the specialist report relevant to this application; • have no, and will not engage in, conflicting interests in the undertaking of the activity; • have no vested interest in the proposed activity proceeding; • undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing the decision of the competent authority; and • all the particulars furnished by me in this specialist input/study are true and correct.
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Revision Record

Revision Number	Date	Section Revised	Reason for Revision
Draft	September 2020		Original for client comment
Final v1	November 2020		Updates based on client comments
Final v2	January 2021	Section 5.3: Existing Air Quality Section 7.5: Assessment of Impact – Impala Proposed Future Operations (All Existing Impala Operations and Proposed Second Flash Dryer Operations)	Updates based on applicant comments
Final v3	February 2021	Table 21: Emission estimation techniques and parameters for construction Table 22: Summary of estimated particulate emissions in tonnes per annum for construction Table 23: Health risk impact significance summary table for the construction operations Table 24: Nuisance impact significance summary table for the construction operations Table 43: Health risk impact significance summary table for the Impala proposed future operations Table 44: Nuisance impact significance summary table for the Impala proposed future operations	Some potential additional dust control mitigations removed as they are not project specific and feasible to implement at the Impala Platinum Limited – Rustenburg Operations
Final v4	March 2021	Table 43: Health risk impact significance summary table for the Impala proposed future operations Table 44: Nuisance impact significance summary table for the Impala proposed future operations	Some potential additional dust control mitigations removed as they are not project specific and feasible to implement at the Impala Platinum Limited – Rustenburg Operations

Competency Profiles

Report author: N A Shackleton (née Gresse), Pr. Sci. Nat., BSc Hons (Meteorology) (University of Pretoria)

Natasha Shackleton started her professional career in Air Quality in April 2011 when she joined Airshed Planning Professionals (Pty) Ltd after completing her Undergraduate Degree at the University of Pretoria in Science. In 2011 she completed her Honours Degree at the University of Pretoria in Meteorology. Natasha is also a member of the South African Society for Atmospheric Sciences (SASAS) and is a registered Professional Natural Scientist with the South African Council for Natural Scientific Professions (SACNASP) (registration no. 116335). Natasha has worked on several air quality specialist studies between 2011 and 2021. She has experience in the various components including emissions quantification for a range of source types, simulations using a range of dispersion models, impacts assessment and health risk screening assessments. Her project experience range over various countries in Africa, providing her with an inclusive knowledge base of international legislation and requirements pertaining to air quality. Whilst most of his working experience has been in South Africa, a number of investigations were made in countries elsewhere, including Burkina Faso, Guinea, Ghana, Madagascar, Mozambique, Namibia, Suriname, Tanzania, Zimbabwe and Zambia.

Report reviewer: Dr Theresa (Terri) Bird, Pr. Sci. Nat., PhD (University of the Witwatersrand)

Dr Terri Bird holds a PhD from the School of Animal, Plant and Environmental Sciences, University of the Witwatersrand, Johannesburg. The focus of her doctoral research was on the impact of sulfur and nitrogen deposition on the soil and waters of the Mpumalanga Highveld. Since March 2012 she has been employed at Airshed Planning Professionals (Pty) Ltd. In this time, she has been involved in air quality impact assessments for various mining operations (including coal, mineral sand, diamond and platinum mines) as well as coal-fired power station ash disposal facilities. She has been a team member on the development of Air Quality Management Plans, both provincial and for specific industries. Recent projects include assessing the impact of Postponement and/or Exemption of Emission Standards for various Listed Activities.

NEMA EIA Regulation (2014, as amended), Appendix 6

NEMA Regulations (2014, as amended) - Appendix 6	Relevant section in report
Details of the specialist who prepared the report.	Report Details (page i)
The expertise of that person to compile a specialist report including curriculum vitae.	Competency Profiles (page iii) Section 14: Appendix A: Authors' Curriculum Vitae (page 172)
A declaration that the person is independent in a form as may be specified by the competent authority.	Report Details (page i)
An indication of the scope of, and the purpose for which, the report was prepared.	Section 1.1: Background (page 1) Section 1.2: Terms of Reference (page 5)
An indication of quality and age of base data used.	Section 5.1: Affected Environment (page 34) Section 5.2: Atmospheric Dispersion Potential (page 35) Section 5.3: Existing Air Quality (page 41)
A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change.	Section 5.3: Existing Air Quality (page 41) Section 9: Impact Assessment: Cumulative (page 158) Section 4: Legislation (page 26)
The date and season of the site investigation and the relevance of the season to the outcome of the assessment.	Description of the current land use in the region, simulations undertaken for the proposed operations and meteorological data included used in the study are considered representative of all seasons. Section 5.2: Atmospheric Dispersion Potential (page 35) Section 5.3: Existing Air Quality (page 41)
A description of the methodology adopted in preparing the report or carrying out the specialised process.	Section 2: Methodology (page 7)
The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure.	Section 5: Air Quality Baseline (page 34)
An identification of any areas to be avoided, including buffers.	Not applicable
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 1 and Section 5.1: Affected Environment (page 34)
A description of any assumptions made and any uncertainties or gaps in knowledge.	Section 2.4: Managing Uncertainties (page 12)
A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment.	Section 6: Impact Assessment: Construction Phase (page 67) Section 7: Impact Assessment: Operational Phase (page 72) Section 8: Impact Assessment: Decommissioning and Closure Phases (page 151) Section 9: Impact Assessment: Cumulative (page 158) Section 10: Impact Assessment: No Go Option (page 163)
Any mitigation measures for inclusion in the EMPr.	Section 11: Air Quality Management (page 164)

NEMA Regulations (2014, as amended) - Appendix 6	Relevant section in report
Any conditions for inclusion in the environmental authorisation	Section 11: Air Quality Management (page 164)
Any monitoring requirements for inclusion in the EMPr or environmental authorisation.	Section 11: Air Quality Management (page 164)
A reasoned opinion as to whether the proposed activity or portions thereof should be authorised.	Section 12: Findings and Recommendations (page 166)
If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan.	Section 12: Findings and Recommendations (page 166)
A description of any consultation process that was undertaken during the course of carrying out the study.	Not applicable
A summary and copies if any comments that were received during any consultation process.	Section 18: Appendix E: Comments and Responses (page 187)
Any other information requested by the competent authority.	None

Executive Summary

The Impala Platinum Limited – Smelter Complex(Impala) is situated in the Rustenburg Local Municipality on the Portion 2 of the farm Beerfontein 263 JQ, approximately 16 km to the north north-west of the town of Rustenburg. Impala is an existing facility with operational dryers that trigger listed activity sub-category 4.1 (drying and calcining) and converters and furnaces that trigger listed activity sub-category 4.16 (smelting and converting of sulfide ores), under the National Environmental Management: Air Quality Act (NEM:AQA), Act no. 39 of 2004.

Impala is now proposing to amend its Atmospheric Emissions Licence to increase its flash drying capacity at its Smelter Complex, which entails:

- The installation of the second flash dryer (Phase 1); and
- The flash drying feed circuit upgrade (Phase 2).

The installation of an additional flash dryer triggers listed activity sub-category 4.1 (drying and calcining).

The installation of a second flash dryer will increase filter cake treatment capacity, which in turn will increase and improve toll concentrate stockpile reclamation capabilities, provided available smelting capacity within the furnace circuit. Currently stockpiled toll material is treated either through the flash drying circuit, or re-pulped and dried through the spray drying circuit. The latter is an inefficient process route due to the additional water that is added to the filtered feed and then evaporated. Flash drying is thus a more suitable process for this type of feedstock.

Business plan toll throughput alone does not, however, justify a second flash dryer of similar size, as the latest plan forecast toll receipts that will barely fill current flash drying capacity. As such, during periods when toll stock is limited to the normal monthly receipts, additional flash drying capacity can be utilised to treat filtered Impala concentrate, thereby offering an opportunity to improve coal consumption and water recovery.

The overall project aims to achieve the following:

- Increase toll drying capacity to allow for growth opportunities in terms of available and additional toll treatment contracts (provided available smelting capacity);
- Increase toll stock retreatment capacity and efficiency. Additional flash drying capacity will negate the need for re-pulping, thus resulting in more cost-effective stockpile reclamation; and
- Continued and complete utilisation of the entire flash drying circuit capacity. In other words, ensure that the available flash drying capacity can be effectively applied to the drying of Impala concentrates in the event of reduced toll throughput, for whichever reason.

Airshed Planning Professionals (Pty) Ltd (Airshed) was appointed by SLR Consulting (Africa) (Pty) Ltd (SLR) to undertake an Air Quality Impact Assessment (AQIA) as part of the Environmental Authorisation (EA) process to identify key aspects that may have significant air quality impacts during the various project phases. As such the report conforms to the amended regulated format requirements for specialist reports as per Appendix 6 of the Environmental Impact Assessment (EIA) Regulations (Government Notice [GN] R982 as amended by GN 326 of

7 April 2017; GN 706 of 13 July 2018 and GN 320 of 20 March 2020). This report covers the impact assessment for the Proposed increase of the Flash Dryer capacity and associated feed circuit modifications at the Impala Rustenburg Smelter Complex (the project).

The scope of work had to include the following:

- Identify and describe the existing air quality of the project area, as well as climatic patterns and features (i.e. the baseline);
- Assess (model) the impact on air quality (specifically particulate matter with reference to Total Particulate Matter [TSP], PM_{10} [Particulate matter with an aerodynamic dimeter less than 10 µm] and $PM_{2.5}$ [particulate matter with an aerodynamic dimeter less than 2.5 µm], sulfur dioxide ([SO_2], oxides of nitrogen [NO_x] expressed as nitrogen dioxide [NO_2] and carbon monoxide [CO]), human health and biota resulting from the proposed project (including impacts associated with the construction, operations, decommissioning and post-closure phases of the project);
- Assess (model) the impact on human health and biota resulting from the Proposed Impala Smelter Complex future operations (all existing smelter complex operations inclusive of the proposed project operations);
- Assess (model) the impact on human health at sensitive receptors resulting from the Proposed Impala future operations (all existing mining and smelter complex operations inclusive of the proposed project operations);
- Identify and describe potential cumulative air quality impacts resulting from the proposed project in relation to existing sources of emissions in the surrounding area;
- Recommend mitigation measures to minimise impacts and/or optimise benefits associated with the proposed project; and
- Recommend a monitoring network to ensure the correct implementation and adequacy of recommenced mitigation measures, if applicable.

The main findings of the baseline assessment are:

- The Air Quality Sensitive Receptors (AQSRs) within a 10 km radius of the proposed operations include Luka to the north, Phokeng to the south-west and south, Freedom Park to the south-east, and Meriting to the south-east.
- The main sources likely to contribute to baseline pollutant emissions include mining and processing operations, vehicle entrained dust from local roads, vehicle exhaust and windblown dust from exposed areas.
- Other sources of pollutants include farming activities (especially crop farming), occasional biomass burning and household fuel burning in the individual residences.
- The area is dominated by winds from the southerly sectors. The average wind speed for 2019 was 1.35 m/s.
- The $PM_{2.5}$ and PM_{10} monitored data shows exceedances of the annual and 24-hour NAAQS. The SO_2 monitored data shows no exceedances of the annual, daily and hourly National Ambient Air Quality Standards (NAAQS).

- The simulations for the current operations (all existing mining and smelter complex operations) at impala had the following results:
    - $PM_{2.5}$ concentrations as a result of mitigated Impala current operations are not in compliance with the future NAAQS at Kelekitso Early Learning Centre and Impala Platinum Hospital over the short-term; and Impala Platinum Hospital over the long-term.
    - PM_{10} concentrations as a result of mitigated Impala current operations are not in compliance with the NAAQS at Impala Platinum Hospital over the short-term but are in compliance with the long-term NAAQS as at AQSRs.
    - SO_2 concentrations as a result of mitigated Impala current operations are within compliance at all AQSRs. The simulated annual average SO_2 concentrations as a result of mitigated Impala proposed future operations are below the critical levels for all vegetation types at all AQSRs except Kelekitso Early Learning Centre, where there is a potential for impacts on cyanobacterial lichens according to European limits.
    - NO_x concentrations as a result of mitigated Impala current operations are not in compliance with the NO_2 NAAQS at Impala Platinum Hospital over the short-term but are in compliance with the long-term NO_2 NAAQS as at AQSRs. The simulated annual average NO_x concentrations as a result of mitigated Impala operations including the proposed operations are below the critical levels (European limits) for all vegetation types at all AQSRs except Impala Platinum Hospital.
- The operations off-site dustfall rates sampled complies in terms of the National Dust Control Regulations (NDCR).

The main findings of the impact assessment are as follows:

- Construction phase:
    - The significance of construction related inhalation health and nuisance impacts are likely to have a "very low" rating without mitigation and "insignificant" rating with mitigation.
- Operational phase:
    - $PM_{2.5}$, PM_{10}, SO_2, NO_x, CO and TSP emissions and impacts were quantified.
    - $PM_{2.5}$, PM_{10}, SO_2, NO_x and CO concentrations as a result of mitigated proposed operations are within compliance with NAAQS off-site and at all AQSRs.
    - The simulated annual average SO_2 and NO_x concentrations as a result of mitigated proposed project operations are likely to be below the critical levels for all vegetation types across the domain.
    - Simulated dustfall rates as a result of mitigated proposed project operations are below the NDCR limits for non-residential areas on-site and beyond the boundary (off-site); and the simulated dustfall rates are below the NDCR limits for residential areas at all AQSRs and below 400 mg/m^2-day at all agricultural areas.
    - The significance of proposed project operations related to inhalation health impacts is likely to be "low" without mitigation measures applied and becomes "very low" with design mitigation measures applied (baghouse). The significance of operations related to nuisance impacts are likely to be "very low" without and with design mitigation.

- $PM_{2.5}$, PM_{10}, SO_2, NO_x and CO concentrations as a result of mitigated proposed future Smelter Complex operations (all existing smelter complex operations inclusive of the proposed project operations) are within compliance with NAAQS off-site and at all AQSRs.
- The simulated annual average SO_2 and NO_x concentrations as a result of mitigated proposed future Smelter Complex operations (all existing smelter complex operations inclusive of the proposed project operations) are likely to be below the critical levels for all vegetation types across the domain.
- Simulated dustfall rates as a result of mitigated proposed future Smelter Complex operations (all existing smelter complex operations inclusive of the proposed project operations) are below the NDCR limits for non-residential areas on-site and beyond the boundary (off-site); and the simulated dustfall rates are below the NDCR limits for residential areas at all AQSRs and below 400 mg/m²-day at all agricultural areas.
- $PM_{2.5}$ concentrations as a result of mitigated Impala proposed future operations (all existing mining and smelter complex operations inclusive of the proposed project operations) are not in compliance with the future NAAQS at Kelekitso Early Learning Centre and Impala Platinum Hospital over the short-term; and Impala Platinum Hospital over the long-term. The source group with the greatest contribution to the simulated concentrations at Kelekitso Early Learning Centre is crushing and screening. The source group with the greatest contribution to the simulated concentrations at Impala Platinum Hospital is vehicles travelling on paved roads.
- PM_{10} concentrations as a result of mitigated Impala proposed future operations (all existing mining and smelter complex operations inclusive of the proposed project operations) are not in compliance with the NAAQS at Impala Platinum Hospital over the short-term but are in compliance with the long-term NAAQS as at AQSRs. The source group with the greatest contribution to the simulated concentrations at Impala Platinum Hospital is vehicles travelling on paved roads.
- SO_2 concentrations as a result of mitigated Impala proposed future operations (all existing mining and smelter complex operations inclusive of the proposed project operations) are within compliance at all AQSRs. The simulated annual average SO_2 concentrations as a result of mitigated Impala proposed future operations are below the critical levels for all vegetation types at all AQSRs except Kelekitso Early Learning Centre, where there is a potential for impacts on cyanobacterial lichens according to European limits.
- NO_x concentrations as a result of mitigated Impala proposed future operations (all existing mining and smelter complex operations inclusive of the proposed project operations) are not in compliance with the NO_2 NAAQS at Impala Platinum Hospital over the short-term but are in compliance with the long-term NO_2 NAAQS as at AQSRs. The simulated annual average NO_x concentrations as a result of mitigated Impala operations including the proposed operations are below the critical levels (European limits) for all vegetation types at all AQSRs except Impala Platinum Hospital. The source group with the greatest contribution to the simulated concentrations at Impala Platinum Hospital is vehicles exhausts.
- The significance of mitigated Impala proposed future operations (all existing mining and smelter complex operations inclusive of the proposed project operations) related to inhalation health

impacts is likely to be “high” without mitigation measures applied and becomes “medium” with design mitigation measures applied. The significance of operations related to nuisance impacts are likely to be “medium” without mitigation measures applied and becomes “low” with design mitigation measures applied.

- Decommissioning and closure phases:
  - The significance of decommissioning operations related inhalation health and nuisance impacts are likely to have a “very low” rating without mitigation and “insignificant” rating with mitigation.
  - The significance of closure operations related inhalation health and nuisance impacts are likely “insignificant”.

To ensure the lowest possible impact on AQSRs and environment it is recommended that the air quality management plan as set out in this report should be adopted. This includes:

- Management of all the Impala operations including the proposed project; resulting in the mitigation of associated air quality impacts;
- Source emissions monitoring;
- Ambient air quality monitoring; and
- Record keeping and community liaison procedures.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

ADE	Australian Government: Department of the Environment and Energy
AEL	Atmospheric Emission Licence
Airshed	Airshed Planning Professionals (Pty) Ltd
AIR	Atmospheric Impact Report
APPA	Atmospheric Pollution Prevention Act
AQIA	Air quality impact assessment
AQMP	Air quality management plan
AQSRs	Air quality sensitive receptors
ASTM	American Society for Testing and Materials
CDP	Carbon Disclosure Project
CE	Control Efficiency
CLRTAP	Convention on Long Range Trans-boundary Air Pollution Limits
CO	Carbon monoxide
CO_2	Carbon dioxide
DEA	Department of Environmental Affairs
DEFF	Department of Environment, Forestry and Fisheries
DEFRA	Department for Environment, Food and Rural Affairs
EA	Environmental Authorisation
ECO	Environmental control officer
EIA	Environmental Impact Assessment
EMPr	Environmental Management Programme
g	Gram
g/s	Gram per second
GG	Government Gazette
GHG	Greenhouse Gases
GLC(s)	Ground level concentration(s)
GLCC	Global land cover characterisation
GN	Government Notice
ha	Hectare
IPCC	Intergovernmental Panel on Climate Change
IPGM	Individual platinum group metals
Impala	Impala Platinum Limited – Rustenburg Operations
kg	Kilogram
kW	Kilowatt
kWh	Kilowatt hour
m	Metre
m^2	Metre squared
m^3	Metre cubed
masl	Metres above sea level
MES	Minimum Emission Standards
mm	Millimetres
m/s	Metres per second

NAAQ Limit	National Ambient Air Quality Limit concentration
NAAQS	National Ambient Air Quality Standards (as a combination of the NAAQ Limit and the allowable frequency of exceedance)
NAEIS	National Atmospheric Emissions Inventory System
NDCR	National Dust Control Regulations
NEMA	National Environmental Management Act (No. 107 of 1998)
NEM:AQA	National Environmental Management: Air Quality Act (No. 39 of 2004)
NO	Nitrogen oxide
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
NPI	National Pollutant Inventory
O_3	Ozone
OEL	South African Occupational Exposure Limits
PGM	Platinum group metals
PM	Particulate matter
PM_{10}	Particulate matter with diameter of less than 10 µm
$PM_{2.5}$	Particulate matter with diameter of less than 2.5 µm
SAAQIS	South African Air Quality Information System
SAGERS	South African Greenhouse Gas Emission Reporting System
SLR	SLR Consulting (South Africa) (Pty) Ltd
SO_2	Sulfur dioxide[1]
SRTM	Shuttle radar topography mission
t/a	Tonnes per annum
TSP	Total suspended particulates
UK	United Kingdom
UNECE	United Nations Economic Commission for Europe
US EPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VKT	Vehicle kilometres travelled
WBPA	Waterberg-Bojanala Priority Area
µ	micro
°C	Degrees Celsius

[1] The spelling of "sulfur" has been standardised to the American spelling throughout the report. The International Union of Pure and Applied Chemistry, the international professional organisation of chemists that operates under the umbrella of UNESCO, published, in 1990, a list of standard names for all chemical elements. It was decided that element 16 should be spelled "sulfur". This compromise was to ensure that in future searchable data bases would not be complicated by spelling variants. (IUPAC. Compendium of Chemical Terminology, 2nd ed. (the "Gold Book"). Compiled by A. D. McNaught and A. Wilkinson. Blackwell Scientific Publications, Oxford (1997). XML on-line corrected version: http://goldbook.iupac.org (2006) created by M. Nic, J. Jirat, B. Kosata; updates compiled by A. Jenkins. ISBN 0-9678550-9-8.doi: 10.1351/goldbook)"

Glossary

Air-shed	An area, bounded by topographical features, within which airborne contaminants can be retained for an extended period
Albedo[2]	The ratio of reflected flux density to incident flux density, referenced to some surface. Albedos commonly tend to be broadband ratios, usually referring either to the entire spectrum of solar radiation, or just to the visible portion. More precise work requires the use of spectral albedos, referenced to specific wavelengths. Visible albedos of natural surfaces range from low values of ~0.04 for calm, deep water and overhead sun, to > 0.8 for fresh snow or thick clouds. Many surfaces show an increase in albedo with increasing solar zenith angle.
Algorithm	A mathematical process or set of rules used for calculation or problem-solving, which is usually undertaken by a computer
Atmospheric dispersion model	A mathematical representation of the physics governing the dispersion of pollutants in the atmosphere
Atmospheric stability	A measure of the propensity for vertical motion in the atmosphere
Baseline	Information gathered at the beginning of a study which describes the environment prior to development of a project and against which predicted changes (impacts) are measured.
Calm / stagnation	A period when wind speeds of less than 0.5 m/s persist
Cartesian grid	A co-ordinate system whose axes are straight lines intersecting at right angles
Causality	The relationship between cause and effect
Closure Phase	This stage of the project includes the period of aftercare and maintenance after the decommissioning phase
Configuring a model	Setting the parameters within a model to perform the desired task
Construction Phase	The stage of project development comprising site preparation as well as all construction activities associated with the development.
Cumulative Impacts	Direct and indirect impacts that act together with current or future potential impacts of other activities or proposed activities in the area/region that affect the same resources and/or receptors.
Dispersion	The lowering of the concentration of pollutants by the combined processes of advection and diffusion
Environment	The external circumstances, conditions and objects that affect the existence of an individual, organism or group. These circumstances include biophysical, social, economic, historical and cultural aspects.
Environmental Authorisation	Permission granted by the competent authority for the applicant to undertake listed activities in terms of the NEMA EIA Regulations, 2014.
Environmental Impact Assessment	A process of evaluating the environmental and socio-economic consequences of a proposed course of action or project.
Environmental Impact Assessment Report	The report produced to relay the information gathered and assessments undertaken during the Environmental Impact Assessment.
Environmental Management Programme	A description of the means (the environmental specification) to achieve environmental objectives and targets during all stages of a specific proposed activity.

[2] Definition from American Meteorological Society's glossary of meteorology

Impact	A change to the existing environment, either adverse or beneficial, that is directly or indirectly due to the development of the project and its associated activities.
Mitigation measures	Design or management measures that are intended to minimise or enhance an impact, depending on the desired effect. These measures are ideally incorporated into a design at an early stage.
Operational Phase	The stage of the works following the Construction Phase, during which the development will function or be used as anticipated in the Environmental Authorisation.
Specialist study	A study into a particular aspect of the environment, undertaken by an expert in that discipline.
Stakeholders	All parties affected by and/or able to influence a project, often those in a position of authority and/or representing others.

Air Quality Specialist Report for the Proposed Increase of the Flash Dryer Capacity and Associated Feed Circuit Modifications at the Impala Rustenburg Smelter Complex

1 INTRODUCTION

1.1 Background

The Impala Platinum Limited Smelter Complex(Impala) is situated in the Rustenburg Local Municipality on Portion 2 of the farm Beerfontein 263 JQ, approximately 16 km to the north northwest of the town of Rustenburg (Figure 1). The locality of Impala, in relation to surrounding residential areas is shown in Figure 2. Impala is an existing facility with operational dryers that trigger listed activity sub-category 4.1 (drying and calcining) and converters and furnaces that trigger listed activity sub-category 4.16 (smelting and converting of sulfide ores), under the National Environmental Management: Air Quality Act (NEM:AQA), Act no. 39 of 2004.

Impala is now proposing to amend its Atmospheric Emissions Licence to increase its flash drying capacity at its Smelter Complex, which entails:

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The installation of an additional flash dryer triggers listed activity sub-category 4.1 (drying and calcining).

The installation of a second flash dryer will increase filter cake treatment capacity, which in turn will increase and improve toll concentrate stockpile reclamation capabilities, provided available smelting capacity within the furnace circuit. Currently stockpiled toll material is treated either through the flash drying circuit, or re-pulped and dried through the spray drying circuit. The latter being an inefficient process route due to the fact that additional water is added to a filtered feed and then evaporated. Flash drying is thus a more suitable process for this type of feedstock.

Business plan toll throughput alone does however not justify a second flash dryer of similar size, as the latest plan forecast toll receipts that will just fill current flash drying capacity. As such, during periods when toll stock is limited to the normal monthly receipts, additional flash drying capacity can be utilised to treat filtered Impala concentrate, thereby offering an opportunity to improve coal consumption and water recovery.

The overall project aims to achieve the following:

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- Continued and complete utilisation of the entire flash drying circuit capacity. In other words, ensure that the available flash drying capacity can be effectively applied to the drying of Impala concentrates in the event of reduced toll throughput, for whichever reason.

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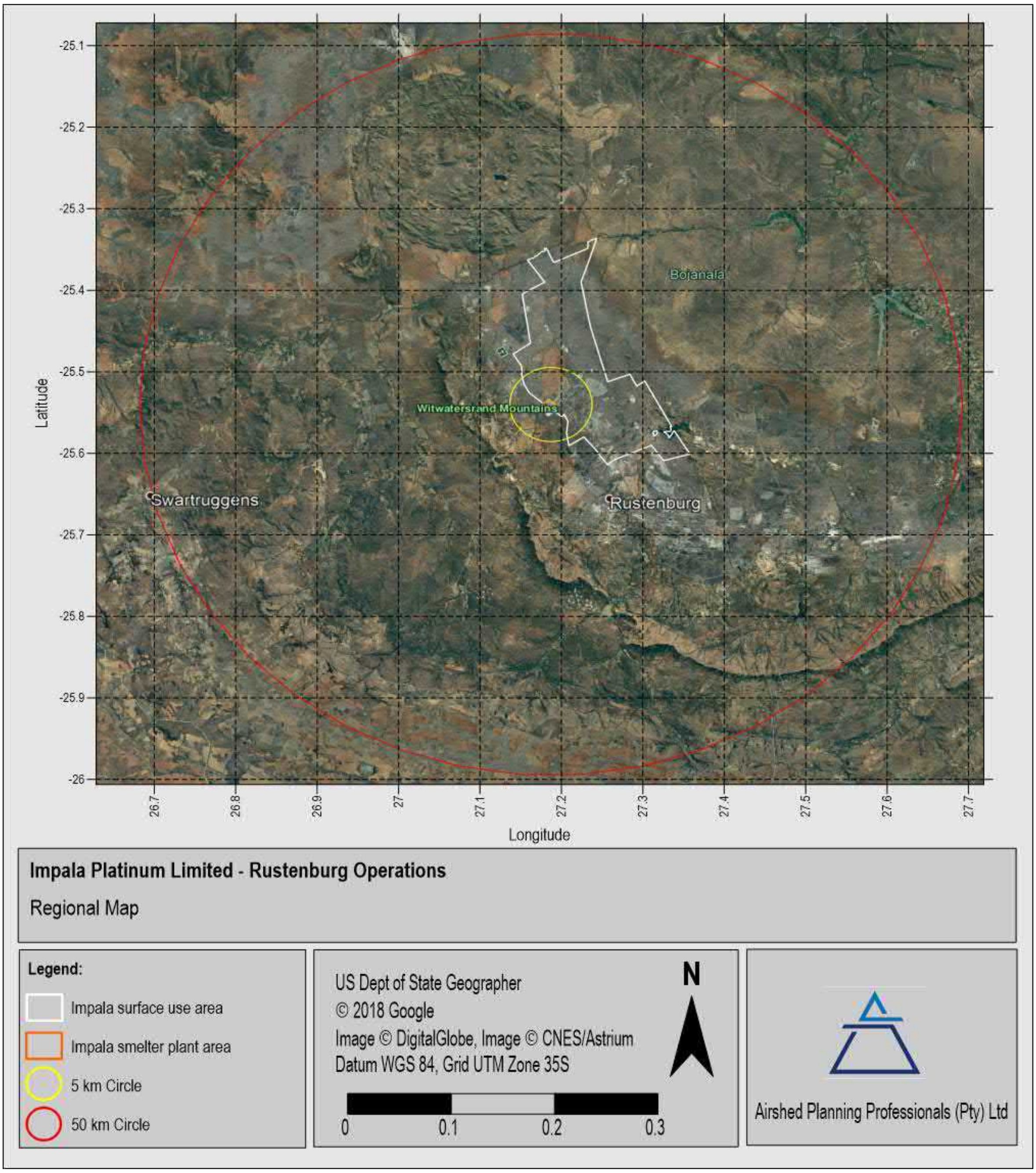


Figure 1: Regional locality map

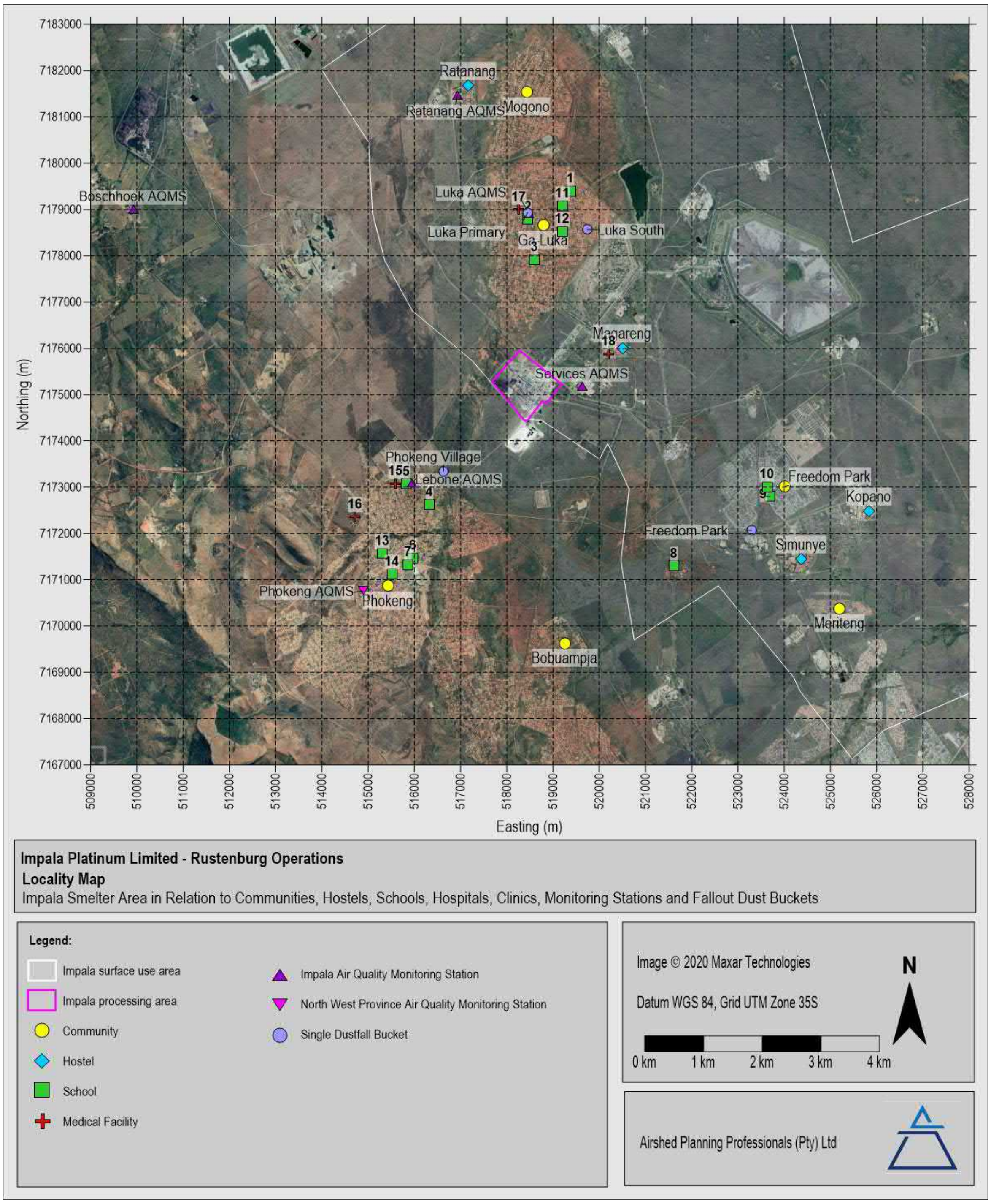


Figure 2: Location of Impala Platinum Limited – Rustenburg Operations Smelter Plant, sensitive receptors, monitoring stations and fallout dust buckets

1.2 Terms of Reference

The specific terms of reference for this study are as follows:

- Identify and describe the existing air quality of the project area, as well as climatic patterns and features (i.e. the baseline);
- Assess (model) the impact on air quality (specifically particulate matter with reference to Total Particulate Matter [TSP], PM_{10} [Particulate matter with an aerodynamic dimeter less than 10 µm] and $PM_{2.5}$ [particulate matter with an aerodynamic dimeter less than 2.5 µm], sulfur dioxide ([SO_2], oxides of nitrogen [NO_x] expressed as nitrogen dioxide [NO_2] and carbon monoxide [CO]), human health and biota resulting from the proposed project (including impacts associated with the construction, operations, decommissioning and post-closure phases of the project);
- Assess (model) the impact on human health and biota resulting from the Proposed Impala Smelter Complex future operations (all existing smelter complex operations inclusive of the proposed project operations);
- Assess (model) the impact on human health at sensitive receptors resulting from the Proposed Impala future operations (all existing mining and smelter complex operations inclusive of the proposed project operations);
- Identify and describe potential cumulative air quality impacts resulting from the proposed project in relation to existing sources of emissions in the surrounding area;
- Recommend mitigation measures to minimise impacts and/or optimise benefits associated with the proposed project; and
- Recommend a monitoring network to ensure the correct implementation and adequacy of recommenced mitigation measures, if applicable.

1.3 Report Structure

Section	Description	Page
1 - Introduction	An introduction to the study including a description of the project and the scope of work.	1
2 - Methodology	A detailed description of the study methodology is given in this section along with all limitations and assumptions relevant to it.	7
3 - Process Description	The project operations are described.	15
4 - Legislation	A summary of applicable environmental legislation is presented	26
5 - Air Quality Baseline	A description of the receiving environment is given. It addresses AQSRs, dispersion potential as well as baseline air quality.	34
6 - Impact Assessment: Construction Phase	Impact discussion and significance rating based on specialist knowledge and the SLR methodology.	67
7 - Impact Assessment: Operational Phase	Emissions and modelling results and significance ranting of air quality impacts based on the SLR methodology.	72
8 - Impact Assessment: Decommissioning and Closure Phases	Impact discussion and significance rating based on specialist knowledge and the SLR methodology.	129

2 METHODOLOGY

The air quality study includes both baseline and predicted impact assessment. The baseline characterisation includes the following enabling tasks:

- Identification of existing sources of emission and characterization of ambient air quality and dustfall levels in the study area;
    - A quantitative assessment of baseline air quality was possible due to the availability of ambient data from four of the five Impala ambient monitoring stations (i.e. Boschhoek, Luka, Lebone, Ratanang) within the study area (Figure 2); however, the ambient data available for the North West station in Phokeng was too low to be representative of the pollutant levels in the vicinity of the station.
    - The fifth Impala ambient monitoring station (i.e. Services) is located in an area where the NAAQS do not apply (Figure 2).
- It is important to have a good understanding of the meteorological parameters governing the rate and extent of dilution and transportation of air pollutants that are generated by the proposed project. The primary meteorological parameters to obtain from measurement include wind speed, wind direction and ambient temperature. Other meteorological parameters that influence the air concentration levels include rainfall (washout) and a measure of atmospheric stability. The latter quantities are normally not measured and are derived from other parameters such as the vertical height temperature difference or the standard deviation of wind direction. The depth of the atmosphere in which the pollutants can mix is similarly derived from other meteorological parameters by means of mathematical parameterizations.
    - The first step was therefore to source any on-site or near-site meteorological observations. As a minimum this data had to include hourly averaged wind speed, wind direction and ambient air temperature.
    - All five of the Impala ambient monitoring stations and the Impala weather station had sufficient data. Since the "Services" ambient station is closest to the proposed project and likely to be influenced by the topographical features and land use and had good availability it would be suitable for the site. The lasted complete year (2019) of data was used to construct wind roses, general climatic information such as diurnal temperature variations, atmospheric stability estimates and used for dispersion modelling.
- Potential air pollution sensitive receptors within the study area were identified and georeferenced for detailed analysis of the impact assessment calculations.

The impact assessment followed with the tasks below:

- The dispersion modelling was executed as per *The Regulations Regarding Air Dispersion Modelling* (GN 533 in Gazette No 37804, 11 July 2014). Three *Levels of Assessment* are defined in the Regulations. A Level 2 assessment approach was deemed adequate. These are described under Section 4.3.
- Preparation of the model control options and input files for the AERMOD dispersion modelling suite. This included the compilation of:
    - terrain information (topography, land use, albedo and surface roughness);
    - source layout; and

  - grid and receptor definitions.
- Preparation of hourly average meteorological data for the wind field and atmospheric dispersion model.
- Preparation of an emissions inventory (particulates) for the existing and proposed operations, including fugitive sources[3]. The emission rates for the existing stacks were based on isokinetic sampling measurements, Minimum Emission Standards (MES) were used for the project stack, and emission factors were used for the fugitive sources.
- For the study, simulations were conducted using the AERMOD dispersion modelling suite, which allowed the calculations of the ambient inhalable concentrations ($PM_{2.5}$, PM_{10}, SO_2, NO_x and CO) and dust fallout. The hourly, daily and annual concentrations and total daily dust deposition were calculated. Dispersion modelling was completed for all operations associated with the proposed project as well as the existing Impala operations.
- The legislative and regulatory context, including emission limits and guidelines, ambient air quality guidelines and dustfall classifications were used to assess the impact and recommend additional emission controls, mitigation measures and air quality management plans to maintain the impact of air pollution to acceptable limits in the study area. The model results were analysed against the National Ambient Air Quality Standards (NAAQS) and National Dust Control Regulations (NDCR).

2.1 Data Analysis for Atmospheric Dispersion Modelling

2.1.1 AERMOD Modelling Suite

The United States Environmental Protection Agency (US EPA) approved AERMOD atmospheric dispersion modelling suite was used for the simulation of ambient air pollutant concentrations and dustfall rates. AERMOD is a Gaussian plume model, best used for near-field applications where the steady-state meteorology assumption is most likely to apply. The AERMOD model is one of the most widely used Gaussian plume model. AERMOD is a model developed with the support of the AMS/EPA Regulatory Model Improvement Committee (AERMIC), whose objective was to include state-of the-art science in regulatory models (Hanna, Egan, Purdum, & Wagler, 1999). AERMOD is a dispersion modelling system with three components, namely: AERMOD (AERMIC Dispersion Model), AERMAP (AERMOD terrain pre-processor), and AERMET (AERMOD meteorological pre-processor).

AERMOD is an advanced new-generation model. It is designed to predict pollution concentrations from continuous point, flare, area, line, and volume sources. AERMOD offers new and potentially improved algorithms for plume rise and buoyancy, and the computation of vertical profiles of wind, turbulence and temperature. However, retains the single straight-line trajectory limitation. AERMET is a meteorological pre-processor for AERMOD. Input data can come from hourly cloud cover observations, surface meteorological observations and twice-a-day upper air soundings. Output includes surface meteorological observations and parameters and vertical profiles of several atmospheric parameters. AERMAP is a terrain pre-processor designed to simplify and standardise the input of terrain data for AERMOD. Input data includes receptor terrain elevation data which may be in the form of digital

[3] Fugitive emissions refer to emissions that are spatially distributed over a wide area and not confined to a specific discharge point as would be the case for process related emissions (IFC, 2007).

terrain data. The output includes, for each receptor, location and height scale, which are elevations used for the computation of air flow around hills. A disadvantage of the model is that spatially varying wind fields, due to topography or other factors cannot be included. Input data types required for the AERMOD model includes source data, meteorological data (pre-processed by the AERMET model), terrain data (pre-processed by the AERMAP model) and information on the nature of the receptor grid.

The components of the AERMOD modelling suite are summarised in Table 1; however, only AERMOD contain the simulation engines to calculate the dispersion and removal mechanisms of pollutants released into this boundary layer. The other codes are mainly used to assist with the preparation of input and output data. Table 1 also includes the development versions of each of the codes used in the investigation.

Table 1: Summary description of AERMOD model suite with versions used in the investigation

Module	Interface Version	Executable	Description
AERMOD	Breeze v9.0.0.23	(US) EPA 19191	Gaussian plume dispersion model.
AERMET	Breeze v7.9.0.3	(US) EPA 18081	Meteorological pre-processor for creating AERMOD compatible formats.
AERMAP	Breeze v9.0.0.23	(US) EPA 18081	Topographical pre-processor for creating digital elevation data in a format compatible with the AERMOD control file.

The execution phase (i.e. dispersion modelling and analyses) involves gathering specific information regarding the emission source(s) and site(s) to be assessed, and subsequently the actual simulation of the emission sources and determination of impact significance. The information gathering included:

- Source information: emission rate, source extents and release height;
- Site information: site layout, terrain information, and land use data;
- Meteorological data: a minimum of wind speed, wind direction, temperature, and sensible heat flux or Obukhov length; and
- Receptor information: locations using discrete receptors and/or gridded receptors.

2.1.1 Meteorological Requirements

An understanding of the atmospheric dispersion potential of the area is essential to an air quality impact assessment. On-site meteorological data from the Impala “Services” ambient station was used. The meteorological data included in the dispersion modelling was for the period from January 2019 to December 2019.

2.1.2 Topographical and Land Use Data

Readily available terrain and land use data was obtained from the United States Geological Survey (USGS) via the Earth Explorer website (U.S. Department of the Interior, U.S. Geological Survey, 2018). Use was made of Shuttle Radar Topography Mission (SRTM) (30 m, 1 arc-sec) data and Global Land Cover Characterisation (GLCC) data for Africa.

2.1.3 Receptor Grid

The dispersion of pollutants expected to arise from proposed operations was simulated for an area covering 40.3 km (east-west) by 44.4 km (north-south). The area was divided into a grid matrix with a resolution of 100 m. AERMOD calculates ground-level concentrations and dustfall rates at each grid point. The grid details used in dispersion modelling are given in Table 2. The discrete receptors data included in the dispersion model input is shown in Table 3.

Table 2: Simulation domain

Simulation domain	
South-western corner of simulation domain	500 000 m (Easting); 7 157 400 m (Northing)
Domain size	40.3 x 44.4 km
Projection	Grid: UTM Zone 34S, Datum: WGS-84
Resolution	100 m

Table 3: Individual air quality sensitive receptors and ambient stations included as discrete receptors points

Receptor name	Easting (m)	Northing (m)
Ratanang	517167.08	7181676.64
Magareng	520500.74	7176006.51
Simunye	524366.10	7171443.78
Kopano	525834.67	7172482.18
Pudunong	515903.11	7172776.37
Phokeng	516934.24	7170404.78
Bobuampja	519254.27	7169631.44
Ga-Luka	518790.26	7178653.78
Mogono	518429.37	7181540.92
Freedom Park	524897.70	7172240.48
Meriteng	525200.38	7170380.48
Kanana	530181.18	7171693.68
Mafika	530412.79	7175476.58
Serutube	530412.79	7176557.40
Thethe Secondary School	519377.93	7179397.49
Luka Primary School	518461.16	7178788.41
Kelekitso Early Learning	518599.59	7177912.67
Matlhware Primary School	516331.88	7172625.28
Kitsong High School	515831.21	7173066.01
Tumagole Primay School	515974.32	7171470.94
Matale Secondary School	515864.27	7171327.44
Kutlwanong School for the Deaf	521618.63	7171294.27
Vukuzenzele Primary School	523686.68	7172802.20

Receptor name	Easting (m)	Northing (m)
Freedom Park Secondary School	523629.85	7173005.48
Molotlegi Secondary School	519207.56	7179077.31
Ramotse Primary School	519200.84	7178525.63
Moremogolo Primary School	515309.04	7171565.29
Semane Early Learning Centre	515518.74	7171118.33
Bafokeng Health Centre	515594.85	7173078.85
Tapologo Hospice Centre	514721.15	7172356.40
Luka Clinic	518263.01	7178995.59
Impala Platinum Hospital	520206.75	7175879.64
Lebone AQMS	515951.00	7173086.00
Services AQMS	519630.00	7175170.00
Luka AQMS	518476.00	7178919.00
Boschhoek AQMS	516933.00	7181473.00
Ratanang AQMS	519377.93	7179397.49

2.1.4 Dispersion results

The dispersion model uses the specific input data to run various algorithms to estimate the dispersion of pollutants between the source and receptor. The model output is in the form of a simulated time-averaged concentration at the receptor. These simulated concentrations are added to suitable background concentrations and compared with the relevant ambient air quality standard or guideline. The post-processing of air concentrations at discrete receptors as well as the regular grid points includes the calculation of various percentiles, specifically the 99^{th} percentile, which corresponds to the requirements of the NAAQS.

Ground level concentration (GLC) isopleth plots presented in this report depict interpolated values from the concentrations simulated by AERMOD for each of the receptor grid points specified. Plots reflecting daily averaging periods contain only the 99.73^{rd} percentile of simulated ground level concentrations, for those averaging periods, over the entire period for which simulations were undertaken. It is therefore possible that even though a high daily average concentration is simulated at certain locations, this may only be true for one day during the period. Typically, NAAQS apply to areas where the Occupational Health and Safety regulations do not apply, thus outside the mine property or lease area. Ambient air quality guidelines and standards are therefore not occupational health indicators but applicable to areas where the public has access i.e. off-site.

2.1.5 Uncertainty of Modelled Results

There will always be some error in any geophysical model; however, modelling is recognised as a credible method for evaluating impacts. It is desirable to structure the model in such a way to minimise the total error. A model represents the most likely outcome of an ensemble of experimental results. The total uncertainty can be thought of as the sum of three components: the uncertainty due to errors in the model physics; the uncertainty due to data errors; and the uncertainty due to stochastic processes (turbulence) in the atmosphere.

The stochastic uncertainty includes all errors or uncertainties in data such as source variability, observed concentrations, and meteorological data. Even if the field instrument accuracy is excellent, there can still be large uncertainties due to unrepresentative placement of the instrument (or taking of a sample for analysis). Model evaluation studies suggest that the data input error term is often a major contributor to total uncertainty. Even in the best tracer studies, the source emissions are known only with an accuracy of ±5%, which translates directly into a minimum error of that magnitude in the model predictions. It is also well known that wind direction errors are the major cause of poor agreement, especially for relatively short-term predictions (minutes to hours) and long downwind distances. All the above factors contribute to the inaccuracies not associated with the mathematical models themselves.

A disadvantage of the model is that spatial varying wind fields, due to topography or other factors cannot be included. Although the model has been shown to be an improvement on the ISC model, especially short-term predictions, the range of uncertainty of the model predictions is -50% to 200%. The accuracy improves with fairly strong wind speeds and during neutral atmospheric conditions.

In quantifying the uncertainty of the modelled results for this assessment, measured ambient data was required which was available for this study and thus model validation was undertaken according to a method described by the US EPA.

2.2 Impact Assessment

Potential impacts of the proposed project were identified based on the dispersion simulations, review of other studies for similar projects and professional experience. The significance of the impacts was assessed using the prescribed SLR impact rating methodology provided. The impact significance was rated for project operations assuming the effective implementation of design mitigation measures.

2.3 Mitigation and Management Recommendations

Practical additional mitigation and optimisation measures that can be implemented effectively to reduce or enhance the significance of impacts were identified.

2.4 Managing Uncertainties

The study is based on a few assumptions and is subject to certain limitations, which should be borne in mind when considering information presented in this report. The validity of the findings of the study is not expected to be affected by these assumptions and limitations:

1. All project information required to calculate emissions for proposed operations was provided by Impala and SLR; it is assumed that all this information is the most recent data and correct.

1. The EA process will be completed by SLR. For this reason, the impact significance of the project was determined based on the SLR impact significance methodology.
2. TSP, PM_{10}, $PM_{2.5}$, SO_2, NO_2 and CO are the main pollutants of concern from the proposed project.
3. The impact of the construction and decommissioning phase impacts are expected to be similar or somewhat less significant than operational phase impacts. Mitigation and management measures recommended for the construction phase are also applicable to the decommissioning phase. No impacts are expected post-closure provided the rehabilitation of final landforms is successful.
4. Meteorology:
    a. Data was available from five Impala ambient stations and one Impala weather station. The data for the period January 2019 to December 2019 was used in the dispersion modelling. The Impala "Services" ambient station is the closet to the proposed operations. The terrain and the land use surrounding both the station and the proposed project are the same and the effects of the terrain and land use on the other meteorological parameters (not measured by these stations) but required for dispersion modelling would not vary between the Impala "Services" station and the proposed operations site. The National Code of Practice for Air Dispersion Modelling described in the Regulations regarding air dispersion modelling (GN 533; 11 July 2014) discusses the effects of land use and it is evident from surface roughness lengths, albedo values and bowen ratios provided in the regulations and international modelling guidelines for different land uses will not vary in terms of these parameters which affect the wind profile, atmospheric mixing and other planetary boundary layer parameters.
    b. The National Code of Practice for Air Dispersion Modelling described in the Regulations regarding air dispersion modelling prescribes the use of a minimum of one year of on-site data or at least three years of appropriate off-site data for use in Level 2 and Level 3 assessments. It also states that the meteorological data must be for a period no older than five years to the year of assessment. The dataset period is within the timeframe recommended by the National Code of Practice for Air Dispersion Modelling as the meteorological data is for one year (on-site measured data) and less than five years old during the assessment period (2020).
5. Emissions:
    a. The impact assessment was limited to the pollutants of concern (listed above). These pollutants are regulated under NAAQS and considered key pollutants released by the operations associated with the proposed project.
    b. The quantification of sources of emission was restricted to the Impala existing and proposed operations. Other existing sources of emission within the area including other companies' mining and processing operations, farming activities, domestic fires, biomass burning, vehicle exhaust emissions and dust entrained by vehicles on public roads were not included as part of the emissions inventory and simulations. Without detailed proposed (for when this project will be operational) operational data for other companies' mining and processing operations as well as estimated future vehicle data for public roads it is difficult to quantify these sources for the period of the proposed project operations. It is difficult to predict the contribution of the domestic and natural fires and farming sources to air quality during the period of the proposed project

operations due to variability of these operations with regards to locality, spatial extent and duration.

6. Dispersion Simulations:
    a. All significant fugitive sources were simulated with the current mitigation measures applied.
    b. The most recent average stack emissions were included in the dispersion simulation task.
    c. It was assumed that all NO_x emitted is converted to NO_2.
7. Greenhouse gas (GHG):
    a. Emissions estimation and modelling was not included in the scope of work.

3 PROCESS DESCRIPTION

3.1 General Process Description

The main activity at Impala is the mining and processing of platinum-bearing ore. The ventilation shafts associated with the underground mining operations, vehicles travelling on unpaved and paved roads, material handling, crushing and screening, plant stacks, windblown dust and burning bays are sources of particulate emissions. Ventilation shafts, vehicles exhausts, plant stacks and burning bays are sources of gaseous emissions. Impala currently comprises various operating components. These activities are listed in Table 4 with the associated pollutants of concern.

Table 4: Air emissions and pollutants associated with Impala Platinum Limited - Rustenburg Operations

Activity	Description	Sources of emission	Main Pollutants
Mining operations (Underground only)	See section 3.1.1	Materials handling Vehicle entrainment Vehicle exhaust	PM - TSP, PM_{10} and $PM_{2.5}$, SO_2, NO_x, CO, volatile organic compounds (VOC) and others
Crushing and screening	See section 3.1.3.2	Crushing Screening	PM
Processing operations	See section 3.1.2	Vehicle entrainment Vehicle exhaust Windblown dust Stacks Furnace and converter fugitives	PM, SO_2, NO_x, CO, VOC and others
Tailings storage facilities	See section 3.1.3.3	Windblown dust	PM
Vehicles and mining equipment	See section 3.1.3.1	Vehicle entrainment Vehicle exhaust	PM, SO_2, NO_x, CO, VOC and others
Laboratory	See section 3.1.3.4	Stacks	hydrogen chloride (HCl), nitric acid, hydrogen sulfide (H_2S), PM, lead (Pb) and metals
Burning bays (explosive packaging)	See section 3.1.3.5	Combustion	PM, SO_2, NO_x
Various domestic facilities			VOC, H_2S and others

The most significant pollutant from point and fugitive sources is PM (particulate matter), occurring from almost all the activities at the Impala operations. For particulate matter, a distinction is made between TSP, thoracic particulates (PM_{10}) and respirable particulates ($PM_{2.5}$). Whereas TSP is of interest due to its implications in terms of nuisance dust impacts, the PM_{10} and $PM_{2.5}$ fractions are considered to determine the potential for human health impacts. Gaseous emissions are more prominent from the processing operations and the mining fleet and equipment and regarded insignificantly low from the other activities.

Each of the operations is briefly described below to provide an overview of the air pollution activities at Impala; however, the Smelter Plant related activities are of the most interest with regards to this assessment and so comprehensive dispersion modelling was undertaken for the smelter area operations which included both the listed activity sources and some fugitive sources.

3.1.1 Mining Operations

Impala Platinum mines two underground reef bodies, the Merensky reef and the UG2 reef. Merensky reef contains more sulfide than the UG2 reef, and the minerals are found in a silicate substrate. The deposit is fairly narrow and mined by underground mining to depths of 1 500 m. All opencast mining operations have ceased with the last opencast pit rehabilitated in December 2013.

Typical operations associated with underground mining include sub-surface drilling and blasting, sub-surface crushing and screening, transferring reef and waste rock to surface with conveyors, material transfer points and stockpiling. The waste rock dumps are located near the shaft areas with the reef transported via road or rail.

3.1.2 Processing Operations

Ore is mined from the Merensky and UG2 reefs at a number of shafts in the vicinity of the smelting operation and is transported via rail to two concentrator plants, where it is milled. The milled ore is introduced to flotation banks where particles containing precious metals are separated as a concentrate, leaving non-valuable tails which are deposited onto tailings dams.

The concentrate is pumped as slurry to the smelter operation where it is dried via spray dryers, smelted in furnaces to remove gangue materials (predominantly silica) and converted in Peirce-Smith converters to remove sulfur and iron. The Impala Platinum Rustenburg Smelter also treats third party materials that are introduced into the furnaces in three different ways namely: via the spray driers, via the flash dryer or fed directly into the furnaces. The converters produce a matte which is the final product from the processing section. The converter matte is transported by truck to the Impala refinery in Springs (Gauteng).

The operation was upgraded in 2008/2009 to increase smelter production capacity to potentially 2.65 million ounces of platinum per year; the project included an extensive upgrade of the smelter air quality management system.

3.1.2.1 Drying

Concentrate drying is conducted by means of coal-fired spray dryers and a single coal-fired flash dryer.

Spray Dryers: The principle of the operation is to atomise (break up into small particles) the partially thickened concentrate in the presence of hot gas. The hot gas is generated in a hot gas generator and utilises the combustion of coal as heat source. Water is rapidly vaporised from the wet concentrate and the majority of the dried concentrate (less than 1% moisture) falls into the drying chamber. The remaining concentrate dust passes into electrostatic precipitators, where the dust is recovered. The dry concentrate is pneumatically transferred into dried concentrate storage silos from where it is pneumatically transferred into the furnaces.

Dryer off-gas is a combination of small amounts of particulates and gases which evolve through the combustion of coal and dust not recovered in the precipitators. The gases include low concentrations of sulfur dioxide (from the presence of a small amount of sulfur in coal), carbon dioxide and carbon monoxide.

Flash Dryer: The flash dryer serves to rapidly evaporate moisture from mechanically de-clotted concentrate filter cake in a stream of hot gas. The resulting product is a fine dry dust that is pneumatically transferred into dried concentrate storage silos from where it is pneumatically transferred into the furnaces. The hot gas required for the evaporation is generated in a hot gas generator and utilises the combustion of coal as a heat source. The flash dryer is fitted with primary and secondary cyclones and a bag house for the capture of dust particles. The flash dryer increases the potential throughput from the dryer section to the furnaces.

Dryer off-gas is a combination of small amounts of dust and gases which evolve through the combustion of coal and dust not recovered in the bag house. The gases include low concentrations of sulfur dioxide (from the presence of a small amount of sulfur in coal), carbon dioxide and carbon monoxide.

Currently the filtration of third party concentrate to produce a filter cake does not take place at the Processing Plant. Concentrate is delivered as filter cake to the Smelter, dried in the flash dryer and fed to the electric furnaces. Upon successful conclusion of this project, filtering capability will have been introduced to dewater slurry concentrate at the Processing Plant.

3.1.2.2 Furnaces

Dry concentrate from the dryers, which includes third party material, is pneumatically transferred into dried concentrate storage silos from where it is pneumatically transferred into the furnaces and smelted. The furnaces utilise AC electrical current, discharged through large electrodes positioned in the furnace bath, to melt the concentrate. The furnaces are lined with refractory materials to contain the high temperature generated in the furnaces and are operated under negative pressure by gas off-takes at either end of the furnaces.

The smelter complex houses three furnaces. The furnaces have a combined maximum operational electrical capacity of 105 MW (1 x 38 MW, 1 x 35 MW and 1x 32 MW).

Concentrate charged into the furnaces separates into two distinctive layers, with a high density matte layer forming below a lower density slag layer. The matte contains the base metal sulfides and precious metals. The slag contains gangue materials, which consist largely of silica, magnesia and smaller amounts of other oxide impurities.

Furnace slag is tapped from the furnaces into a high pressure water stream (granulator), which results in the flash-freezing of the slag in a granulated form. The granulated slag is then transferred to the slag milling and flotation plant, for recovery of precious metals entrained in the slag. Molten furnace matte is tapped from the furnaces into large ladles that are transferred, by means of an overhead crane, into the converters.

Off-gas from the furnaces is directed to a gas cleaning plant, the Sulfacid™ Plant. Before reaching the Sulfacid™ Plant, the off-gas first passes through an electrostatic precipitator circuit to remove the dust.
The off-gas circuit consists of:

- Two large electrostatic precipitators (ESPs) in parallel, each able to accommodate the full off-gas load of three furnaces;
- Two quench scrubbers (downstream of the ESP) facilitating gas cooling and cleaning;
- The Sulfacid™ plant comprising 12 reactors which can accommodate the off-gas from three furnaces; and
- Further cleaning of the off-gas from the Sulfacid™ plant in a lime scrubber.

3.1.2.3 Converter

Molten matte is tapped from the furnaces into ladles. An overhead crane transports the full ladles across the aisle where the furnace matte is tipped into the open mouth of a converter. The converters are cylindrical in shape and are known as Peirce-Smith converters. When sufficient furnace matte has been charged, the entire converter rotates so that an extraction hood covers the open port (the converter mouth). Pressurised air is injected into the converters below the level of the molten material. This serves to remove sulfur and iron from the furnace matte through oxidation reactions.

Sulfur is removed as sulfur dioxide gas, which is largely captured by the extraction hood and directed to a radial flow scrubber and a conventional single-contact sulfuric acid plant. Iron is removed as an iron silicate (fayalite) through the addition of silica sand to the molten materials in the converter. Fayalite is less dense than the converter matte and forms a discrete slag layer on the surface. The slag layer is skimmed off into ladles, granulated in a high pressure water stream and reprocessed through the slag plant to recover valuable materials entrained in the slag. During the conversion, fugitive gases and dust may escape from the converter hoods.

The converting process is exothermic and produces heat as a by-product of the oxidation reactions that occur in the converter. Following converter slag removal, converter matte is poured from the open converter port into ladles and granulated in a high pressure water stream. The granulated converter matte is the final product and is transported by road to the refinery in Springs.

The converter operation comprises six vessels with a combined throughput capacity of 370 tonnes per day. Converter off-gas is the feed gas for the Acid Plant and has a minimum sulfur dioxide content of 4.35% at a maximum rate of 15 cubic meters per second (normalised). This gas stream cannot be vented directly to the atmosphere due to the high sulfur dioxide concentration. The function of the Acid Plant is primarily to remove sulfur dioxide from the converter off-gas stream. The feed gas is routed through a wet scrubber, a primary and two secondary wet electrostatic precipitators that removes sulfur trioxide and dust from the gas stream before entering the Acid Plant. After moisture removal in the drying tower, sulfur dioxide is catalytically converted to sulfur trioxide in a single stage conversion, which is then absorbed into a recirculating acid stream to form industrial grade sulfuric acid.

3.1.2.4 Tail Gas and Fugitive Gas Scrubbers

The tail gas lime scrubber comprises the mixing of the cleaned off-gas from the Sulfacid™ plant and the Acid Plant and the scrubbing of the combined gas stream with a milk of lime slurry before being emitted to the atmosphere. Gypsum is produced as a by-product in the process.

The furnace and converter abatement system also includes a fugitive gas lime scrubber in addition to the tail gas lime scrubber described above. Approximately 50 % of the fugitive dust and gas from the off-gas streams are captured in hoods and cleaned in the fugitive gas lime scrubber.

3.1.3 Other Activities

Support functions include the transport of reef between the shafts and the smelter. It also includes transportation of employees and other vehicle activity on the roads.

3.1.3.1 Vehicle emissions

Impala's Transport Department provided information on vehicles and equipment at the facility for a transport study conducted in 2016. The current vehicle and equipment fleet were assumed to be similar to the 2016 inventory and comprise of light duty vehicles, earthmoving vehicles, busses, cranes, heavy duty vehicles, etc. The 2016 inventory was allocated to the public roads within the Impala surface use area and activities at Impala.

3.1.3.2 Crushing and screening

Crushing and screening operations can be a significant dust-generating source if uncontrolled. Dust fallout in the vicinity of crushers also gives rise to the potential for re-entrainment of dust by vehicles or by wind. The large percentage of fines in the deposited material enhances the potential for it to become airborne.

Primary crushing, secondary crushing and screening of ore occur at Impala. Fugitive dust emissions due to the crushing and screening operations include emissions from the loading of crusher hoppers, crushing and discharge of material from crushers.

3.1.3.3 Tailings Storage Facilities

Impala has two tailings impoundments, one dormant (No. 1 & 2) and one active (No. 3 & 4). Currently, only pipeline spillage is disposed of at No. 3. The active tailings dam has a footprint of approximately 800 ha with a surface area of ~410 ha. On the western side of the tailings impoundment is the buttress dam that serves as a strong wall for the tailings dam. The buttress also comprises of tailings material. All the sidewalls of the tailings dam seemed well covered with grass and crushed slag is placed on the crests of the step-ins. Crushed waste rock is placed on the access roads, serving as a dust suppressant. The surface area has a constant wet beach of approximately 50%. Most of the flat areas on the step-ins have grass.

3.1.3.4 Processing Laboratory in Rustenburg

Impala Processing Laboratory is situated in Rustenburg and it comprises of three core sections namely; Fire Assay, Analytical and the individual platinum group metals (IPGM) sections. The Fire Assay section determines platinum group metals (PGM) in samples by means of lead collection which takes place during fusion of sample with a suitable flux followed by purification of PGM bead by cupellation and high temperature cupellation. The Analytical Section includes the determination of base metals in samples that require various sample preparation steps, mainly acid digestion and sodium peroxide fusion, prior to instrumental analysis by a variety of techniques namely; Inductively coupled plasma optical emission spectroscopy (ICP-OES), flame atomic adsorption spectroscopy (FAAS), X-ray fluorescence (XRF) and ultra-violet/visible spectroscopy (UV/Vis). The Analytical Section also includes a Water Laboratory in which electrochemical and photometric techniques are used to determine an array of analytes in shaft, borehole, surface and special water samples from various mining operations. The IPGM section determines the individual platinum group elements by nickel sulfide collection, acid dissolution and hotplate digestion followed by ICP-OES analysis

The PGM and IPGM sections are equipped with dust extraction systems at the flux preparation and sample preparation areas. The Fire Assay furnace room process has three steps including (1) separation of the slag from the lead button containing PGMs in fusion process, (2) separation of the lead from the silver/PGM bead by volatilisation of the lead oxide in the cupellation process and (3) volatilisation of remaining lead and silver and purification of PGM bead in high temperature cupellation process. These high temperature processes are carried out by means of small smelting furnaces that are all fitted with extraction hoods. For step 1 the fusion furnace emissions are vented to one stack fitted to electrostatic precipitator devices (ESP) in the form of cased dust filters and for steps 2 and 3 the muffle furnace emissions are vented to a second stack also fitted with ESP in dust control units. The fusion process and dust emission controls from the IPGM section are similar to that of Fire Assay section except precious metal are collected in nickel sulfide button. The splitting rooms for Fire Assay and Analytical sections are fitted with extraction units that are directly linked to bag filters. Maintenance is done on the extraction filter units every month and bags are checked and emptied on a weekly basis.

Other processes at the laboratory resulting in off-gas emissions include the acid digestion steps in the IPGM section whereby HCl and H_2S fumes are generated, extracted and neutralised by means of scrubber systems in place. The acid dissolution and sodium peroxide fusion steps in the Analytical ICP and FAAS preparation sections also generate acidic fumes, to a much lesser extent than in IPGM, which are extracted to stacks without scrubbing. The IPGM and Analytical base metal standards rooms are also equipped with extraction units for the acidic fumes that are generated during standard preparation.

3.1.3.5 Waste Incineration Processes

In terms of the regulations to the Explosives Act, Impala has to destroy their explosives waste by burning in the open air. All explosives packaging is burnt at designated burning bays located at the various shafts. The explosives waste only comprises of bulk bags and paper with all other explosives waste destroyed underground during actual blasts or removed from site by a licensed contractor.

3.2 Proposed Project Process Description

Impala is now planning to increase its flash drying capacity, which requires the installation of a second flash dryer (Phase 1) and associated feed circuit modifications (Phase 2). This will increase filter cake treatment capacity, which in turn will increase and improve toll concentrate stockpile reclamation capabilities. The main project components that make up each phase are listed below.

Second Flash Dryer (Phase 1)	**Flash Drying Feed Circuit Upgrade (Phase 2)**
The main components of Phase 1 include: • Transfer Tower; • Wet Feeder; • Wet Feed Conveyors; • Flash Dryer (similarly sized unit (45 tph dry) to the existing dryer); and • Baghouse.	The main components of Phase 2 include: • Structural modifications include; • Feed Distribution Tower; • Filter Plant; and • Wet Feed Conveyors.

The current estimates for the new flash dryer allow for a similar sized unit (45 tph dry) to that of the existing flash dryer, in order to assist planned maintenance and spare keeping strategies. The upgrade of the flash dryer feed circuit will create intermediate buffering in the feed circuit to enable constant feed to wither or both dryers, thereby improving control and maximising throughput and efficiency of the existing infrastructure. The integration of a filter plant into the feed circuit will allow Impala concentrates to be fed into the process and recover additional water from this source.

It must be noted that the increase in flash drying capacity will not result in an exceedance of current smelting capacity, since this is limited by furnace smelting capacity.

3.2.1 Construction Phase

During the construction phase several facilities need to be established. These include the second flash dryer including the associated baghouse, new conveyors with feed hoppers and a filtration plant. These facilities will all be incorporated into the layout of the operation phase facilities. Access to site will be via the existing Smelter Plant access and internal roads. The following activities are proposed:

- Collection, storage and removal of construction related waste; and
- Construction of all infrastructure required for the operational phase.

Fugitive particulate matter (PM) emissions will be released to the atmosphere during these activities. Fugitive emissions refer to emissions that are spatially distributed over a wide area and not confined to a specific discharge point as would be the case for process related emissions (IFC, 2007). In addition to fugitive PM emissions, combustion related PM and gaseous emissions will also be released from construction equipment and construction related traffic. Key pollutants from combustion of fossil fuels include PM_{10} and $PM_{2.5}$, SO_2, NO_x, CO, formaldehyde, and VOC. PM emitted from diesel combustion will mostly be in the form of black carbon, commonly referred to as diesel particulate matter (DPM). It is anticipated the construction phase activities would be undertaken for a period of 30 months (2.5 years) and in a phased approach so that the project will not impact the current flash drying throughput nor availability.

Phase 1 (Figure 3 and Figure 5) will comprise the construction of the new flash dryer complete with intermediate dedicated feed conveyor. This will allow existing dryer operation and re-pulping to continue unhindered. The estimated execution period is 18 months.

Phase 2 (Figure 3 and Figure 5) will involve the upgrade of the flash drying feed circuit, comprising a transfer tower complete with wet feed bin, screw feeders and feed conveyors, along with structural modifications. This upgrade will enable both dryers to be fed simultaneously via the existing circuit, while addressing inconsistent feed challenges inherent to the current feed system. It will also negate the need for additional dedicated labour to maintain feed profiles at two separate feeding stations. Estimated execution period of 3 months, which will commence upon completion of Phase 1.

This phase will also include the installation of a filter plant to pre-treat PGM concentrate slurry for processing through the enlarged flash dryer circuit. This installation will unlock water recovery potential currently lost through evaporation within the spray drying circuit, while improving coal unit consumption by offsetting a portion of the throughput from the least efficient spray drying units, by means of complete utilisation of available flash dryer capacity. It will also provide relief in terms of production pressure on the spray dryer installations, thereby facilitating more regular maintenance. This will involve demolition of the toll mill re-pulping circuit. The execution period is expected to be 9 months.

3.2.2 Operational Phase

The main operation associated with the proposed project is a coal-fired second flash dryer to treat filtered Impala concentrate. There will also be transportation of materials via conveyor as well as filtration plant facilities. The proposed process flow diagram and site layout for the flash dryers are shown in Figure 4 and Figure 5, respectively.

Other than the second flash dryer, the operations will be powered by grid power. Potential pollutants from the operations are discussed in Table 5. The proposed second flash dryer and associated facilities will likely be operational 24 hours per day, 7 days per week.

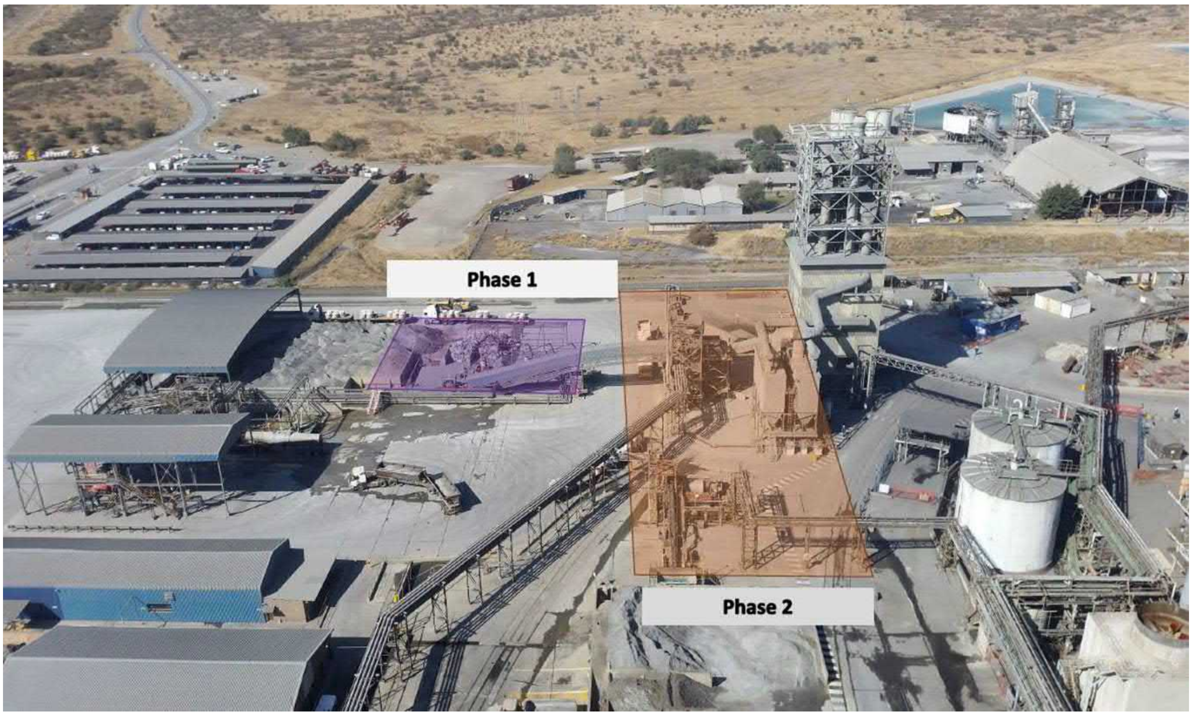


Figure 3: Proposed phase locations

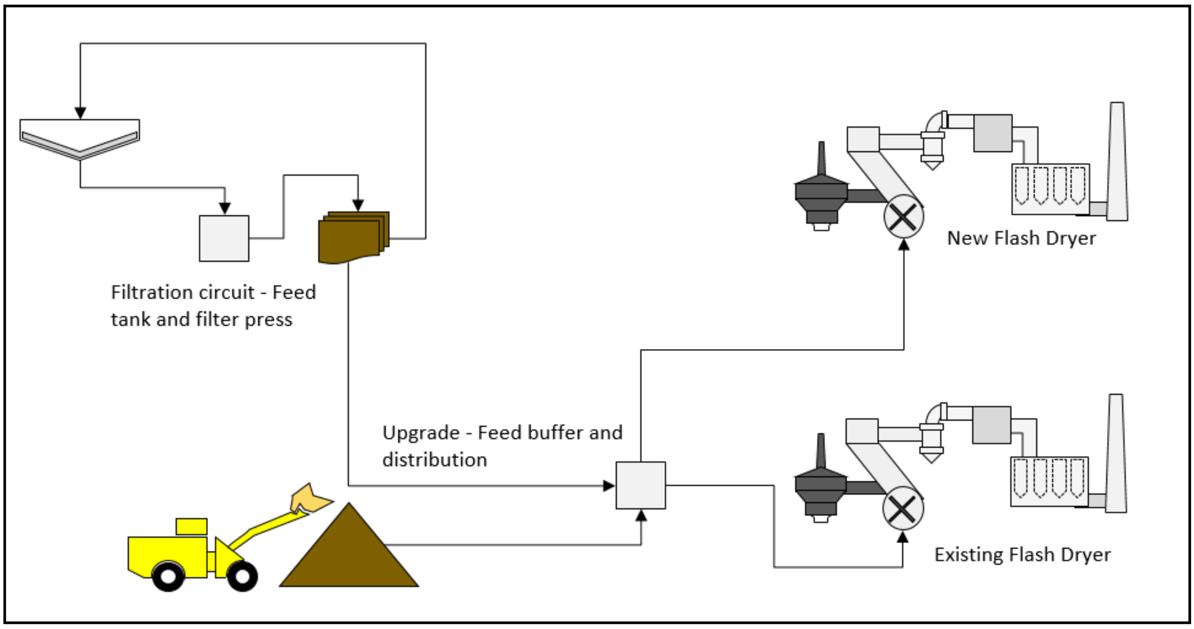


Figure 4: Proposed process flow sheet

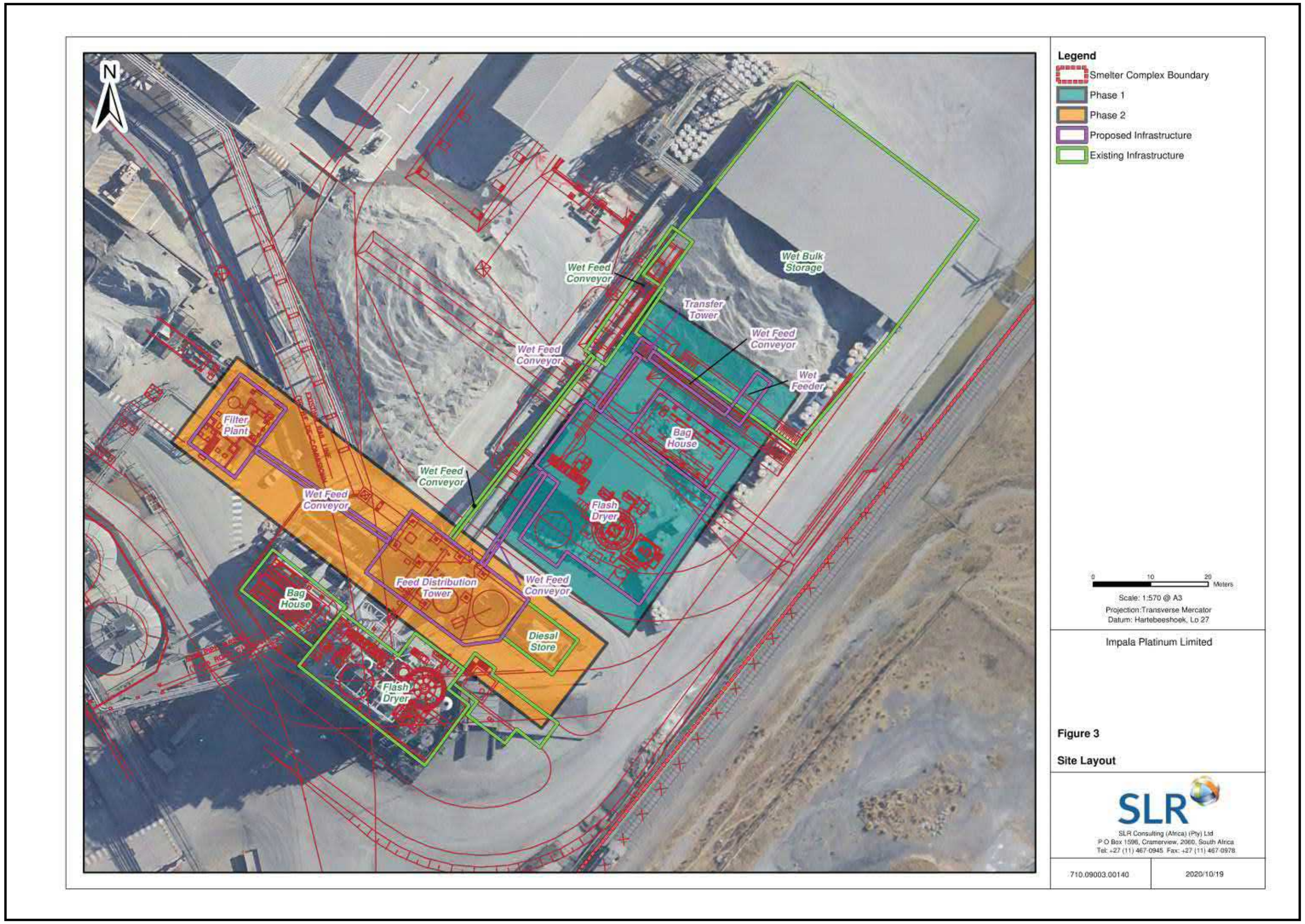


Figure 5: Proposed site layout (aerial image)

Table 5: Air emissions and pollutants associated with the Project operational phase

Activity	Sources of emission	Main Pollutants
Flash dryer operations	Flash dryer baghouse stack	TSP, PM_{10}, $PM_{2.5}$, SO_2, NO_x and CO
Transportation and handling of materials	Materials handling	TSP, PM_{10} and $PM_{2.5}$

3.2.3 Decommissioning and Closure Phase

The removal of infrastructure is planned for the decommissioning phase. Fugitive PM emissions as well as combustion related PM and gaseous emissions will be released from mobile equipment, and traffic. The duration of this phase is unknown and will include removal of plant and equipment and construction of structures to make the site safe. Closure monitoring should occur periodically to determine if the decommissioning works have been successfully completed.

4 LEGISLATION

Prior to assessing the impact of proposed activities on human health and the environment, reference needs to be made to the air quality regulations governing the calculation and impact of such operations i.e. reporting requirements, emission standards, ambient air quality standards and dust control regulations.

Emission standards are generally provided for point sources, specify the amount of the pollutant acceptable in an emission stream and are often based on proven efficiencies of air pollution control equipment. Air quality guidelines and standards are fundamental to effective air quality management, providing the link between the source of atmospheric emissions and the user of that air at the downstream receptor site. The ambient air quality standards and guideline values indicate safe daily exposure levels for the majority of the population, including the very young and the elderly, throughout an individual's lifetime. Air quality guidelines and standards are normally given for specific averaging or exposure periods.

This section summarises legislation from NEMA and NEM:AQA. A portion of the NEMA EIA Regulations, the Listed Activities and Minimum National Emission Standards (MES) Regulations, National Atmospheric Emission Reporting Regulations, Regulations regarding Air Dispersion Modelling, NAAQS and NDCR are relevant to the Project and are discussed below.

4.1 NEMA EIA Regulations

In terms of the National Environmental Management Act, 1998 (NEMA) Environmental Impact Assessment (EIA) Regulations (GN R982 as amended by GN 326 of 7 April 2017; GN 706 of 13 July 2018 and GN 320 of 20 March 2020) a specialist report must contain certain information (see table on page iv for full list of information required). A site environmental sensitivity screening must also be conducted for the specialist assessment using the Department screening tool to determine among other information the development incentives, restrictions, exclusions or prohibitions that apply to the proposed development site as well as the most environmental sensitive features on the site based on the site sensitivity screening results for the application classification that was selected. Based on the site sensitivity screening the only requirements is that the study considers the requirements set out in the Waterberg-Bojanala Priority Area (WBPA) Air Quality Management Plan and Threat Assessment, and that the report fulfils the NEMA EIA Regulations Appendix 6 Specialist Report requirements.

4.2 Listed Activities

The NEM:AQA (Act No. 39 of 2004 as amended) mandates the Minister of Environment to publish a list of activities which result in atmospheric emissions and consequently cause significant detrimental effects on the environment, human health and social welfare, economic conditions, ecological conditions or cultural heritage. The updated Listed Activities and Minimum National Emission Standards (MES) were published in 2013 (GN 893, in Government Gazette No. 37054) as amended by GN 551, 12 June 2015; GN 1207, 18 October 2018; GN 687, 22 May 2019 and GN 421, 27 March 2020). The existing and proposed operations on-site fall under two listed activities and require an Atmospheric Emissions Licences (AEL) thus national MES, AELs and Atmospheric Impact Reports (AIRs) are discussed in this section

4.2.1 Emissions Standards

The proposed second flash dryer will be considered a listed activity under Section 21 of the NEM:AQA. MES and special arrangements for these activities are included in Table 6.

Table 6: MES for subcategory 4.1 listed activities, drying and calcining

Description:	**Drying and calcining of mineral solids including ore.**		
Application:	**Facilities with capacity more than 100 tonnes/month product.**		
Substance or mixture of substance:		**Plant status**	**mg/Nm³ under normal conditions of 273 K and 101.3 kPa**
Common name	**Chemical symbol**		
Particulate matter	n/a	New	50
Sulfur dioxide	SO_2	New	1 000
Oxides of nitrogen	NO_x expressed as NO_2	New	500

4.2.2 Applying for an AEL

Impala Platinum Limited will be required to apply for a variation AEL. An AEL must include all sources of emission, not only those considered listed activities. In terms of the AEL application, the **applicant** should take into account the following sections of NEM:AQA:

37. Application for atmospheric emission licences:

(1) A person must apply for an AEL by lodging with the licensing authority of the area in which the listed activity is to be carried out, an application in the form required.

(2) An application for an AEL must be accompanied by –

(a) The prescribed processing fee; and

(b) Such documentation and information as may be required by the licensing authority.

38. Procedure for licence applications:

(1) The licensing authority –

(a) May, to the extent that is reasonable to do so, require the applicant, at the applicant's expense, to obtain and provide it by a given date with other information contained in or submitted in connection with the application;

(b) May conduct its own investigation on the likely effect of the proposed license on air quality;

(c) May invite written comments from any organ of state which has an interest in the matter; and

(d) Must afford the applicant an opportunity to make representations on any adverse statements or objections to the application.

(2) Section 24 of the NEMA and section 22 of the Environmental Conservation Act apply to all applications for atmospheric emission licenses, and both an applicant and the licensing authority must comply with those sections and any applicable notice issued or regulations made in relation to those sections.

(3) –

(a) An applicant must take appropriate steps to bring the application to the attention of relevant organs of state, interested persons and the public.

(b) Such steps must include the publication of a notice in at least two newspapers circulating the area in which the listed activity is applied for is or is to be carried out and must-

(i) Describe the nature and purpose of the license applied for;

(ii) Give particulars of the listed activity, including the place where it is to be carried out;

(iii) State a reasonable period within which written representations on or objections to the application may be submitted and the address or place where it must be submitted; and

(iv) Contain such other particulars as the licensing authority may require.

4.2.3 Atmospheric Impact Report

Under section 30 of NEM:AQA, an air quality officer may require any person to submit an AIR in the format prescribed if a review of provisional AEL or AEL is undertaken. The format of the AIR is stipulated in the Regulations Prescribing the Format of the Atmospheric Impact Report (GN 747 in Government Gazette No. 36904 dated 11 October 2013 as amended by GN R283, 2 April 2015).

4.3 Atmospheric Emissions Reporting Regulations

The National Atmospheric Emission Reporting Regulations (GN R283 in Government Gazette No. 38633) came into effect on 2 April 2015. The purpose of the regulations is to regulate the reporting of data and information from an identified point, non-point and mobile sources of atmospheric emissions to an internet-based National Atmospheric Emissions Inventory System (NAEIS). The NAEIS is a component of the South African Air Quality Information System (SAAQIS). Its objective is to provide all stakeholders with relevant, up to date and accurate information on South Africa's emissions profile for informed decision making.

Emission sources and data providers are classified according to groups. The Impala operations would be classified under Group A ("Listed activity published in terms of section 21(1) of the Act"). Emission reports from this group must be made in the format required for NAEIS.

As per the regulations, Impala and/or their data provider should be registered on the NAEIS system as they are currently operating. Data providers must inform the relevant authority of changes if there are any:

- Change in registration details;
- Transfer of ownership; or
- Activities being discontinued.

A data provider must submit the required information for the preceding calendar year to the NAEIS by 31 March of each year. Records of data submitted must be kept for a period of 5 years and must be made available for inspection by the relevant authority. The relevant authority must request a data provider, in writing to verify the information submitted if the information is incomplete or incorrect. The data provider then has 60 days to verify the information. If the verified information is incorrect or incomplete the relevant authority must instruct a data provider, in writing, to submit supporting documentation prepared by an independent person. The relevant authority cannot be held liable for cost of the verification of data. A person guilty of an offence in terms of section 13 of these regulations is liable for penalties.

4.3.1 Greenhouse Gas Emissions

Regulations pertaining to GHG reporting using the NAEIS were published on 3 April 2017 (GN 257 in Government Gazette 40762). The South African mandatory reporting guidelines focus on the reporting of Scope 1 emissions only. The three broad scopes for estimating GHG are:

- Scope 1: All direct GHG emissions.
- Scope 2: Indirect GHG emissions from consumption of purchased electricity, heat or steam.
- Scope 3: Other indirect emissions, such as the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity, electricity-related activities not covered in Scope 2, outsourced activities, waste disposal, etc.

The South African Greenhouse Gas Emission Reporting System (SAGERS) web-based monitoring and reporting system will be used to collect GHG information in a standard format for comparison and analyses. The system forms part of the national atmospheric emission inventory component of South African Atmospheric Emission Licensing and Inventory Portal (SAAELIP).

The Department of Environment, Forestry and Fisheries (DEFF) is working together with local sectors to develop country specific emissions factors in certain areas; however, in the interim the Intergovernmental Panel on Climate Change's (IPCC) default emission figures may be used to populate the SAAQIS GHG emission factor database. These country specific emission factors will replace some of the default IPCC emission factors. Technical guidelines for GHG emission estimation have been issued.

Also, the Carbon Tax Act (Act 15 of 2019) includes details on the imposition of a tax on the CO_2-e of GHG emissions. Certain production processes indicated in Annexure A of the Declaration of Greenhouse Gases as Priority Pollutants (GN 710 in GG 40966, 21 July 2017) with GHG in excess of 0.1 Mt, measured as CO_2-e, are required to submit a pollution prevention plan to the Minister for approval.

Although Impala do quantify and report their GHG emissions to the Carbon Disclosure Project (CDP) according to the United Kingdom's (UK) Department for Environment, Food and Rural Affairs (DEFRA) voluntary reporting guidelines; however, they do not report to SAGERS.

4.4 Industry Requirements as part of the Waterberg-Bojanala Priority Area (WBPA) Air Quality Management Plan (AQMP)

There are a few requirements listed in the WBPA AQMP that is applicable to all industries (including mining industries), these are:

- Appointment of an Environmental Officer.
- Appointment of industry representatives who will be the official mandated to agree on emission control and reduction initiatives.
- Annual reporting of operational emissions (minimum of listed activities emissions) on the NAEIS.
- Compliance with MES (or agreed limits contained in the AEL).
- To operate according to the conditions provided within the AEL.
- To make ambient monitoring data accessible to the authorities.
- To make ambient monitoring data accessible to the public (not compulsory).

4.5 Atmospheric Dispersion Modelling Regulations

Air dispersion modelling provides a cost-effective means for assessing the impact of air emission sources, the major focus of which is to determine compliance with the relevant ambient air quality standards. Dispersion modelling provides a versatile means of assessing various emission options for the management of emissions from existing or proposed installations. Regulations regarding Air Dispersion Modelling were promulgated in GN 533, in Government Gazette No. 37804; 11 July 2014, and recommend a suite of dispersion models to be applied for regulatory practices as well as guidance on modelling input requirements, protocols and procedures to be followed. The Regulations regarding Air Dispersion Modelling are applicable –

(a) in the development of an air quality management plan, as contemplated in *Chapter 3* of the NEM:AQA;
(b) in the development of a priority area air quality management plan, as contemplated in *Section 19* of the NEM:AQA;
(c) in the development of an AIR, as contemplated in *Section 30* of the NEM:AQA; and,
(d) in the development of a specialist air quality impact assessment study, as contemplated in *Chapter 5* of the NEMAQA.

Three *Levels of Assessment* are defined in the Regulations. The three levels are:

- Level 1: where worst-case air quality impacts are assessed using simpler screening models
- Level 2: for assessment of air quality impacts as part of license application or amendment processes, where impacts are the greatest within a few kilometres downwind (less than 50km)
- Level 3: require more sophisticated dispersion models (and corresponding input data, resources and model operator expertise) in situation:
    - where a detailed understanding of air quality impacts, in time and space, is required;
    - where it is important to account for causality effects, calms, non-linear plume trajectories, spatial variations in turbulent mixing, multiple source types & chemical transformations;
    - when conducting permitting and/or environmental assessment process for large industrial developments that have considerable social, economic and environmental consequences;

- when evaluating air quality management approaches involving multi-source, multi-sector contributions from permitted and non-permitted sources in an air-shed; or,
- when assessing contaminants resulting from non-linear processes (e.g. deposition, ground level ozone [O_3], particulate formation, visibility).

The first step in the dispersion modelling exercise requires a clear objective of the modelling exercise and thereby gives clear direction to the choice of the dispersion model most suited for the purpose. Accordingly, Level 2 was deemed appropriate for this study.

4.6 South African National Ambient Air Quality Standards

Criteria pollutants are considered those pollutants most commonly found in the atmosphere, that have proven detrimental health effects when inhaled and are regulated by ambient air quality criteria. These generally include PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO and O_3.

The initial NAAQS were published for comment in the Government Gazette on 9 June 2007. The revised NAAQS were subsequently published for comment in the Government Gazette on the 13th of March 2009. The final revised NAAQS were published in the Government Gazette on the 24th of December 2009 (GN 1210, Government Gazette 32816) and additional standards for $PM_{2.5}$ were published on the 29th June 2012 (GN 486, Government Gazette no. 35463). NAAQS for the pollutants assessed in this study are listed in Table 7.

Table 7: National Ambient Air Quality Standards

Pollutant	Averaging Period	Concentration (µg/m³)	Permitted Frequency of Exceedance	Compliance Date
PM_{10}	24-hour	75	4	Currently enforceable
	1 year	40	-	Currently enforceable
$PM_{2.5}$	24-hour	40	4	1 January 2016 till 31 December 2029 (currently enforceable)
	24-hour	25	4	1 January 2030
	1 year	20	-	1 January 2016 till 31 December 2029 (currently enforceable)
	1 year	15	-	1 January 2030
SO_2	10-minutes	500	526	Currently enforceable
	1-hour	350	88	Currently enforceable
	24-hour	125	4	Currently enforceable
	1 year	50	-	Currently enforceable
NO_2	1-hour	200	88	Currently enforceable
	1 year	40	-	Currently enforceable
CO	1-hour	30 000	88	Currently enforceable
	8-hour	10 000	11	Currently enforceable

4.7 National Dust Control Regulations

The NDCR were published on 1 November 2013 (GN R827 in Government Gazette No. 36974). The purpose of the regulations is to prescribe general measures for the control of dust in all areas including residential and non-residential areas. The standard for acceptable dustfall rates for residential and non-residential areas is set out in Table 8. According to these regulations the dustfall at the boundary or beyond the boundary of the premises where it originates cannot exceed 600 mg/m²- day in residential and light commercial areas; or 1 200 mg/m²-day in areas other than residential and light commercial areas.

In addition to the dustfall limits, the NDCR prescribe monitoring procedures and reporting requirements. This will be based on the measuring reference method ASTM 01739 averaged over 30 days.

Table 8: Acceptable dustfall rates

Restriction Area	Dustfall rate (D) (mg/m²-day, 30-day average)	Permitted frequency of exceeding dust fall rate
Residential	D < 600	Two within a year, not sequential months
Non-residential	600 < D < 1 200	Two within a year, not sequential months

Notes: The method to be used for measuring dustfall rate and the guideline for locating sampling points shall be ASTM D1739: 1970, or equivalent method approved by any internationally recognized body

4.8 Screening Criteria for Animals and Vegetation

4.8.1 Assessment Criteria for Vegetation Impacts from Dustfall Rates

Limited information is available on the impact of dust on vegetation and grazing quality. While there is little direct evidence of the impact of dustfall on vegetation in the South African context, a review of European studies has shown the potential for reduced growth and photosynthetic activity in sunflower and cotton plants exposed to dust fall rates greater than 400 mg/m²- day (Farmer, 1993). In addition, there is anecdotal evidence to indicate that over extended periods, high dustfall levels in grazing lands can soil vegetation and this can impact the teeth of livestock (Farmer, 1993).

4.8.2 Assessment Criteria for Vegetation Impacts from SO_2 and NO_x

The impact of emissions on surrounding vegetation was assessed by comparing the simulated annual SO_2 and NO_2 concentrations for each of the emission scenarios against the critical levels for vegetation as defined by the United Nations Economic Commission for Europe (UNECE) Convention on Long Range Trans-boundary Air Pollution Limits (CLRTAP, 2015) (Table 9).

Table 9: Critical levels for SO_2 and NO_2 by vegetation type (CLRTAP, 2015)

Pollutant	Vegetation Type	Critical Level (µg/m³)	Time Period[a]
SO_2	Cyanobacterial lichens	10	Annual average
	Forest ecosystems (including understorey vegetation)	20	Annual average and Half-year mean (winter)
	(Semi-)natural vegetation	20	Annual average and Half-year mean (winter)
	Agricultural crops	30	Annual average and Half-year mean (winter)
NO_2	All	30	Annual average and Half-year mean (winter)
		75	Daily average

Notes: (a) For the purposes of mapping of critical levels and exceedances CLRTAP recommend using only the annual average, due to increased reliability of mapped and simulated data for the longer time period. It is also noted that long-term effects of NO_X are considered to be more significant than short-term effects (CLRTAP, 2015).

5 AIR QUALITY BASELINE

5.1 Affected Environment

Air Quality Sensitive Receptors (AQSRs) primarily refer to places where people reside; however, it may also refer to other sensitive environments that may adversely be affected by air pollutants. Ambient air quality guidelines and standards, as discussed under Section 4, have been developed to protect human health. Ambient air quality, in contrast to occupation exposure, pertains to areas outside of an industrial site/mine boundary where the public has access to and according to the NEM:AQA excludes areas regulated under the Occupational Health and Safety Act (Act No 85 of 1993). The state of the air document published by the Department of Environmental Affairs (DEA), now DEFF says: "Air quality limits and thresholds are fundamental to effective air quality management. Ambient air quality limits serve to indicate what levels of exposure to pollution are generally safe for most people, including the very young and the elderly, over their lifetimes."[4]

AQSRs within a 10 km radius (Figure 2) of the proposed operations include Luka to the north, Phokeng to the south-west and south, Freedom Park to the south-east, and Meriting to the south-east. Table 10 lists the individual sensitive receptors (i.e. schools and medical facilities) (included as discrete receptors within the dispersion model) that may be influenced by air pollution emissions from the proposed project. These receptors are also depicted in Figure 2.

The topography near the site is mostly undulating and ranges from 950 metres above sea-level (masl) to 1 700 masl within the modelling domain. The overall land use pattern associated with the surrounding area is mainly mining and industrial activities and agricultural cattle farming interspersed by pastures. Land use to the north of the Impala Smelter Plant includes the settlement of Luka, while the Phokeng settlement is located south-west and south of the smelter (Figure 2).

Table 10: Identified individual air quality sensitive receptors

AQSR ID	AQSR Name	Longitude	Latitude
1	Thethe Secondary School	27.192824	-25.50248
2	Luka Primary School	27.18371	-25.507991
3	Kelekitso Early Learning Centre	27.185099	-25.515898
4	Matlhware Primary School	27.162596	-25.563672
5	Kitsong High School	27.157606	-25.559698
6	Tumagole Primary School	27.15905	-25.5741
7	Matale Secondary School	27.157956	-25.575397
8	Kutlwanong School for the Deaf	27.215251	-25.575624
9	Vukuzenzele Primary School	27.235815	-25.561975
10	Freedom Park Secondary School	27.235246	-25.56014
11	Molotlegi Secondary School	27.191133	-25.505373
12	Ramotse Primary School	27.191074	-25.510355

[4] https://www.environment.gov.za/sites/default/files/docs/stateofair_executive_iaiquality_standardsonjectives.pdf

AQSR ID	AQSR Name	Longitude	Latitude
13	Moremogolo Primary School	27.152425	-25.573255
14	Semane Early Learning Centre	27.154518	-25.577289
15	Bafokeng Health Centre	27.155253	-25.559584
16	Tapologo Hospice Centre	27.146563	-25.566117
17	Luka Clinic	27.181735	-25.506123
18	Impala Platinum Hospital	27.201124	-25.534236

5.2 Atmospheric Dispersion Potential

Meteorological mechanisms direct the dispersion, transformation and eventual removal of pollutants from the atmosphere. The extent to which pollution will accumulate or disperse in the atmosphere is dependent on the degree of thermal and mechanical turbulence within the earth's boundary layer. This dispersion comprises vertical and horizontal components of motion. The stability of the atmosphere and the depth of the surface-mixing layer define the vertical component. The horizontal dispersion of pollution in the boundary layer is primarily a function of the wind field. The wind speed determines both the distance of downwind transport and the rate of dilution because of plume 'stretching'. The generation of mechanical turbulence is similarly a function of wind speed, in combination with surface roughness. The wind direction, and variability in wind direction, determines the general path pollutants will follow, and the extent of crosswind spreading. The pollution concentration levels therefore fluctuate in response to changes in atmospheric stability, to concurrent variations in the mixing depth, and to shifts in the wind field (Tiwary & Colls, 2010).

The spatial variations, and diurnal and seasonal changes, in the wind field and stability regime are functions of atmospheric processes operating at various temporal and spatial scales (Goldreich & Tyson, 1988). The atmospheric processes at macro- and meso-scales need therefore be considered in order to accurately parameterise the atmospheric dispersion potential of a particular area. A qualitative description of the synoptic systems determining the macro-ventilation potential of the region may be provided based on the review of pertinent literature. These meso-scale systems may be investigated through the analysis of meteorological data observed for the region.

Impala Services ambient station data availability for 2017 was 96.8% while 2017 had data availability of 83%, and 2019 had data availability of 98.9% (97% for temperature). The US EPA "Meteorological Monitoring Guidance for Regulatory Modeling Applications" states that for dispersion modelling purposes, a meteorological dataset should 90% complete (US EPA, 2017; US EPA, 2005). The Impala Services ambient station data for where the most recent complete year (2019) of hourly sequential data was used to construct wind roses, general climatic information such as diurnal temperature variations, atmospheric stability estimates and for dispersion modelling.

5.2.1 Local Wind Field

The vertical dispersion of pollution is largely a function of the wind field. The wind speed determines both the distance of downward transport and the rate of dilution of pollutants. The generation of mechanical turbulence is similarly a function of wind speed, in combination with surface roughness (Tiwary & Colls, 2010).

The wind roses comprise 16 spokes, which represent the directions from which winds blew during a specific period. The colours used in the wind roses below, reflect the different categories of wind speeds; the orange area, for example, representing winds between 4 and 5 m/s. The dotted circles provide information regarding the frequency of occurrence of wind speed and direction categories. The frequency with which calms occurred, i.e. periods during which the wind speed was below 1 m/s are also indicated.

To avoid the overly conservative concentration estimates being made by AERMOD during calm conditions[5] the National Code of Practice for Air Dispersion Modelling suggests that all wind speeds greater than/equal to the anemometer starting threshold (AST) and less than 1 m/s be replaced with the value of 1 m/s. This approach was undertaken for the study and 57% of the wind speeds were replaced with 1 m/s.

The period wind field and diurnal variability in the wind field are shown in Figure 6, while the seasonal variations are shown in Figure 7. The wind field is dominated by winds from the southerly sectors. Calm conditions occurred 0.39% of the time, with the average wind speed over the period of 1.35 m/s. Wind from the east and east-south-east having higher speeds were greater during the day with a lower frequency of calm conditions (0.21% during the day) than during the night (0.57% during the night). Day-time shows dominant easterly and east-south-easterly components to the wind field and during the night winds these winds decrease and the south-south-westerly winds dominate. Strong winds in excess of 4 m/s occurred most frequently during spring followed by summer. Calm conditions occurred most frequently during the winter months. Although it may appear on the wind roses that the northerly winds are not being measured correctly, it was determined that the frequency of these winds are 0.3%. Assuming all the missing data is for northerly sector the maximum amount of time that the winds may originate from the north is 1.4%.

[5] The Gaussian plume equation on which AERMOD algorithms are based is inverse proportional to wind speed resulting in overestimates of concentrations at wind speeds less than 1 m/s.

Figure 6: Period, day- and night-time wind roses (AERMET processed measured data, January 2019 to December 2019)

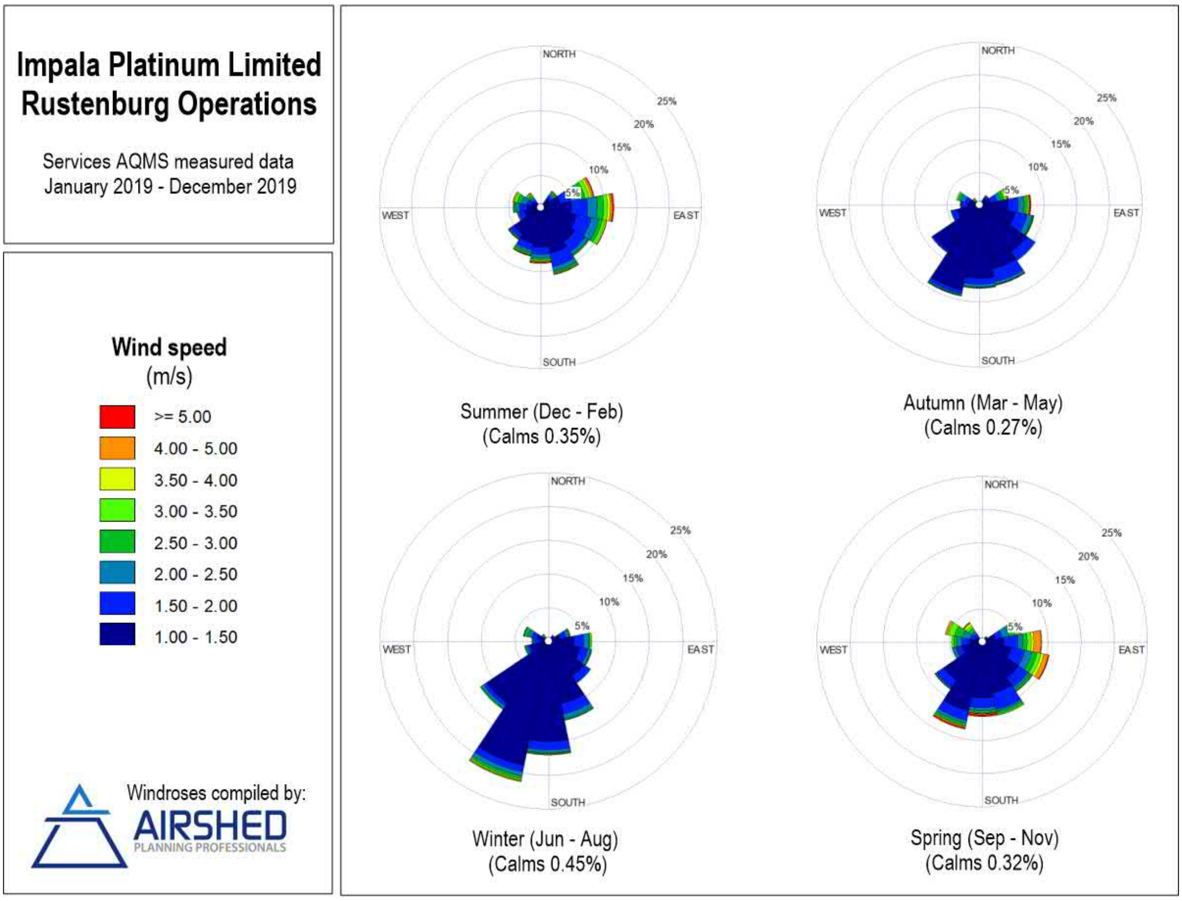


Figure 7: Seasonal wind roses (AERMET processed measured data, January 2019 to December 2019)

5.2.2 Ambient Temperature

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

Monthly mean, maximum and minimum temperatures are given in Table 11. Diurnal temperature variability is presented in Figure 8. Temperatures ranged between 1°C and 38°C. The highest temperatures occurred in October and the lowest in July. During the day, temperatures increase to reach maximum at around 14:00 in the afternoon. Ambient air temperature decreases to reach a minimum at around 06:00 i.e. just before sunrise.

Table 11: Monthly temperature summary (AERMET processed measured data, January 2019 to December 2019)

Minimum, Average and Maximum Temperatures (°C)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Hourly Minimum	16	14	15	8	6	2	1	5	4	11	15	12
Monthly Average	25	24	25	19	17	13	13	18	20	25	25	24
Hourly Maximum	36	36	36	32	28	27	28	30	33	38	36	37

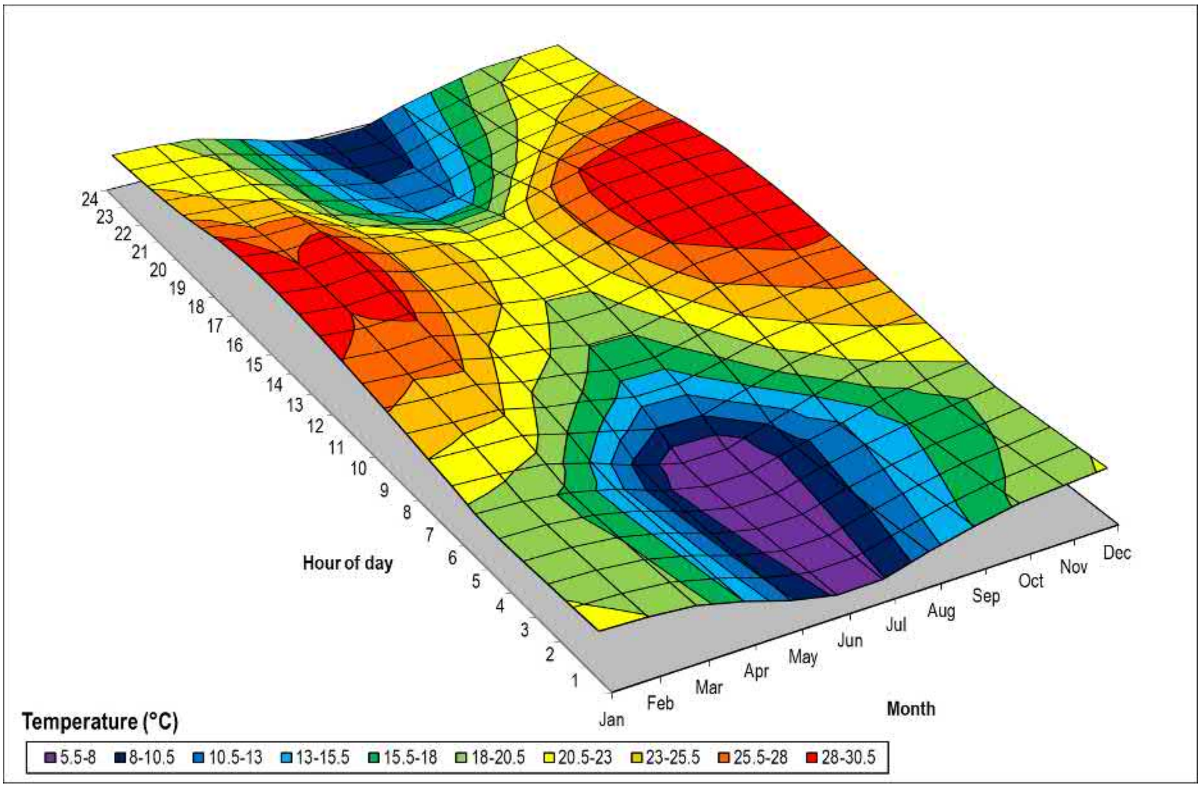


Figure 8: Diurnal temperature profile (AERMET processed measured data, January 2019 to December 2019)

5.2.3 Atmospheric Stability

The new generation air dispersion models differ from the models traditionally used in a number of aspects, the most important of which are the description of atmospheric stability as a continuum rather than discrete classes. The atmospheric boundary layer properties are therefore described by two parameters; the boundary layer depth and the Obukhov length (often referred to as the Monin-Obukhov length).

The Obukhov length (L_{Mo}) provides a measure of the importance of buoyancy generated by the heating of the ground and mechanical mixing generated by the frictional effect of the earth's surface. Physically, it can be thought of as representing the depth of the boundary layer within which mechanical mixing is the dominant form of turbulence generation (CERC, 2004). The atmospheric boundary layer constitutes the first few hundred metres of the atmosphere. During daytime, the atmospheric boundary layer is characterised by thermal turbulence due to the heating of the earth's surface. Night-times are characterised by weak vertical mixing and the predominance of a stable layer. These conditions are normally associated with low wind speeds and lower dilution potential.

Diurnal variation in atmospheric stability, as calculated from measured data, and described by the inverse Obukhov length is provided in Figure 9. The highest concentrations for ground level, or near-ground level releases from non-wind dependent sources would occur during weak wind speeds and stable (night-time) atmospheric conditions. For elevated releases, unstable conditions can result in very high concentrations of poorly diluted emissions close to the stack. This is called *looping* (Figure 9(c)) and occurs mostly during daytime hours. Neutral conditions disperse the plume fairly equally in both the vertical and horizontal planes and the plume shape is referred to as *coning* (Figure 9(b)). Stable conditions prevent the plume from mixing vertically, although it can still spread horizontally and is called *fanning* (Figure 9(a)) (Tiwary & Colls, 2010). For ground level releases such as fugitive dust the highest ground level concentrations will occur during stable night-time conditions.

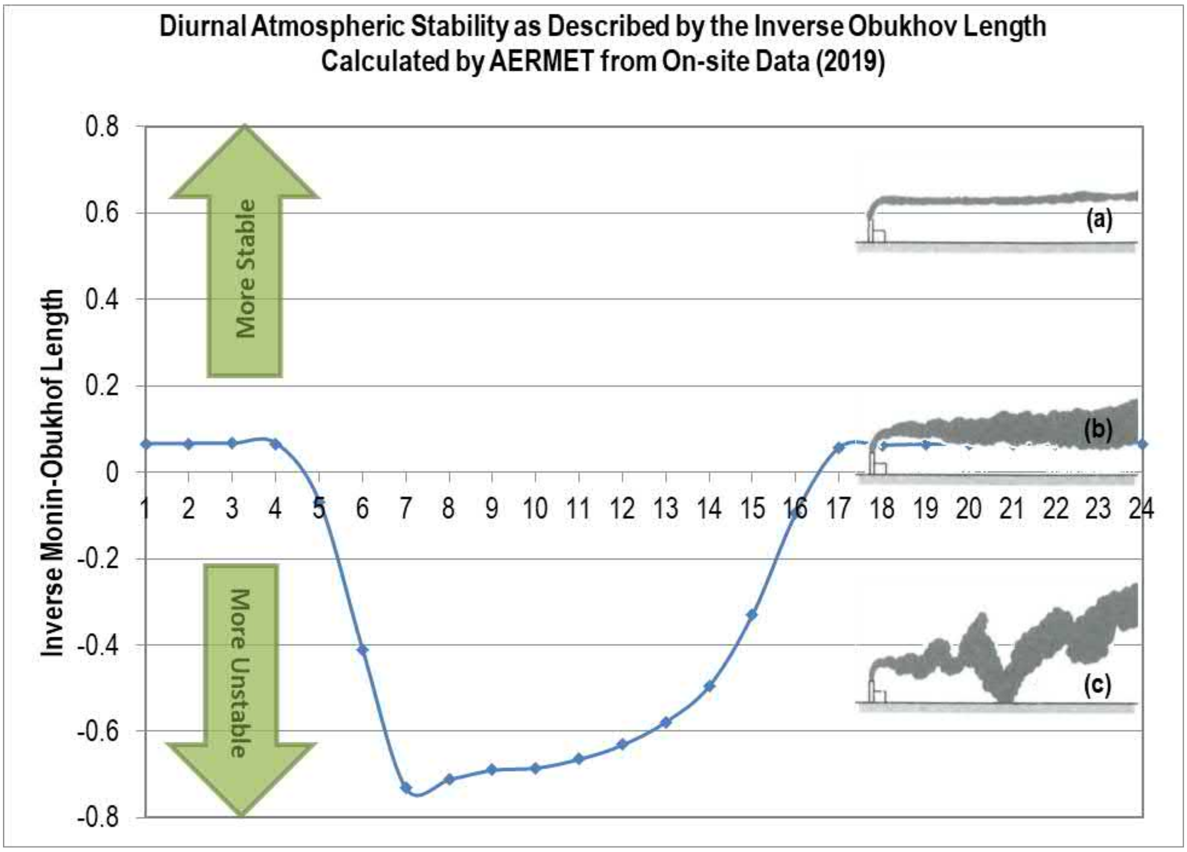
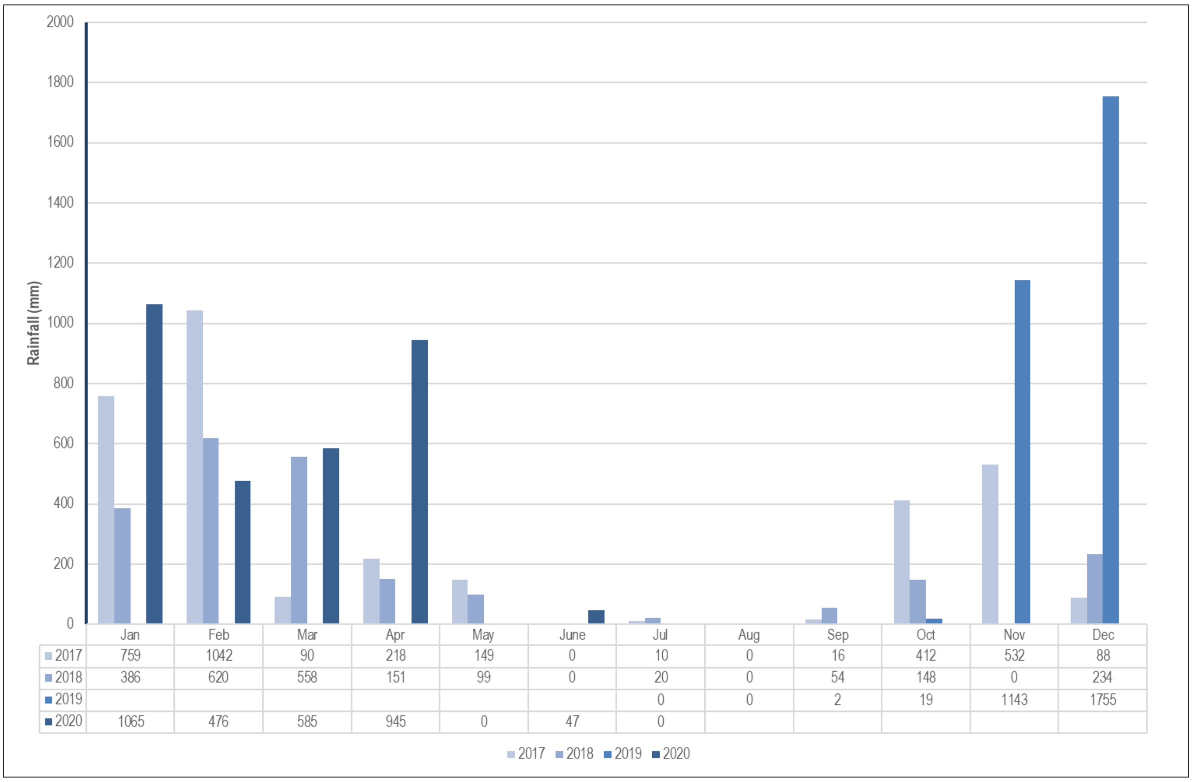


Figure 9: Diurnal atmospheric stability (AERMET processed measured data, January 2019 to December 2019)

5.2.4 Precipitation

Rainfall is important to air pollution studies since it represents an effective removal mechanism of atmospheric pollutants. Monthly rainfall obtained from the Impala Lebone ambient station data is presented in Figure 10. A significant portion (six months) of the 2019 year did not have rainfall measurements thus the total measured rainfall is likely less than the actual annual rainfall for 2019. No rainfall measurements are available for the last five months of 2020 thus the total measured rainfall is likely less than what the actual annual rainfall for 2020 will be. Total average annual rainfall from January 2017 to December 2018 is 2 704 mm. The rainfall for 2017 and 2018 was 3 316 mm, and 2 271 mm, respectively. Rainfall in this area occurs mostly during the summer months although it also rains during spring and autumn while the winter months are dry.



	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
2017	759	1042	90	218	149	0	10	0	16	412	532	88
2018	386	620	558	151	99	0	20	0	54	148	0	234
2019							0	0	2	19	1143	1755
2020	1065	476	585	945	0	47	0					

Figure 10: Monthly rainfall (Lebone ambient station measured data, January 2017 to July 2020)

5.3 Existing Air Quality

Bojanala Platinum District Municipality was declared a Priority Area in terms of Section 18(4) read with Section 57(1)(a) on the 15 June 2012 (GN 495, Government Gazette No. 35435). Based on this, the other contributing activities in the region are identified. Current land uses in the region include numerous mining operations (both underground and opencast), industries and small residential communities, business trade and agricultural activities. Industries in the region include two platinum smelter operations (viz.: Anglo Platinum Waterval Smelter Operation and Lonmin Western Platinum) and three ferro-chrome industries (viz. the Xstrata Rustenburg, Xstrata Wonderkop and Merafe Ferrochrome). In addition, there are a number of smaller boiler operations and incinerators. Fugitive dust sources include other mining and quarry operations and tailings storage facilities (viz. Anglo Platinum and Lonmin). Other sources of gaseous and particulate emissions include vehicle tailpipe emissions, domestic fuel burning, biomass burning and regionally transported pollutants from other areas.

The current air quality in the study area is mostly influenced by mining and processing activities at other companies' operations, as well as farming activities, domestic fires, vehicle exhaust emissions and dust entrained by vehicles. These emission sources vary from activities that generate relatively course airborne particulates (such as dust from paved and unpaved roads, and the mine sites) to fine PM such as that emitted by vehicle exhausts, diesel power generators and processing operations. Other sources of PM include occasional fires in the residential areas and farming activities. Emissions from unpaved roads constitute a major source of emissions to the atmosphere in South Africa. When a vehicle travels on an unpaved road, the force of the wheels on the road surface causes pulverization of surface material. Particles are lifted and dropped from the rolling wheels, and the road surface is exposed to strong turbulent air shear with the surface. The turbulent wake behind the vehicle continues to act on the road surface after the vehicle has passed. Dust emissions from unpaved roads are a function of vehicle traffic and the silt loading on the roads. Emissions from paved roads are significantly less than those originating from unpaved roads, however they do contribute to the particulate load of the atmosphere. Particulate emissions occur whenever vehicles travel over a paved surface. The fugitive dust emissions are due to the re-suspension of loose material on the road surface. Emissions generated by wind erosion are dependent on the frequency of disturbance of the erodible surface. Every time that a surface is disturbed e.g. by mining, agriculture and/or grazing activities, its erosion potential is restored.

5.3.1 Measured Air Pollutant Concentrations – $PM_{2.5}$, PM_{10} and SO_2

Ten-minute (sub-hourly) measured data for $PM_{2.5}$, PM_{10} and SO_2 at the five Impala ambient stations was made available. The data from the four air quality monitoring stations (AQMS) that fall within areas where the NAAQS are applicable for the period 1 January 2016 to 31 July 2020 is discussed in this section. The data availability for the four off-site AQMS is provided in Table 12.

The $PM_{2.5}$ monitored data shows exceedances of the annual NAAQS at Luka in 2016, 2018, 2019 and 2020; Lebone in 2017 and 2020; and Ratanang in 2018 (Figure 11). Exceedances of the daily $PM_{2.5}$ NAAQS were recorded at Boschhoek in 2017, 2019 and 2020; Luka in all the years discussed (2016, 2017, 2018, 2019 and 2020); Lebone in all the years discussed (2016, 2017, 2018, 2019 and 2020); and Ratanang in all three years that monitoring data was available (2018, 2019 and 2020) (Figure 12).

The PM_{10} monitored data shows exceedances of the annual NAAQS at Boschhoek in 2019; Luka in all the years discussed (2016, 2017, 2018, 2019 and 2020); Lebone in all the years 2016, 2017 and 2019; and Ratanang in 2018 (Figure 13). Exceedances of the daily PM_{10} NAAQS were measured at Boschhoek, Luka and Lebone in all the years discussed (2016, 2017, 2018, 2019 and 2020); and Ratanang in 2018 and 2019 (Figure 14).

The SO_2 monitored data shows no exceedances of the annual, daily and hourly NAAQS at any of the off-site monitoring stations (Figure 15 to Figure 17).

Table 12: Monitoring data availability[(a)]

Year	Boschhoek	Luka	Lebone	Ratanang
		$PM_{2.5}$		
2016	82%	89%	90%	81%
2017	50%	91%	97%	99%
2018	95%	87%	87%	95%
2019	92%	97%	99%	87%
2020[(b)]	96%	100%	94%	100%
		PM_{10}		
2016	82%	89%	90%	81%
2017	54%	91%	97%	99%

Year	Boschhoek	Luka	Lebone	Ratanang
2018	95%	87%	87%	95%
2019	97%	97%	99%	87%
2020(b)	96%	100%	94%	100%
		SO_2		
2016	75%	89%	90%	81%
2017	93%	87%	94%	99%
2018	100%	87%	91%	95%
2019	98%	96%	99%	94%
2020(b)	97%	100%	94%	82%

Notes:

(a) Based on hourly sequential data

(b) Ends 31 July 2020 – based on 5 112 hours

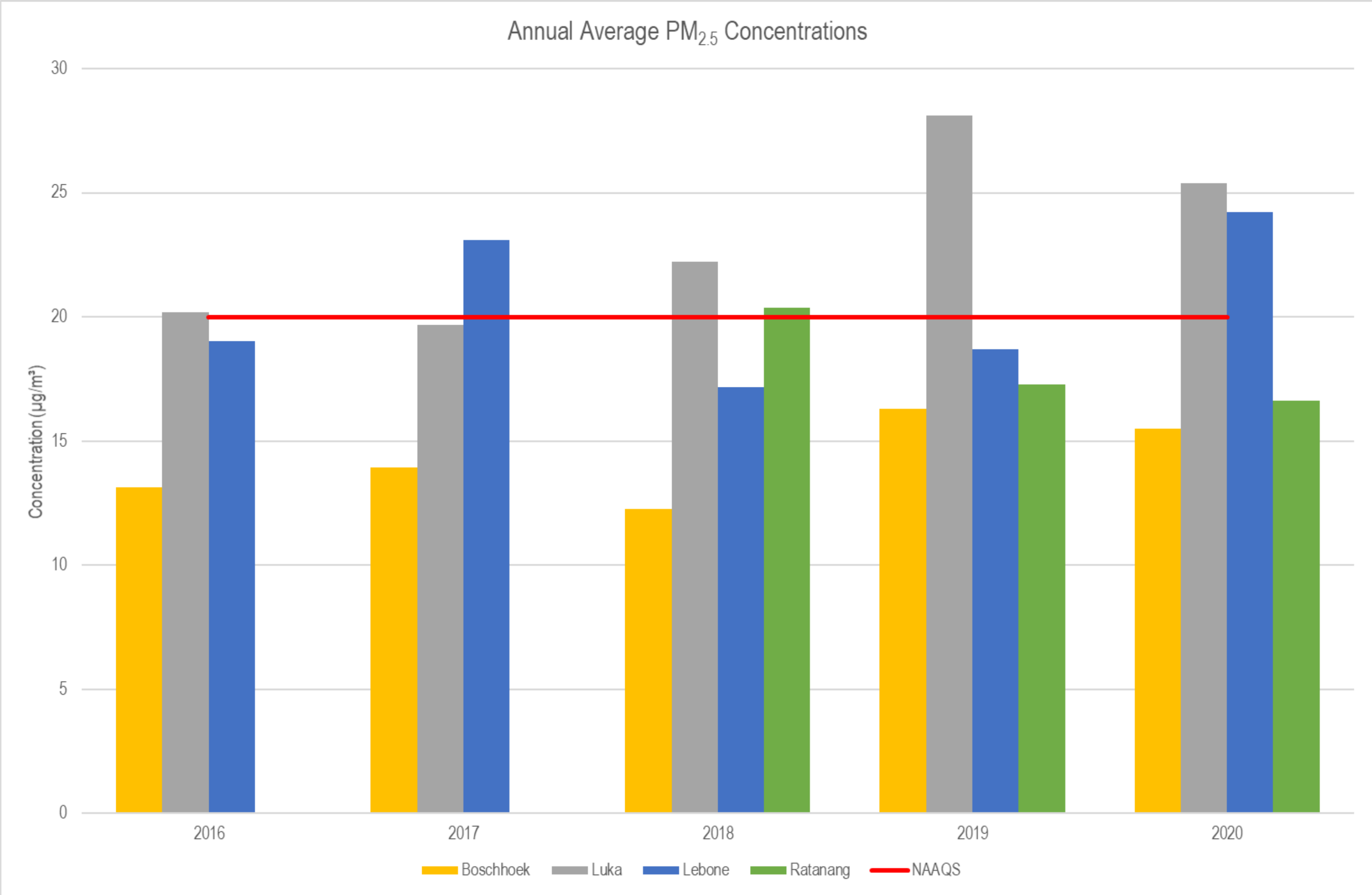


Figure 11: Measured $PM_{2.5}$ annual average concentrations based on sub-hourly measured data

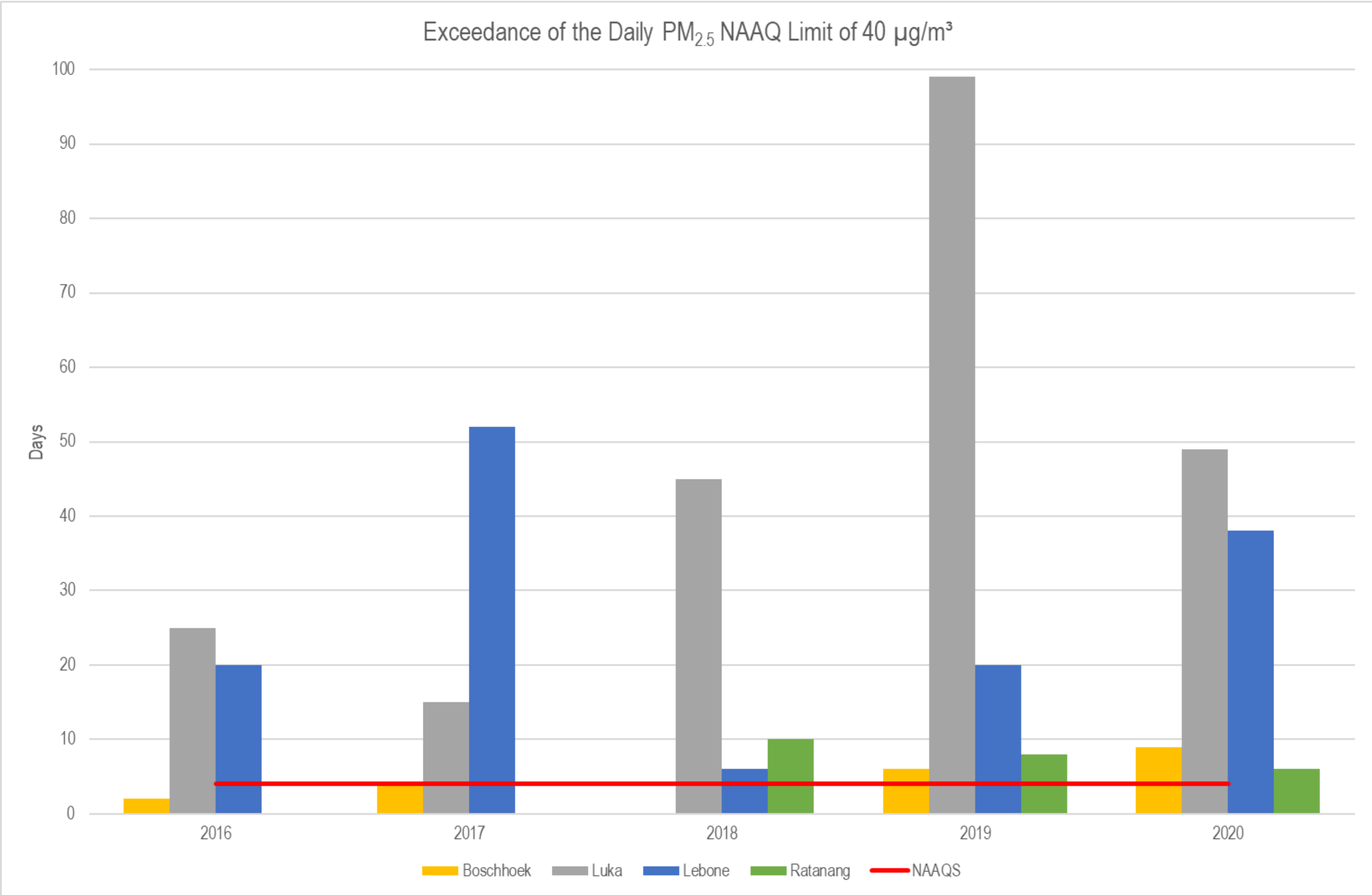


Figure 12: Number of days exceeding the NAAQ limit of 40 µg/m³ for $PM_{2.5}$ based on sub-hourly measured data

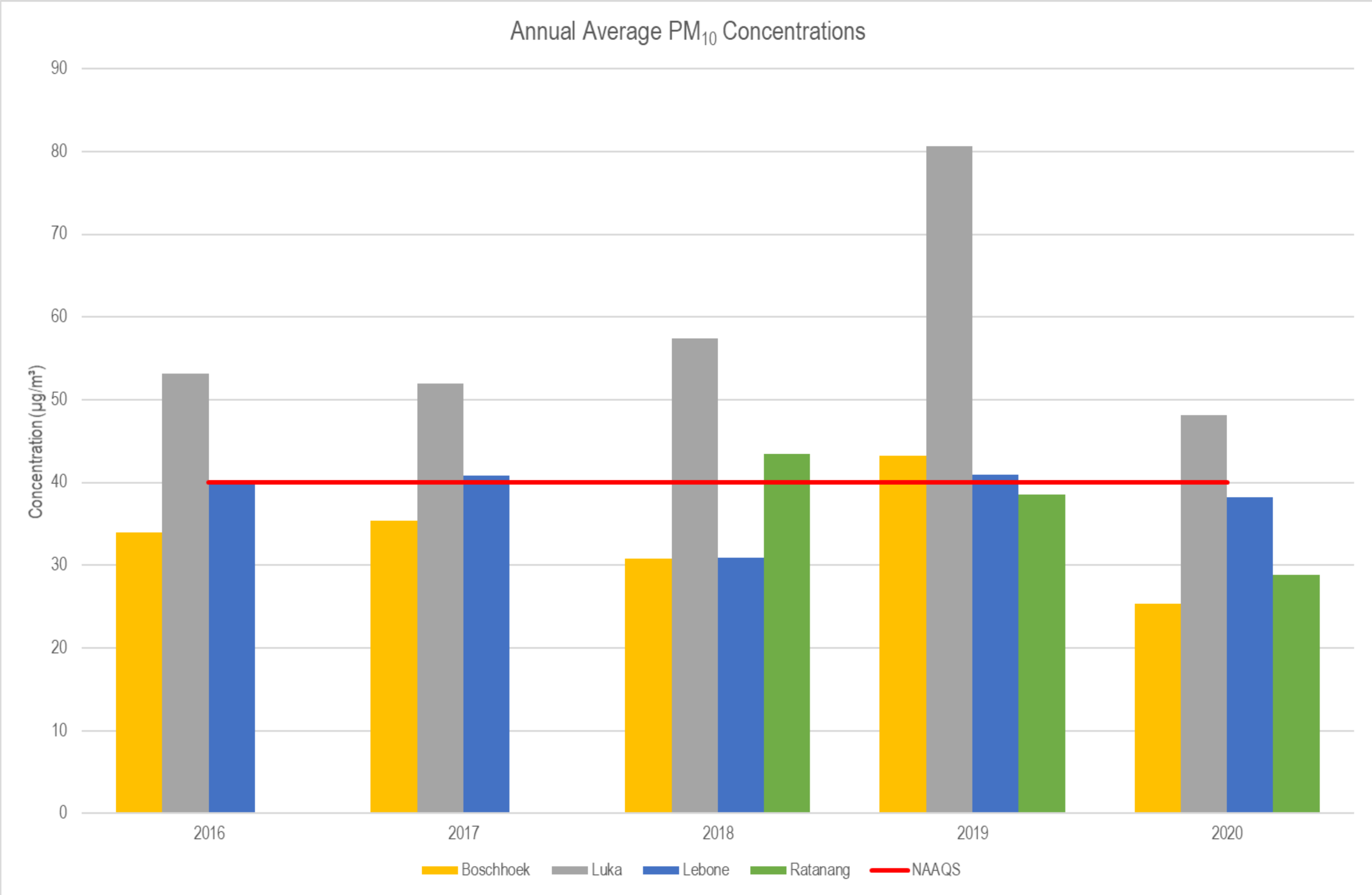


Figure 13: Measured PM_{10} annual average concentrations based on sub-hourly measured data

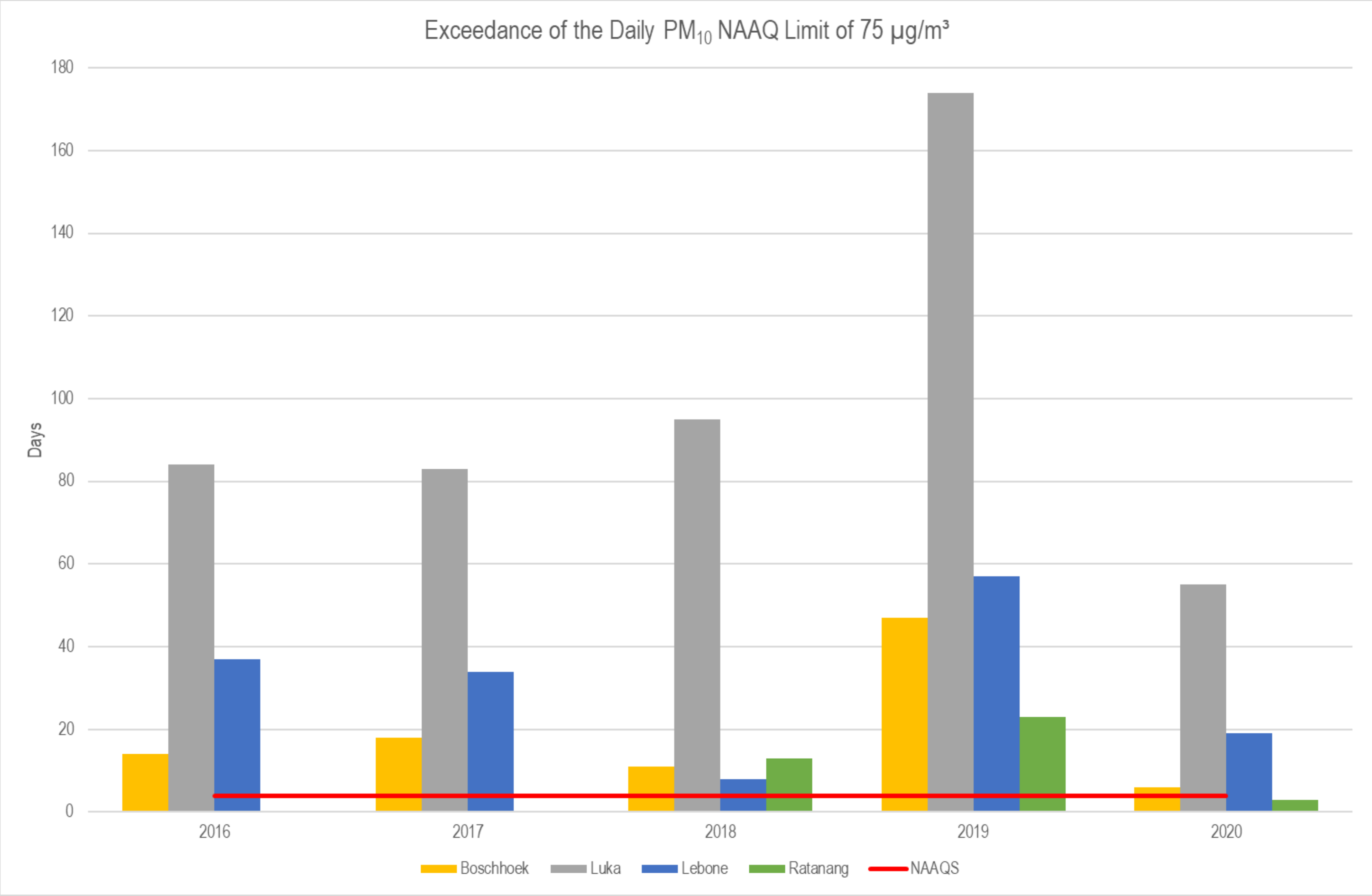


Figure 14: Number of days exceeding the NAAQ limit of 75 µg/m³ for PM_{10} based on sub-hourly measured data

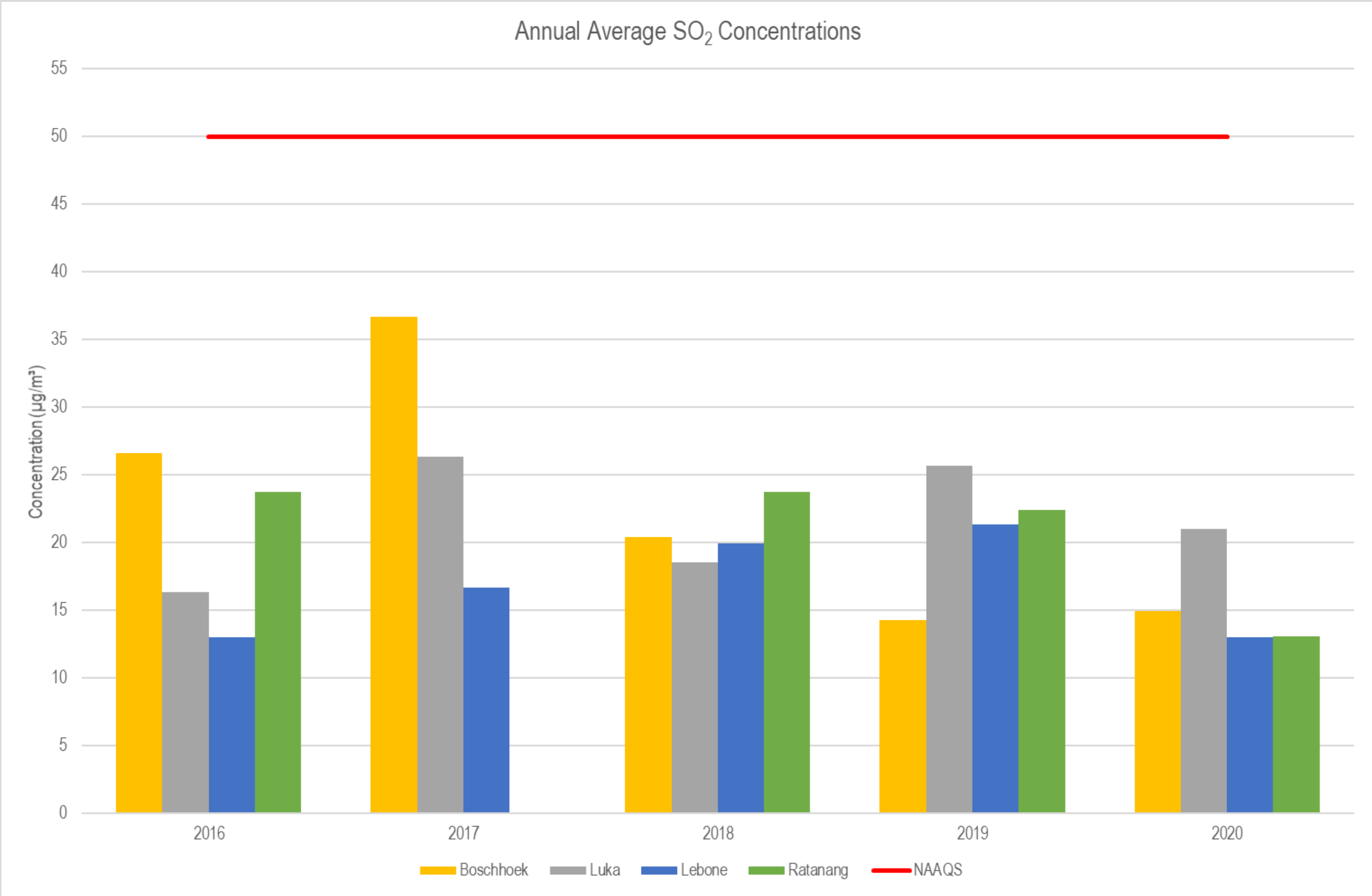


Figure 15: Measured SO_2 annual average concentrations based on sub-hourly measured data

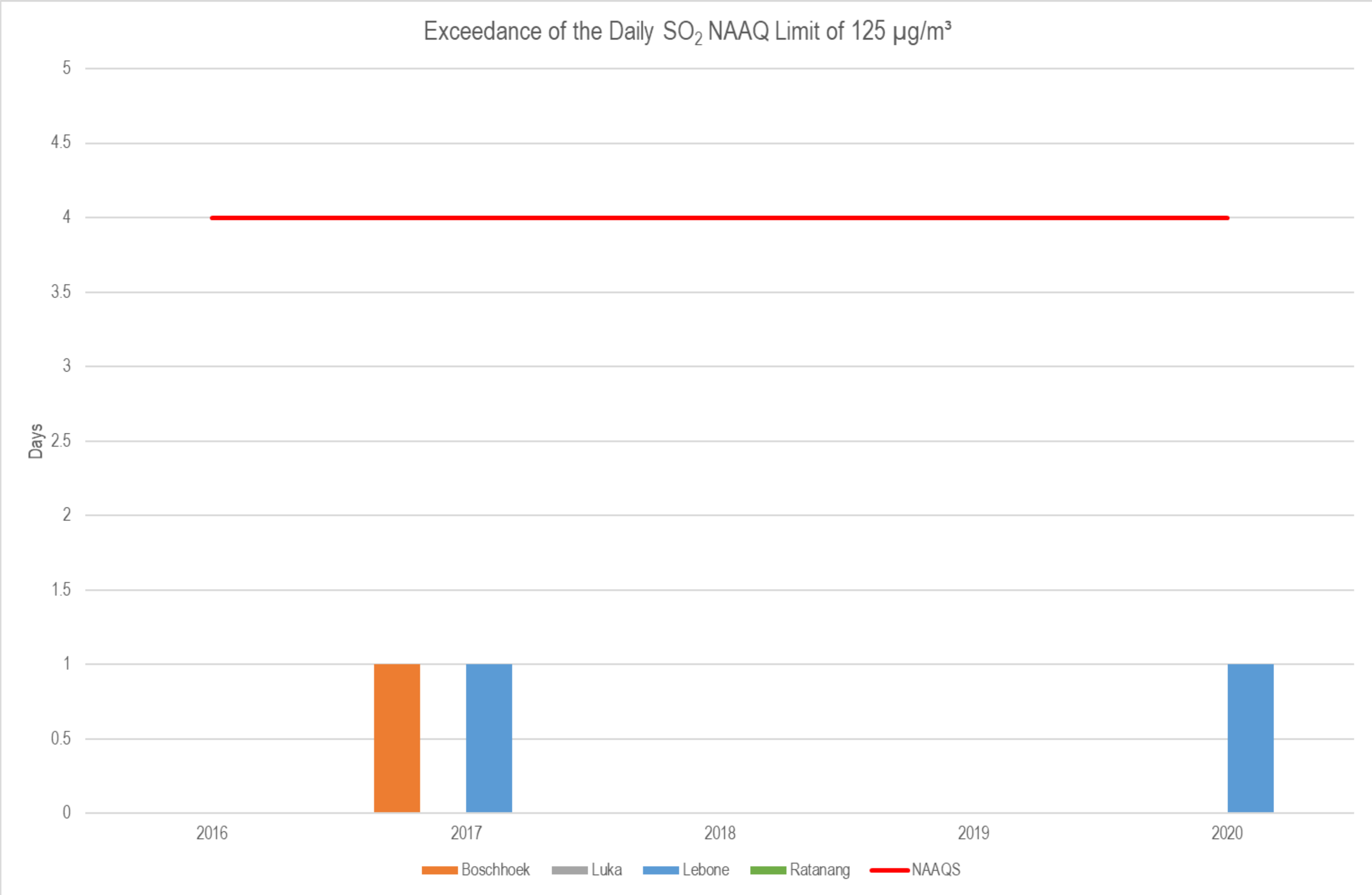


Figure 16: Number of days exceeding the NAAQ limit of 125 µg/m³ for SO_2 based on sub-hourly measured data (blank columns indicate no exceedances)

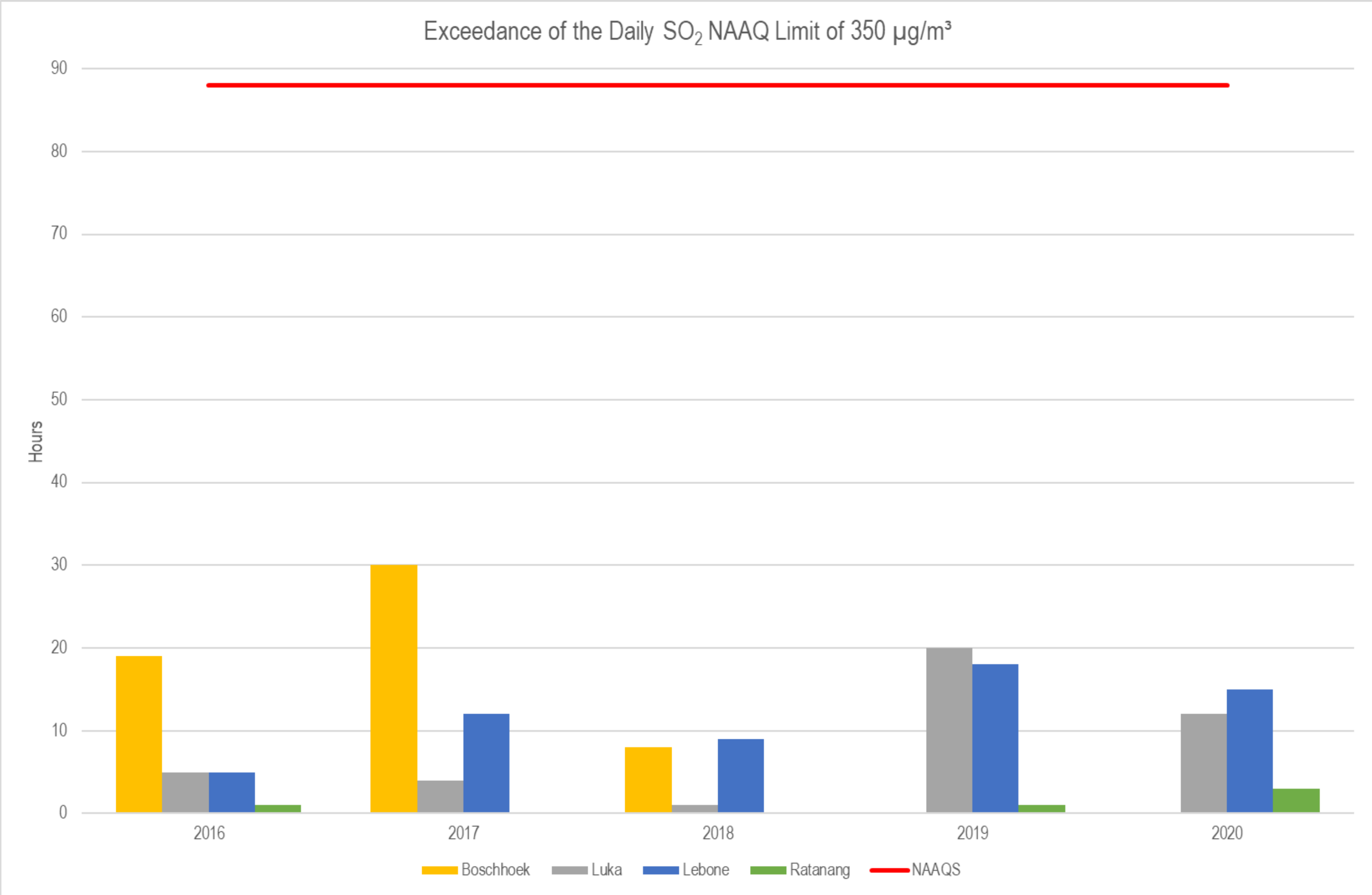


Figure 17: Number of hours exceeding the NAAQ limit of 350 µg/m³ for SO_2 based on sub-hourly measured data

5.3.2 *Simulated Air Pollutant Concentrations – $PM_{2.5}$, PM_{10}, SO_2 and NO_2*

Simulation results of particulate and gaseous emissions for the current operations at the entire Impala facility are discussed in this section. The current Impala operations comprises of all the existing mitigated mining and processing sources at Impala. The summarised simulated results for $PM_{2.5}$, PM_{10}, SO_2 and NO_x are shown in Table 13 to Table 16 (figures in bold indicate exceedances of the current NAAQS, figures in bold and italic indicate exceedances of the future [2030] NAAQS).

The simulated $PM_{2.5}$ exceeds the future annual NAAQS (15 µg/m³) at Impala Platinum Hospital (Table 13) but not the current annual NAAQS (20 µg/m³). The simulated $PM_{2.5}$ exceeds the future 24-hour NAAQS (4 days of exceedance of 25 µg/m³) at Kelekitso Early Learning Centre and Impala Platinum Hospital (Table 13) but not the current 24-hour NAAQS (4 days of exceedance of 40 µg/m³). Therefore, the simulated $PM_{2.5}$ is compliant with the current annual and 24-hour NAAQS at all the AQSRs detailed in Table 3 and Figure 2, but could potentially exceed the future annual and 24-hour NAAQS at Impala Platinum Hospital and the future 24-hour NAAQS at Kelekitso Early Learning Centre.

The simulated PM_{10} exceeds the annual NAAQS (40 µg/m³) and 24-hour NAAQS (4 days of exceedance of 75 µg/m³) at Impala Platinum Hospital (Table 14).

The simulated SO_2 does not exceed the annual NAAQS (50 µg/m³), 24-hour NAAQS (4 days of exceedance of 125 µg/m³) or 1-hour NAAQS (88 hours of exceedance of 350 µg/m³) at any of the AQSRs detailed in Table 3 and Figure 2 (Table 15). The simulated annual average SO_2 concentrations are below the critical levels for all vegetation types at all AQSRs except Kelekitso Early Learning Centre (Table 40). At Kelekitso Early Learning Centre there is a potential for impacts on cyanobacterial lichens according to European limits (Table 15).

The simulated NO_x does not exceed the annual NAAQS (40 µg/m³) at any of the AQSRs detailed in Table 3 and Figure 2 (Table 16). The simulated NO_x exceeds the 1-hour NO_2 NAAQS (88 hours of exceedance of 200 µg/m³) at Impala Platinum Hospital (Table 16). The simulated annual average NO_x concentrations are below the critical levels (European limits) for all vegetation types at all AQSRs detailed in Table 3 and Figure 2 except Impala Platinum Hospital (Table 16).

Table 13: Summary of simulated results for $PM_{2.5}$ as a result of the Impala current operations

Pollutant	$PM_{2.5}$		
Averaging Period	Annual	24-hour	
Reporting Unit	Concentration in µg/m³	Days per year	
NAAQS	20 µg/m³/ 15 µg/m³	4 allowable exceedances of 25 µg/m³	4 allowable exceedances of 40 µg/m³
AQSR/Source Group	Impala Current Operations (All Existing Impala Operations with Current Mitigation Measures Applied)		
Ratanang	4.84	0	0
Magareng	12.6	4	0
Simunye	6.26	0	0
Kopano	3.68	0	0
Pudunong	1.34	0	0
Phokeng	0.431	0	0
Bobuampja	0.427	0	0
Ga-Luka	9.58	1	0
Mogono	5.05	0	0
Freedom	4.04	0	0
Meriteng	4.35	0	0
Kanana	0.874	0	0
Mafika	1.02	0	0
Serutube	1.26	0	0
Thethe Secondary School	7.80	0	0
Luka Primary School	8.97	1	0
Kelekitso Early Learning Centre	13.5	**23**	0
Matlhware Primary School	1.32	0	0
Kitsong High School	1.62	0	0
Tumagole Primary School	0.732	0	0
Matale Secondary School	0.64	0	0
Kutlwanong School for the Deaf	1.34	0	0
Vukuzenzele Primary School	4.34	0	0
Freedom Park Secondary School	4.08	0	0
Molotlegi Secondary School	8.60	0	0
Ramotse Primary School	10.7	2	0
Moremogolo Primary School	0.621	0	0
Semane Early Learning Centre	0.533	0	0
Bafokeng Health Centre	1.41	0	0

Pollutant	$PM_{2.5}$		
Averaging Period	Annual	24-hour	
Reporting Unit	Concentration in µg/m³	Days per year	
NAAQS	20 µg/m³/ 15 µg/m³	4 allowable exceedances of 25 µg/m³	4 allowable exceedances of 40 µg/m³
AQSR/Source Group	Impala Current Operations (All Existing Impala Operations with Current Mitigation Measures Applied)		
Tapologo Hospice Centre	0.76	0	0
Luka Clinic	8.25	0	0
Impala Platinum Hospital	***17.0***	***41***	2
Lebone AQMS	1.55	0	0
Luka AQMS	8.58	1	0
Boschhoek AQMS	0.904	0	0
Ratanang AQMS	5.84	0	0

Table 14: Summary of simulated results for PM_{10} as a result of the Impala current operations

Pollutant	PM_{10}	
Averaging Period	Annual	24-hour
Reporting Unit	Concentration in µg/m³	Days per year
NAAQS	40 µg/m³	4 allowable exceedances of 75 µg/m³
AQSR/Source Group	Impala Current Operations (All Existing Impala Operations with Current Mitigation Measures Applied)	
Ratanang	12.3	0
Magareng	35.6	1
Simunye	21.1	0
Kopano	11.5	0
Pudunong	2.74	0
Phokeng	0.867	0
Bobuampja	0.877	0
Ga-Luka	20.6	0
Mogono	12.2	0
Freedom	12.5	0
Meriteng	12.2	0
Kanana	1.78	0
Mafika	2.33	0
Serutube	3.01	0
Thethe Secondary School	17.3	0

Pollutant	PM_{10}	
Averaging Period	Annual	24-hour
Reporting Unit	Concentration in µg/m³	Days per year
NAAQS	40 µg/m³	4 allowable exceedances of 75 µg/m³
AQSR/Source Group	Impala Current Operations (All Existing Impala Operations with Current Mitigation Measures Applied)	
Luka Primary School	19.2	0
Kelekitso Early Learning Centre	28.6	0
Matlhware Primary School	2.73	0
Kitsong High School	3.31	0
Tumagole Primary School	1.51	0
Matale Secondary School	1.30	0
Kutlwanong School for the Deaf	3.22	0
Vukuzenzele Primary School	13.0	0
Freedom Park Secondary School	12.0	0
Molotlegi Secondary School	18.8	0
Ramotse Primary School	23.0	0
Moremogolo Primary School	1.17	0
Semane Early Learning Centre	1.04	0
Bafokeng Health Centre	2.84	0
Tapologo Hospice Centre	1.41	0
Luka Clinic	17.8	0
Impala Platinum Hospital	**50.8**	**39**
Lebone AQMS	3.16	0
Luka AQMS	18.4	0
Boschhoek AQMS	1.83	0
Ratanang AQMS	16.1	0

Table 15: Summary of simulated results for SO_2 as a result of the Impala current operations

Pollutant	SO_2		
Averaging Period	Annual	24-hour	1-hour
Reporting Unit	Concentration in µg/m³	Days per year	Hours per year
NAAQS	50 µg/m³	4 allowable exceedances of 125 µg/m³	88 allowable exceedances of 350 µg/m³
AQSR/Source Group	Impala Current Operations (All Existing Impala Operations with Current Mitigation Measures Applied)		
Ratanang	7.44	0	0

Pollutant	SO_2		
Averaging Period	Annual	24-hour	1-hour
Reporting Unit	Concentration in µg/m³	Days per year	Hours per year
NAAQS	50 µg/m³	4 allowable exceedances of 125 µg/m³	88 allowable exceedances of 350 µg/m³
AQSR/Source Group	Impala Current Operations (All Existing Impala Operations with Current Mitigation Measures Applied)		
Magareng	4.56	0	0
Simunye	4.51	0	0
Kopano	3.42	0	0
Pudunong	4.48	0	10
Phokeng	1.50	0	4
Bobuampja	1.25	0	1
Ga-Luka	8.74	0	0
Mogono	7.73	0	0
Freedom	3.68	0	0
Meriteng	5.42	0	0
Kanana	1.58	0	0
Mafika	1.81	0	0
Serutube	1.87	0	0
Thethe Secondary School	8.19	0	1
Luka Primary School	9.05	0	0
Kelekitso Early Learning Centre	10.1	0	4
Matlhware Primary School	3.69	0	5
Kitsong High School	5.16	0	10
Tumagole Primary School	2.40	0	4
Matale Secondary School	2.28	0	4
Kutlwanong School for the Deaf	2.63	0	0
Vukuzenzele Primary School	3.87	0	0
Freedom Park Secondary School	3.76	0	0
Molotlegi Secondary School	8.42	0	1
Ramotse Primary School	8.97	0	1
Moremogolo Primary School	3.10	0	6
Semane Early Learning Centre	2.10	0	2
Bafokeng Health Centre	5.66	0	27
Tapologo Hospice Centre	4.41	0	19
Luka Clinic	9.08	0	1

Pollutant	SO_2		
Averaging Period	Annual	24-hour	1-hour
Reporting Unit	Concentration in µg/m³	Days per year	Hours per year
NAAQS	50 µg/m³	4 allowable exceedances of 125 µg/m³	88 allowable exceedances of 350 µg/m³
AQSR/Source Group	Impala Current Operations (All Existing Impala Operations with Current Mitigation Measures Applied)		
Impala Platinum Hospital	5.41	0	0
Lebone AQMS	5.37	0	23
Luka AQMS	8.94	0	0
Boschhoek AQMS	3.13	0	0
Ratanang AQMS	7.57	0	0

Table 16: Summary of simulated results for NO_x as a result of the Impala current operations

Pollutant	NO_x	
Averaging Period	Annual	1-hour
Reporting Unit	Concentration in µg/m³	Hours per year
NAAQS	40 µg/m³	88 allowable exceedances of 200 µg/m³
AQSR/Source Group	Impala Current Operations (All Existing Impala Operations with Current Mitigation Measures Applied)	
Ratanang	8.39	0
Magareng	23.7	16
Simunye	19.9	47
Kopano	10.3	0
Pudunong	1.76	0
Phokeng	0.881	0
Bobuampja	0.890	0
Ga-Luka	6.47	0
Mogono	7.68	0
Freedom	11.0	13
Meriteng	11.4	20
Kanana	1.29	0
Mafika	2.11	0
Serutube	2.57	0
Thethe Secondary School	6.89	0
Luka Primary School	6.19	0
Kelekitso Early Learning Centre	7.08	0

Pollutant	NO_x	
Averaging Period	Annual	1-hour
Reporting Unit	Concentration in µg/m³	Hours per year
NAAQS	40 µg/m³	88 allowable exceedances of 200 µg/m³
AQSR/Source Group	Impala Current Operations (All Existing Impala Operations with Current Mitigation Measures Applied)	
Matlhware Primary School	1.67	0
Kitsong High School	1.95	0
Tumagole Primary School	1.21	0
Matale Secondary School	1.13	0
Kutlwanong School for the Deaf	2.63	0
Vukuzenzele Primary School	10.7	0
Freedom Park Secondary School	9.72	0
Molotlegi Secondary School	6.73	0
Ramotse Primary School	7.05	0
Moremogolo Primary School	1.36	0
Semane Early Learning Centre	1.04	0
Bafokeng Health Centre	1.96	0
Tapologo Hospice Centre	1.75	0
Luka Clinic	6.12	0
Impala Platinum Hospital	37.6	**330**
Lebone AQMS	1.98	0
Luka AQMS	6.14	0
Boschhoek AQMS	1.42	0
Ratanang AQMS	11.9	0

5.3.3 Measured Dustfall Rates

Dust fallout sampling is being undertaken at Impala for both external (off-site/residential) and internal (on-site) buckets. The network includes at 36 locations (27 non-residential sites and 9 residential sites) in accordance with ASTM D1739 (1970). Figure 2 shows the locations of the external units. Dustfall rates at the external sampling sites from January 2016 to June 2020 are summarised in Table 17. There was one exceedance of the NDCR limit for residential areas at Platinum Village in November 2018 (value in bold); however, it is believed that this sample was contaminated or tampered with. SGS stated the following in the November 2018 report: "During the sample changes it was reported that at Site 24 (Platinum Village) there were construction activities in the vicinity; hence a possibility of sample contamination/tampering. Therefore, the result is flagged and cannot be used for compliance but for information purposes only" (Naidoo, 2018). The operations off-site dustfall rates shown by the sampling complies in terms of the NDCR as there were no exceedances of more than two times per year at a site or for consecutive months at a site.

Table 17: Dustfall rates summary for external buckets

Dustfall Rate (NDCR Limit for Residential Areas = 600 mg/m²-day)												
Period	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Boschhoek Primary												
2016	ND	ND	ND	37	31	17	27	17	10	99	59	74
2017	49	34	60	23	10	30	19	23	31	53	89	83
2018	98	87	44	47	81	24	27	109	198	67	47	116
2019	90	118	26	51	21	53	64	47	87	65	65	37
2020	58	57	102	29	33	33	-	-	-	-	-	-
Luka South												
2016	27	31	10	33	18	7	26	24	21	43	54	54
2017	19	13	27	33	32	37	21	31	51	72	39	54
2018	164	122	33	26	34	31	22	41	103	57	39	180
2019	141	89	75	64	37	47	98	97	59	40	144	49
2020	10	44	59	12	46	57	-	-	-	-	-	-
Luka Primary												
2016	19	129	155	63	90	97	122	42	52	59	102	133
2017	70	64	134	48	67	41	68	66	121	63	181	ND
2018	86	265	105	23	37	173	68	102	86	51	128	129
2019	108	233	203	196	33	150	543	233	185	133	326	170
2020	26	156	163	40	30	30	-	-	-	-	-	-
Luka North												
2016	173	48	148	47	58	21	30	11	175	75	168	59
2017	27	34	133	43	28	46	33	79	155	65	115	95
2018	65	95	182	64	107	27	71	83	228	ND	ND	184
2019	24	41	51	27	36	14	97	65	181	194	321	250
2020	ND	67	229	22	76	88	-	-	-	-	-	-
Luka Village Tailings												
2016	381	73	35	ND	ND	ND	ND	ND	ND	ND	ND	ND
2017	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2018	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2019	ND	ND	ND	33	26	138	97	104	57	87	126	59
2020	58	64	53	58	26	159	-	-	-	-	-	-
Luka Village Shaft17												
2016	274	36	92	36	42	19	29	23	79	100	72	58
2017	25	23	58	ND	15	22	23	41	80	113	37	105
2018	84	70	57	16	33	22	14	71	93	85	91	40
2019	189	406	79	25	13	31	82	46	81	96	78	121
2020	65	69	175	5	22	45	-	-	-	-	-	-
Phokeng Village												
2016	ND	ND	ND	56	24	17	33	11	170	90	109	69
2017	51	39	122	18	25	29	22	32	189	122	75	143
2018	73	32	31	17	38	16	14	37	48	30	24	79

Dustfall Rate (NDCR Limit for Residential Areas = 600 mg/m²-day)												
Period	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
2019	57	77	18	22	12	36	18	46	39	25	32	91
2020	19	15	44	17	38	13	-	-	-	-	-	-
Freedom Park												
2016	109	35	43	72	19	18	47	45	38	57	82	99
2017	114	175	57	ND	15	7	36	34	ND	66	41	
2018	36	61	52	38	31	34	557	49	81	87	68	85
2019	18	69	40	26	37	42	62	68	70	114	270	50
2020	46	93	ND	7	10	16	-	-	-	-	-	-
Platinum Village												
2016	106	51	24	42	14	21	28	36	21	50	36	59
2017	17	47	28	9	31	31	18	31	40	37	68	41
2018	99	66	39	16	108	101	87	65	39	37	**9186***	65
2019	71	47	38	79	32	38	35	7	72	116	60	119
2020	75	42	76	53	20	15	-	-	-	-	-	-

Notes:

* Possible sample contamination/tampering Based on hourly sequential data

5.3.4 Model Validation

In the US EPA Guideline on Air Quality Models (US EPA, 2017), the need to address the uncertainties associated with dispersion modelling is acknowledged as an important issue that should be considered. The US Guideline divides the uncertainty associated with dispersion model predictions into two main types (US EPA, 2017), as follows:

- Reducible uncertainty, which results from (1) Uncertainties in the input values of the known conditions (i.e., emission characteristics and meteorological data); (2) errors in the measured concentrations which are used to compute the concentration residuals; and (3) inadequate model physics and formulation. The "reducible" uncertainties can be minimized through better (more accurate and more representative) measurements and better model physics.
- Inherent uncertainty is associated with the stochastic (turbulent) nature of the atmosphere and its representation (approximation) by numerical models. Models predict concentrations that represent an ensemble average of numerous repetitions for the same nominal event. An individual observed value can deviate significantly from the ensemble value. This uncertainty may be responsible for a ± 50% deviation from the measured value.

Atmospheric dispersion models are often criticised for being inadequate since "*…it is only a model approximating reality*", and therefore include inherent uncertainty. Both reducible and inherent uncertainties mean that dispersion modelling results may over- or under-estimate measured ground-level concentrations at any specific time or place. However, the US EPA Guideline on Air Quality Models (US EPA, 2017) also states that:

"Models are more reliable for estimating longer time-averaged concentrations than for estimating short-term concentrations at specific locations; and the models are reasonably reliable in estimating the magnitude of highest concentrations occurring sometime, somewhere within an area. For example, errors in highest estimated concentrations of ± 10 to 40 percent are found to be typical, certainly well within the often-quoted factor-of-two accuracy that has long been recognized for these models."

More detail on the model uncertainties is provided in Appendix C.

Ambient concentrations of SO_2, and PM measured by Impala in the study area help provide an understanding of existing ambient air concentrations as well as providing a means of verifying the dispersion modelling. Since the aim of the investigation is to illustrate the change in ground level concentrations from the current levels (i.e. current operations emission scenario) to those levels resulting from the introduction of the proposed second Flash Dryer, the intention was not to comprehensively include all air emissions within the study area. Unaccounted emissions include those from other mining activities and industries, agricultural activities, activities occurring within the communities, and biomass burning, as well as long-range transport into the modelling domain. However, information about agricultural and community activities, such as the amount of traffic within the community and the amount of fuel used for heating is often difficult to estimate.

These emissions, when combined, may potentially add up to be a significant portion of the observed concentrations in the modelling domain. In terms of the current investigation, the portion of air quality due to air emission sources that is not included in the model's emissions inventory constitutes the background concentration.

A summary of the simulated current $PM_{2.5}$, PM_{10} and SO_2 concentrations and their comparison with observations are given in Table 18, Table 19 and Table 20 respectively. In order to establish model performance under average emission conditions, it is not uncommon to use a certain percentile of simulated and observed concentrations for comparison. Although these may range from a 90th to 99.9th percentile, it was decided to use the NAAQS for guidance. For criteria pollutants $PM_{2.5}$, PM_{10} and SO_2 the NAAQS requires compliance with the 99th percentile. As hourly averages, this allows exceedances of the limit value of 88 hours (SO_2) or 4 days ($PM_{2.5}$, PM_{10} and SO_2) per year. Estimated short-term (hourly or daily) background concentrations (not associated with the emissions included in the simulations) used the observed concentration value when simulated concentrations from the Impala current operations indicate very small contributions (0.1 µg/m^3).

Table 18 summarises the comparisons between simulated and observed $PM_{2.5}$ concentrations at the monitoring stations in the study area. As shown in the table the difference between simulated and observation increases when considering long-term comparisons (i.e. 50th percentile and annual average), clearly illustrating the contribution of emission sources not included in the dispersion model's emissions inventory. For Services AQMS higher concentrations were simulated than the observed 99th percentile concentrations.

As stipulated in the US EPA Guideline on Air Quality Models (US EPA, 2017), models are more reliable for estimating longer time-averaged concentrations than for estimating short-term concentrations at specific locations.

This is observed at Services AQMS (the meteorological data station) where the simulated annual average concentrations compare well to the observed concentrations.

Table 18: Comparison of simulated and observed $PM_{2.5}$ concentrations at monitoring stations in the study area

Description	$PM_{2.5}$ concentration (µg/m³)			Unaccounted Fraction*
	Simulated	Observed	Unaccounted	
Boschhoek AQMS				
99th Percentile	20.9	63.3	42.4	0.67
90th Percentile	0.672	30.7	30.0	0.98
50th Percentile	0.153	11.9	11.7	0.99
Annual Average	0.873	15.3	14.4	0.94
Luka AQMS				
99th Percentile	93.8	124	30.4	0.24
90th Percentile	22.1	63.2	41.1	0.65
50th Percentile	1.86	17.4	15.6	0.89
Annual Average	8.28	27.3	19.0	0.70
Services AQMS				
99th Percentile	187	73.6	-113	-1.5
90th Percentile	24.7	42.1	17.5	0.41
50th Percentile	6.89	14.3	7.41	0.52
Annual Average	14.0	19.6	5.61	0.29
Lebone AQMS				
99th Percentile	29.6	101	71.0	0.71
90th Percentile	1.45	38.1	36.6	0.96
50th Percentile	0.358	10.6	10.2	0.97
Annual Average	1.50	19.6	18.1	0.92
Ratanang AQMS				
99th Percentile	45.5	58.2	12.8	0.22
90th Percentile	16.2	36.3	20.2	0.56
50th Percentile	1.00	12.6	11.6	0.92
Annual Average	5.64	16.3	10.7	0.65

* unaccounted fraction as a percentage of observed concentration

In Figure 18, the fractional bias (calculated based on the full 2019 year data set of simulated hourly concentrations) is plotted with the means on the X-axis and the standard deviations on the Y-axis. The box on the plot encloses the area of the graph where the model predictions are within a fractional bias between -2 and +2; indicating an acceptable correlation. The US EPA states that predictions within a factor of two are a reasonable performance target for a model before it is used for refined regulatory analysis (US EPA, 1992). Data points appearing on the left half of the plot indicate an over-prediction and those on the right half of the plot represent under-predictions. For this assessment, the simulated current $PM_{2.5}$ concentrations show an over-prediction of measured concentrations at Services AQMS. At all the AQMS the fractional bias of the means was less than 2, indicating an acceptable correlation.

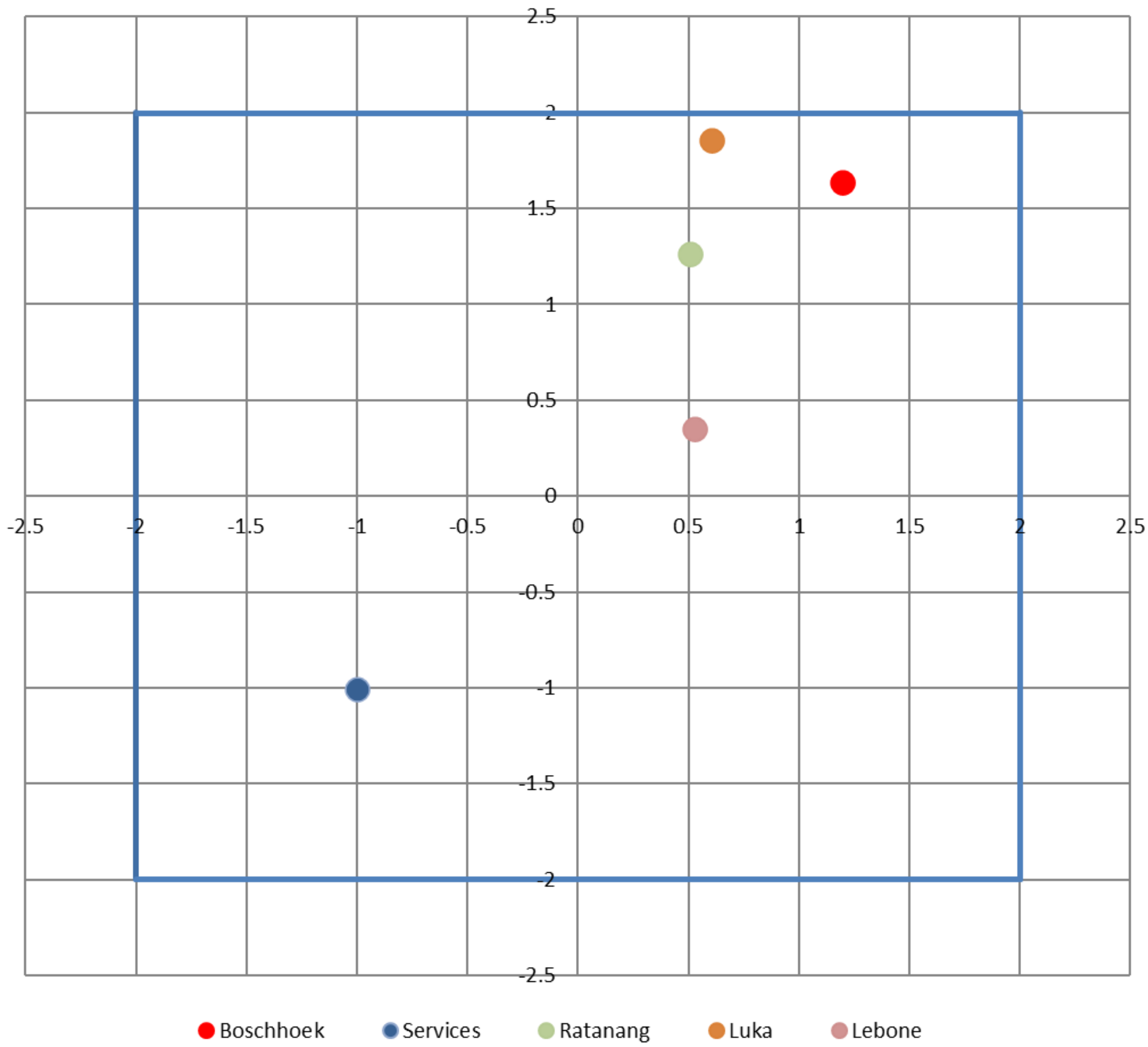


Figure 18: Fractional bias of means and standard deviation for $PM_{2.5}$

The same calculations and comparisons were repeated for PM_{10} simulations and observations. Table 19 summarises the comparisons between simulated and observed PM_{10} concentrations at the monitoring stations in the study area. For Services AQMS higher concentrations were simulated than the observed 99th percentile concentrations.

As for $PM_{2.5}$, the difference between simulated and observed PM_{10} concentrations within community areas increases when considering long-term comparisons (i.e. 50th percentile and annual average), illustrating the contribution of emission sources not included in the dispersion model's emissions inventory.

Table 19: Comparison of simulated and observed PM_{10} concentrations at monitoring stations in the study area

Description	PM_{10} concentration (µg/m³)			Unaccounted Fraction*
	Simulated	Observed	Unaccounted	
		Boschhoek AQMS		
99th Percentile	46.6	227	181	0.80
90th Percentile	1.11	83.9	82.8	0.99
50th Percentile	0.290	28.8	28.5	0.99
Annual Average	1.77	40.5	38.7	0.96
		Luka AQMS		
99th Percentile	186	426	240	0.56
90th Percentile	54.1	177	123	0.69
50th Percentile	3.72	50.3	46.5	0.93
Annual Average	17.8	78.3	60.5	0.77
		Services AQMS		
99th Percentile	384	185	-200	-1.1
90th Percentile	69.6	84.0	14.4	0.17
50th Percentile	17.2	32.4	15.2	0.47
Annual Average	33.6	42.5	8.83	0.21
		Lebone AQMS		
99th Percentile	62.8	238	175.6	0.74
90th Percentile	2.39	85.0	82.6	0.97
50th Percentile	0.688	20.4	19.7	0.97
Annual Average	3.05	42.5	39.4	0.93
		Ratanang AQMS		
99th Percentile	93.5	146	52.9	0.36
90th Percentile	56.3	77.4	21.1	0.27
50th Percentile	2.20	27.8	25.6	0.92
Annual Average	15.5	35.8	20.2	0.57

* unaccounted fraction as a percentage of observed concentration

Subsequently, fractional biases (i.e. using the 99^{th} percentile simulated concentrations and the estimated background concentration) were calculated for the monitoring stations within the study area. The results are summarised in Figure 19. The fractional bias of the means and standard deviations for Services AQMS indicated an over-prediction of the simulated PM_{10} concentrations. The model's simulations are shown to within the acceptable model performance range (-2.0 to +2.0) at all AQMS within the study area.

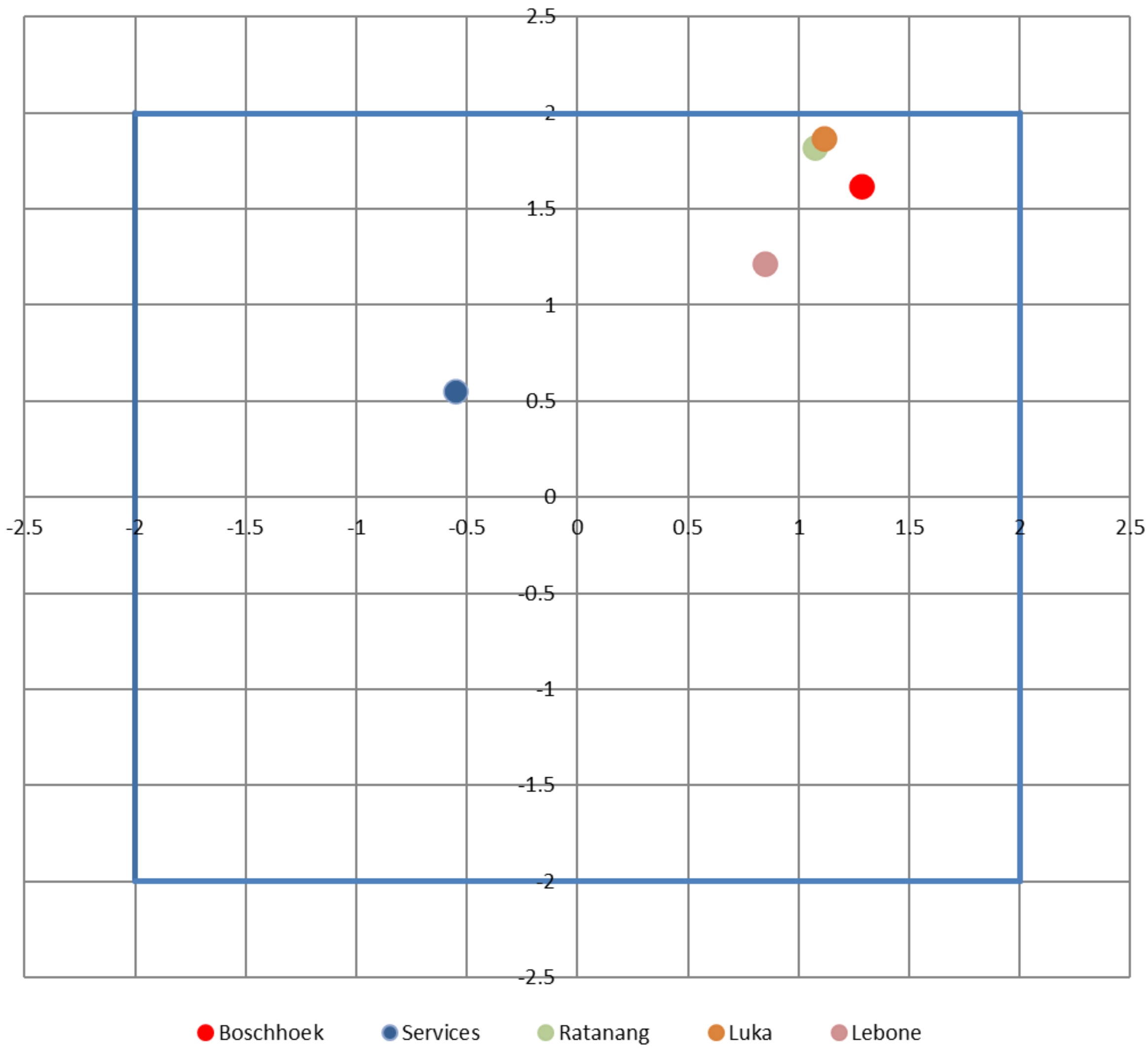


Figure 19: Fractional bias of means and standard deviation for PM_{10}

The same calculations and comparisons were repeated for SO_2 simulations and observations. Table 20 summarises the comparisons between simulated and observed SO_2 concentrations at the monitoring stations in the study area. For Boschhoek AQMS and Ratanang AQMS higher concentrations were simulated than the observed 99th percentile concentrations.

The differences between the simulated and observed 99th percentile concentrations are smaller in the community areas than at Services AQMS indicating that peaks (the higher measured concentrations) at the community based AQMS are likely attributed to the Impala existing operations. At the other percentiles given (Table 20; 90th percentile 50th percentile and annual average) the difference between simulated and observed SO_2 concentrations are larger suggesting contribution from emission sources not included in the dispersion model's emissions inventory.

Table 20: Comparison of simulated and observed SO_2 concentrations at monitoring stations in the study area

Description	SO_2 concentration (µg/m³)			Unaccounted Fraction*
	Simulated	Observed	Unaccounted	
Boschhoek AQMS				
99th Percentile	78.3	56.3	-22	-0.39
90th Percentile	2.00	24.2	22.2	0.92
50th Percentile	0.440	11.2	10.7	0.96
Annual Average	3.02	13.1	10.1	0.77
Luka AQMS				
99th Percentile	142	187	45.6	0.24
90th Percentile	14.9	53.2	38.4	0.72
50th Percentile	1.18	13.3	12.1	0.91
Annual Average	8.64	24.7	16.0	0.65
Services AQMS				
99th Percentile	92.7	212	119	0.56
90th Percentile	13.4	52.5	39.1	0.75
50th Percentile	2.40	17.8	15.4	0.86
Annual Average	7.46	27.9	20.5	0.73
Lebone AQMS				
99th Percentile	142	156	14.3	0.09
90th Percentile	4.48	40.4	36.0	0.89
50th Percentile	0.775	11.3	10.5	0.93
Annual Average	5.19	27.9	22.7	0.81
Ratanang AQMS				
99th Percentile	130	110	-19.9	-0.18
90th Percentile	11.1	46.0	34.9	0.76
50th Percentile	0.91	14.6	13.7	0.94
Annual Average	7.3	20.0	12.7	0.64

* unaccounted fraction as a percentage of observed concentration

Fractional biases (i.e. using the 99^{th} percentile simulated concentrations and the estimated background concentration) were calculated for the monitoring stations within the study area. The results are summarised in Figure 20. The fractional bias of the means and standard deviations for Boschhoek AQMS indicated an over-prediction of the simulated SO_2 concentrations. The model's simulations are shown to within the acceptable model performance range (-2.0 to +2.0) at all AQMS within the study area.

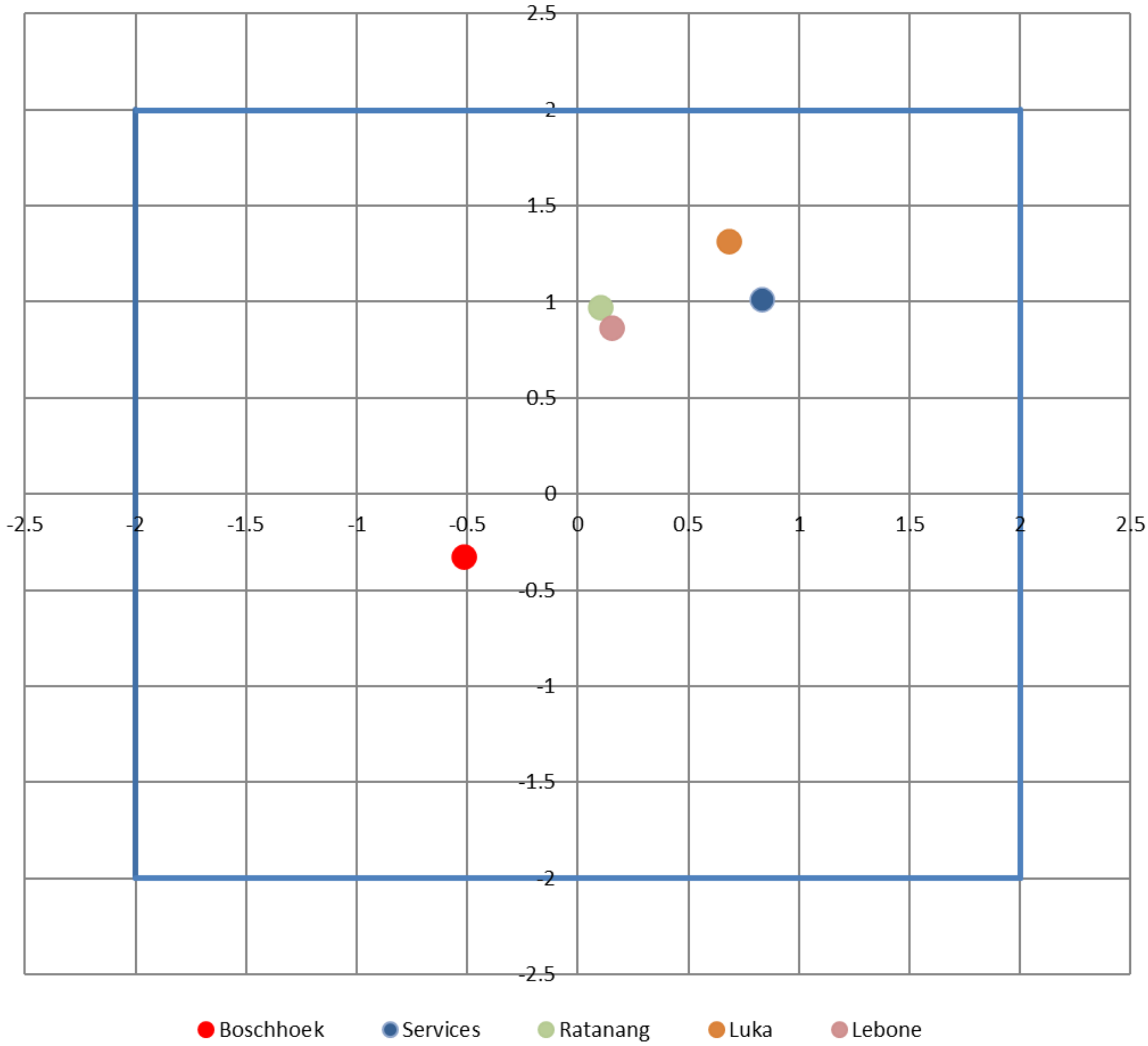


Figure 20: Fractional bias of means and standard deviation for SO_2

6 IMPACT ASSESSMENT: CONSTRUCTION PHASE

6.1 Emissions Inventory for Construction Phase

During the construction phase several facilities need to be added. The following activities will take place:

- Collection, storage and removal of construction related waste;
- Construction of all infrastructure required for the operational phase; and
- Operation of mechanical equipment.

A summary of sources quantified, emissions estimation techniques applied, and source input parameters are summarised in Table 21 and the summary of estimated particulate emissions is provided in Table 22.

Table 21: Emission estimation techniques and parameters for construction

Source Group	Emission Estimation Technique	Input Parameters/Notes
General construction	US EPA emission factor (US EPA, 1995) $EF = k \cdot 2.69$ Where EF is the emission factor in t/ha-month k is the particle size multiplier (k_{TSP} – 1, k_{PM10} – 0.35, $k_{PM2.5}$ – 0.18)	A total surface infrastructure area of ~0.18 ha was estimated from the site layout map. It was assumed that 25% of this area would be under construction at any given point in time. The roads are paved. **Hours of operation:** 7 days per week (Monday to Saturday), 24-hours per day. **Design mitigation:** None.
Construction equipment	NPI single valued emission factors (ADE, 2008) for: Tractor Crane Forklift	**Operating power:** Tractor – 60.8 kW Crane – 76 kW Forklift – 49.4 kW **Hours of operation:** 7 days per week (Monday to Sunday), 24-hours per day. **Design Mitigation:** None.

Table 22: Summary of estimated particulate emissions in tonnes per annum for construction

Source Group	Estimated UNMITIGATED Emissions (t/a)						Estimated MITIGATED Particulate Emissions (t/a)		
	$PM_{2.5}$	PM_{10}	TSP	SO_2	NO_x	CO	$PM_{2.5}$	PM_{10}	TSP
General Construction	0.008	0.016	0.044	-	-	-	0.004	0.008	0.022
Mobile Construction Equipment	0.382	0.382	0.382	0.016	5.08	1.90	-	-	-

6.2 Assessment of Impact – Construction

Dispersion modelling for the construction phase was considered to be unrepresentative of the actual activities that will result in dust and gaseous emissions. It is not anticipated that the various construction activities will result in higher $PM_{2.5}$ and PM_{10} GLCs and dustfall rates than the operational phase activities. The temporary nature of the construction activities will likely reduce the significance of the potential impacts. The main pollutants of concern are PM. A qualitative assessment of the PM_{10}, $PM_{2.5}$ and TSP impacts during construction operations is discussed below.

6.3 Impact Significance Rating - Construction

6.3.1 Impact A1: Potential for Impacts on Human Health from Increased Pollutant Concentrations Associated with General Construction Activities

The sources of emissions would include collection, storage and removal of construction related waste; the construction of all required infrastructure; and the operation of mechanical equipment. It is unlikely that the long-term and short-term NAAQS will be exceeded at AQSRs (with and without mitigation). The construction operations are likely to last for 2.5 years. The significance rating is “very low” without mitigation applied and “insignificant” with mitigation measures applied (Table 23).

6.3.2 Impact A2: Increased Nuisance Dustfall Rates Associated with General Construction Activities

The sources of emissions would include collection, storage and removal of construction related waste; the construction of all required infrastructure; and the operation of mechanical equipment. It is unlikely that the NDCR limit for residential areas will be exceeded at AQSRs (with and without mitigation). The construction operations are likely to last for 2.5 years. The significance rating is “very low” without mitigation applied and “insignificant” with mitigation measures applied (Table 24).

Table 23: Health risk impact significance summary table for the construction operations

Air Quality	Description	Rating
Project activity or issue	Construction	Not applicable (N/A)
Potential impact	Increased health risk at AQSRs	N/A
	Nature of the Impact	
Positive or negative	Negative due to increase in $PM_{2.5}$ and PM_{10} concentrations at AQSRs	-
	Significance Before Mitigation	
Intensity	Minor (Slight) change, disturbance or nuisance. Associated with minor consequences or deterioration. Targets, limits and thresholds of concern rarely exceeded. Require only minor interventions or clean-up actions. Sporadic complaints could be expected.	L
Duration	Short-term, occurs for more than 1 but less than 5 years. Reversible over time.	L
Extent	A part of the site/property.	VL
Consequence	Very Low.	
Probability	Conceivable.	L
Significance	**It will not have an influence on the decision. Does not require any mitigation.**	**Very Low**
	Significance After Mitigation	
Intensity	Negligible change, disturbance or nuisance. Associated with very minor consequences or deterioration. Targets, limits and thresholds of concern never exceeded. No interventions or clean-up actions required. No complaints anticipated.	VL
Duration	Short-term, occurs for more than 1 but less than 5 years. Reversible over time.	L
Extent	A part of the site/property.	VL
Consequence	Low.	
Probability	Conceivable.	L
Significance	**Inconsequential, not requiring any consideration.**	**Insignificant**

Air Quality	Description	Rating
Potential mitigation measures (construction)	• Reductions of vehicle exhaust emissions through the use of better-quality diesel; and inspection and maintenance programs.	N/A

Table 24: Nuisance impact significance summary table for the construction operations

Air Quality	Description	Rating
Project activity or issue	Construction	N/A
Potential impact	Nuisance dustfall rates at AQSRs	N/A
Nature of the Impact		
Positive or negative	Negative due to increase in dustfall rates at AQSRs	-
Significance Before Mitigation		
Intensity	Minor (Slight) change, disturbance or nuisance. Associated with minor consequences or deterioration. Targets, limits and thresholds of concern rarely exceeded. Require only minor interventions or clean-up actions. Sporadic complaints could be expected.	L
Duration	Short-term, occurs for more than 1 but less than 5 years. Reversible over time.	L
Extent	A part of the site/property.	VL
Consequence	Very Low.	
Probability	Conceivable.	L
Significance	**It will not have an influence on the decision. Does not require any mitigation.**	**Very Low**
Significance After Mitigation		
Intensity	Negligible change, disturbance or nuisance. Associated with very minor consequences or deterioration. Targets, limits and thresholds of concern never exceeded. No interventions or clean-up actions required. No complaints anticipated.	VL
Duration	Short-term, occurs for more than 1 but less than 5 years. Reversible over time.	L
Extent	A part of the site/property.	VL

Air Quality	Description	Rating
Consequence	Low.	
Probability	Conceivable.	L
Significance	**Inconsequential, not requiring any consideration.**	**Insignificant**
Potential mitigation measures (construction)	• Reductions of vehicle exhaust emissions through the use of better-quality diesel; and inspection and maintenance programs.	N/A

7 IMPACT ASSESSMENT: OPERATIONAL PHASE

The following scenarios were included in the dispersion modelling:

- The proposed operations with design mitigation;
- The smelter plant proposed future operations with existing and design mitigation (existing smelter plant and proposed flash dryer operations); and
- The Impala proposed future operations with existing and design mitigation (existing Impala operations associated with the mining and processing, and the proposed flash dryer operations).

7.1 Emissions Inventory

Expected sources of atmospheric emissions during the operational phase associated with the proposed project include:

- Particulate and gaseous emissions from the proposed flash dryer, emitted through the baghouse stack; and
- Particulate emissions from materials handling at conveyor transfer points.

The sources of atmospheric emissions during the operational phase associated with the existing operations include:

- Particulate and gaseous emissions from underground operations, emitted through the ventilation shaft;
- Particulate emissions from materials handling at the shafts, waste dumps, conveyor transfer points and stockpiles;
- Particulate emissions from crushers and screens;
- Particulate emissions from wind erosion at waste dumps, tailings storage facilities and stockpiles;
- Particulate emissions from vehicle entrainment along the unpaved and paved on-site roads; and
- Particulate and gaseous emissions from vehicles' exhaust.

A summary of sources quantified, emissions estimation techniques applied, and source input parameters are summarised in Table 25, Table 26, Table 27, Table 28 and Table 29. Estimated annual average mitigated emissions, in tonnes per annum (t/a), per source group, are presented in Table 33. Source contributions to Particulate Matter (PM) are provided in Figure 21. Crushing and screening emissions contributed most notably to the total annual $PM_{2.5}$ (31%), PM_{10} (31%) and TSP (54%) emissions. Stacks are the second most significant contributor to total annual $PM_{2.5}$ and PM_{10} emissions. Vehicles travelling on paved roads are the second contributor to total annual TSP emissions. Stacks (45%) are the main contributor to the total annual SO_2 emissions followed closely by building fugitives (35%).

Table 25: Emission estimation techniques and parameters

Source Group	Emission Estimation Technique	Input Parameters/Notes
Ventilation Shafts (underground mining)	South African Occupational Exposure Limits (OEL) for $PM_{2.5}$ and PM_{10}	1) 0.335 mg/m³ 2) 11.5 mg/m³ 3) 3 mg/m³ for $PM_{2.5}$ and 10 mg/m³ for PM_{10} It was assumed for 1 and 2 that $PM_{2.5}$ is measured. The actual volumetric flow rates (m³/h) were calculated from the following provided information: • Exit velocity (m/s) • Exit temperature (°C) • Tip diameter (m)/ tip area (m²)
Materials Handling	US EPA emission factor equation (US EPA, 2006a) $$EF = k \cdot 0.0016 \cdot \left(\frac{U}{2.3}\right)^{1.3} \cdot \left(\frac{M}{2}\right)^{-1.4}$$ Where EF is the emission factor in kg/tonne material handled k is the particle size multiplier (k_{TSP} – 0.74, k_{PM10} – 0.35, $k_{PM2.5}$ – 0.053) U is the average wind speed in m/s M is the material moisture content in %	The materials handling operations included the handling of ore and waste at the shafts; waste at the waste dumps; ore, waste and LSP at the concentrator; and smelter raw materials and products. An average **wind speed** of **1.35 m/s** was determined from the measured data. The **moisture contents** were given for ore – 5%; mined waste – 5%; coal – 4.8%; and gypsum – 8%. The **moisture content** was determined from samples for waste dump waste – 0.72%. **Hours of operation:** 365 days per year, 24-hours per day. **Mitigation:** None
Vehicle Entrained Dust from Paved Roads	US EPA emission factor equation (US EPA, 2011) $$EF = k \cdot (sL)^{0.91} \cdot (W)^{1.02}$$ Where EF is the emission factor in g/vehicle kilometre travelled (VKT) k is the particle size multiplier (k_{TSP} – 3.23, k_{PM10} – 0.62, $k_{PM2.5}$ – 0.15) sL is the road surface material silt loading in g/m² W is the average weight vehicles in tonnes	Transport activities include the transport of ore and waste along the paved roads to the processing facility; service vehicles, ambulances and buses travelling along the paved roads. Total VKT were provided. Vehicles' **average weight** was based on the manufacturer specifications (vehicle types were provided). The **road surface silt loading** of **9.7 g/m²** was applied in calculations. It is based on the average silt loading for paved roads associated with iron and steel production (US EPA, 2011).

Source Group	Emission Estimation Technique	Input Parameters/Notes
		Hours of operation: Service vehicles - 365 days per year, 24 hours per day; trucks – Monday to Thursday, 14.5 hours per day (05H30 – 16H00) and Friday to Saturday, 7 hours per day (06H00 – 12H00); buses – Monday to Sunday, 04H00 – 07H00, 12H00 – 16H00, and 19H00 – 22H00. **Mitigation:** None
Vehicle Entrained Dust from Unpaved Roads	US EPA emission factor equation (US EPA, 2006b) $$EF = k \cdot \left(\frac{s}{12}\right)^{a} \cdot \left(\frac{W}{3}\right)^{b} \cdot 281.9$$ Where EF is the emission factor in g/VKT k is the particle size multiplier (k_{TSP} – 4.9, k_{PM10} – 1.5, $k_{PM2.5}$ – 0.15) a is a constant (k_{TSP} – 0.7, k_{PM10} – 0.9, $k_{PM2.5}$ – 0.9) b is a constant (k_{TSP} – 0.45, k_{PM10} – 0.45, $k_{PM2.5}$ – 0.45) s is the road surface material silt content in % W is the average weight vehicles in tonnes	Transport activities include the transport of ore and waste along the unpaved roads at the shafts. Total VKT were provided. Vehicles' **average weight** was based on the manufacturer specifications (vehicle types were provided). The unpaved road surface material silt content is 29.59%. This is above the maximum silt content recommended for the equation and the maximum **road surface silt content** of **25.2%** (US EPA, 2006b) for the equation was applied in calculations. **Hours of operation:** Trucks (including water truck) – Monday to Thursday, 14.5 hours per day (05H30 – 16H00) and Friday to Saturday, 7 hours per day (06H00 – 12H00). **Mitigation:** Watering
Grading	US EPA emission factor equation (US EPA, 1998) and NPI emission factor equation (ADE, 2012) $$EF = 0.0034 \cdot (S)^{2.4}$$ Where EF is the emission factor in kg/KT S is the speed in km/h PM_{10}/TSP ratio = 0.60 (US EPA, 1998) $PM_{2.5}$/TSP ratio = 0.031 (US EPA, 1998)	Grading activities include the grading of unpaved roads. Total VKT was given. Grader's **speed** was based on the manufacturer specifications (grader type was provided). **Hours of operation:** 365 days per year, 24 hours per day. **Mitigation:** None
Crushing and Screening	NPI single valued emission factors for low moisture ore (ADE, 2012) TSP – 0.2 kg/tonne (primary crushing), 0.6 kg/tonne (secondary crushing), 1.4 kg/tonne (tertiary crushing), 0.08 kg/tonne (screening)	Primary crushing rate for crusher at Shaft 1 ~ 174 t/h Primary crushers also located at shaft 10 and shaft 16 – information provided indicated that these are not operational.

Source Group	Emission Estimation Technique	Input Parameters/Notes
	PM_{10} – 0.02 kg/tonne (primary crushing), 0.04 kg/tonne (secondary crushing), 0.08 kg/tonne (tertiary crushing), 0.06 kg/tonne (screening) $PM_{2.5}$ – *assumed* to be 50% of PM_{10} resulting in 0.01 kg/tonne (primary crushing), 0.02 kg/tonne (secondary crushing), 0.04 kg/tonne (tertiary crushing), 0.03 kg/tonne (screening)	Screening rate for Nordberg Grizzly Scalper at Milling Section of Central Concentrator Plant (East and West) ~ 607 t/h (Merensky and MF2) Primary crushing rate for Nordberg C-Series Jaw Crusher at Milling Section of Central Concentrator Plant (East) ~ 303 t/h (Merensky and MF2) Secondary crushing rate for Secondary Hammer Crusher at Milling Section of Central Concentrator Plant (East) ~ 303 t/h (Merensky and MF2) Primary crushing rate for Primary Hammer Crusher at Milling Section of Central Concentrator Plant (West) ~ 303 t/h (Merensky and MF2) Secondary crushing rate for Secondary Hammer Crusher at Milling Section of Central Concentrator Plant (West) ~ 303 t/h (Merensky and MF2) Screening rate for H1-9-3 Single Dech Horizontal Screens at Milling Section of UG2 ~ 143 t/h (UG2) – 4 vibrating screens installed, 4 operational Primary crushing rate for Hazemag Impactor APS-1006 K at Milling Section of UG2 ~ 571 t/h (UG2) Secondary crushing rate for APSM-1604 at Milling Section of UG2 ~ 571 t/h (UG2) Screening rate for Linatex MK3 Banana Screen at Pebble Circuit of UG2 ~ 10 t/h (UG2) Primary crushing rate for Nordberg C80 at Pebble Circuit of UG2 ~ 300 t/h (UG2) Secondary crushing rate for Nordberg HP300 at Pebble Circuit of UG2 ~ 300 t/h (UG2) – 3 installed, 1 operational Screening rate for Vibramech GF45100 Scalping Screen at Pebble Circuit of UG2 ~ 300 t/h (UG2) Tertiary crushing was assumed to take place as in the previous inventory (this was located at the smelter with a rate of ~ 12 t/h). **Hours of operation:** 365 days per year, 24 hours per day. **Mitigation:** Shaft 1 – none; other crushers and screens - enclosure without fabric filters with an assumed resultant control efficiency of 70%
Windblown Dust	ADDAS model (Burger & Held, 1997)	**Hours of emission:** Emission rates are calculated for each hour based on each source's particle density, moisture content and particle size distribution.

Source Group	Emission Estimation Technique	Input Parameters/Notes
		For wind erosion to occur, the wind speed needs to exceed a certain threshold, called the threshold velocity. Emissions are only calculated for wind speeds exceeding the threshold – TSF ≥ 9 m/s and WRD ≥ 8.5 m/s. **Mitigation:** None
Vehicle Exhaust	NPI single valued emission factors (ADE, 2008).	Note that sulfur content of diesel fuel was assumed to be 10 ppm. **Hours of operation:** Service vehicles - 365 days per year, 24 hours per day; trucks – Monday to Thursday, 14.5 hours per day (05H30 – 16H00) and Friday to Saturday, 7 hours per day (06H00 – 12H00); buses – Monday to Sunday, 04H00 – 07H00, 12H00 – 16H00, and 19H00 – 22H00. **Mitigation:** None
Stacks	Existing stacks: • Emissions provided (updated isokinetic stack sampling data) • Stack parameters provided (updated isokinetic stack sampling data and previous study) Proposed second flash dryer stack: • Assumed emissions will not exceed the MES, thus MES values were used • Assumed the same stack parameters provided for the existing flash dryer (updated isokinetic stack sampling data and previous study)	**Hours of operation:** 365 days per year, 24 hours per day.
Furnace and Converter Fugitives	Calculated based on (Dewitt, 1980) (with a 90% control efficiency) or provided (SO_2 mass balance)	**Hours of operation:** 365 days per year, 24 hours per day.

Table 26: Ventilation shaft parameters

Description	Latitude	Longitude	Height (m)	Tip diameter (m)	Tip dimensions (m)	Exit temperature (°C)	Exit velocity (m/s)
1 Upcast Shaft	25.596620753436 S	27.242515098521 E	8.0	4.10	-	21.5	39.4
1A Upcast Shaft	25.586299975069 S	27.267773845576 E	8.0	5.10	-	20.0	25.5
2A Shaft	25.5472990 S	27.2172590 E	8.0	4.60	-	19.0	1.80

Description	Latitude	Longitude	Height (m)	Tip diameter (m)	Tip dimensions (m)	Exit temperature (°C)	Exit velocity (m/s)
4B Shaft	25.532251688359 S	27.197157993593 E	8.0	5.10[(a)]	2 x 2.4	20.0	16.2
5 Vent Shaft	25.546103259325 S	27.223231538941 E	8.0	2.47[(a)]	3 x 3.55	19.8	18.0
6A Vent Shaft	25.48607978514 S	27.160220471017 E	8.0	3.68	-	14.0	11.3
7 Vent Shaft	25.496672162937 S	27.179232431167 E	8.0	4.60[(a)]	2.44 x 2	22.8	15.2
8 Vent Shafts	25.465438228406 S	27.167010456785 E	8.0	2.49	-	27.0	57.7
2 Vent Shaft	25.547732855909 S	27.217527950896 E	8.0	4.60	-	20.5	16.0
10 Vent Shaft	25.536597279251 S	27.241428700798 E	8.0	5.20	-	20.5	18.8
11B Upcast Shaft	25.507807739596 S	27.219972345772 E	8.0	5.75	-	20.5	19.8
12 Upcast Shaft	25.450500259717 S	27.171356047676 E	8.0	5.10	-	26.5	22.0
12B North Shaft (Brattice Shaft)	25.4337460 S	27.1764650 E	8.0	8.50	-	26.5	13.4
14 Upcast Shaft	25.479832998233 S	27.195256797578 E	8.0	5.10	-	20	16.2
14A Upcast Shaft	25.472228214174 S	27.209379967975 E	8.0	5.60	-	21.5	22.7
16V Upcast Shaft	25.567559614351 S	27.28841540231 E	8.0	6.80	-	25.0[(b)]	1.50
17V Upcast Shaft	25.534696083236 S	27.282168615404 E	8.0	9.00	-	25.0[(b)]	20.4
20V Upcast Shaft	25.421982319493 S	27.155874880126 E	8.0	6.50	-	25.0[(b)]	16.2

Notes:

(a) Calculated based on the tip area

(b) Assumed – no data available

Table 27: Road parameters

Description	ID	Latitude	Longitude	Length (m)	Width (m)
Paved Roads					

Description	ID	Latitude	Longitude	Length (m)	Width (m)
IMPR0150	IMPR0150	25.545861511119 S	27.203778279913 E	1 600.00	7.4
IMPR0130	IMPR0130	25.556278650523 S	27.213182641876 E	600.00	7.4
IMPR0140	IMPR0140	25.556278650523 S	27.213182641876 E	800.00	7.4
IMPR0340	IMPR0340a	25.562934045143 S	27.21607629171 E	989.00	7.4
IMPR0340	IMPR0340b	25.571286541339 S	27.220251255623 E	645.00	7.4
IMPR0340	IMPR0340c	25.571475422284 S	27.226484326792 E	449.00	7.4
IMPR0340	IMPR0340d	25.574025315035 S	27.229600862377 E	574.00	7.4
IMPR0290	IMPR0290a	25.574591957868 S	27.235645052602 E	313.00	7.4
IMPR0290	IMPR0290b	25.571475422284 S	27.235739493074 E	288.00	7.4
IMPR0290	IMPR0290c	25.569964374728 S	27.237911623936 E	236.00	7.4
IMPR0290	IMPR0290d	25.568736648588 S	27.239800433381 E	842.00	7.4
IMPR0290	IMPR0290e	25.565714553476 S	27.24811119494 E	528.00	7.4
IMPR0291	IMPR0291a	25.565714553476 S	27.24811119494 E	200.00	7.4
IMPR0291	IMPR0291b	25.56834795759 S	27.252415968961 E	200.00	7.4
IMPR0040	IMPR0040a	25.574591957868 S	27.235645052602 E	139.00	7.4
IMPR0040	IMPR0040b	25.57506416023 S	27.236872778741 E	104.00	7.4
IMPR0040	IMPR0040c	25.562934045143 S	27.21607629171 E	616.00	7.4
IMPR0041	IMPR0041a	25.575118321068 S	27.236964321155 E	158.00	7.4
IMPR0041	IMPR0041b	25.576871668195 S	27.23596240851 E	253.00	7.4
IMPR0030	UMPR0030	25.574363961989 S	27.244289377597 E	2 700.00	7.4
IMPR0020	IMPR0020	25.593988906545 S	27.249784200007 E	300.00	7.4
IMPR0010	IMPR0010	25.593988906545 S	27.249784200007 E	894.00	7.4

Description	ID	Latitude	Longitude	Length (m)	Width (m)
IMPR0031	IMPR0031	25.586469566676 S	27.267755422295 E	1 995.00	7.4
IMPR0120	IMPR0120a	25.568736648588 S	27.239800433381 E	988.00	7.4
IMPR0120	IMPR0120b	25.561204584714 S	27.233542425889 E	889.00	7.4
IMPR0120	IMPR0120c	25.553083697655 S	27.233768006085 E	328.00	7.4
IMPR0121	IMPR0121	25.568736648588 S	27.239800433381 E	400.00	7.4
IMPR0292	IMPR0292a	25.538798987714 S	27.25241047442 E	772.00	7.4
IMPR0292	IMPR0292b	25.545311419902 S	27.251408561776 E	1 172.00	7.4
IMPR0292	IMPR0292c	25.553493706496 S	27.245814549512 E	730.00	7.4
IMPR0292	IMPR0292d	25.560089631404 S	27.246232013114 E	328.00	7.4
IMPR0292	IMPR0292e	25.562928383896 S	27.248152345682 E	292.00	7.4
IMPR0292	IMPR0292f	25.564097281981 S	27.250657127293 E	178.00	7.4
IMPR0300	IMPR0300	25.535208800739 S	27.251575547217 E	500.00	7.4
IMPR0120	IMPR0120a	25.540969798443 S	27.232956670578 E	256.00	7.4
IMPR0120	IMPR0120b	25.54247266741 S	27.234793510426 E	272.00	7.4
IMPR0120	IMPR0120c	25.542389174689 S	27.237381784756 E	276.00	7.4
IMPR0100	IMPR0100a	25.535041815298 S	27.199476089716 E	308.00	7.4
IMPR0100	IMPR0100b	25.534874829858 S	27.20264881309 E	787.00	7.4
IMPR0100	IMPR0100c	25.535041815298 S	27.209411723438 E	750.00	7.4
IMPR0100	IMPR0100d	25.537379611468 S	27.217927980914 E	986.00	7.4
IMPR0090	IMPR0090	25.543224101893 S	27.224189934941 E	900.00	7.4
IMPR0170	IMPR0170a	25.5447372304 S	27.201886005039 E	400.00	7.4
IMPR0170	IMPR0170b	25.543985296413 S	27.207299929745 E	400.00	7.4

Description	ID	Latitude	Longitude	Length (m)	Width (m)
IMPR0211	IMPR0211a	25.538798987714 S	27.174511766331 E	874.00	7.4
IMPR0211	IMPR0211b	25.543391087334 S	27.181692140281 E	438.00	7.4
IMPR0211	IMPR0211c	25.54723175247 S	27.181107691238 E	231.00	7.4
PROV0010/KANANA Road	PROV0010e	25.562934045143 S	27.21607629171 E	2 307.00	7.4
PROV0010/KANANA Road	PROV0010f	25.550376735302 S	27.234971100464 E	710.00	7.4
PROV0010/KANANA Road	PROV0010g	25.546328490703 S	27.240870140419 E	1 485.00	7.4
PROV0010/KANANA Road	PROV0010h	25.538798987714 S	27.25241047442 E	352.00	7.4
PROV0010/KANANA Road	PROV0010i	25.538505943398 S	27.256060435767 E	1 011.00	7.4
PROV0010/KANANA Road	PROV0010j	25.543872574689 S	27.264064902776 E	2 819.00	7.4
IMPR0311	IMPR0311a	25.493887971269 S	27.237948957052 E	647.00	7.4
IMPR0311	IMPR0311b	25.49417392841 S	27.232134495187 E	375.00	7.4
IMPR0311	IMPR0311c	25.497033499819 S	27.229560880919 E	887.00	7.4
IMPR0311	IMPR0311d	25.498653923617 S	27.222125995255 E	944.00	7.4
IMPR0310	IMPR0310a	25.506184128328 S	27.215930257202 E	170.00	7.4
IMPR0310	IMPR0310b	25.507804552126 S	27.216406852437 E	1 225.00	7.4
IMPR0310	IMPR0310c	25.516955180636 S	27.208400052491 E	622.00	7.4
IMPR0070	IMPR0070a	25.521435175843 S	27.204777928706 E	1 000.00	7.4
IMPR0070	IMPR0070b	25.529632613883 S	27.198391552559 E	375.00	7.4
IMPR0060	IMPR0060a	25.533064099574 S	27.200393252545 E	200.00	7.4
IMPR0060	IMPR0060b	25.535041815298 S	27.199476089716 E	1 000.00	7.4
IMPR0060	IMPR0060c	25.541833451895 S	27.192958366882 E	400.00	7.4
IMPR0334	IMPR0334	25.442415685904 S	27.196008576385 E	1 300.00	7.4

Description	ID	Latitude	Longitude	Length (m)	Width (m)
IMPR0332	IMPR0332	25.466436085741 S	27.215072385779 E	1 400.00	7.4
IMPR0331	IMPR0331	25.476063309485 S	27.206588990599 E	1 100.00	7.4
IMPR0330	IMPR0330a	25.470439485714 S	27.202013676344 E	200.00	7.4
IMPR0330	IMPR0330b	25.471297357137 S	27.200488571592 E	304.00	7.4
IMPR0330	IMPR0330c	25.473680333311 S	27.200107295405 E	866.00	7.4
IMPR0330	IMPR0330d	25.477874371378 S	27.192577090694 E	693.00	7.4
IMPR0330	IMPR0330e	25.483116918961 S	27.194960066868 E	1 395.00	7.4
IMPR0250	IMPR0250a	25.516955180636 S	27.208400052491 E	1 097.00	7.4
IMPR0250	IMPR0250b	25.508090509267 S	27.2049685668 E	1 969.00	7.4
IMPR0230	IMPR0230a	25.49541307602 S	27.191337943083 E	275.00	7.4
IMPR0230	IMPR0230b	25.49322073794 S	27.189908157379 E	360.00	7.4
IMPR0230	IMPR0230c	25.490265847484 S	27.189050285956 E	616.00	7.4
IMPR0230	IMPR0230d	25.495317756973 S	27.178279233648 E	610.00	7.4
IMPR0230	IMPR0230e	25.495317756973 S	27.178279233648 E	1 007.00	7.4
IMPR0230	IMPR0230f	25.494936480785 S	27.167984776575 E	1 036.00	7.4
IMPR0230	IMPR0230g	25.48597649037 S	27.166936267059 E	386.00	7.4
IMPR0230	IMPR0230h	25.482640323726 S	27.166554990871 E	379.00	7.4
IMPR0190	IMPR0190a	25.539597461627 S	27.189932623086 E	320.00	7.4
IMPR0190	IMPR0190b	25.539597461627 S	27.187294787367 E	252.00	7.4
IMPR0190	IMPR0190c	25.541689538232 S	27.18547559032 E	387.00	7.4
IMPR0190	IMPR0190d	25.543326815574 S	27.188386305596 E	336.00	7.4
IMPR0190	IMPR0190e	25.544407066163 S	27.190956666895 E	1 242.00	7.4

Description	ID	Latitude	Longitude	Length (m)	Width (m)
IMPR0500	IMPR0500	25.422589324134 S	27.159120105207 E	2 000.00	7.4
IMPR0321	IMPR0321a	25.430500805033 S	27.177040086038 E	400.00	7.4
IMPR0321	IMPR0321b	25.434447872275 S	27.176834404343 E	556.00	7.4
IMPR0321	IMPR0321c	25.438904905041 S	27.178289761981 E	808.00	7.4
IMPR0320	IMPR0320a	25.446272653084 S	27.175015207296 E	208.00	7.4
IMPR0320	IMPR0320b	25.44763705087 S	27.1771072839 E	283.00	7.4
IMPR0320	IMPR0320c	25.446272653084 S	27.175015207296 E	229.00	7.4
IMPR0320	IMPR0320d	25.448728569098 S	27.174742327739 E	610.00	7.4
IMPR0320	IMPR0320e	25.454731919356 S	27.175379046705 E	430.00	7.4
IMPR0280	IMPR0280a	25.457733594484 S	27.1732869701 E	310.00	7.4
IMPR0280	IMPR0280b	25.459007032417 S	27.16983049571 E	630.00	7.4
IMPR0220	IMPR0220a	25.464373663708 S	27.1675564994 E	1 342.00	7.4
IMPR0220	IMPR0220b	25.475470765698 S	27.163645225748 E	315.00	7.4
IMPR0220	IMPR0220c	25.478381480975 S	27.164736743977 E	262.00	7.4
IMPR0240	IMPR0240a	25.480829261834 S	27.163600100415 E	439.00	7.4
IMPR0240	IMPR0240b	25.480829261834 S	27.163600100415 E	559.00	7.4
IMPR0240	IMPR0240c	25.480829261834 S	27.163600100415 E	218.00	7.4
IMPR0240	IMPR0240d	25.480829261834 S	27.163600100415 E	1 345.00	7.4
IMPR0240	IMPR0240e	25.480829261834 S	27.163600100415 E	660.00	7.4
IMPR0240	IMPR0240f	25.480829261834 S	27.163600100415 E	1 252.00	7.4
IMPR0270	IMPR0270a	25.50703383447 S	27.171194893496 E	673.00	7.4
IMPR0270	IMPR0270b	25.509853589898 S	27.164281944715 E	379.00	7.4

Description	ID	Latitude	Longitude	Length (m)	Width (m)
IMPR0270	IMPR0270c	25.511036067979 S	27.161462189291 E	476.00	7.4
IMPR0210	IMPR0210	25.515311181041 S	27.163190426486 E	2 700.00	7.4
IMPR0200	IMPR0200a	25.530865315798 S	27.179108400653 E	1 412.00	7.4
IMPR0200	IMPR0200b	25.539597461627 S	27.189932623086 E	502.00	7.4
IMPR0160	IMPR0160a	25.541833451895 S	27.192958366882 E	236.00	7.4
IMPR0160	IMPR0160b	25.543053936017 S	27.195390214229 E	477.00	7.4
IMPR0160	IMPR0160c	25.544236414098 S	27.199847246996 E	252.00	7.4
IMPR0160	IMPR0160d	25.5447372304 S	27.201886005039 E	158.00	7.4
IMPR0050	IMPR0050a	25.541833451895 S	27.192958366882 E	100.00	7.4
IMPR0050	IMPR0050b	25.538414983546 S	27.198391889358 E	200.00	7.4
IMPR0180	IMPR0180a	25.546146347105 S	27.203400247573 E	1 131.00	7.4
IMPR0180	IMPR0180b	25.556081980827 S	27.199977046038 E	640.00	7.4
IMPR0180	IMPR0180c	25.56150900765 S	27.197722742589 E	578.00	7.4
IMPR0400	IMPR0400	25.559608629151 S	27.286986785576 E	940.00	7.4
PROV0010/KANANA Road	PROV0010a	25.56188262546 S	27.184111192534 E	487.00	7.4
PROV0010/KANANA Road	PROV0010b	25.563337983098 S	27.188477265448 E	786.00	7.4
PROV0010/KANANA Road	PROV0010c	25.566703497636 S	27.195390214229 E	1 010.00	7.4
PROV0010/KANANA Road	PROV0010d	25.570159972027 S	27.204395239615 E	1 456.00	7.4
PROV0020	PROV0020	25.566703497636 S	27.195390214229 E	2 000.00	7.4
PROV0030/PHOKENG Road	PROV0030a	25.530865315798 S	27.179108400653 E	937.00	7.4
PROV0030/PHOKENG Road	PROV0030b	25.538798987714 S	27.174511766331 E	3 441.00	7.4
MERITENG Road (Provincial Road)	MERITa	25.583531070327 S	27.265065461153 E	404.00	7.4

Description	ID	Latitude	Longitude	Length (m)	Width (m)
MERITENG Road (Provincial Road)	MERITb	25.586469566676 S	27.267755422295 E	2 483.00	7.4
PROV0040	PROV0040a	25.530865315798 S	27.179108400653 E	4 320.00	7.4
PROV0040	PROV0040b	25.492553504611 S	27.183617100279 E	3 234.00	7.4
PROV0040	PROV0040c	25.465192302379 S	27.175379046705 E	784.00	7.4
PROV0040	PROV0040d	25.464373663708 S	27.1675564994 E	1 280.00	7.4
PROV0040	PROV0040e	25.465192302379 S	27.175379046705 E	3 240.00	7.4
IMPR0150	IMPR0150	25.545861511119 S	27.203778279913 E	1 600.00	7.4
IMPR0130	IMPR0130	25.556278650523 S	27.213182641876 E	600.00	7.4
IMPR0140	IMPR0140	25.556278650523 S	27.213182641876 E	800.00	7.4
IMPR0340	IMPR0340a	25.562934045143 S	27.21607629171 E	989.00	7.4
IMPR0340	IMPR0340b	25.571286541339 S	27.220251255623 E	645.00	7.4
IMPR0340	IMPR0340c	25.571475422284 S	27.226484326792 E	449.00	7.4
IMPR0340	IMPR0340d	25.574025315035 S	27.229600862377 E	574.00	7.4
IMPR0290	IMPR0290a	25.574591957868 S	27.235645052602 E	313.00	7.4
IMPR0290	IMPR0290b	25.571475422284 S	27.235739493074 E	288.00	7.4
IMPR0290	IMPR0290c	25.569964374728 S	27.237911623936 E	236.00	7.4
IMPR0290	IMPR0290d	25.568736648588 S	27.239800433381 E	842.00	7.4
IMPR0290	IMPR0290e	25.565714553476 S	27.24811119494 E	528.00	7.4
IMPR0291	IMPR0291a	25.565714553476 S	27.24811119494 E	200.00	7.4
IMPR0291	IMPR0291b	25.56834795759 S	27.252415968961 E	200.00	7.4
IMPR0040	IMPR0040a	25.574591957868 S	27.235645052602 E	139.00	7.4
IMPR0040	IMPR0040b	25.57506416023 S	27.236872778741 E	104.00	7.4

Description	ID	Latitude	Longitude	Length (m)	Width (m)
IMPR0040	IMPR0040c	25.562934045143 S	27.21607629171 E	616.00	7.4
IMPR0041	IMPR0041a	25.575118321068 S	27.236964321155 E	158.00	7.4
IMPR0041	IMPR0041b	25.576871668195 S	27.23596240851 E	253.00	7.4
IMPR0030	UMPR0030	25.574363961989 S	27.244289377597 E	2 700.00	7.4
IMPR0020	IMPR0020	25.593988906545 S	27.249784200007 E	300.00	7.4
IMPR0010	IMPR0010	25.593988906545 S	27.249784200007 E	894.00	7.4
IMPR0031	IMPR0031	25.586469566676 S	27.267755422295 E	1 995.00	7.4
IMPR0120	IMPR0120a	25.568736648588 S	27.239800433381 E	988.00	7.4
IMPR0120	IMPR0120b	25.561204584714 S	27.233542425889 E	889.00	7.4
IMPR0120	IMPR0120c	25.553083697655 S	27.233768006085 E	328.00	7.4
IMPR0121	IMPR0121	25.568736648588 S	27.239800433381 E	400.00	7.4
IMPR0292	IMPR0292a	25.538798987714 S	27.25241047442 E	772.00	7.4
IMPR0292	IMPR0292b	25.545311419902 S	27.251408561776 E	1 172.00	7.4
IMPR0292	IMPR0292c	25.553493706496 S	27.245814549512 E	730.00	7.4
IMPR0292	IMPR0292d	25.560089631404 S	27.246232013114 E	328.00	7.4
IMPR0292	IMPR0292e	25.562928383896 S	27.248152345682 E	292.00	7.4
IMPR0292	IMPR0292f	25.564097281981 S	27.250657127293 E	178.00	7.4
IMPR0300	IMPR0300	25.535208800739 S	27.251575547217 E	500.00	7.4
IMPR0120	IMPR0120a	25.540969798443 S	27.232956670578 E	256.00	7.4
IMPR0120	IMPR0120b	25.54247266741 S	27.234793510426 E	272.00	7.4
IMPR0120	IMPR0120c	25.542389174689 S	27.237381784756 E	276.00	7.4
IMPR0100	IMPR0100a	25.535041815298 S	27.199476089716 E	308.00	7.4

Description	ID	Latitude	Longitude	Length (m)	Width (m)
IMPR0100	IMPR0100b	25.534874829858 S	27.20264881309 E	787.00	7.4
IMPR0100	IMPR0100c	25.535041815298 S	27.209411723438 E	750.00	7.4
IMPR0100	IMPR0100d	25.537379611468 S	27.217927980914 E	986.00	7.4
IMPR0090	IMPR0090	25.543224101893 S	27.224189934941 E	900.00	7.4
IMPR0170	IMPR0170a	25.5447372304 S	27.201886005039 E	400.00	7.4
IMPR0170	IMPR0170b	25.543985296413 S	27.207299929745 E	400.00	7.4
IMPR0211	IMPR0211a	25.538798987714 S	27.174511766331 E	874.00	7.4
IMPR0211	IMPR0211b	25.543391087334 S	27.181692140281 E	438.00	7.4
IMPR0211	IMPR0211c	25.54723175247 S	27.181107691238 E	231.00	7.4
PROV0010/KANANA Road	PROV0010e	25.562934045143 S	27.21607629171 E	2 307.00	7.4
PROV0010/KANANA Road	PROV0010f	25.550376735302 S	27.234971100464 E	710.00	7.4
PROV0010/KANANA Road	PROV0010g	25.546328490703 S	27.240870140419 E	1 485.00	7.4
PROV0010/KANANA Road	PROV0010h	25.538798987714 S	27.25241047442 E	352.00	7.4
PROV0010/KANANA Road	PROV0010i	25.538505943398 S	27.256060435767 E	1 011.00	7.4
PROV0010/KANANA Road	PROV0010j	25.543872574689 S	27.264064902776 E	2 819.00	7.4
IMPR0311	IMPR0311a	25.493887971269 S	27.237948957052 E	647.00	7.4
IMPR0311	IMPR0311b	25.49417392841 S	27.232134495187 E	375.00	7.4
IMPR0311	IMPR0311c	25.497033499819 S	27.229560880919 E	887.00	7.4
IMPR0311	IMPR0311d	25.498653923617 S	27.222125995255 E	944.00	7.4
IMPR0310	IMPR0310a	25.506184128328 S	27.215930257202 E	170.00	7.4
IMPR0310	IMPR0310b	25.507804552126 S	27.216406852437 E	1 225.00	7.4
IMPR0310	IMPR0310c	25.516955180636 S	27.208400052491 E	622.00	7.4

Description	ID	Latitude	Longitude	Length (m)	Width (m)
IMPR0070	IMPR0070a	25.521435175843 S	27.204777928706 E	1 000.00	7.4
IMPR0070	IMPR0070b	25.529632613883 S	27.198391552559 E	375.00	7.4
IMPR0060	IMPR0060a	25.533064099574 S	27.200393252545 E	200.00	7.4
IMPR0060	IMPR0060b	25.535041815298 S	27.199476089716 E	1 000.00	7.4
IMPR0060	IMPR0060c	25.541833451895 S	27.192958366882 E	400.00	7.4
IMPR0334	IMPR0334	25.442415685904 S	27.196008576385 E	1 300.00	7.4
IMPR0332	IMPR0332	25.466436085741 S	27.215072385779 E	1 400.00	7.4
IMPR0331	IMPR0331	25.476063309485 S	27.206588990599 E	1 100.00	7.4
IMPR0330	IMPR0330a	25.470439485714 S	27.202013676344 E	200.00	7.4
IMPR0330	IMPR0330b	25.471297357137 S	27.200488571592 E	304.00	7.4
IMPR0330	IMPR0330c	25.473680333311 S	27.200107295405 E	866.00	7.4
IMPR0330	IMPR0330d	25.477874371378 S	27.192577090694 E	693.00	7.4
IMPR0330	IMPR0330e	25.483116918961 S	27.194960066868 E	1 395.00	7.4
IMPR0250	IMPR0250a	25.516955180636 S	27.208400052491 E	1 097.00	7.4
IMPR0250	IMPR0250b	25.508090509267 S	27.2049685668 E	1 969.00	7.4
IMPR0230	IMPR0230a	25.49541307602 S	27.191337943083 E	275.00	7.4
IMPR0230	IMPR0230b	25.49322073794 S	27.189908157379 E	360.00	7.4
IMPR0230	IMPR0230c	25.490265847484 S	27.189050285956 E	616.00	7.4
IMPR0230	IMPR0230d	25.495317756973 S	27.178279233648 E	610.00	7.4
IMPR0230	IMPR0230e	25.495317756973 S	27.178279233648 E	1 007.00	7.4
IMPR0230	IMPR0230f	25.494936480785 S	27.167984776575 E	1 036.00	7.4
IMPR0230	IMPR0230g	25.48597649037 S	27.166936267059 E	386.00	7.4

Description	ID	Latitude	Longitude	Length (m)	Width (m)
IMPR0230	IMPR0230h	25.482640323726 S	27.166554990871 E	379.00	7.4
IMPR0190	IMPR0190a	25.539597461627 S	27.189932623086 E	320.00	7.4
IMPR0190	IMPR0190b	25.539597461627 S	27.187294787367 E	252.00	7.4
IMPR0190	IMPR0190c	25.541689538232 S	27.18547559032 E	387.00	7.4
IMPR0190	IMPR0190d	25.543326815574 S	27.188386305596 E	336.00	7.4
IMPR0190	IMPR0190e	25.544407066163 S	27.190956666895 E	1 242.00	7.4
IMPR0500	IMPR0500	25.422589324134 S	27.159120105207 E	2 000.00	7.4
IMPR0321	IMPR0321a	25.430500805033 S	27.177040086038 E	400.00	7.4
IMPR0321	IMPR0321b	25.434447872275 S	27.176834404343 E	556.00	7.4
IMPR0321	IMPR0321c	25.438904905041 S	27.178289761981 E	808.00	7.4
IMPR0320	IMPR0320a	25.446272653084 S	27.175015207296 E	208.00	7.4
IMPR0320	IMPR0320b	25.44763705087 S	27.1771072839 E	283.00	7.4
IMPR0320	IMPR0320c	25.446272653084 S	27.175015207296 E	229.00	7.4
IMPR0320	IMPR0320d	25.448728569098 S	27.174742327739 E	610.00	7.4
IMPR0320	IMPR0320e	25.454731919356 S	27.175379046705 E	430.00	7.4
IMPR0280	IMPR0280a	25.457733594484 S	27.1732869701 E	310.00	7.4
IMPR0280	IMPR0280b	25.459007032417 S	27.16983049571 E	630.00	7.4
IMPR0220	IMPR0220a	25.464373663708 S	27.1675564994 E	1 342.00	7.4
IMPR0220	IMPR0220b	25.475470765698 S	27.163645225748 E	315.00	7.4
IMPR0220	IMPR0220c	25.478381480975 S	27.164736743977 E	262.00	7.4
IMPR0240	IMPR0240a	25.480829261834 S	27.163600100415 E	439.00	7.4
IMPR0240	IMPR0240b	25.480829261834 S	27.163600100415 E	559.00	7.4

Description	ID	Latitude	Longitude	Length (m)	Width (m)
IMPR0240	IMPR0240c	25.480829261834 S	27.163600100415 E	218.00	7.4
IMPR0240	IMPR0240d	25.480829261834 S	27.163600100415 E	1 345.00	7.4
IMPR0240	IMPR0240e	25.480829261834 S	27.163600100415 E	660.00	7.4
IMPR0240	IMPR0240f	25.480829261834 S	27.163600100415 E	1 252.00	7.4
IMPR0270	IMPR0270a	25.50703383447 S	27.171194893496 E	673.00	7.4
IMPR0270	IMPR0270b	25.509853589898 S	27.164281944715 E	379.00	7.4
IMPR0270	IMPR0270c	25.511036067979 S	27.161462189291 E	476.00	7.4
IMPR0210	IMPR0210	25.515311181041 S	27.163190426486 E	2 700.00	7.4
IMPR0200	IMPR0200a	25.530865315798 S	27.179108400653 E	1 412.00	7.4
IMPR0200	IMPR0200b	25.539597461627 S	27.189932623086 E	502.00	7.4
IMPR0160	IMPR0160a	25.541833451895 S	27.192958366882 E	236.00	7.4
IMPR0160	IMPR0160b	25.543053936017 S	27.195390214229 E	477.00	7.4
IMPR0160	IMPR0160c	25.544236414098 S	27.199847246996 E	252.00	7.4
IMPR0160	IMPR0160d	25.5447372304 S	27.201886005039 E	158.00	7.4
IMPR0050	IMPR0050a	25.541833451895 S	27.192958366882 E	100.00	7.4
IMPR0050	IMPR0050b	25.538414983546 S	27.198391889358 E	200.00	7.4
IMPR0180	IMPR0180a	25.546146347105 S	27.203400247573 E	1 131.00	7.4
IMPR0180	IMPR0180b	25.556081980827 S	27.199977046038 E	640.00	7.4
IMPR0180	IMPR0180c	25.56150900765 S	27.197722742589 E	578.00	7.4
IMPR0400	IMPR0400	25.559608629151 S	27.286986785576 E	940.00	7.4
PROV0010/KANANA Road	PROV0010a	25.56188262546 S	27.184111192534 E	487.00	7.4
PROV0010/KANANA Road	PROV0010b	25.563337983098 S	27.188477265448 E	786.00	7.4

Description	ID	Latitude	Longitude	Length (m)	Width (m)
PROV0010/KANANA Road	PROV0010c	25.566703497636 S	27.195390214229 E	1 010.00	7.4
PROV0010/KANANA Road	PROV0010d	25.570159972027 S	27.204395239615 E	1 456.00	7.4
PROV0020	PROV0020	25.566703497636 S	27.195390214229 E	2 000.00	7.4
PROV0030/PHOKENG Road	PROV0030a	25.530865315798 S	27.179108400653 E	937.00	7.4
PROV0030/PHOKENG Road	PROV0030b	25.538798987714 S	27.174511766331 E	3 441.00	7.4
MERITENG Road (Provincial Road)	MERITa	25.583531070327 S	27.265065461153 E	404.00	7.4
MERITENG Road (Provincial Road)	MERITb	25.586469566676 S	27.267755422295 E	2 483.00	7.4
PROV0040	PROV0040a	25.530865315798 S	27.179108400653 E	4 320.00	7.4
PROV0040	PROV0040b	25.492553504611 S	27.183617100279 E	3 234.00	7.4
PROV0040	PROV0040c	25.465192302379 S	27.175379046705 E	784.00	7.4
PROV0040	PROV0040d	25.464373663708 S	27.1675564994 E	1 280.00	7.4
PROV0040	PROV0040e	25.465192302379 S	27.175379046705 E	3 240.00	7.4
Unpaved Roads					
IMPR0450	IMPRD0450a	25.543326815574 S	27.285895267348 E	1 400.00	7.4
IMPR0450	IMPRD0450b	25.542872016313 S	27.27297896831 E	657.00	7.4
IMPR0450	IMPRD0450c	25.537869224432 S	27.268158096134 E	660.00	7.4
IMPD0130	IMPD0130	25.535208800739 S	27.251575547217 E	2 000.00	7.4
Shaft 1	U1	25.594948109736 S	27.244826635751 E	379.00	7.4
Shaft 1	U2	25.597675872319 S	27.246872457689 E	525.00	7.4
Shaft 1	U3	25.598357812965 S	27.251646042209 E	466.00	7.4
Shaft 2	U4	25.576876682621 S	27.249941190595 E	806.00	7.4
Shaft 6	U5	25.475949467035 S	27.169472194384 E	274.00	7.4

Description	ID	Latitude	Longitude	Length (m)	Width (m)
Shaft 6	U6	25.476972378004 S	27.167085402124 E	322.00	7.4
Shaft 6	U7	25.479018199941 S	27.167426372447 E	454.00	7.4
Shaft 7	U8	25.497089627056 S	27.20629698926 E	937.00	7.4
Shaft 10	U9	25.535619273547 S	27.247895368657 E	1 214.00	7.4

Table 28: Stack parameters

Description	Latitude	Longitude	Height (m)	Tip diameter (m)	Exit temperature (°C)	Barometric Pressure (kPa)	Exit velocity (m/s)
Spray Drier 1	25.5421700 S	27.18342 E	40.0	2.5	87.0(b)	88.9(b)	6.7(b)
Spray Drier 4	25.5413300 S	27.18237 E	45.0	3.3	90.0(c)	89.2(c)	14.7(c)
Spray Drier 5	25.5404100 S	27.18303 E	40.0	2.5	88.0(c)	88.78(c)	11.4(c)
Spray Drier 6	25.5409700 S	27.18171 E	40.0	3.0	86.0(b)	88.5(b)	10.5(b)
Flash Dryer 7	25.5437900 S	27.18552 E	35.6	1.5	105(b)	88.7(b)	19.6(b)
Tailgas Scrubber	25.5433500 S	27.18442 E	77.	2.2	44.0(b)	88.2(b)	5.7(b)
Fugitive Scrubber	25.5433000 S	27.18394 E	40.0	1.3	21.3(b)	88.9(b)	4.7(b)
Main Stack	25.5423500 S	27.18407 E	70.0	2.0	240(d)	102(d)	14.5(d)
Flash Dryer 2(a) (proposed)	25.5431430 S	27.185659 E	35.6	1.5	105(b)	88.7(b)	19.6(b)

Notes:

(a) Assumed the same as existing Flash Dryer
(b) Based on 2020 emission survey (C & M Consulting Engineers, 2020) average results
(c) Based on 2018 emission survey (C & M Consulting Engineers, 2018) average results
(d) Assumed the same as previous emissions inventory and study conducted by Airshed (Grobler, 2018)

Table 29: Stack emissions

Description	PM (mg/Nm³)	CO (mg/Nm³)	NO_x expressed as NO_2 (mg/Nm³)	SO_2 (mg/Nm³)	PM (g/s)	CO (g/s)	NO_x (g/s)	SO_2 (g/s)
Spray Drier 1[(a)]	178	19.1	241	109	3.31	0.361	4.47	2.03
Spray Drier 4[(a)]	78.2	16.1	96.9	180	1.50	0.306	1.83	3.42
Spray Drier 5[(b)]	106	0.9	96.8	172	3.03	0.028	3.03	5.36
Spray Drier 6[(a)]	81.1	39.8	300	240	2.53	1.25	9.36	7.50
Flash Dryer 1[(a)]	8.10	99.8	379.0	614	0.14	1.64	6.19	10.0
Tailgas Scrubber[(a)]	105	1.40	5.70	7.50	2.45	0.008	0.031	0.042
Fugitive Scrubber[(a)]	7.20	5 560	257	1 630	0.04	135	6.25	39.7
Main Stack[(c)(d)]	50.0	-	350	6 660	4.28	-	30.0	570
Flash Dryer 2[(d)] (proposed)	50.0	-	500	1 000	0.82	1.64	8.17	16.3

Notes:

(e) Based on 2020 emission survey (C & M Consulting Engineers, 2020) average results

(f) Based on 2018 emission survey (C & M Consulting Engineers, 2018) average results

(g) Based on previous emissions inventory and study conducted by Airshed (Grobler, 2018)

(h) Based on MES

Table 30: Stack respirable and inhalable particulate emissions

Description	$PM_{2.5}$ (g/s)	PM_{10} (g/s)
Spray Drier 1[(a)]	1.16	3.13
Spray Drier 4[(a)]	0.56	1.45
Spray Drier 5[()]	1.40	2.94
Spray Drier 6[(a)]	1.66	2.52

Description	$PM_{2.5}$ (g/s)	PM_{10} (g/s)
Flash Dryer 1[(a)]	0.07	0.14
Tailgas Scrubber[(a)]	1.87	2.36
Fugitive Scrubber[(c)]	0.04	0.04
Main Stack[(a)]	3.26	4.12
Flash Dryer 2[(a)] **(proposed)**	0.42	0.81

Notes:

(a) Calculated based on provided emissions and particle size distribution

(b) Assumed average particle size distribution of all dryers

(c) Assumed 100% PM is $PM_{2.5}$

Table 31: Building parameters

Description	Latitude	Longitude	Height (m)	Length (m)	Width (m)
Main Building	25.54235 S	27.18407 E	22.25	10.35	2.59

Table 32: Building emissions

Description	$PM_{2.5}$ (g/s)	PM_{10} (g/s)	TSP (g/s)	NO_x	SO_2
Main Building	10.3[(a)]	15.3[(a)]	18.8[(a)]	-	64.4[(b)]

Notes:

(a) Calculated based on (Dewitt, 1980) (with a 90% control efficiency)

(b) Based on mass balance (average g/s)

Table 33: Calculated annual emission rates in tonnes per annum per source group

Operational Phase	$PM_{2.5}$	PM_{10}	TSP	DPM	CO	NO_x	SO_2	VOC
Stacks[(a)]	226[(f)(g)]	422[(f)(g)]	435[(e)]	-	4 379[(e)]	1 241[(e)]	2 663[(e)]	-

Furnace and Converter Fugitives	146[(h)(i)]	210[(h)(i)]	250[(h)(i)]	-	-	-	2 037[(j)]	-
Ventilation Shafts	77.2[(b)]	77.2[(b)]	77.2[(b)]	-	-	-	1 199[(c)]	-
Materials Handling	3.89	25.7	54.3	-	-	-	-	-
Crushing and Screening	242	493	3 065	-	-	-	-	-
Unpaved Roads	0.019	0.188	0.530	-	-	-	-	-
Paved Roads	70.5	291	1 518	-	-	-	-	-
Grading	$5.9x10^{-05}$	0.001	0.002	-	-	-	-	-
Vehicle Exhaust	2.57	2.64	2.64	2.57	35.2	13.7	0.033	2.05
Windblown Dust[(d)]	22.4	63.5	229	-	-	-	-	-
Total (t/a)	**795**	**1 586**	**5633**	**3**	**4 415**	**1 254**	**5 899**	**2**

Notes:

(a) Routine stacks only – emergency stack emissions excluded

(b) Based on average measured inhalable particulates TWA concentration

(c) Based on international Occupational Health and Safety Guidelines for underground SO_2 concentrations

(d) Windblown dust estimated using ADDAS model (Burger & Held, 1997)

(e) Based on 2020 emission survey (C & M Consulting Engineers, 2020) and 2018 emission survey (C & M Consulting Engineers, 2018)

(f) Calculated based on provided emissions and particle size distribution and 100% PM is $PM_{2.5}$ for fugitive scrubber

(g) Calculated based on as study conducted to determine the PM_1, $PM_{2.5}$ and PM_{10} emissions from different industries (Ehrlich, Noll, Kalkoff, Baumbach, & Dreiseidler, 2007).

(h) Calculated based on (Dewitt, 1980) (with a 90% control efficiency)

(i) Calculated based on:

   a. Furnaces – 17 taps per day of 30 minute duration

   b. Convertors - 32 taps per day of 30 minute duration

(j) Based on mass balance provided by Impala Platinum Limited

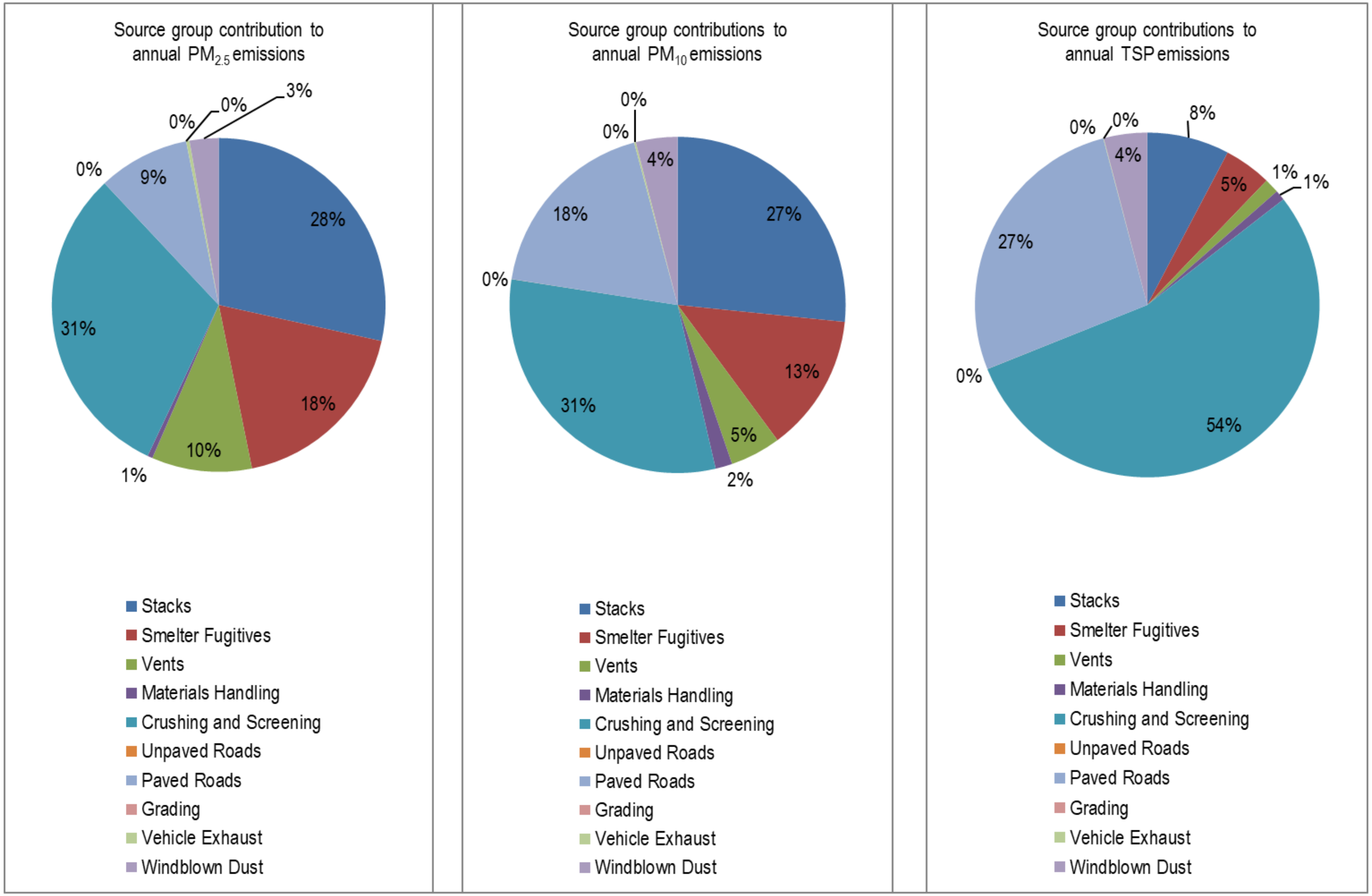


Figure 21: Source group contributions to estimated annual mitigated PM emissions from the Impala Platinum Limited - Rustenburg Operations

7.2 Assessment of Impact – Proposed Flash Dryer Operations

Simulation results of particulate and gaseous emissions for the proposed second flash dryer operations are discussed in this section.

7.2.1 Respirable particulate matter ($PM_{2.5}$)

With the proposed Flash Dryer PM emitted at the New Plant MES (50 mg/Nm³) and the measured particle size distribution for the existing flash dryer applied, the simulated annual average $PM_{2.5}$ concentrations do not exceed the current NAAQS of 20 µg/m³ or the future NAAQS of 15 µg/m³ off-site or at any AQSRs (Figure 22). The simulated 24-hour $PM_{2.5}$ concentrations are below the current and future NAAQ limit and thus the current 24-hour NAAQS (4 days of exceedance of 40 µg/m³) and the future 24-hour NAAQS (4 days of exceedance of 25 µg/m³) are not exceeded off-site or at any AQSRs (Figure 23).

7.2.2 Inhalable particulate matter (PM_{10})

Simulated annual average PM_{10} concentrations, as a result of the proposed Flash Dryer with PM emitted at the New Plant MES (50 mg/Nm³) and the measured particle size distribution for the existing flash dryer applied, do not exceed the NAAQS of 40 µg/m³ off-site or at any AQSRs (Figure 24). The simulated 24-hour PM_{10} concentrations are below the 24-hour NAAQ limit and thus the 24-hour NAAQS (4 days of exceedance of 75 µg/m³) are not exceeded off-site or at any AQSRs (Figure 25).

7.2.3 Fallout Dust

The simulated daily average dustfall rates as a result of the proposed Flash Dryer with PM emitted at the New Plant MES (50 mg/Nm³) does not exceed the NDCR limit for non-residential areas (1 200 mg/m²-day) on-site and does not exceed the NDCR limit for residential areas (600 mg/m²-day) at any AQSRs and are below 400 mg/m²-day at all agricultural areas (Figure 26).

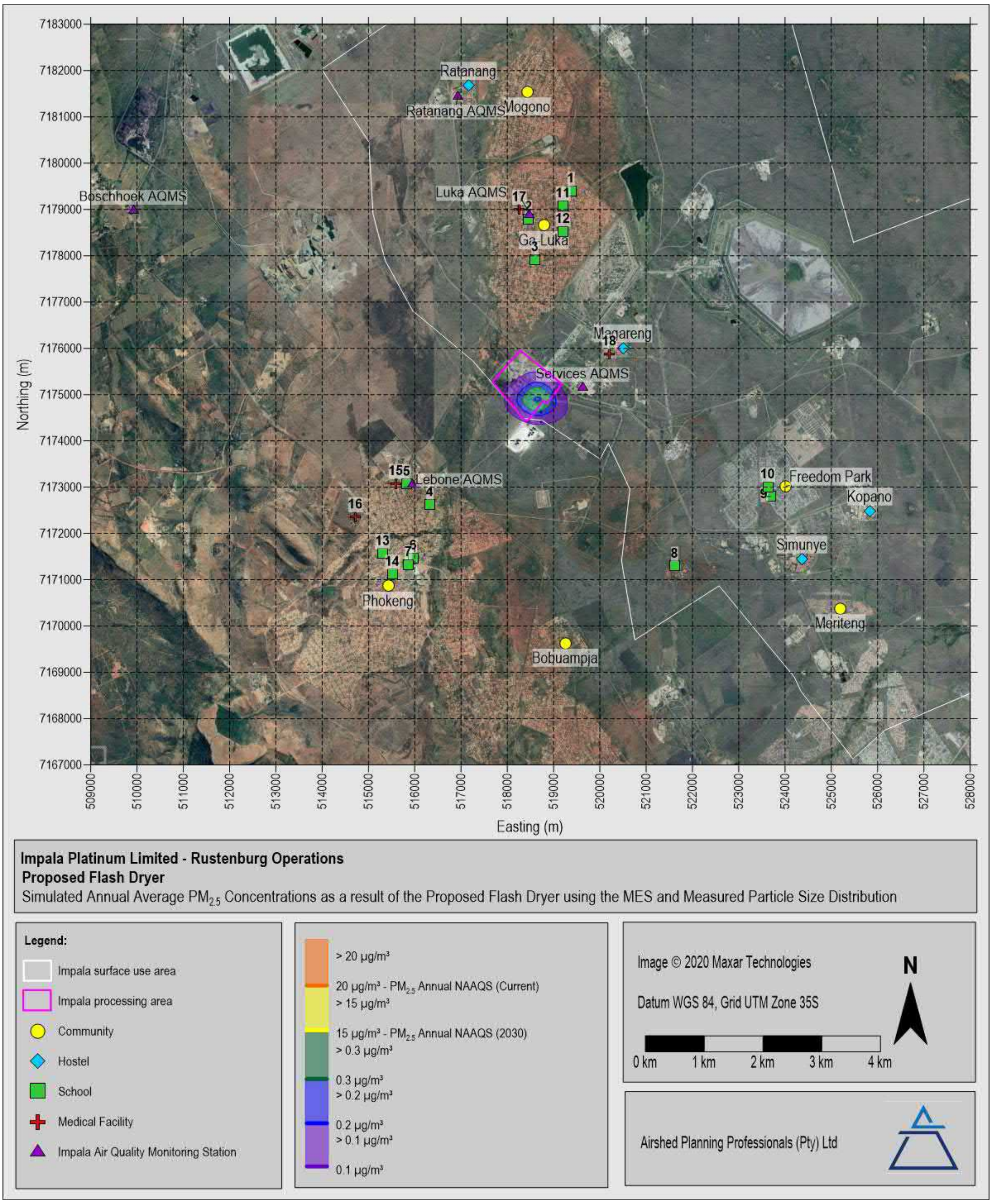


Figure 22: Simulated annual average $PM_{2.5}$ concentrations as a result of the proposed flash dryer operations

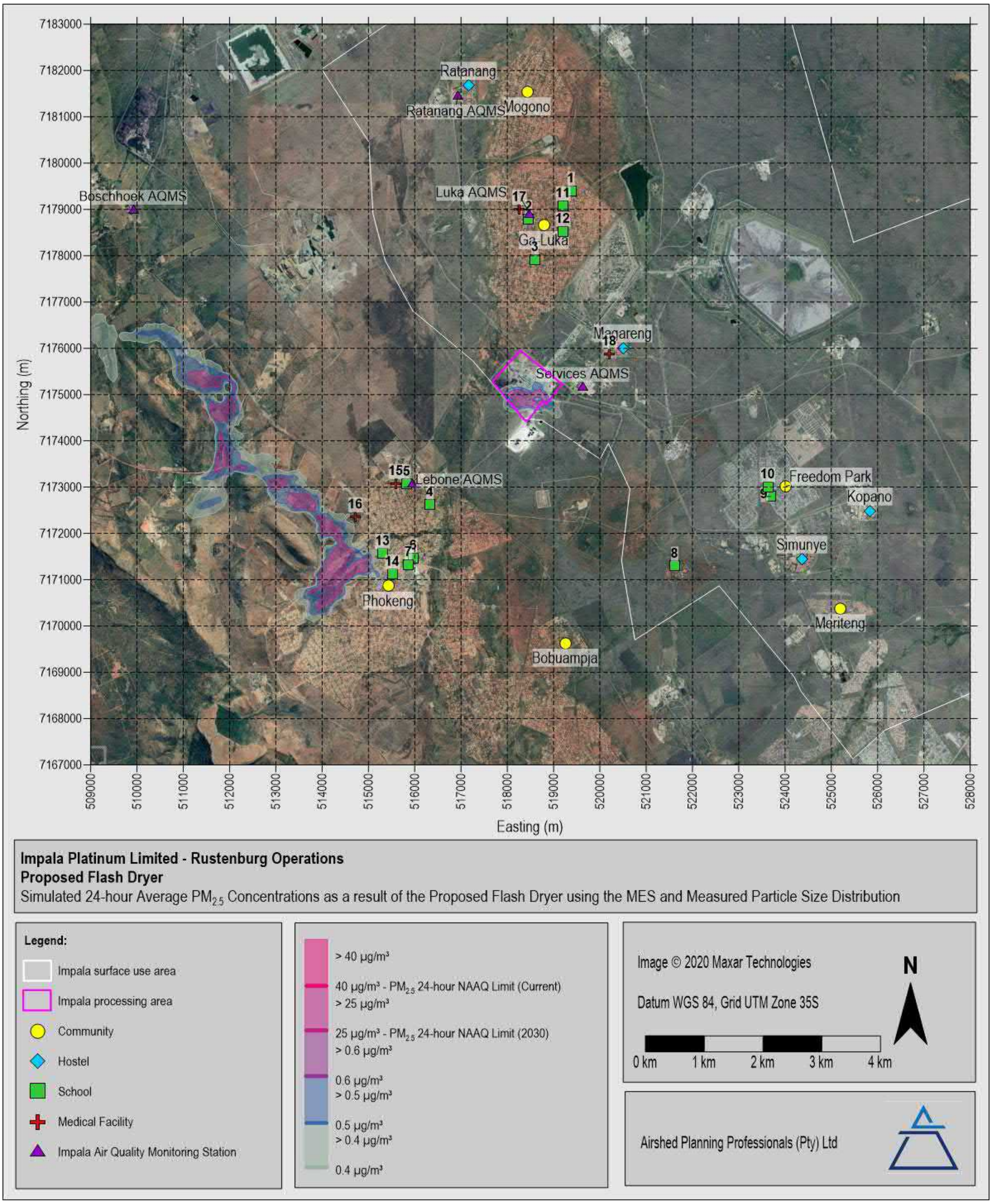


Figure 23: Simulated 24-hour average $PM_{2.5}$ concentrations as a result of the proposed flash dryer operations

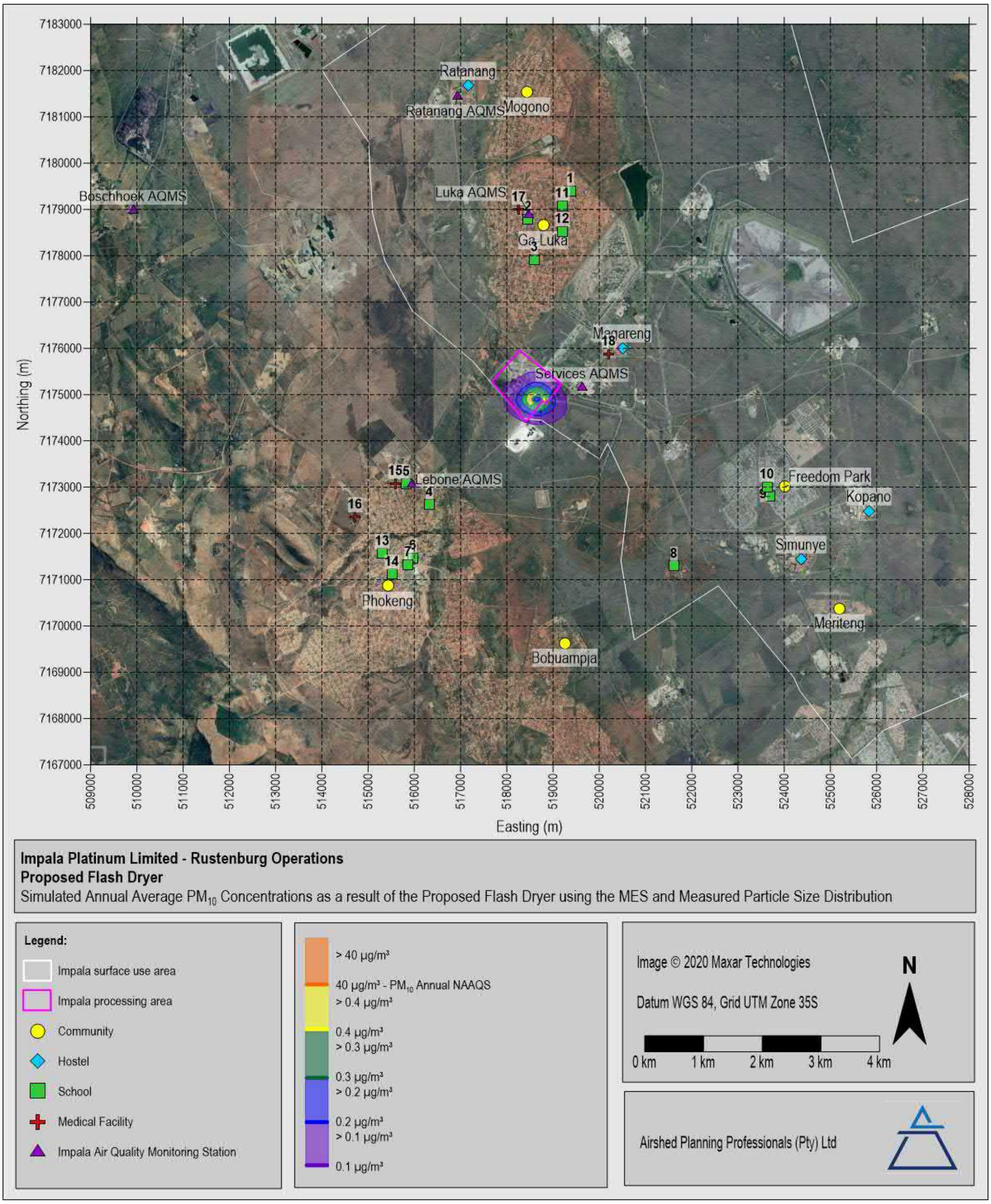


Figure 24: Simulated annual average PM_{10} concentrations as a result of the proposed flash dryer operations

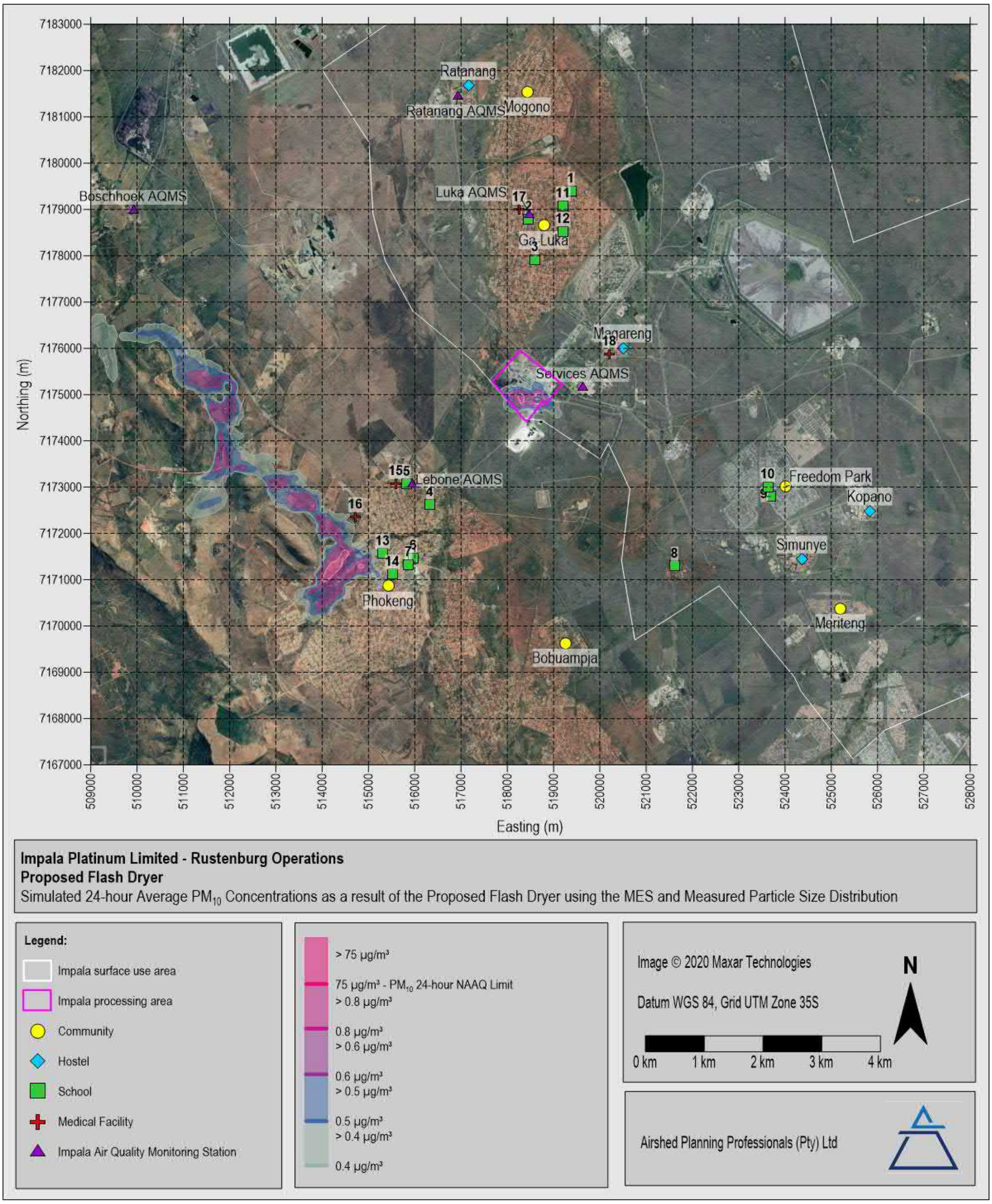


Figure 25: Simulated 24-hour average PM_{10} concentrations as a result of the proposed flash dryer operations

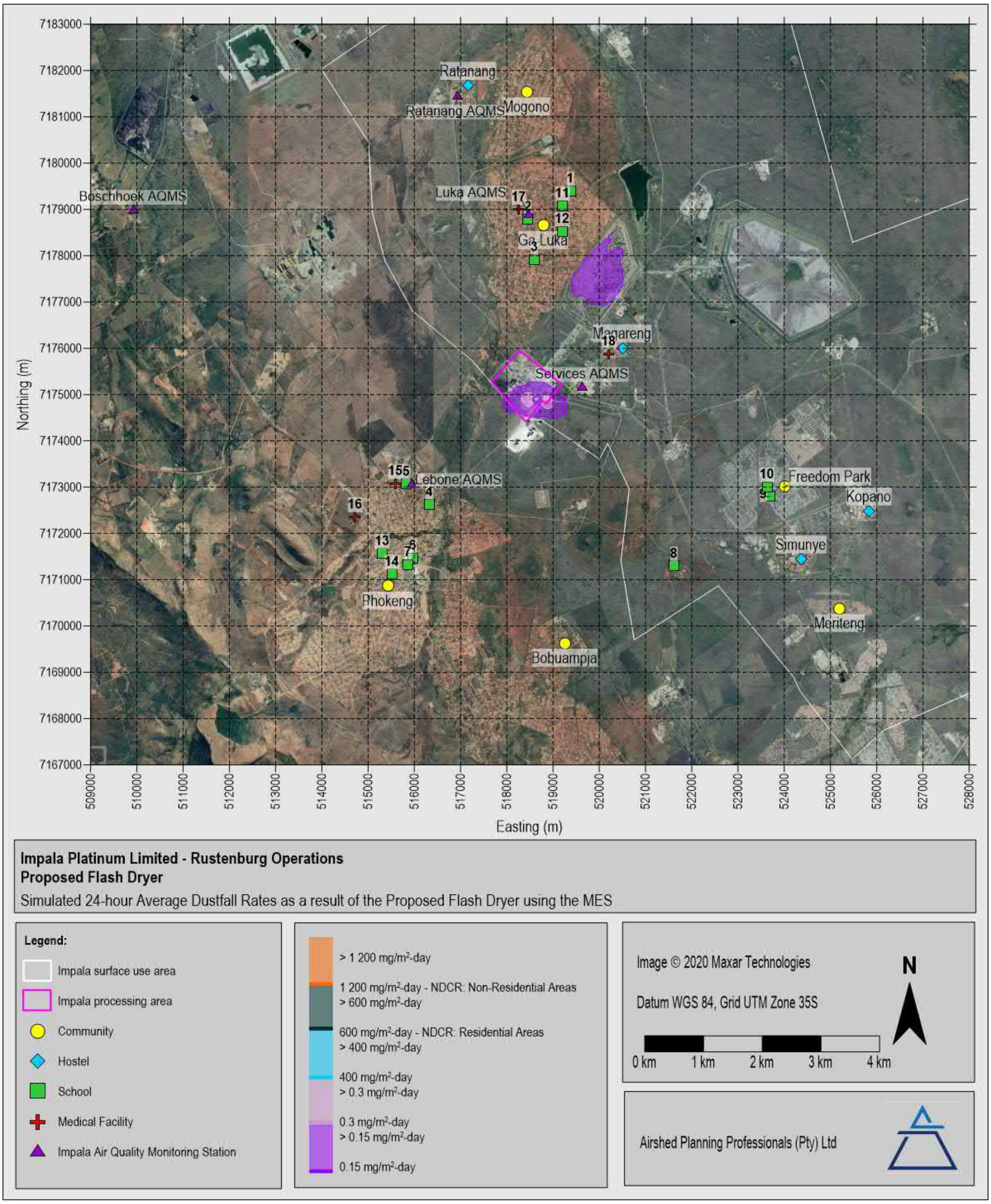


Figure 26: Simulated average daily dustfall rates as a result of the proposed flash dryer operations

7.2.4 Sulfur Dioxide (SO_2)

With the proposed Flash Dryer SO_2 emitted at the New Plant MES (1 000 mg/Nm³), the simulated annual average SO_2 concentrations do not exceed the NAAQS of 50 µg/m³ off-site or at any AQSRs (Figure 27). The simulated 24-hour SO_2 concentrations are below the NAAQ limit and thus the 24-hour NAAQS (4 days of exceedance of 125 µg/m³) is not exceeded off-site or at any AQSRs (Figure 28). The simulated 1-hour SO_2 concentrations are below the NAAQ limit and thus do not exceed the 1-hour NAAQS (88 hours of exceedance of 350 µg/m³) off-site or at any AQSRs (Figure 29). The simulated annual average SO_2 concentrations are likely to be below the critical levels for all vegetation types across the domain (Figure 27 referenced against Table 9).

7.2.5 Nitrogen Dioxide (NO_2)

It was assumed that all NO_x is converted to NO_2 and the simulated NO_x concentrations were compared to the NO_2 NAAQS. Simulated annual average NO_x concentrations, as a result of the proposed Flash Dryer with NO_x emitted at the New Plant MES (500 mg/Nm³), do not exceed the NO_2 NAAQS of 40 µg/m³ off-site or at any AQSRs (Figure 30). The simulated 1-hour NO_x concentrations are below the 1-hour NO_2 NAAQ limit and thus the 1-hour NO_2 NAAQS (88 hours of exceedance of 200 µg/m³) are not exceeded off-site or at any AQSRs (Figure 25). The simulated annual average NO_x concentrations are likely to be below the critical levels for all vegetation types across the domain (Figure 30 referenced against Table 9).

7.2.6 Carbon Monoxide (CO)

With the proposed Flash Dryer CO emitted at the same levels as the existing flash dryer, the simulated 8-hour CO concentrations are below the NAAQ limit and thus the 8-hour NAAQS (11 8-hours of exceedance of 10 000 µg/m³) is not exceeded off-site or at any AQSRs (Figure 32). The simulated 1-hour CO concentrations are below the NAAQ limit and thus do not exceed the 1-hour NAAQS (88 hours of exceedance of 30 000 µg/m³) off-site or at any AQSRs (Figure 33).

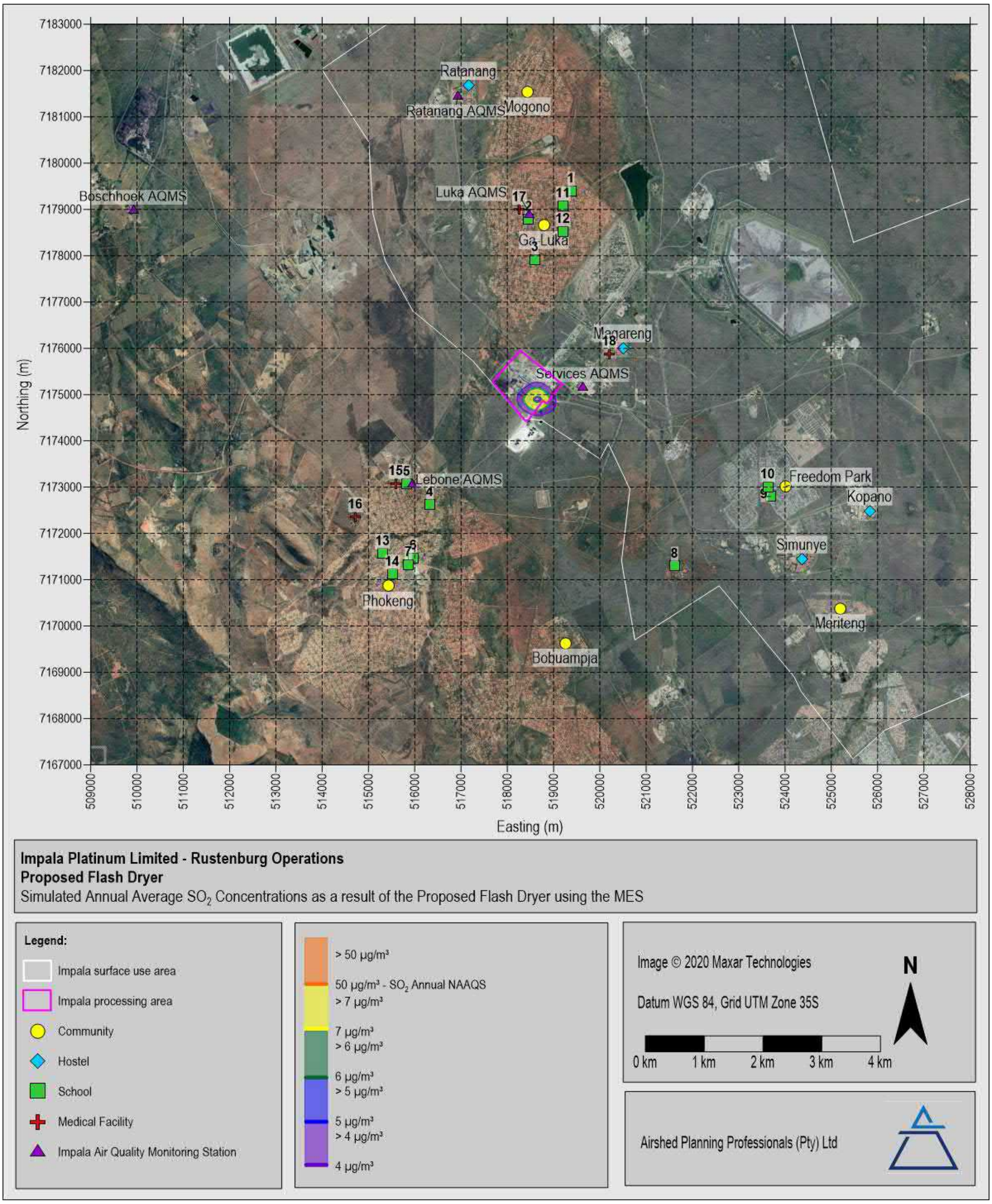


Figure 27: Simulated annual average SO_2 concentrations as a result of the proposed flash dryer operations

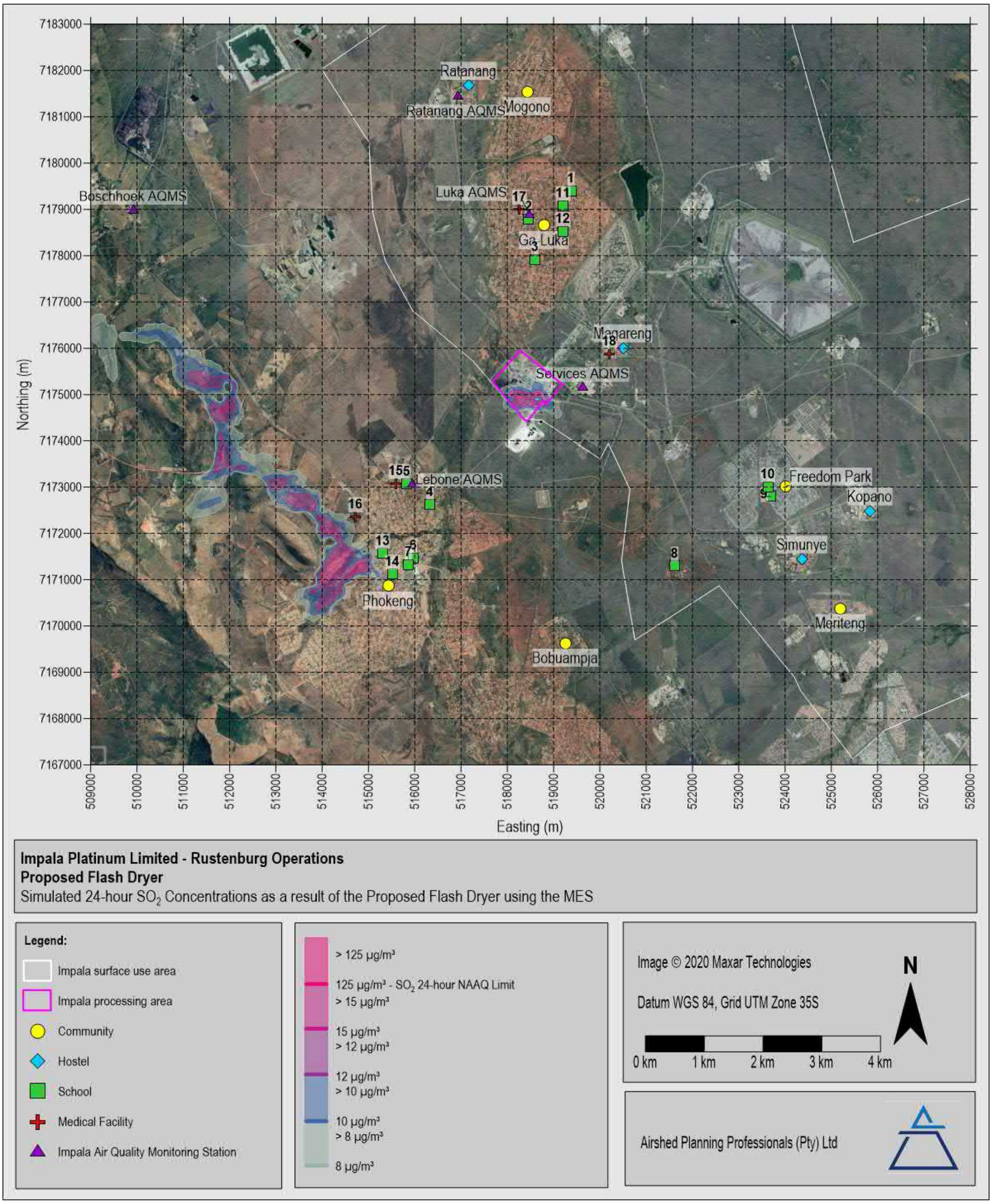


Figure 28: Simulated 24-hour average SO_2 concentrations as a result of the proposed flash dryer operations

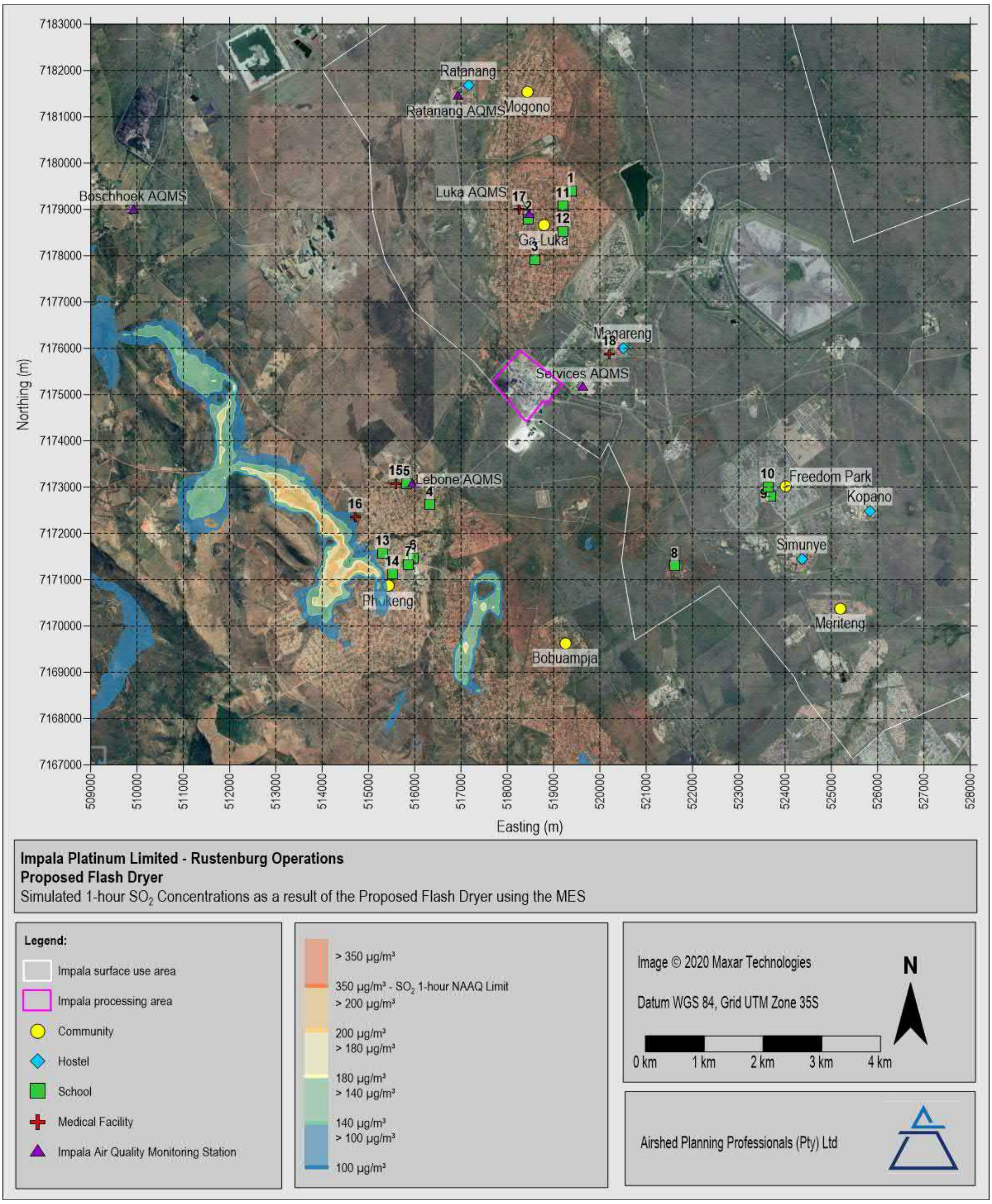


Figure 29: Simulated 1-hour SO_2 concentrations as a result of the proposed flash dryer operations

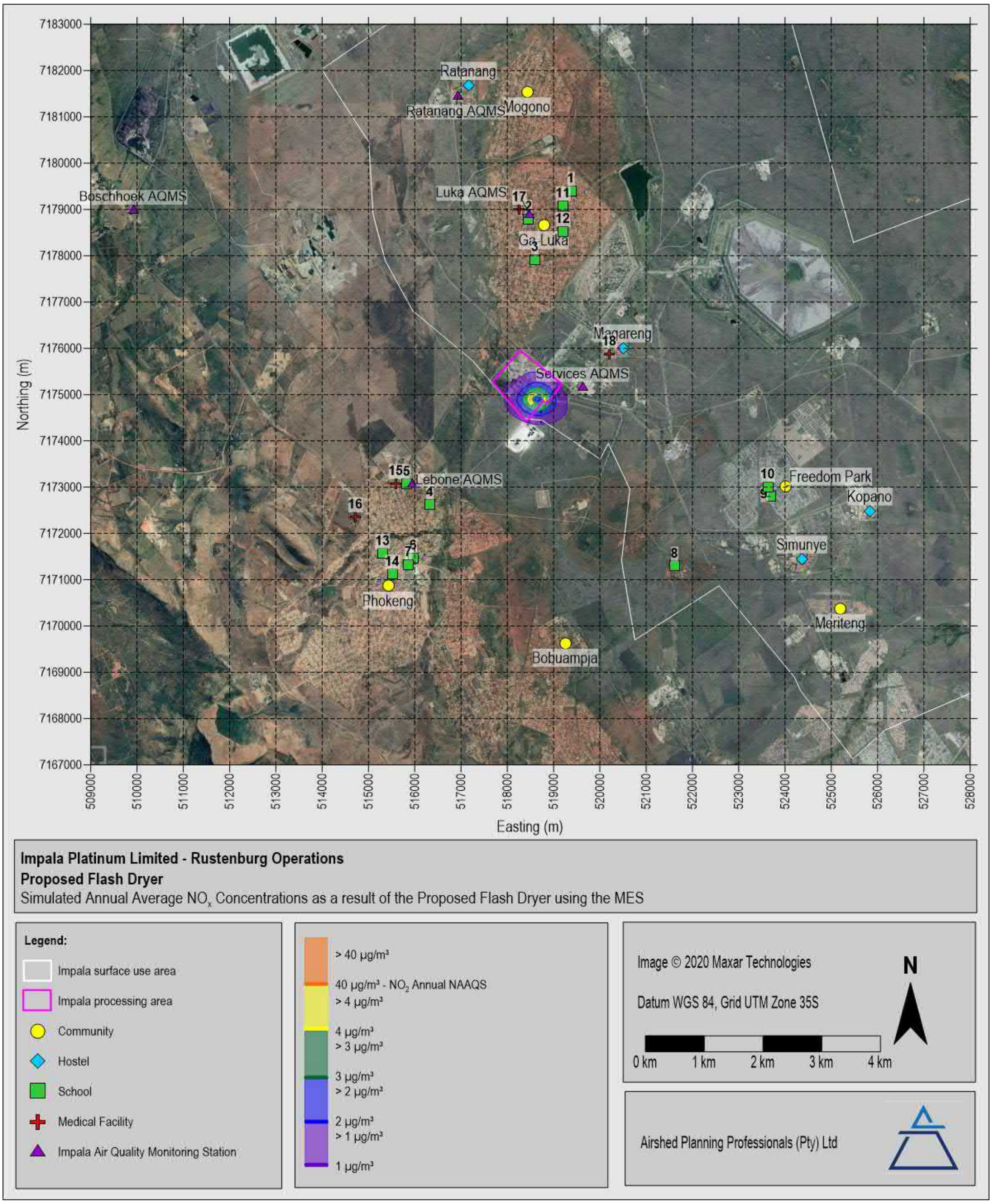


Figure 30: Simulated annual average NO_x concentrations as a result of the proposed flash dryer operations

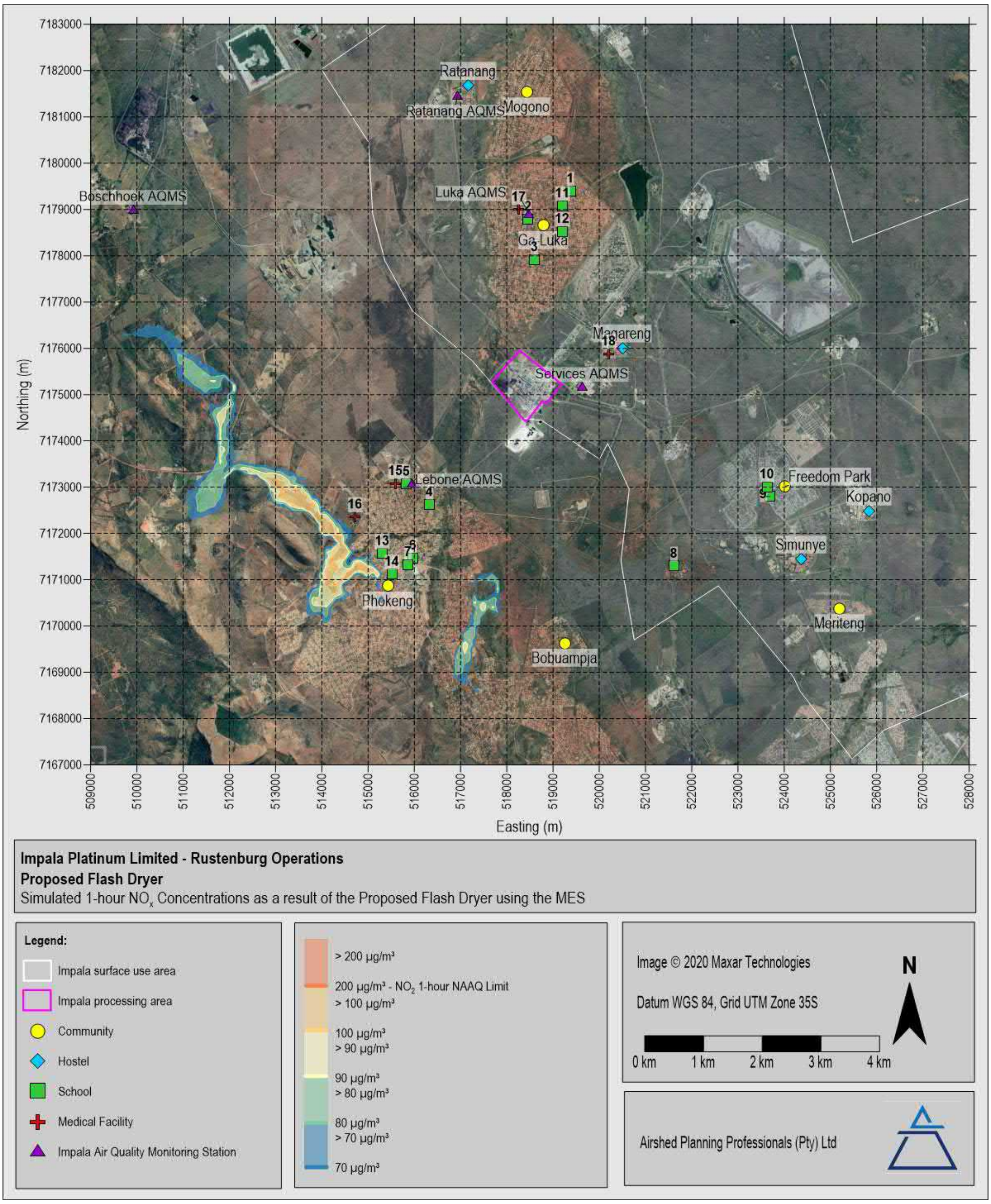


Figure 31: Simulated 1-hour NO_x concentrations as a result of the proposed flash dryer operations

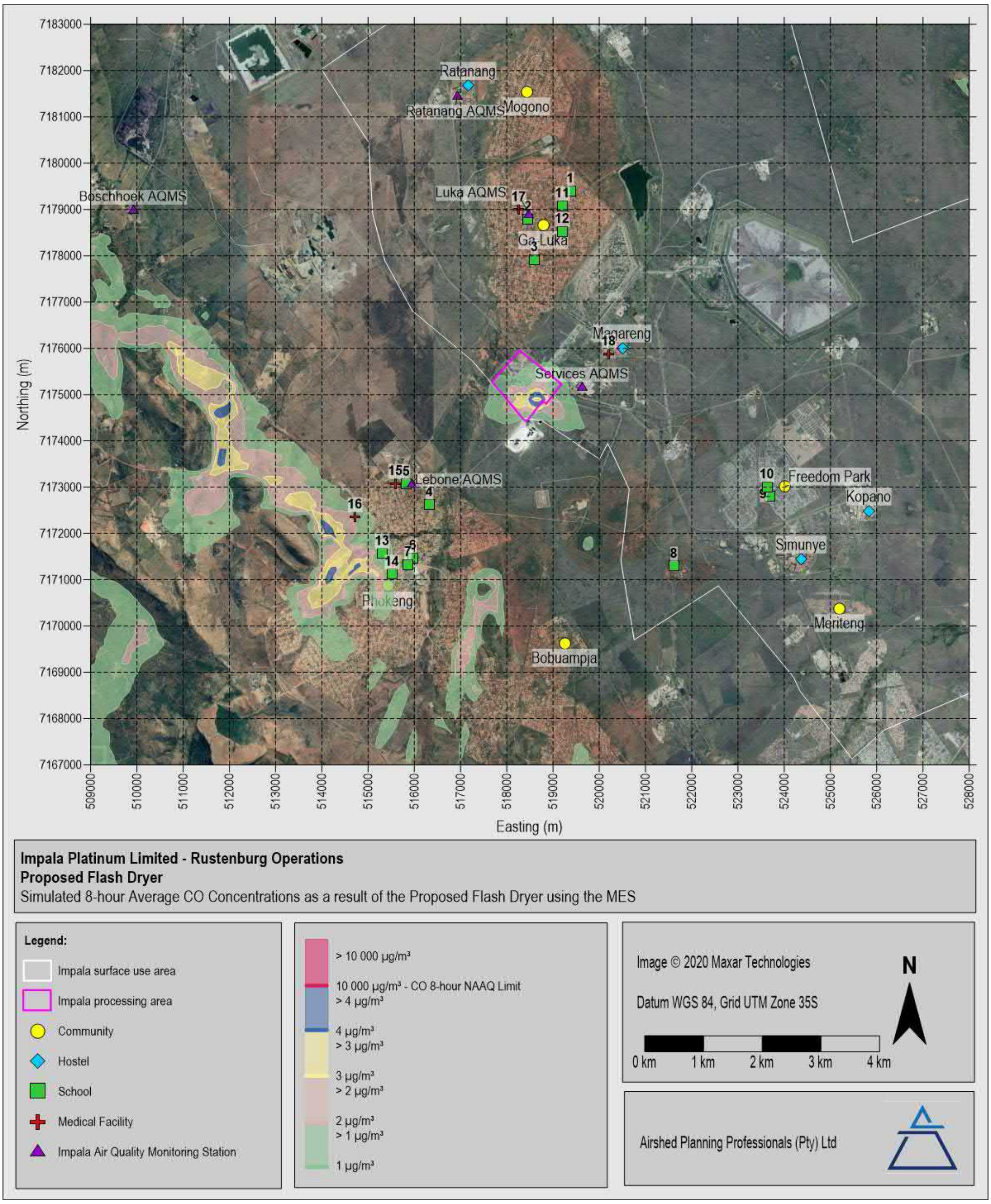


Figure 32: Simulated 8-hour average CO concentrations as a result of the proposed flash dryer operations

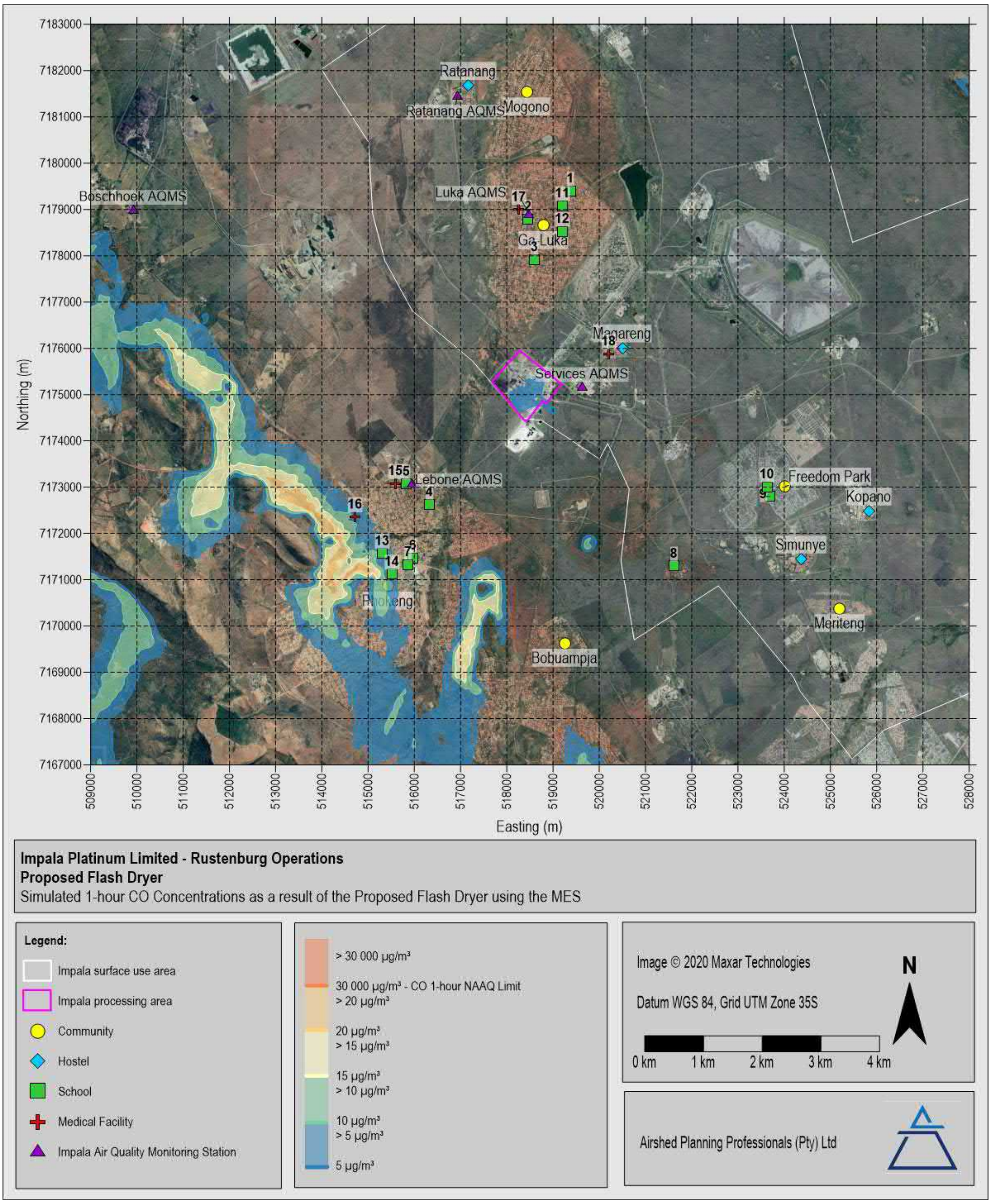


Figure 33: Simulated 1-hour CO concentrations as a result of the proposed flash dryer operations

7.3 Impact Significance Rating – Proposed Flash Dryer Operations

Non-compliance of $PM_{2.5}$, PM_{10}, SO_2, NO_x or CO concentrations with the relevant NAAQS could result in human health impacts. The potential significance of the impacts based the quantitative assessment of $PM_{2.5}$, PM_{10}, SO_2, NO_x and CO and dustfall rates (TSP) during the operational phase as a result of the proposed second flash dryer only is discussed below. The current SLR rating methodology (Section 17) was used. "Unmitigated" operations should only occur if the baghouse is not maintained and filters become saturated with PM; thus, reducing the efficiency of PM capture. These conditions would not be considered normal operating conditions and thus the emissions do not need to comply with MES; in previous baghouse failure events, Impala have replaced the baghouse within a reasonable period. The operation of the existing flash dryer during baghouse down-time is limited to a period of 1% of the year (which is approximately 3.5 days) and the same condition will likely apply to the proposed second flash dryer. PM will be the only pollutant affected by baghouse failure; the remaining pollutants will likely be emitted at MES, as modelled.

Two potential direct operational phase impacts on the air quality of the area were identified:

- B1a: Potential impact on human health from increased pollutant concentrations due to proposed operations; and
- B2a: Increased nuisance dustfall rates associated with the proposed operations.

7.3.1 Potential Impact B1a: Potential Impact on Human Health from Increased Pollutant Concentrations Caused by Activities Associated with the Proposed Operations

It is unlikely that the long-term and short-term NAAQS will be exceeded at AQSRs as a result of the project with mitigation; however, the short-term NAAQS could be exceeded in areas in which they are applicable (off-site) without mitigation. The impacts will cease at the end of the operational life of the activity. The significance rating is "low" without mitigation measures applied and becomes "very low" with design mitigation measures applied (Table 34).

7.3.2 Potential Impact B2a: Increased Nuisance Dustfall Rates Associated with the Proposed Operations

It is unlikely that the NDCR limit for residential areas will be exceeded at AQSRs (with and without mitigation) as a result of the project. The impacts will cease at the end of the operational life of the activity. The significance rating is "very low" without and with design mitigation measures applied (Table 35).

Table 34: Health risk impact significance summary table for the proposed operations

Air Quality	Description	Rating
Project activity or issue	Proposed operations associated with the proposed second flash dryer	N/A
Potential impact	Increased health risk at AQSRs	N/A
	Nature of the Impact	
Positive or negative	Negative due to increase in $PM_{2.5}$, PM_{10}, SO_2, NO_x and CO concentrations at AQSRs	-
	Significance Before Mitigation	
Intensity	Minor (Slight) change, disturbance or nuisance. Associated with minor consequences or deterioration. Targets, limits and thresholds of concern rarely exceeded. Require only minor interventions or clean-up actions. Sporadic complaints could be expected.	L
Duration	Long term, between 10 and 20 years (likely to cease at the end of the operational life of the activity).	H
Extent	Whole site.	L
Consequence	Medium.	
Probability	Possible.	L
Significance	**Unlikely that it will have a real influence on the decision. Limited mitigation is likely to be required.**	**Low**
	Significance After Design Mitigation	
Intensity	Negligible change, disturbance or nuisance. Associated with very minor consequences or deterioration. Targets, limits and thresholds of concern never exceeded. No interventions or clean-up actions required. No complaints anticipated.	VL
Duration	Long term, between 10 and 20 years (likely to cease at the end of the operational life of the activity).	H
Extent	A part of the site/property.	VL
Consequence	Low.	

Air Quality	Description	Rating
Probability	Possible.	M
Significance	**It will not have an influence on the decision. Does not require any mitigation.**	**Very Low**
Design mitigation measures	Baghouse.	N/A

Table 35: Nuisance impact significance summary table for the proposed operations

Air Quality	Description	Rating
Project activity or issue	Proposed operations associated with the proposed second flash dryer	N/A
Potential impact	Nuisance dustfall rates at AQSRs	N/A
Nature of the Impact		
Positive or negative	Negative due to increase in dustfall rates at AQSRs	-
Significance Before Mitigation		
Intensity	Negligible change, disturbance or nuisance. Associated with very minor consequences or deterioration. Targets, limits and thresholds of concern never exceeded. No interventions or clean-up actions required. No complaints anticipated.	VL
Duration	Long term, between 10 and 20 years (likely to cease at the end of the operational life of the activity).	H
Extent	A part of the site/property.	VL
Consequence	Low.	
Probability	Possible.	M
Significance	**It will not have an influence on the decision. Does not require any mitigation.**	**Very Low**
Significance After Mitigation		
Intensity	Negligible change, disturbance or nuisance. Associated with very minor consequences or deterioration. Targets, limits and thresholds of concern never exceeded. No interventions or clean-up actions required. No complaints anticipated.	VL

Air Quality	Description	Rating
Duration	Long term, between 10 and 20 years (likely to cease at the end of the operational life of the activity).	H
Extent	A part of the site/property.	VL
Consequence	Low.	
Probability	Possible.	M
Significance	**It will not have an influence on the decision. Does not require any mitigation.**	**Very Low**
Design mitigation measures	Baghouse.	N/A

Notes: Although the significance rating does not change for the “nuisance dustfall rates at AQSRs” between unmitigated and design mitigated the extent of impacted area does reduce with design mitigation applied.

7.4 Assessment of Impact – Smelter Complex Proposed Future Operations (Existing Smelter Complex and Proposed Second Flash Dryer Operations)

Simulation results of particulate and gaseous emissions for the proposed future operations at the Impala Smelter Plant are discussed in this section. The future Impala Smelter Plant operations comprises of the existing mitigated dryers, converter and furnace sources and the proposed second Flash Dryer operations.

7.4.1 Respirable particulate matter ($PM_{2.5}$)

The simulated annual average $PM_{2.5}$ concentrations as a result of the Smelter Plant proposed future operations do not exceed the current NAAQS of 20 µg/m^3 or the future NAAQS of 15 µg/m^3 off-site or at any AQSRs (Figure 34). The simulated 24-hour $PM_{2.5}$ concentrations are above the current and future NAAQ limit (Figure 35) but the current 24-hour NAAQS (4 days of exceedance of 40 µg/m^3) and the future 24-hour NAAQS (4 days of exceedance of 25 µg/m^3) are not exceeded off-site or at any AQSRs (Figure 36).

7.4.2 Inhalable particulate matter (PM_{10})

Simulated annual average PM_{10} concentrations as a result of the Smelter Plant proposed future operations do not exceed the NAAQS of 40 µg/m^3 off-site or at any AQSRs (Figure 37). The simulated 24-hour PM_{10} concentrations are below the 24-hour NAAQ limit and thus the 24-hour NAAQS (4 days of exceedance of 75 µg/m^3) are not exceeded off-site or at any AQSRs (Figure 38).

7.4.3 Fallout Dust

The simulated daily average dustfall rates as a result of the Smelter Plant proposed future operations does not exceed the NDCR limit for non-residential areas (1 200 mg/m^2-day) on-site and does not exceed the NDCR limit for residential areas (600 mg/m^2-day) at any AQSRs and are below 400 mg/m^2-day at all agricultural areas (Figure 39).

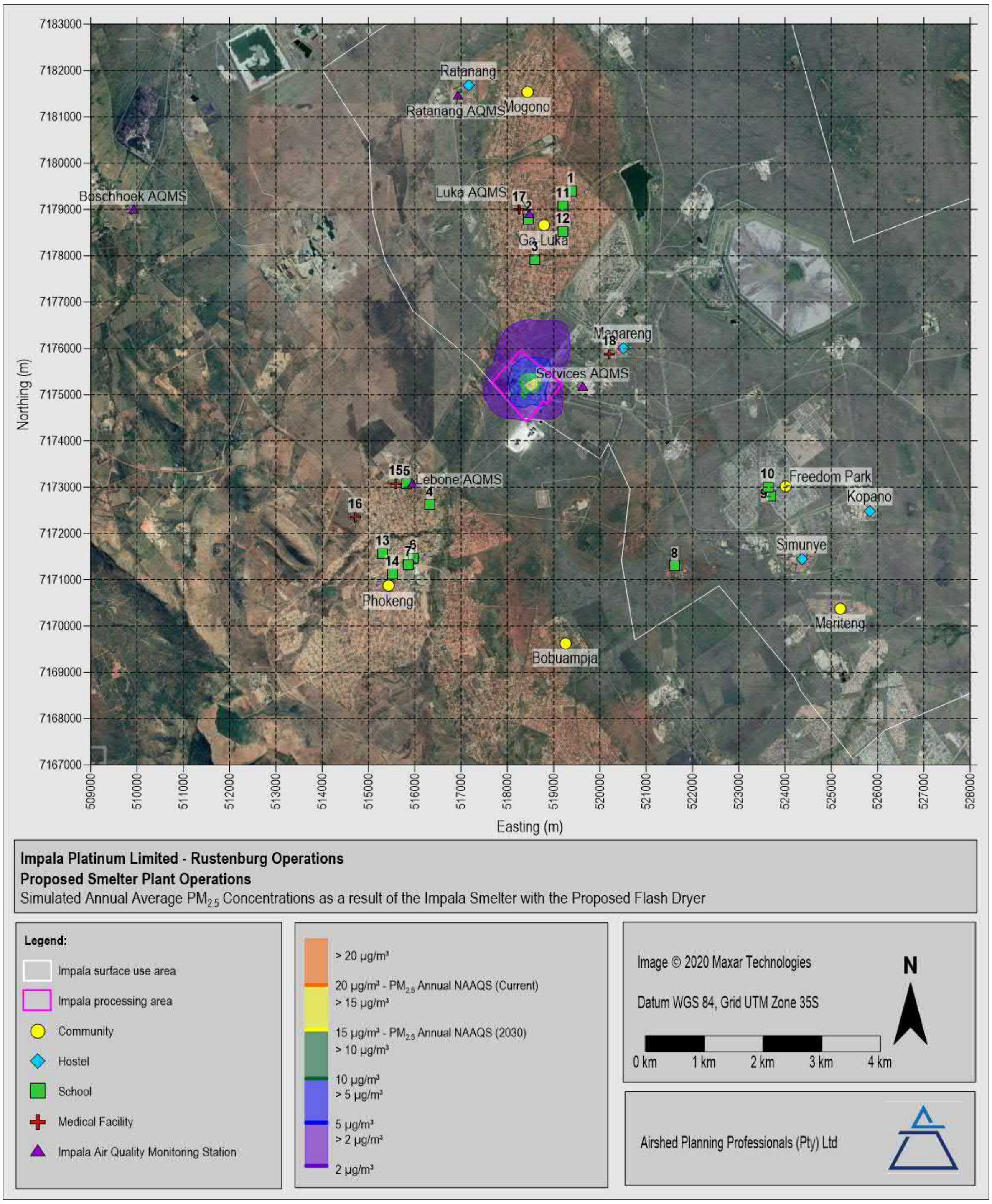


Figure 34: Simulated annual average $PM_{2.5}$ concentrations as a result of the future smelter plant operations

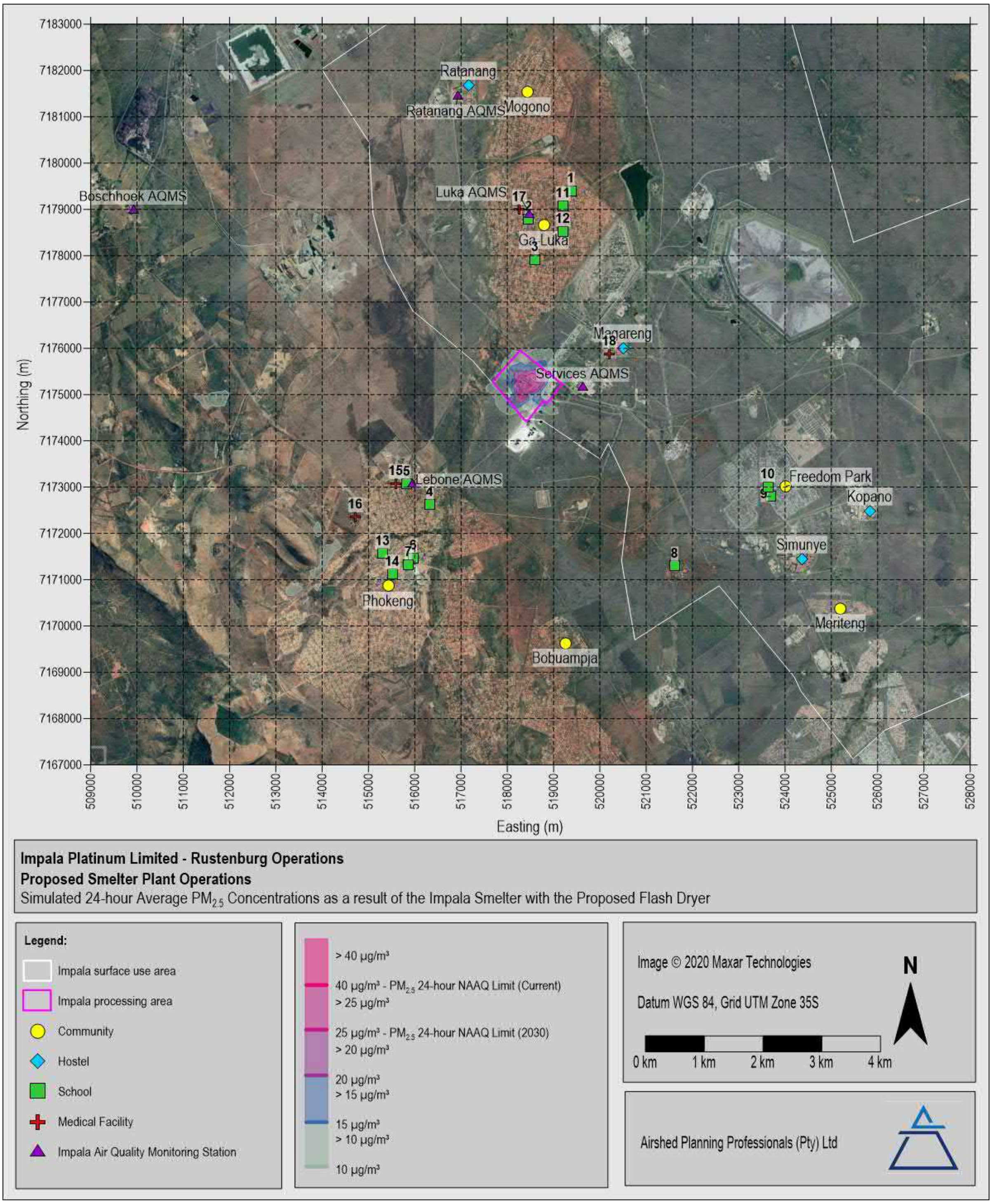


Figure 35: Simulated 24-hour average $PM_{2.5}$ concentrations as a result of the future smelter plant operations

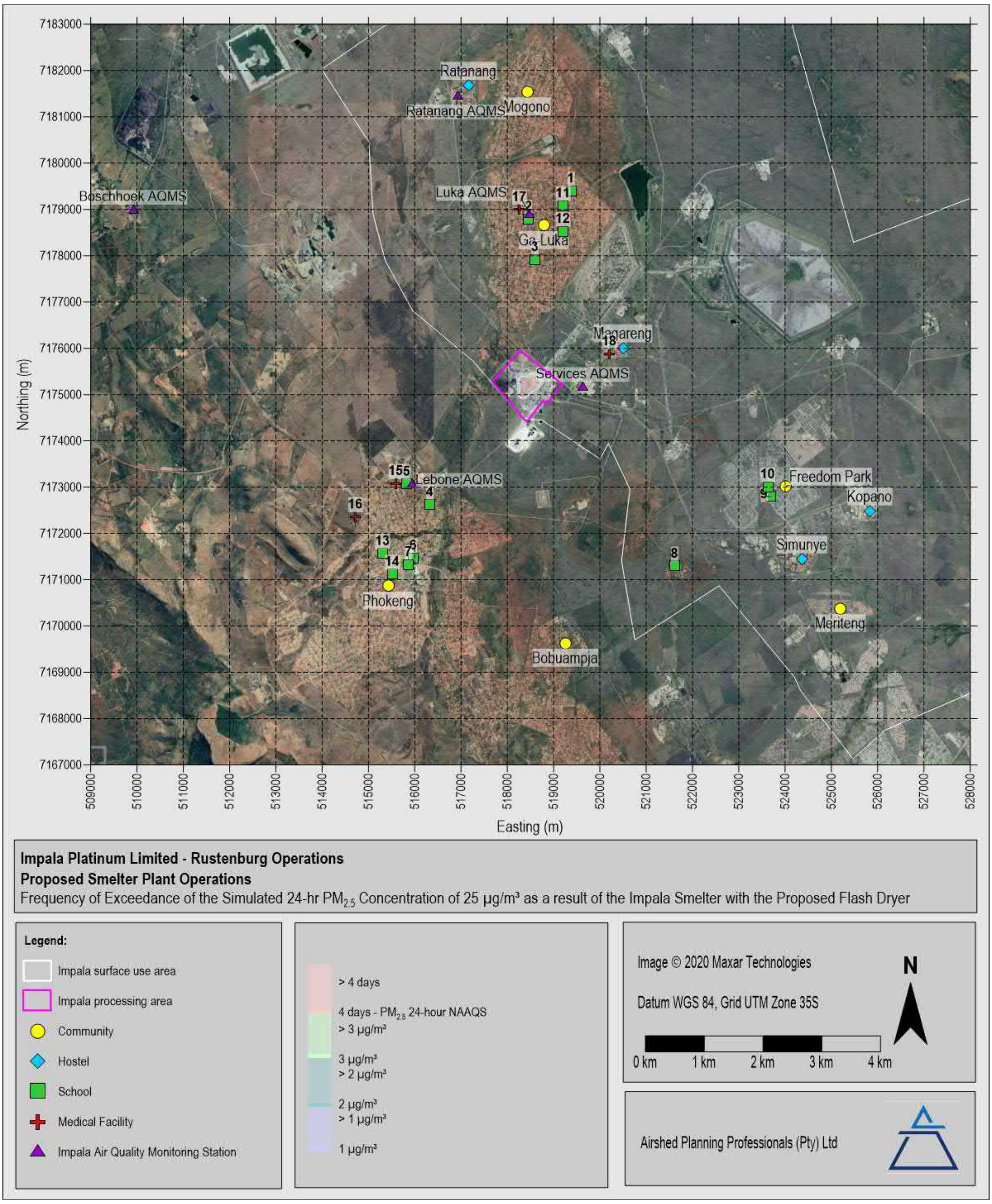


Figure 36: Simulated frequency of exceedance 24-hour average $PM_{2.5}$ concentration of 25 µg/m³ as a result of the future smelter plant operations

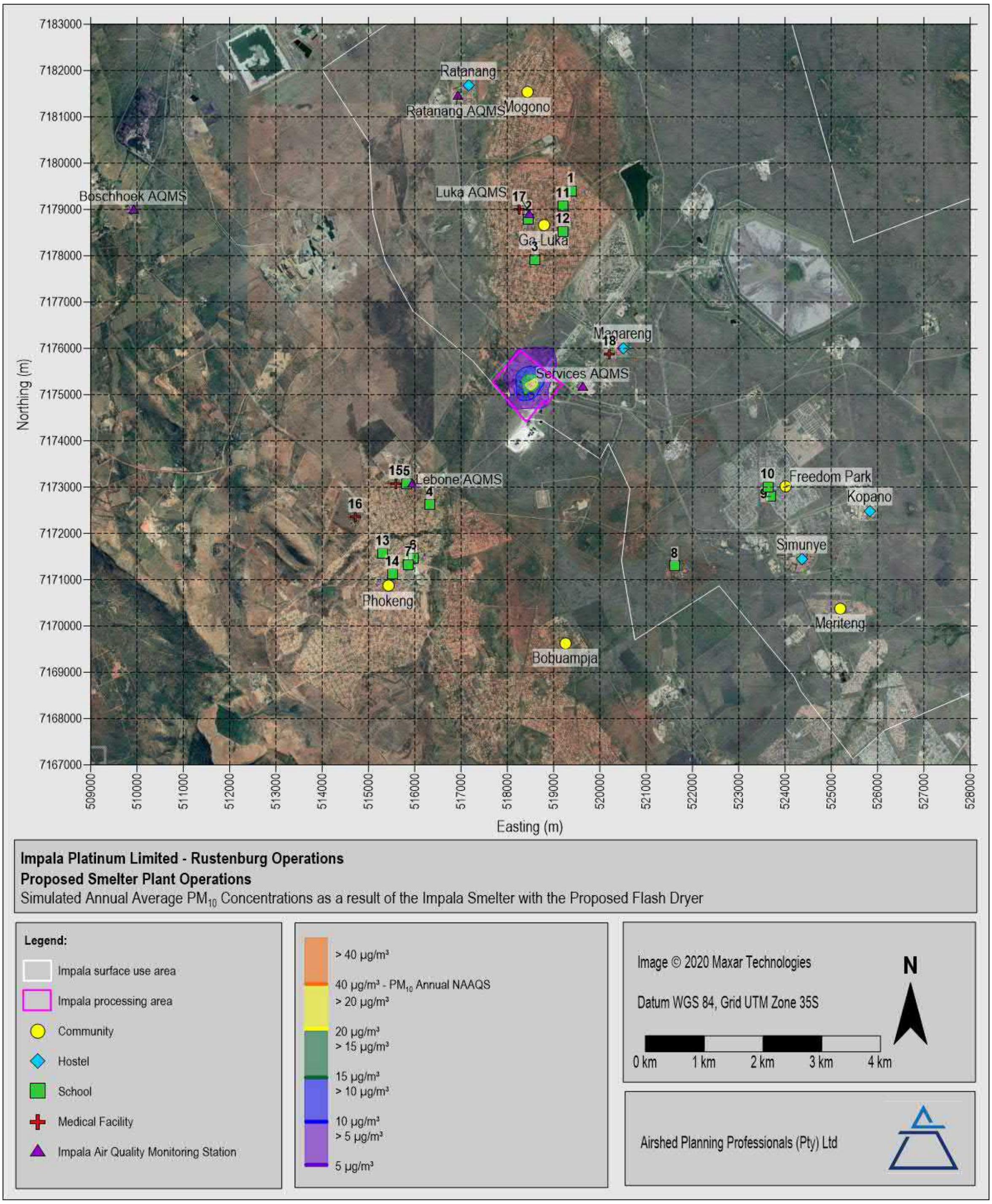


Figure 37: Simulated annual average PM_{10} concentrations as a result of the future smelter plant operations

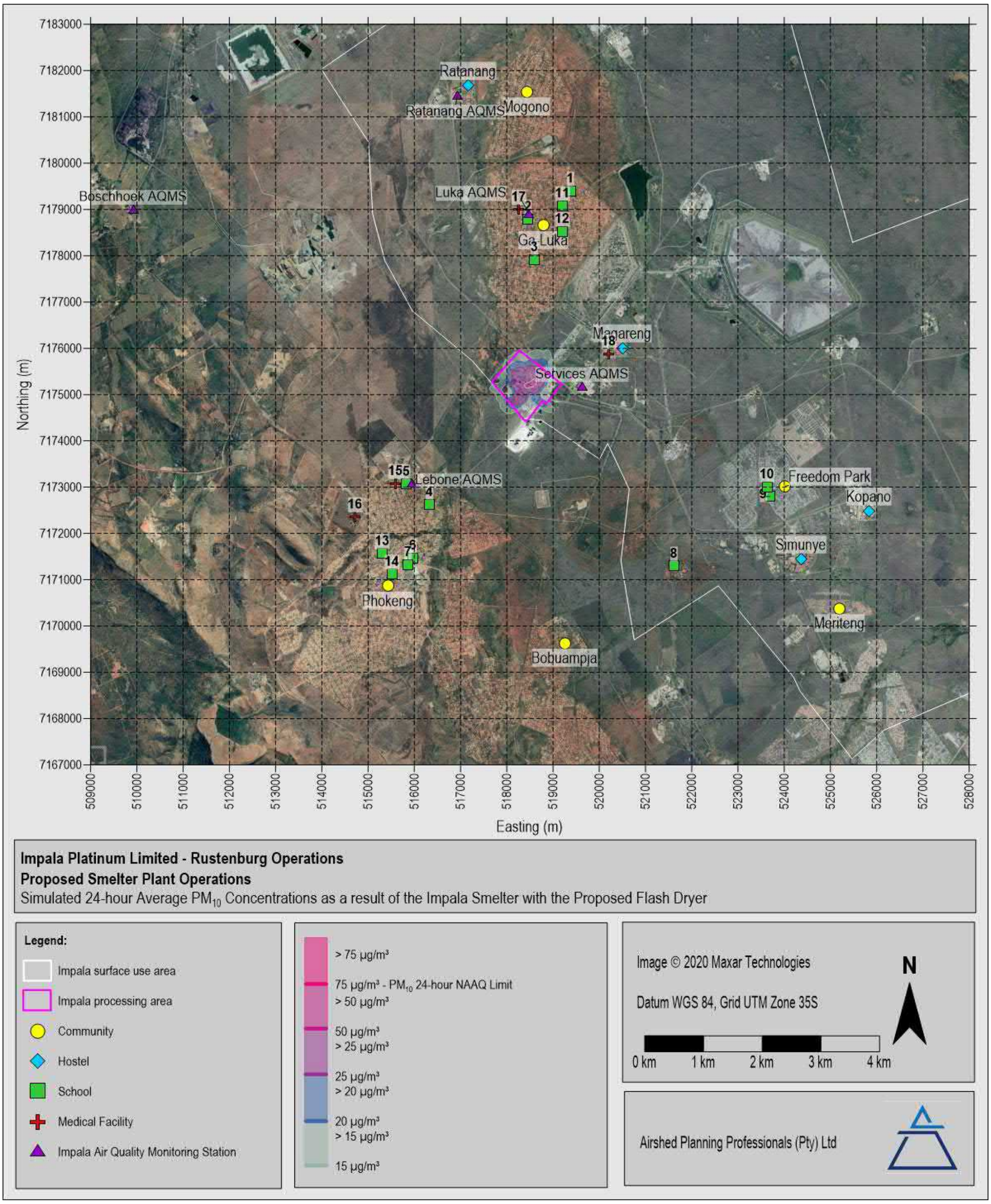


Figure 38: Simulated 24-hour average PM_{10} concentrations as a result of the future smelter plant operations

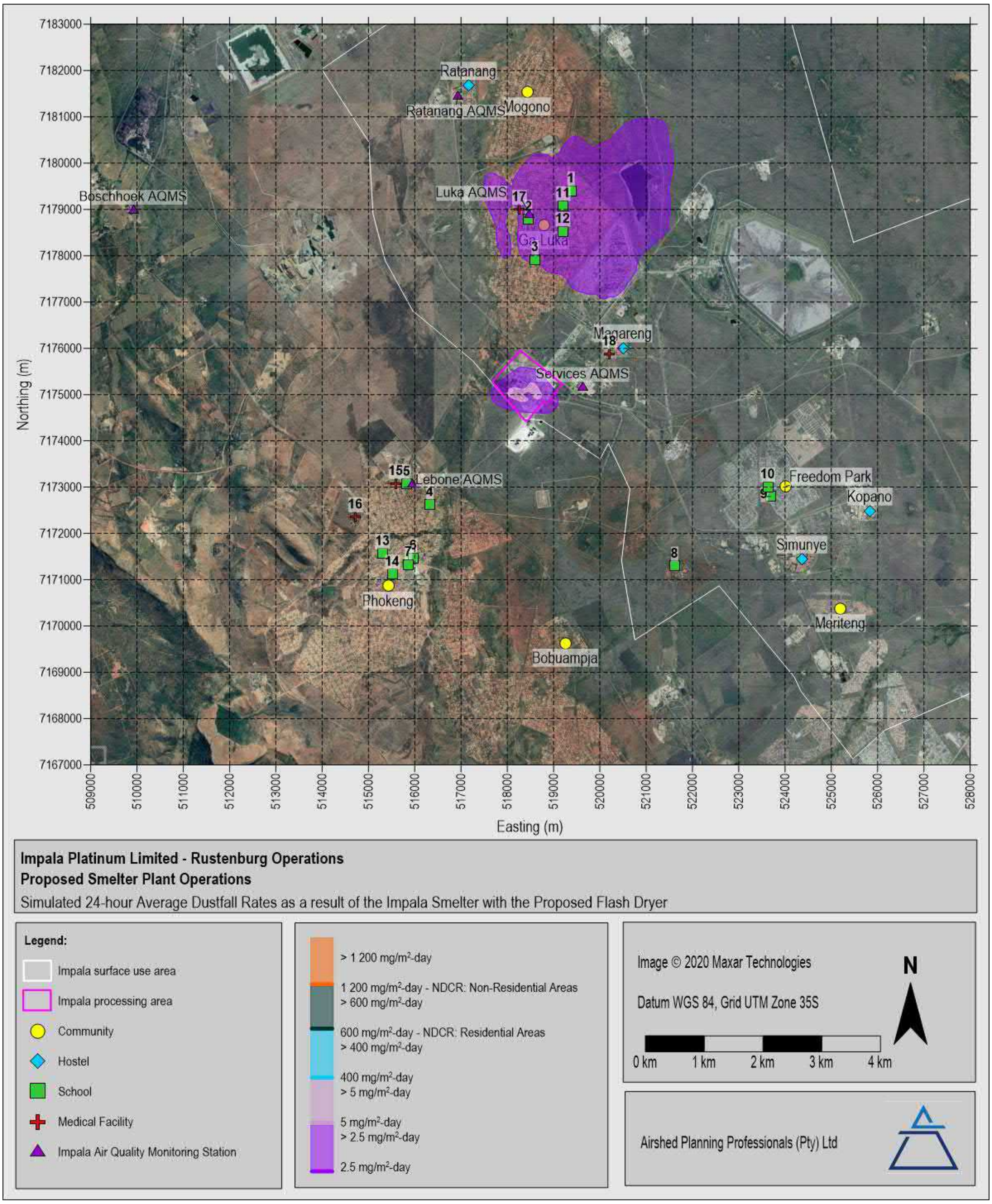


Figure 39: Simulated average daily dustfall rates as a result of the future smelter plant operations

7.4.4 Sulfur Dioxide (SO_2)

The simulated annual average SO_2 concentrations as a result of the Smelter Plant proposed future operations do not exceed the NAAQS of 50 µg/m^3 off-site or at any AQSRs (Figure 40). The simulated 24-hour SO_2 concentrations are above the NAAQ limit but the 24-hour NAAQS (4 days of exceedance of 125 µg/m^3) is not exceeded off-site or at any AQSRs (Figure 41). The simulated 1-hour SO_2 concentrations are above the NAAQ limit but do not exceed the 1-hour NAAQS (88 hours of exceedance of 350 µg/m^3) off-site or at any AQSRs (Figure 42). The simulated annual average SO_2 concentrations are likely to be below the critical levels for all vegetation types across the domain (Figure 40).

7.4.5 Nitrogen Dioxide (NO_2)

It was assumed that all NO_x is converted to NO_2 and the simulated NO_x concentrations were compared to the NO_2 NAAQS. Simulated annual average NO_x concentrations, as a result of Smelter Plant proposed future operations, do not exceed the NO_2 NAAQS of 40 µg/m^3 off-site or at any AQSRs (Figure 43). The simulated 1-hour NO_x concentrations are below the 1-hour NO_2 NAAQ limit and thus the 1-hour NAAQS (88 hours of exceedance of 200 µg/m^3) are not exceeded off-site or at any AQSRs (Figure 44). The simulated annual average NO_x concentrations are likely to be below the critical levels for all vegetation types across the domain (Figure 43).

7.4.6 Carbon Monoxide (CO)

The simulated 8-hour CO concentrations as a result of the Smelter Plant proposed future operations are below the NAAQ limit and thus the 8-hour NAAQS (11 8-hours of exceedance of 10 000 µg/m^3) is not exceeded off-site or at any AQSRs (Figure 45). The simulated 1-hour CO concentrations are below the NAAQ limit and thus do not exceed the 1-hour NAAQS (88 hours of exceedance of 30 000 µg/m^3) off-site or at any AQSRs (Figure 46).

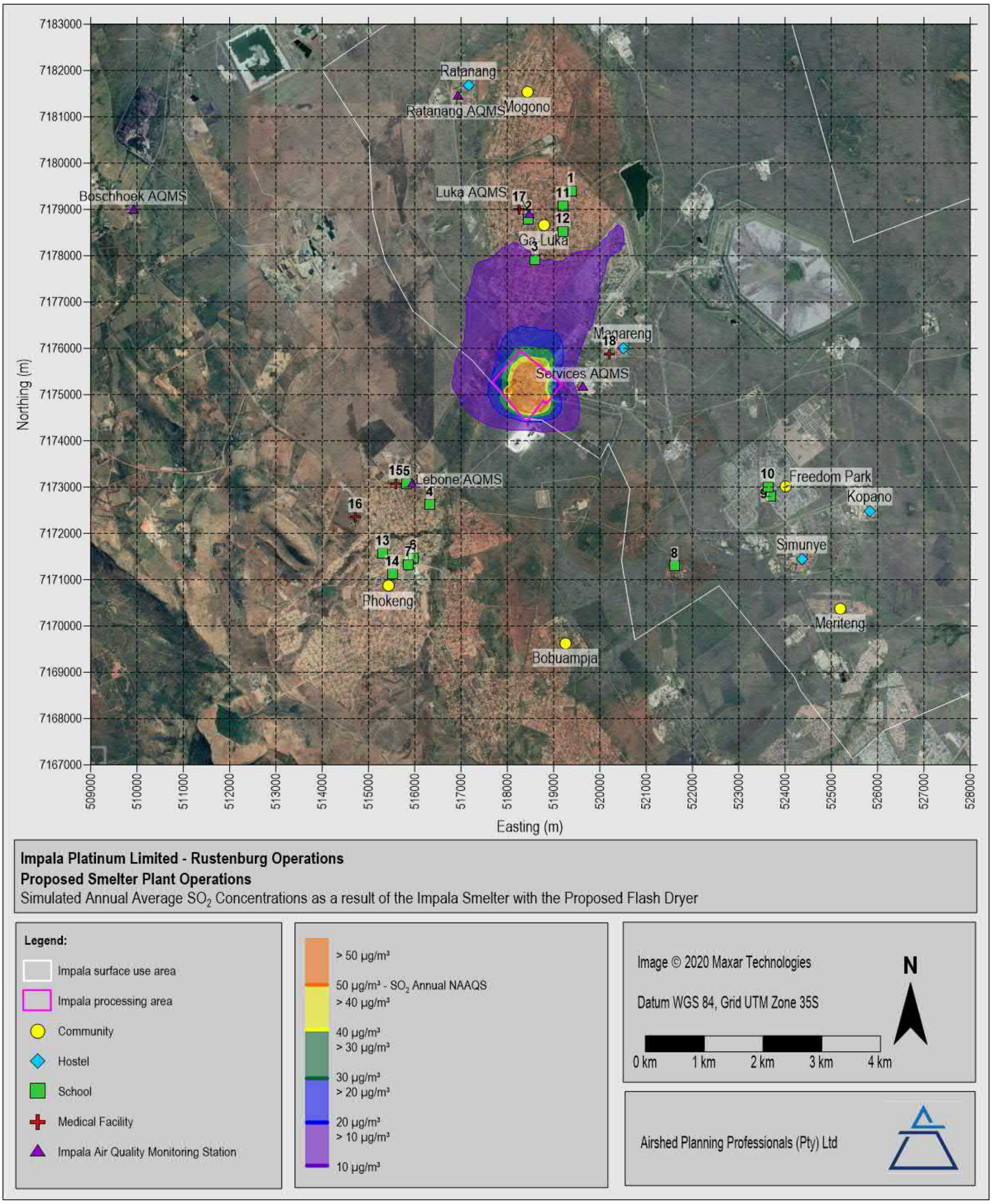


Figure 40: Simulated annual average SO_2 concentrations as a result of the future smelter plant operations

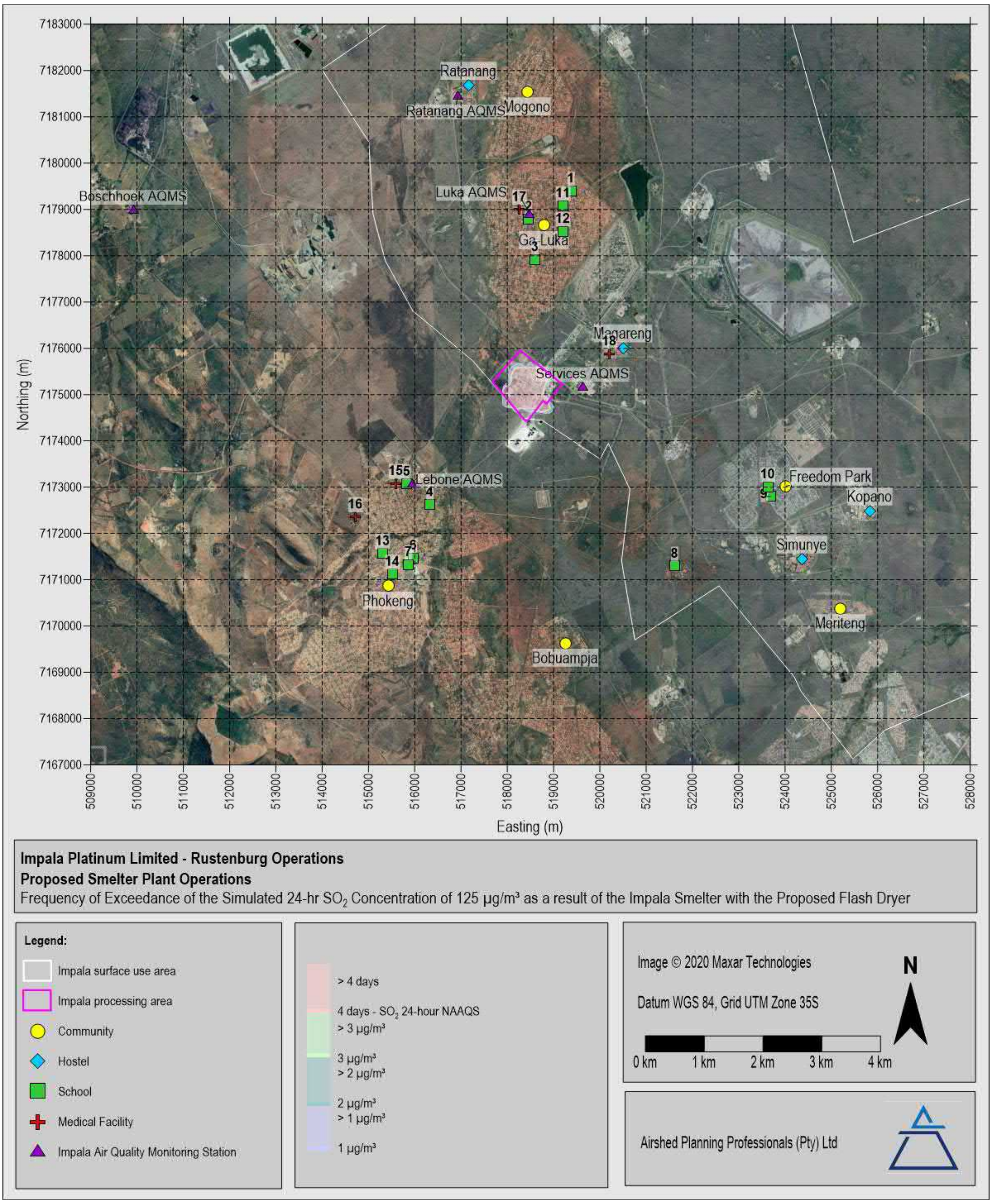


Figure 41: Simulated frequency of exceedance of the 24-hour average SO_2 concentration of 125 µg/m³ as a result of the future smelter plant operations

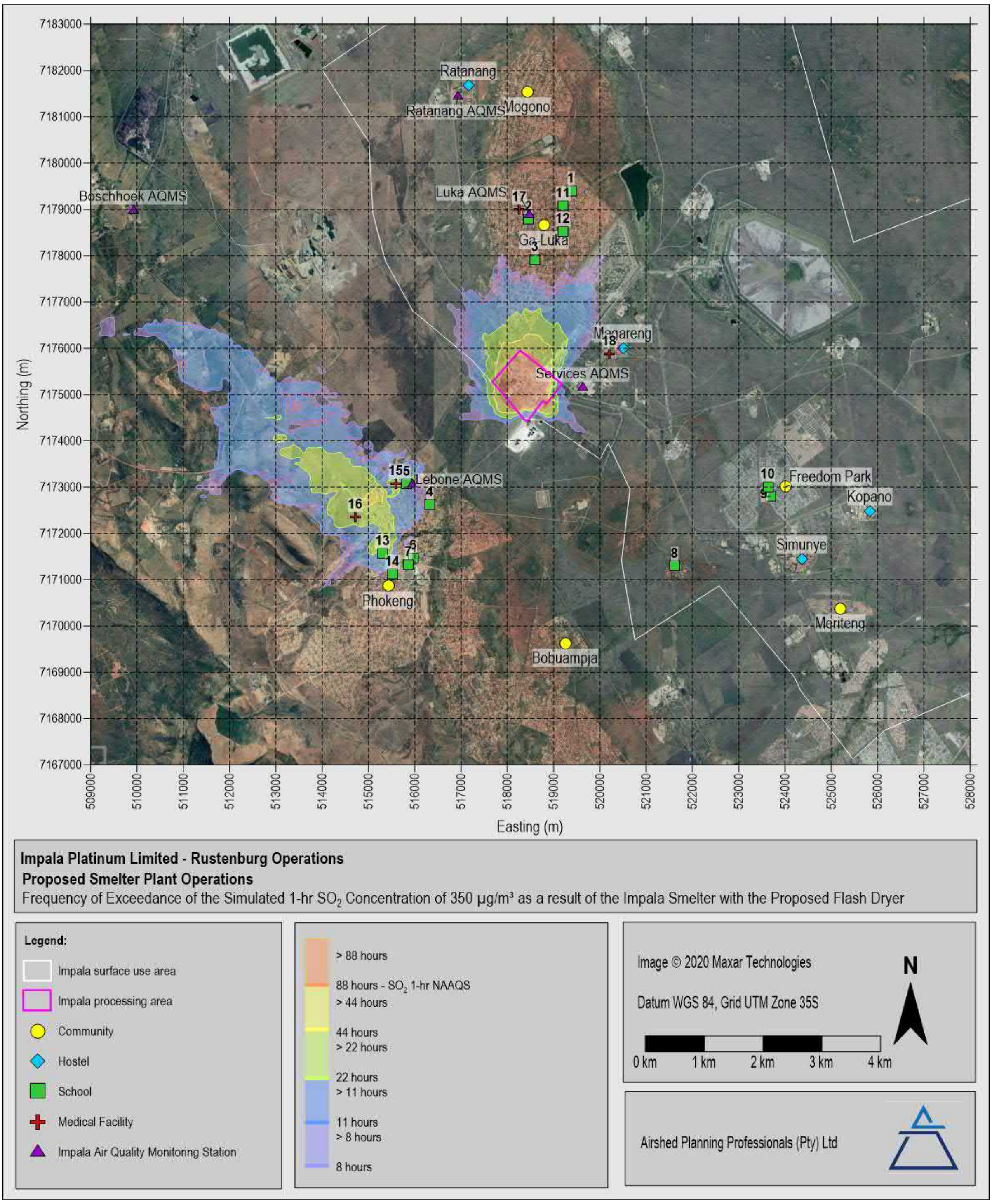


Figure 42: Simulated frequency of exceedance of the 1-hour SO_2 concentration of 350 µg/m³ as a result of the future smelter plant operations

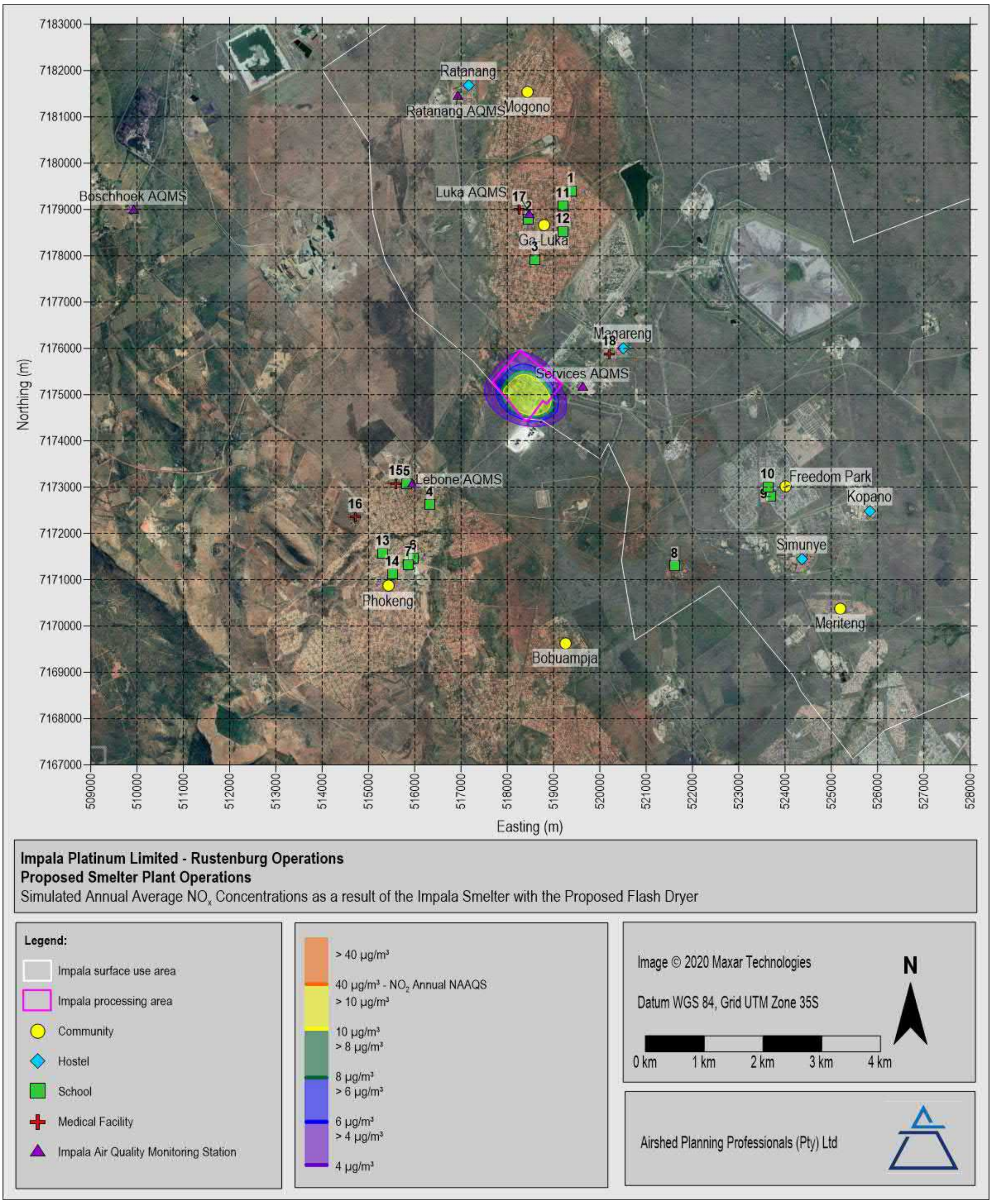


Figure 43: Simulated annual average NO_x concentrations as a result of the future smelter plant operations

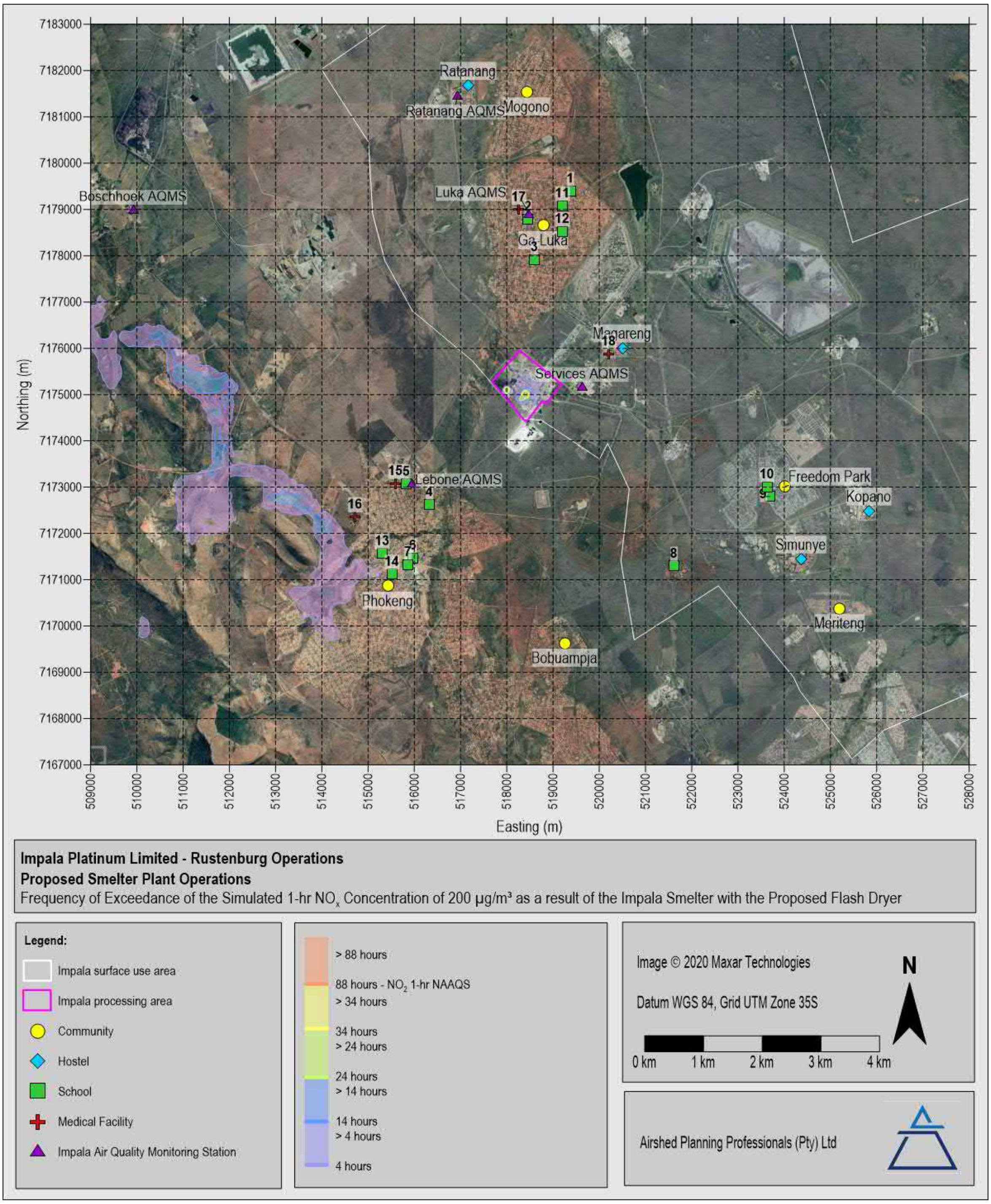


Figure 44: Simulated frequency of exceedance of the 1-hour NO_x concentration of 200 µg/m³ as a result of the future smelter plant operations

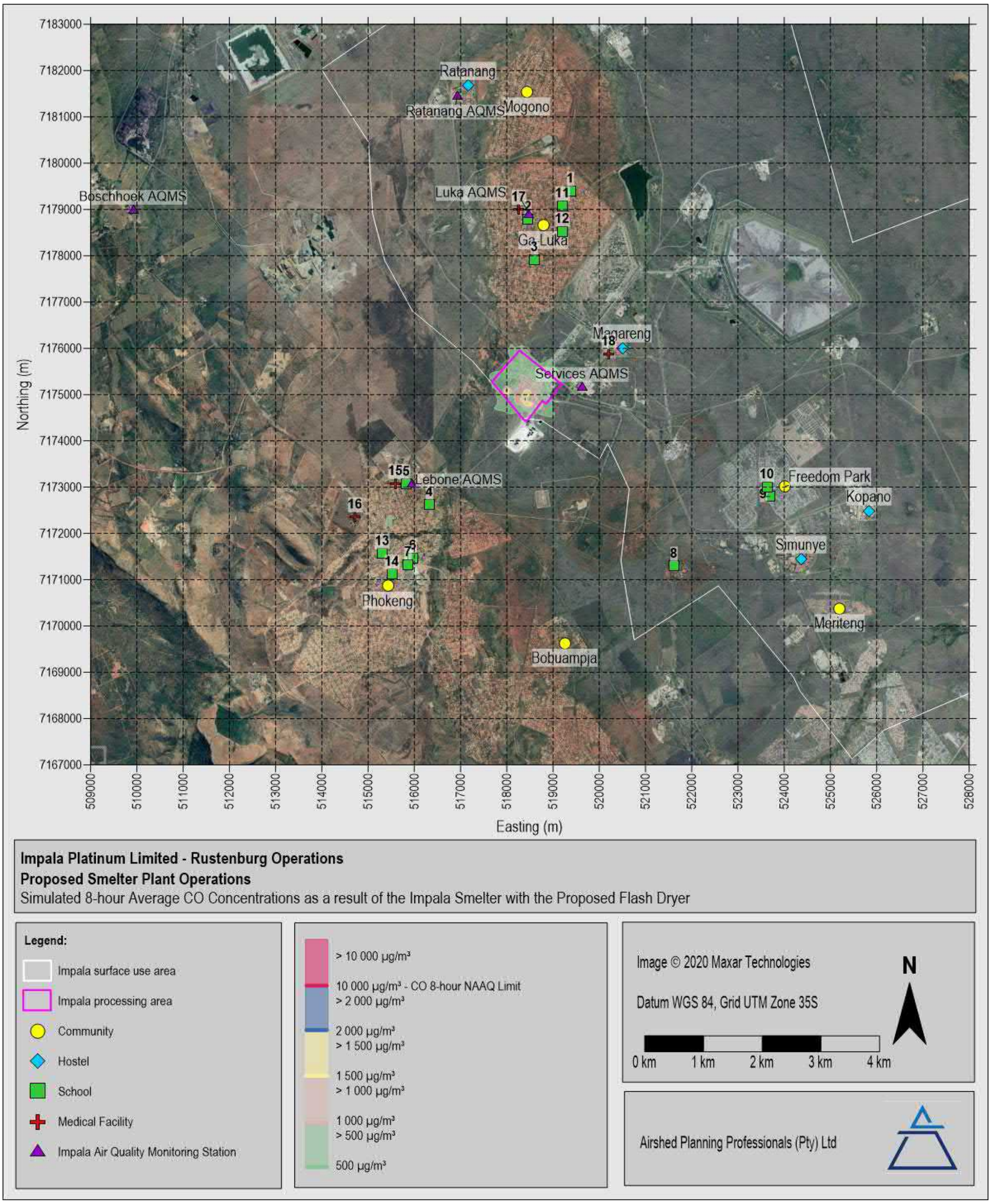


Figure 45: Simulated 8-hour average CO concentrations as a result of the future smelter plant operations

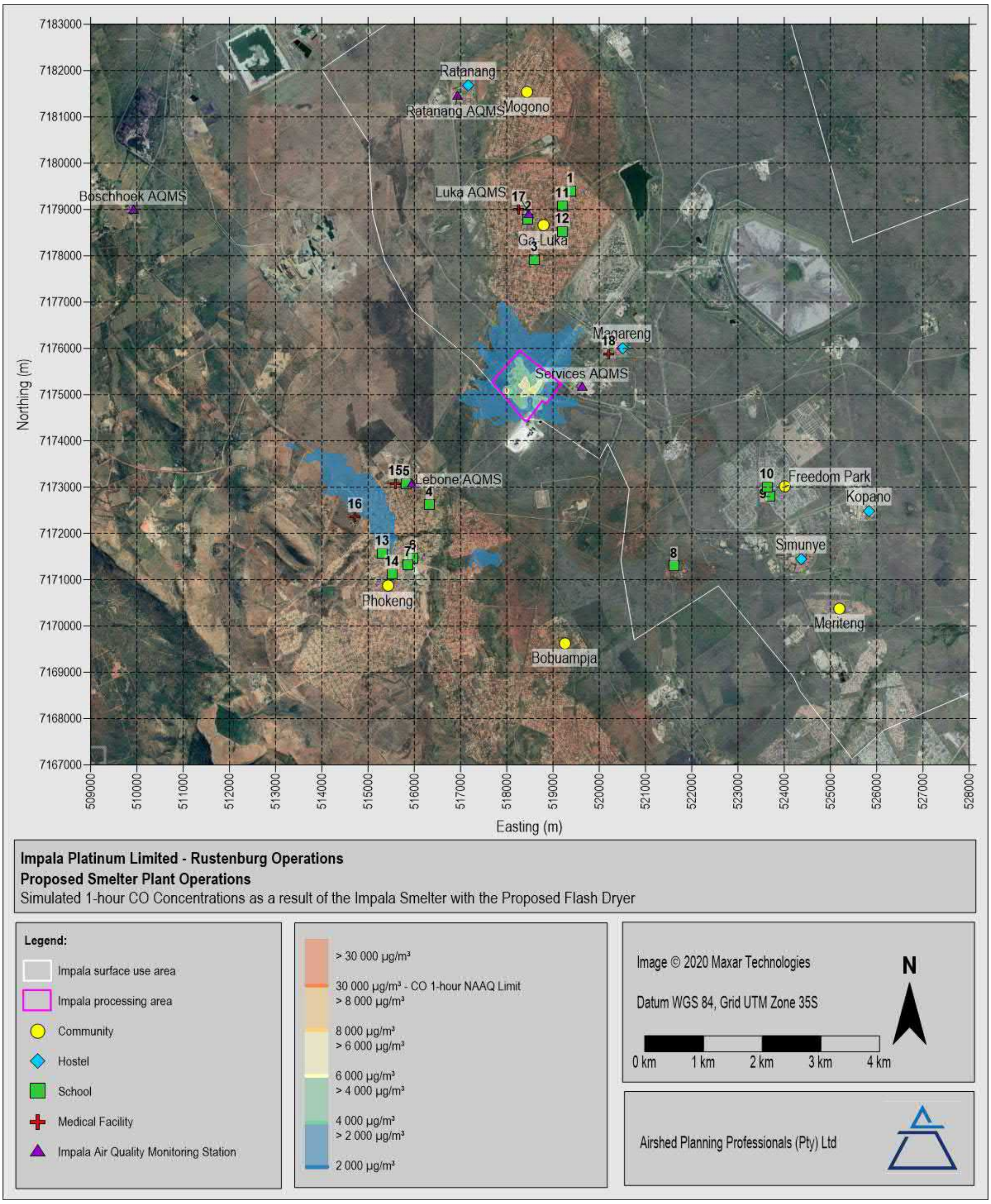


Figure 46: Simulated 1-hour CO concentrations as a result of the future smelter plant operations

7.5 Assessment of Impact – Impala Proposed Future Operations (All Existing Impala Operations and Proposed Second Flash Dryer Operations)

Simulation results of particulate and gaseous emissions for the proposed future operations at the entire Impala facility are discussed in this section. The future Impala operations comprises of all the existing mitigated sources at Impala and the proposed second flash dryer operations. The summarised simulated results for $PM_{2.5}$, PM_{10}, SO_2 and NO_x are shown in Table 36 to Table 41 (figures in bold indicate exceedances of the NAAQS). The source group contributions based on the simulated results for $PM_{2.5}$, PM_{10} and NO_x are shown in Table 37 to Table 42.

The simulated $PM_{2.5}$ exceeds the future annual NAAQS (15 µg/m³) at Impala Platinum Hospital (Table 36). The simulated $PM_{2.5}$ exceeds the future 24-hour NAAQS (4 days of exceedance of 25 µg/m³) at Kelekitso Early Learning Centre and Impala Platinum Hospital (Table 36). The source group with the greatest contribution to the simulated concentrations at Kelekitso Early Learning Centre is crushing and screening (Figure 47):

1. Crushing and Screening = 81.2%
2. Vehicles Travelling on Paved Roads (incl. Vehicle Exhaust) = 8.9%
3. Smelter Building Fugitives = 4.3%
4. Current Stacks = 3.1%
5. Ventilation Shafts = 2.1%
6. Proposed Flash Dryer Stack = 0.2%
7. Materials Handling = 0.1%
8. Vehicles Travelling on Unpaved Roads (incl. Vehicle Exhaust & Grading) = <0.1%
9. Windblown dust from Tailings Storage Facilities = <0.1%
10. Windblown dust from Waste Rock Dumps = <0.1%

It is likely that the crushing and screening is the main contributor to simulated ground-level $PM_{2.5}$ concentrations as there are nine operational crushers and eight operational screens, crushing and screening what is considered low moisture materials. Additionally, the crushers and screens are operating upwind of the Learning Centre 34% of the period. A control efficiency of 70% was applied to the crushing and screening emissions to account for enclosure of crushers and screens, without particulate matter ("dust") extraction systems and fabric filters (baghouses).

The source group with the greatest contribution to the simulated concentrations at Impala Platinum Hospital is vehicles travelling on paved roads (Figure 48):

1. Vehicles Travelling on Paved Roads (incl. Vehicle Exhaust) = 51.7%
2. Crushing and Screening = 40%
3. Ventilation Shafts = 4.6%
4. Smelter Building Fugitives = 1.7%
5. Current Stacks = 1.6%
6. Materials Handling = 0.2%
7. Proposed Flash Dryer Stack = 0.1%
8. Vehicles Travelling on Unpaved Roads (incl. Vehicle Exhaust & Grading) = <0.1%
9. Windblown dust from Tailings Storage Facilities = <0.1%
10. Windblown dust from Waste Rock Dumps = <0.1%

Table 36: Summary of simulated results for $PM_{2.5}$ as a result of the Impala proposed future operations

Pollutant	$PM_{2.5}$		
Averaging Period	Annual	24-hour	
Reporting Unit	Concentration in µg/m³	Days per year	
NAAQS	20 µg/m³/ 15 µg/m³	4 allowable exceedances of 25 µg/m³	4 allowable exceedances of 40 µg/m³
AQSR/Source Group	Impala Proposed Future Operations (All Existing Impala Operations and Proposed Flash Dryer Operations)		
Ratanang	4.85	0	0
Magareng	12.7	4	0
Simunye	6.26	0	0
Kopano	3.69	0	0
Pudunong	1.36	0	0
Phokeng	0.440	0	0
Bobuampja	0.433	0	0
Ga-Luka	9.61	1	0
Mogono	5.06	0	0
Freedom	4.05	0	0
Meriteng	4.36	0	0
Kanana	0.880	0	0
Mafika	1.03	0	0
Serutube	1.27	0	0
Thethe Secondary School	7.82	0	0
Luka Primary School	9.00	1	0
Kelekitso Early Learning Centre	13.6	**23**	0
Matlhware Primary School	1.34	0	0
Kitsong High School	1.64	0	0
Tumagole Primary School	0.743	0	0
Matale Secondary School	0.65	0	0
Kutlwanong School for the Deaf	1.35	0	0
Vukuzenzele Primary School	4.35	0	0
Freedom Park Secondary School	4.09	0	0
Molotlegi Secondary School	8.62	0	0
Ramotse Primary School	10.7	2	0
Moremogolo Primary School	0.647	0	0
Semane Early Learning Centre	0.548	0	0

Pollutant	$PM_{2.5}$		
Averaging Period	Annual	24-hour	
Reporting Unit	Concentration in µg/m³	Days per year	
NAAQS	20 µg/m³/ 15 µg/m³	4 allowable exceedances of 25 µg/m³	4 allowable exceedances of 40 µg/m³
AQSR/Source Group	Impala Proposed Future Operations (All Existing Impala Operations and Proposed Flash Dryer Operations)		
Bafokeng Health Centre	1.42	0	0
Tapologo Hospice Centre	0.80	0	0
Luka Clinic	8.28	0	0
Impala Platinum Hospital	17.0	**41**	2
Lebone AQMS	1.57	0	0
Luka AQMS	8.60	1	0
Boschhoek AQMS	0.918	0	0
Ratanang AQMS	5.86	0	0

Table 37: Source group contributions to simulated results for $PM_{2.5}$ as a result of the Impala proposed future operations

Pollutant	$PM_{2.5}$									
Averaging Period	Annual									
AQSR/Source Group	Building Fugitives	Materials Handling	Vehicles Travelling on Paved Roads	Current Stacks	Vehicles Travelling on Unpaved Roads	Ventilation Shafts	Windblown Dust from Tailings Storage Facilities	Windblown Dust from Waste Rock Dumps	Crushing and Screening	Proposed Flash Dryer
Ratanang	2.8%	0.5%	33.1%	5.2%	0.0%	7.4%	0.0%	0.0%	50.6%	0.4%
Magareng	1.7%	0.3%	43.2%	1.9%	0.0%	4.0%	0.0%	0.0%	48.8%	0.1%
Simunye	0.6%	0.8%	69.3%	1.8%	0.0%	3.9%	0.0%	0.0%	23.4%	0.1%
Kopano	0.8%	3.4%	57.3%	2.7%	0.0%	8.1%	0.0%	0.0%	27.6%	0.2%
Pudunong	3.9%	0.5%	11.6%	12.9%	0.0%	4.7%	0.0%	0.0%	65.4%	1.0%
Phokeng	1.5%	0.9%	17.2%	24.6%	0.0%	9.5%	0.0%	0.0%	44.2%	2.1%
Bobuampja	2.0%	1.3%	18.3%	20.3%	0.0%	11.4%	0.0%	0.0%	45.2%	1.4%
Ga-Luka	4.1%	0.2%	11.4%	3.8%	0.0%	3.0%	0.0%	0.0%	77.2%	0.3%
Mogono	2.9%	0.5%	27.5%	4.7%	0.0%	9.6%	0.0%	0.0%	54.3%	0.3%
Freedom	0.9%	1.5%	56.9%	2.7%	0.0%	5.8%	0.0%	0.0%	32.0%	0.2%
Meriteng	0.6%	1.7%	43.4%	2.3%	0.0%	8.9%	0.0%	0.0%	42.8%	0.2%
Kanana	1.6%	14.8%	18.5%	8.6%	0.0%	13.2%	0.0%	0.0%	42.6%	0.7%
Mafika	1.3%	8.6%	30.7%	7.0%	0.0%	21.5%	0.0%	0.0%	30.4%	0.5%
Serutube	1.2%	10.0%	33.7%	5.3%	0.0%	17.8%	0.0%	0.0%	31.5%	0.4%
Thethe Secondary School	2.4%	0.4%	42.5%	4.5%	0.0%	6.4%	0.0%	0.0%	43.5%	0.3%
Luka Primary School	3.8%	0.3%	15.4%	3.8%	0.0%	4.1%	0.0%	0.0%	72.3%	0.3%
Kelekitso Early Learning Centre	4.2%	0.2%	11.3%	4.2%	0.0%	2.9%	0.0%	0.0%	77.0%	0.3%

Pollutant	PM2.5									
Averaging Period	Annual									
AQSR/Source Group	Building Fugitives	Materials Handling	Vehicles Travelling on Paved Roads	Current Stacks	Vehicles Travelling on Unpaved Roads	Ventilation Shafts	Windblown Dust from Tailings Storage Facilities	Windblown Dust from Waste Rock Dumps	Crushing and Screening	Proposed Flash Dryer
Matlhware Primary School	4.3%	0.1%	8.9%	3.1%	0.0%	2.1%	0.0%	0.0%	81.2%	0.2%
Kitsong High School	3.8%	0.5%	12.4%	12.5%	0.0%	5.2%	0.0%	0.0%	64.7%	0.9%
Tumagole Primary School	4.2%	0.4%	10.5%	11.8%	0.0%	4.1%	0.0%	0.0%	68.0%	0.9%
Matale Secondary School	2.6%	0.7%	15.0%	16.9%	0.0%	7.3%	0.0%	0.0%	56.0%	1.4%
Kutlwanong School for the Deaf	2.4%	0.7%	15.3%	19.5%	0.0%	7.6%	0.0%	0.0%	52.7%	1.8%
Vukuzenzele Primary School	2.5%	1.2%	27.1%	8.5%	0.0%	7.6%	0.0%	0.0%	52.4%	0.6%
Freedom Park Secondary School	1.0%	1.0%	51.5%	3.0%	0.0%	4.7%	0.0%	0.0%	38.5%	0.2%
Molotlegi Secondary School	1.1%	1.0%	49.3%	3.2%	0.0%	5.1%	0.0%	0.0%	40.0%	0.2%
Ramotse Primary School	3.9%	0.3%	13.5%	3.7%	0.0%	3.8%	0.0%	0.0%	74.5%	0.3%
Moremogolo Primary School	4.0%	0.2%	11.6%	3.2%	0.0%	3.0%	0.0%	0.0%	77.7%	0.2%
Semane Early Learning Centre	1.9%	0.6%	12.7%	30.1%	0.0%	6.7%	0.0%	0.0%	43.8%	4.0%
Bafokeng Health Centre	2.2%	0.7%	14.5%	25.9%	0.0%	7.5%	0.0%	0.0%	46.5%	2.9%
Tapologo Hospice Centre	4.1%	0.5%	10.8%	14.0%	0.0%	4.3%	0.0%	0.0%	65.1%	1.2%
Luka Clinic	2.3%	0.5%	11.6%	32.4%	0.0%	5.3%	0.0%	0.0%	43.2%	4.7%
Impala Platinum Hospital	4.1%	0.3%	12.0%	4.5%	0.0%	3.0%	0.0%	0.0%	75.8%	0.3%
Lebone AQMS	4.1%	0.5%	10.8%	12.5%	0.0%	4.3%	0.0%	0.0%	66.8%	1.0%
Services AQMS	3.0%	0.1%	23.1%	3.6%	0.0%	1.4%	0.0%	0.0%	68.5%	0.3%
Luka AQMS	4.1%	0.2%	11.7%	4.3%	0.0%	3.0%	0.0%	0.0%	76.3%	0.3%

Pollutant	PM2.5									
Averaging Period	Annual									
AQSR/Source Group	Building Fugitives	Materials Handling	Vehicles Travelling on Paved Roads	Current Stacks	Vehicles Travelling on Unpaved Roads	Ventilation Shafts	Windblown Dust from Tailings Storage Facilities	Windblown Dust from Waste Rock Dumps	Crushing and Screening	Proposed Flash Dryer
Boschhoek AQMS	3.1%	0.5%	14.4%	19.3%	0.0%	6.1%	0.0%	0.0%	55.1%	1.5%
Ratanang AQMS	4.1%	0.5%	10.8%	12.5%	0.0%	4.3%	0.0%	0.0%	66.8%	1.0%

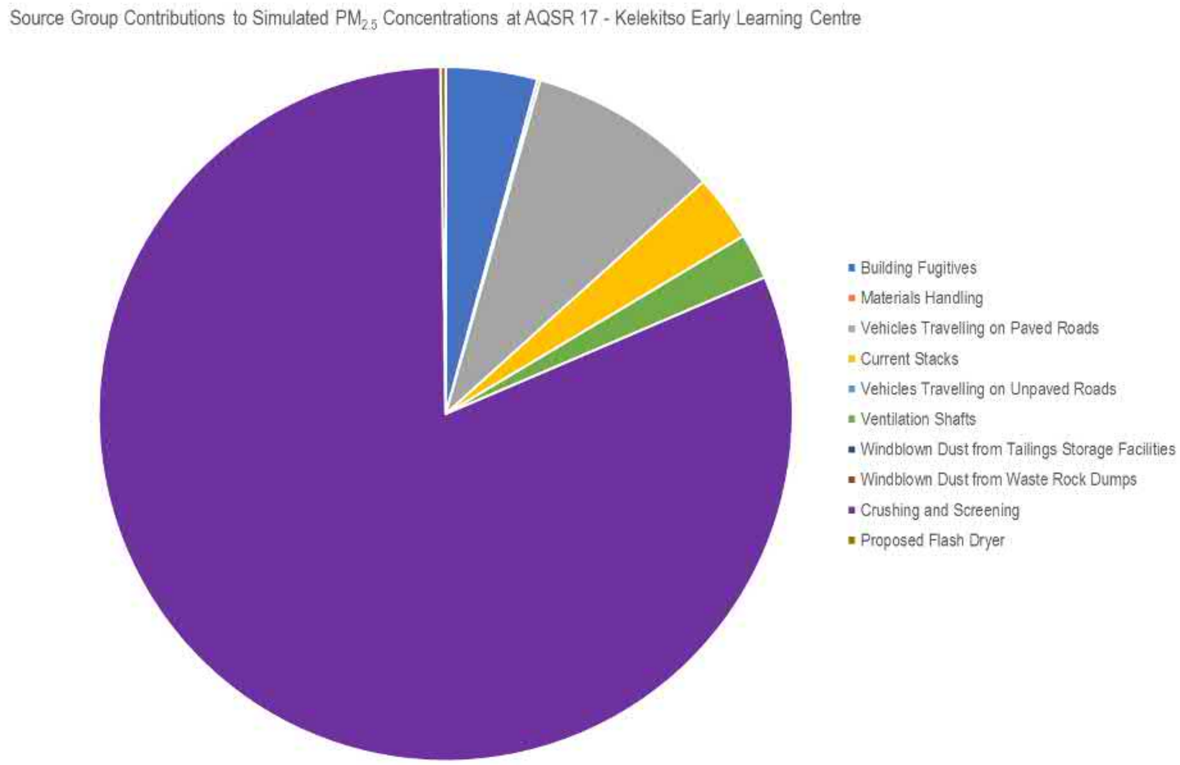


Figure 47: Source group contributions to simulated results for $PM_{2.5}$ at Kelekitso Early Learning Centre as a result of the Impala proposed future operations

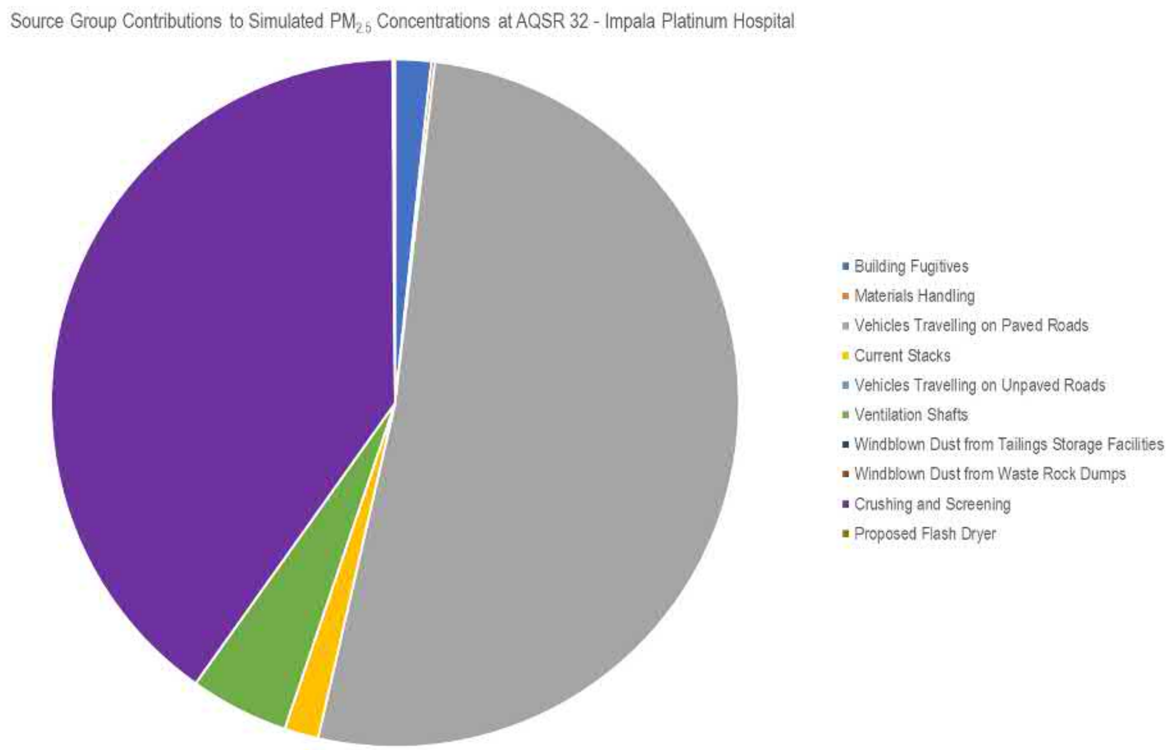


Figure 48: Source group contributions to simulated results for $PM_{2.5}$ at Impala Platinum Hospital as a result of the Impala proposed future operations

The simulated PM_{10} exceeds the annual NAAQS (40 µg/m³) and 24-hour NAAQS (4 days of exceedance of 75 µg/m³) at Impala Platinum Hospital (Table 38). The source group with the greatest contribution to the simulated concentrations at Impala Platinum Hospital is vehicles travelling on paved roads (Figure 49):

1. Vehicles Travelling on Paved Roads (incl. Vehicle Exhaust) = 69.9%
2. Crushing and Screening = 26.9%
3. Ventilation Shafts = 1.6%
4. Smelter Building Fugitives = 0.8%
5. Current Stacks = 0.5%
6. Materials Handling = 0.3%
7. Proposed Flash Dryer Stack = <0.1%
8. Vehicles Travelling on Unpaved Roads (incl. Vehicle Exhaust & Grading) = <0.1%
9. Windblown dust from Tailings Storage Facilities = <0.1%
10. Windblown dust from Waste Rock Dumps = <0.1%

Table 38: Summary of simulated results for PM_{10} as a result of the Impala proposed future operations

Pollutant	PM_{10}	
Averaging Period	Annual	24-hour
Reporting Unit	Concentration in µg/m³	Days per year
NAAQS	40 µg/m³	4 allowable exceedances of 75 µg/m³
AQSR/Source Group	Impala Proposed Future Operations (All Existing Impala Operations and Proposed Flash Dryer Operations)	
Ratanang	12.3	0
Magareng	35.6	1
Simunye	21.1	0
Kopano	11.5	0
Pudunong	2.76	0
Phokeng	0.876	0
Bobuampja	0.883	0
Ga-Luka	20.6	0
Mogono	12.2	0
Freedom	12.5	0
Meriteng	12.2	0
Kanana	1.78	0
Mafika	2.34	0
Serutube	3.02	0
Thethe Secondary School	17.4	0
Luka Primary School	19.3	0
Kelekitso Early Learning Centre	28.6	0
Matlhware Primary School	2.74	0

Pollutant	PM_{10}	
Averaging Period	Annual	24-hour
Reporting Unit	Concentration in µg/m³	Days per year
NAAQS	40 µg/m³	4 allowable exceedances of 75 µg/m³
AQSR/Source Group	Impala Proposed Future Operations (All Existing Impala Operations and Proposed Flash Dryer Operations)	
Kitsong High School	3.32	0
Tumagole Primary School	1.52	0
Matale Secondary School	1.31	0
Kutlwanong School for the Deaf	3.23	0
Vukuzenzele Primary School	13.0	0
Freedom Park Secondary School	12.0	0
Molotlegi Secondary School	18.8	0
Ramotse Primary School	23.0	0
Moremogolo Primary School	1.20	0
Semane Early Learning Centre	1.06	0
Bafokeng Health Centre	2.86	0
Tapologo Hospice Centre	1.45	0
Luka Clinic	17.8	0
Impala Platinum Hospital	**50.8**	**39**
Lebone AQMS	3.18	0
Luka AQMS	18.5	0
Boschhoek AQMS	1.85	0
Ratanang AQMS	16.1	0

Table 39: Source group contributions to simulated results for PM_{10} as a result of the Impala proposed future operations

Pollutant	PM_{10}									
Averaging Period	Annual									
AQSR/Source Group	Building Fugitives	Materials Handling	Vehicles Travelling on Paved Roads	Current Stacks	Vehicles Travelling on Unpaved Roads	Ventilation Shafts	Windblown Dust from Tailings Storage Facilities	Windblown Dust from Waste Rock Dumps	Crushing and Screening	Proposed Flash Dryer
Ratanang	1.6%	1.0%	52.4%	2.1%	0.0%	2.9%	0.0%	0.0%	39.9%	0.1%
Magareng	0.9%	0.5%	61.8%	0.7%	0.0%	1.4%	0.0%	0.0%	34.7%	0.0%
Simunye	0.3%	1.0%	83.1%	0.5%	0.1%	1.2%	0.0%	0.0%	13.9%	0.0%
Kopano	0.4%	4.7%	73.8%	0.8%	0.0%	2.6%	0.0%	0.0%	17.7%	0.1%
Pudunong	2.8%	0.7%	23.0%	6.3%	0.0%	2.3%	0.0%	0.0%	64.3%	0.5%
Phokeng	1.1%	1.4%	34.7%	12.3%	0.0%	4.8%	0.0%	0.0%	44.5%	1.1%
Bobuampja	1.4%	1.8%	36.2%	10.0%	0.0%	5.6%	0.0%	0.0%	44.3%	0.7%
Ga-Luka	2.8%	0.4%	21.4%	1.8%	0.0%	1.4%	0.0%	0.0%	72.0%	0.1%
Mogono	1.8%	1.1%	46.0%	1.9%	0.0%	4.0%	0.0%	0.0%	45.0%	0.1%
Freedom	0.4%	1.8%	74.2%	0.9%	0.0%	1.9%	0.0%	0.0%	20.7%	0.1%
Meriteng	0.3%	2.6%	62.4%	0.8%	0.0%	3.2%	0.0%	0.0%	30.5%	0.1%
Kanana	1.2%	8.8%	36.7%	4.2%	0.0%	6.5%	0.0%	0.0%	42.2%	0.3%
Mafika	0.9%	5.2%	54.4%	3.1%	0.0%	9.5%	0.0%	0.0%	26.8%	0.2%
Serutube	0.8%	5.6%	57.1%	2.2%	0.0%	7.5%	0.0%	0.0%	26.6%	0.2%
Thethe Secondary School	2.5%	0.6%	28.0%	1.7%	0.0%	1.9%	0.0%	0.0%	65.1%	0.1%
Luka Primary School	2.9%	0.5%	21.2%	1.9%	0.0%	1.3%	0.0%	0.0%	72.0%	0.1%
Kelekitso Early Learning Centre	3.0%	0.3%	17.0%	1.5%	0.0%	1.0%	0.0%	0.0%	77.1%	0.1%

Pollutant	PM10									
Averaging Period	Annual									
AQSR/Source Group	Building Fugitives	Materials Handling	Vehicles Travelling on Paved Roads	Current Stacks	Vehicles Travelling on Unpaved Roads	Ventilation Shafts	Windblown Dust from Tailings Storage Facilities	Windblown Dust from Waste Rock Dumps	Crushing and Screening	Proposed Flash Dryer
Matlhware Primary School	2.8%	0.8%	24.3%	6.1%	0.0%	2.5%	0.0%	0.0%	63.1%	0.4%
Kitsong High School	3.1%	0.6%	20.9%	5.8%	0.0%	2.0%	0.0%	0.0%	67.1%	0.5%
Tumagole Primary School	1.9%	1.0%	29.7%	8.3%	0.0%	3.6%	0.0%	0.0%	54.9%	0.7%
Matale Secondary School	1.8%	1.0%	30.5%	9.7%	0.0%	3.8%	0.0%	0.0%	52.3%	0.9%
Kutlwanong School for the Deaf	1.6%	1.7%	45.8%	3.6%	0.0%	3.2%	0.0%	0.0%	43.9%	0.2%
Vukuzenzele Primary School	0.5%	1.4%	69.6%	1.0%	0.0%	1.6%	0.0%	0.0%	25.8%	0.1%
Freedom Park Secondary School	0.6%	1.3%	67.9%	1.1%	0.0%	1.7%	0.0%	0.0%	27.3%	0.1%
Molotlegi Secondary School	2.6%	0.5%	25.0%	1.7%	0.0%	1.8%	0.0%	0.0%	68.2%	0.1%
Ramotse Primary School	2.8%	0.4%	21.6%	1.5%	0.0%	1.4%	0.0%	0.0%	72.2%	0.1%
Moremogolo Primary School	1.5%	1.0%	27.8%	16.3%	0.0%	3.6%	0.0%	0.0%	47.5%	2.2%
Semane Early Learning Centre	1.7%	1.1%	30.2%	13.4%	0.0%	3.9%	0.0%	0.0%	48.2%	1.5%
Bafokeng Health Centre	3.1%	0.7%	21.6%	7.0%	0.0%	2.1%	0.0%	0.0%	64.9%	0.6%
Tapologo Hospice Centre	1.9%	0.9%	26.0%	17.9%	0.0%	3.0%	0.0%	0.0%	47.8%	2.6%
Luka Clinic	2.8%	0.5%	22.5%	2.1%	0.0%	1.4%	0.0%	0.0%	70.5%	0.1%
Impala Platinum Hospital	0.8%	0.3%	69.9%	0.5%	0.0%	1.6%	0.0%	0.0%	26.9%	0.0%
Lebone AQMS	3.0%	0.7%	21.5%	6.2%	0.0%	2.1%	0.0%	0.0%	66.0%	0.5%
Services AQMS	1.9%	0.2%	38.7%	1.5%	0.0%	0.6%	0.0%	0.0%	57.1%	0.1%
Luka AQMS	2.9%	0.5%	22.0%	2.0%	0.0%	1.4%	0.0%	0.0%	71.2%	0.1%

Pollutant	PM_{10}									
Averaging Period	Annual									
AQSR/Source Group	Building Fugitives	Materials Handling	Vehicles Travelling on Paved Roads	Current Stacks	Vehicles Travelling on Unpaved Roads	Ventilation Shafts	Windblown Dust from Tailings Storage Facilities	Windblown Dust from Waste Rock Dumps	Crushing and Screening	Proposed Flash Dryer
Boschhoek AQMS	2.3%	0.9%	28.7%	9.6%	0.0%	3.0%	0.0%	0.0%	54.8%	0.7%
Ratanang AQMS	1.3%	0.7%	62.2%	1.6%	0.0%	2.3%	0.0%	0.0%	31.7%	0.1%

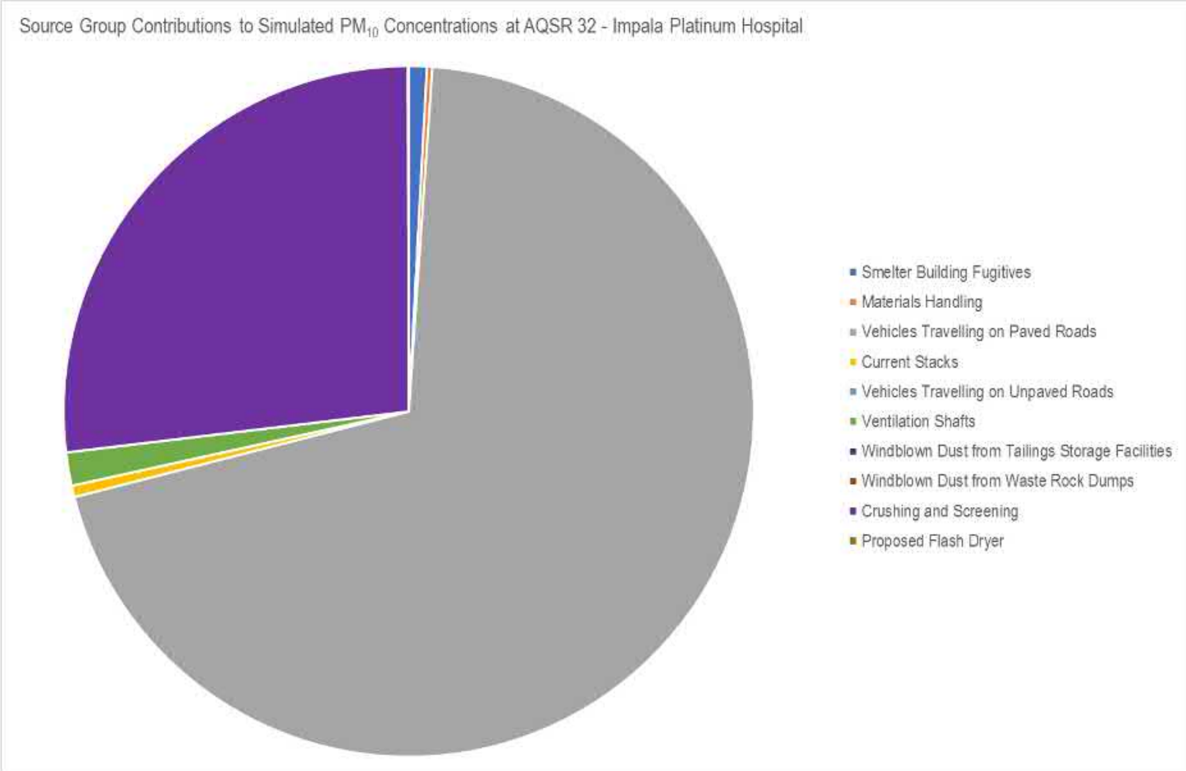


Figure 49: Source group contributions to simulated results for PM_{10} at Impala Platinum Hospital as a result of the Impala proposed future operations

The simulated SO_2 does not exceed the annual NAAQS (50 µg/m³), 24-hour NAAQS (4 days of exceedance of 125 µg/m³) or 1-hour NAAQS (88 hours of exceedance of 300 µg/m³) at any AQSRs (Table 40). The simulated annual average SO_2 concentrations are below the critical levels for all vegetation types at all AQSRs except Kelekitso Early Learning Centre (Table 40). At Kelekitso Early Learning Centre there is a potential for impacts on cyanobacterial lichens according to European limits (Table 31).

Table 40: Summary of simulated results for SO_2 as a result of the Impala proposed future operations

Pollutant	SO_2		
Averaging Period	**Annual**	**24-hour**	**1-hour**
Reporting Unit	**Concentration in µg/m³**	**Days per year**	**Hours per year**
NAAQS	**50 µg/m³**	**4 allowable exceedances of 125 µg/m³**	**88 allowable exceedances of 350 µg/m³**
AQSR/Source Group	**Impala Proposed Future Operations (All Existing Impala Operations and Proposed Flash Dryer Operations)**		
Ratanang	7.78	0	0
Magareng	4.91	0	0
Simunye	4.68	0	0
Kopano	3.56	0	0
Pudunong	4.75	0	12

Pollutant	SO_2		
Averaging Period	Annual	24-hour	1-hour
Reporting Unit	Concentration in µg/m³	Days per year	Hours per year
NAAQS	50 µg/m³	4 allowable exceedances of 125 µg/m³	88 allowable exceedances of 350 µg/m³
AQSR/Source Group	Impala Proposed Future Operations (All Existing Impala Operations and Proposed Flash Dryer Operations)		
Phokeng	1.69	0	6
Bobuampja	1.37	0	1
Ga-Luka	9.26	0	1
Mogono	8.06	0	0
Freedom	3.84	0	0
Meriteng	5.57	0	0
Kanana	1.70	0	0
Mafika	1.92	0	0
Serutube	1.98	0	0
Thethe Secondary School	8.61	0	1
Luka Primary School	9.58	0	0
Kelekitso Early Learning Centre	10.7	0	4
Matlhware Primary School	3.93	0	6
Kitsong High School	5.46	0	11
Tumagole Primary School	2.61	0	4
Matale Secondary School	2.52	0	4
Kutlwanong School for the Deaf	2.79	0	0
Vukuzenzele Primary School	4.05	0	0
Freedom Park Secondary School	3.95	0	0
Molotlegi Secondary School	8.87	0	1
Ramotse Primary School	9.48	0	3
Moremogolo Primary School	3.62	0	24
Semane Early Learning Centre	2.41	0	4
Bafokeng Health Centre	6.00	0	37
Tapologo Hospice Centre	5.16	0	34
Luka Clinic	9.60	0	1
Impala Platinum Hospital	5.81	0	0
Lebone AQMS	5.68	0	27
Luka AQMS	9.46	0	0
Boschhoek AQMS	3.41	0	0

Pollutant	SO_2		
Averaging Period	Annual	24-hour	1-hour
Reporting Unit	Concentration in µg/m³	Days per year	Hours per year
NAAQS	50 µg/m³	4 allowable exceedances of 125 µg/m³	88 allowable exceedances of 350 µg/m³
AQSR/Source Group	Impala Proposed Future Operations (All Existing Impala Operations and Proposed Flash Dryer Operations)		
Ratanang AQMS	7.92	0	0

The simulated NO_x exceeds the 1-hour NO_2 NAAQS (88 hours of exceedance of 200 µg/m³) at Impala Platinum Hospital (Table 41). The simulated annual average NO_x concentrations are below the critical levels (European limits) for all vegetation types at all AQSRs except Impala Platinum Hospital (Table 41). The source group with the greatest contribution to the simulated concentrations at Impala Platinum Hospital is vehicle exhausts (Figure 50):

1. Vehicle Exhaust (both paved and unpaved roads) = 97%
2. Current Stacks = 2%
3. Proposed Flash Dryer Stack = 1%

Table 41: Summary of simulated results for NO_x as a result of the Impala proposed future operations

Pollutant	NO_x	
Averaging Period	Annual	1-hour
Reporting Unit	Concentration in µg/m³	Hours per year
NAAQS	40 µg/m³	88 allowable exceedances of 200 µg/m³
AQSR/Source Group	Impala Proposed Future Operations (All Existing Impala Operations and Proposed Flash Dryer Operations)	
Ratanang	8.56	0
Magareng	23.9	16
Simunye	20.0	47
Kopano	10.4	0
Pudunong	1.90	0
Phokeng	0.975	0
Bobuampja	0.952	0
Ga-Luka	6.73	0
Mogono	7.84	0
Freedom	11.1	13
Meriteng	11.5	20
Kanana	1.35	0
Mafika	2.17	0
Serutube	2.62	0

Pollutant	NO_x	
Averaging Period	Annual	1-hour
Reporting Unit	Concentration in µg/m³	Hours per year
NAAQS	40 µg/m³	88 allowable exceedances of 200 µg/m³
AQSR/Source Group	Impala Proposed Future Operations (All Existing Impala Operations and Proposed Flash Dryer Operations)	
Thethe Secondary School	7.10	0
Luka Primary School	6.46	0
Kelekitso Early Learning Centre	7.40	0
Matlhware Primary School	1.79	0
Kitsong High School	2.10	0
Tumagole Primary School	1.31	0
Matale Secondary School	1.25	0
Kutlwanong School for the Deaf	2.71	0
Vukuzenzele Primary School	10.8	0
Freedom Park Secondary School	9.81	0
Molotlegi Secondary School	6.95	0
Ramotse Primary School	7.30	0
Moremogolo Primary School	1.62	0
Semane Early Learning Centre	1.19	0
Bafokeng Health Centre	2.14	0
Tapologo Hospice Centre	2.13	0
Luka Clinic	6.38	0
Impala Platinum Hospital	37.8	**330**
Lebone AQMS	2.14	0
Luka AQMS	6.40	0
Boschhoek AQMS	1.55	0
Ratanang AQMS	12.1	0

Table 42: Source group contributions to simulated results for NO_x as a result of the Impala proposed future operations

Pollutant	NO_x		
Averaging Period	Annual		
AQSR/Source Group	Vehicle Exhaust	Current Stacks	Proposed Flash Dryer
Ratanang	81%	17%	2%
Magareng	96%	3%	1%
Simunye	96%	3%	0%
Kopano	94%	5%	1%

Pollutant	NO_x		
Averaging Period	Annual		
AQSR/Source Group	Vehicle Exhaust	Current Stacks	Proposed Flash Dryer
Pudunong	38%	53%	8%
Phokeng	40%	48%	12%
Bobuampja	49%	42%	9%
Ga-Luka	72%	24%	4%
Mogono	79%	19%	2%
Freedom	94%	5%	1%
Meriteng	93%	6%	1%
Kanana	64%	30%	6%
Mafika	78%	19%	3%
Serutube	83%	15%	3%
Thethe Secondary School	76%	21%	3%
Luka Primary School	70%	26%	4%
Kelekitso Early Learning Centre	72%	23%	5%
Matlhware Primary School	44%	48%	8%
Kitsong High School	38%	54%	8%
Tumagole Primary School	42%	48%	10%
Matale Secondary School	39%	50%	11%
Kutlwanong School for the Deaf	74%	22%	4%
Vukuzenzele Primary School	93%	6%	1%
Freedom Park Secondary School	92%	7%	1%
Molotlegi Secondary School	75%	22%	4%
Ramotse Primary School	75%	21%	4%
Moremogolo Primary School	24%	58%	18%
Semane Early Learning Centre	32%	53%	15%
Bafokeng Health Centre	33%	58%	9%
Tapologo Hospice Centre	20%	61%	19%
Luka Clinic	69%	27%	4%
Impala Platinum Hospital	97%	2%	1%
Lebone AQMS	37%	55%	8%
Services AQMS	88%	10%	3%
Luka AQMS	70%	26%	4%
Boschhoek AQMS	39%	52%	10%
Ratanang AQMS	87%	12%	2%

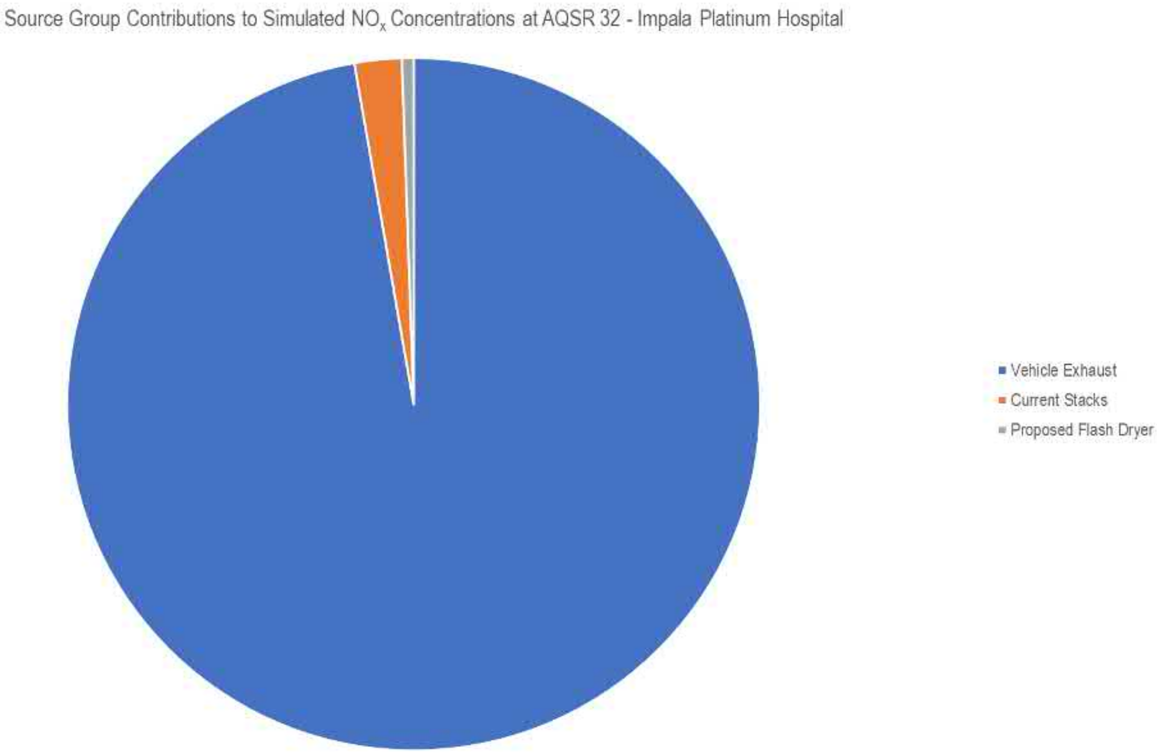


Figure 50: Source group contributions to simulated results for NO_x at Impala Platinum Hospital as a result of the Impala proposed future operations

7.6 Impact Significance Rating – Impala Proposed Future Operations (All Existing Impala Operations and Proposed Second Flash Dryer Operations)

Non-compliance of $PM_{2.5}$, PM_{10}, SO_2 or NO_x concentrations with the relevant NAAQS could result in human health impacts. The potential significance of the impacts based the quantitative assessment of $PM_{2.5}$, PM_{10}, SO_2 and NO_x and qualitative assessment of dustfall rates (TSP) during the operational phase as a result of the Impala proposed future operations (all existing impala operations and proposed second flash dryer operations) is discussed below. The current SLR rating methodology (Section 17) was used.

Two potential direct operational phase impacts on the air quality of the area were identified:

- B1b: Potential impact on human health from increased pollutant concentrations due to Impala proposed future operations; and
- B2b: Increased nuisance dustfall rates associated with the Impala proposed future operations.

7.6.1 Potential Impact B1b: Potential Impact on Human Health from Increased Pollutant Concentrations Caused by Activities Associated with the Impala Proposed Future Operations

It is likely that the long-term and short-term NAAQS will be exceeded at Impala Platinum Hospital (with and without mitigation); and the long-term and short-term NAAQS are also expected to be exceeded in other areas in which they are applicable (off-site). The impacts will cease at the end of the operational life of the activity. The significance rating is “high” without mitigation measures applied and becomes “medium” with design mitigation measures applied (Table 43).

7.6.2 Potential Impact B2b: Increased Nuisance Dustfall Rates Associated with the Impala Proposed Future Operations

It is unlikely that the NDCR limit for residential areas will be exceeded at AQSRs (with mitigation). The impacts will cease at the end of the operational life of the activity. The significance rating is “medium” without and “low” with design mitigation measures applied (Table 44).

Table 43: Health risk impact significance summary table for the Impala proposed future operations

Air Quality	Description	Rating
Project activity or issue	Impala proposed future operations (all existing impala operations and proposed second flash dryer operations)	N/A
Potential impact	Health risk at AQSRs	N/A
	Nature of the Impact	
Positive or negative	Negative due to increase in $PM_{2.5}$, PM_{10}, SO_2, NO_x and CO concentrations at AQSRs	-
	Significance Before Mitigation	
Intensity	Prominent change, disturbance or degradation. Associated with real and substantial consequences. May result in illness or injury. Targets, limits and thresholds of concern regularly exceeded. Will definitely require intervention. Threats of community action. Regular complaints can be expected when the impact takes place.	H
Duration	Long term, likely to cease at the end of the operational life of the activity.	H
Extent	Beyond the site boundary, affecting immediate neighbours.	M
Consequence	High.	
Probability	Probable.	H
Significance	**It must have an influence on the decision. Substantial mitigation will be required.**	**High**
	Significance After Design Mitigation	
Intensity	Prominent change, disturbance or degradation. Associated with real and substantial consequences. May result in illness or injury. Targets, limits and thresholds of concern regularly exceeded. Will definitely require intervention. Threats of community action. Regular complaints can be expected when the impact takes place.	H
Duration	Long term, likely to cease at the end of the operational life of the activity.	H
Extent	Beyond the site boundary, affecting immediate neighbours.	M

Air Quality	Description	Rating
Consequence	High.	
Probability	Possible/ frequent.	M
Significance	**It should have an influence on the decision. Mitigation will be required.**	**Medium**
Design mitigation measures	Crushing and screening – enclosure and water sprays with a resultant CE of 85%. Vehicles travelling on unpaved roads – 75% CE for level 2 watering.	N/A

Table 44: Nuisance impact significance summary table for the Impala proposed future operations

Air Quality	Description	Rating
Project activity or issue	Impala proposed future operations (all existing impala operations and proposed second flash dryer operations)	N/A
Potential impact	Nuisance dustfall rates at AQSRs	N/A
Nature of the Impact		
Positive or negative	Negative due to increase in dustfall rates at AQSRs	-
Significance Before Mitigation		
Intensity	Moderate change, disturbance or discomfort. Associated with real but not substantial consequences. Targets, limits and thresholds of concern may occasionally be exceeded. Likely to require some intervention. Occasional complaints can be expected.	M
Duration	Long term, likely to cease at the end of the operational life of the activity.	H
Extent	Beyond the site boundary, affecting immediate neighbours.	M
Consequence	Medium.	
Probability	Probable.	H
Significance	**It should have an influence on the decision. Mitigation will be required.**	**Medium**
Significance After Mitigation		

Air Quality	Description	Rating
Intensity	Minor (Slight) change, disturbance or nuisance. Associated with minor consequences or deterioration. Targets, limits and thresholds of concern rarely exceeded. Require only minor interventions or clean-up actions. Sporadic complaints could be expected.	L
Duration	Long term, likely to cease at the end of the operational life of the activity.	H
Extent	Beyond the site boundary, affecting immediate neighbours.	M
Consequence	Medium.	
Probability	Possible/ frequent.	M
Significance	**Unlikely that it will have a real influence on the decision. Limited mitigation is likely to be required.**	**Low**
Design mitigation measures	Crushing and screening – enclosure and water sprays with a resultant CE of 85%. Vehicles travelling on unpaved roads – 75% CE for level 2 watering.	N/A

Notes: Although the significance rating does not change for the "nuisance dustfall rates at AQSRs" between unmitigated and design mitigated the extent of impacted area does reduce with design mitigation applied.

8 IMPACT ASSESSMENT: DECOMMISSIONING AND CLOSURE PHASES

8.1 Increase in Pollutant Concentrations and Dustfall Rates

It is assumed that all operations will have ceased by the decommissioning phase. It is expected that all surface infrastructure will be demolished and removed except for roads which will remain for public use. It is also expected that the stockpile surfaces will be covered with topsoil and vegetated.

The potential for air quality impacts during the decommissioning phase will depend on the extent of demolition and rehabilitation efforts during decommissioning and on features which will remain.
The likely activities associated with the decommissioning phase of the operations are:

- infrastructure removal/demolition;
- topsoil recovered from stockpiles for rehabilitation and re-vegetation of surroundings;
- vehicle entrainment on unpaved road surfaces during rehabilitation. Once that is done, vehicle activity associated with Impala should cease; and
- exhaust emissions from vehicles utilised during the closure phase. Once that is done, vehicle activity associated with Impala should cease.

The closure phase includes the period of aftercare and maintenance after the decommissioning phase. During this phase rehabilitated areas are checked and maintained. The activities that may be included are irregular and minimal vehicle entrainment on roads and vehicle exhaust emissions when the property is checked on.

8.2 Assessment of Impact

Insufficient data was available for the decommissioning and closure phases to allow for dispersion modelling of the actual activities that will result in dust emissions to be undertaken. It is anticipated that the various activities would not result in higher $PM_{2.5}$, PM_{10}, SO2, NO_x and CO GLCs and dustfall rates than the operational phase activities. The temporary nature of the decommissioning activities would likely reduce the significance of the potential impacts. The minimal activities during closure will likely result in insignificant potential impacts. A qualitative assessment of decommissioning and closure operations from the $PM_{2.5}$, PM_{10}, SO2, NO_x, CO and TSP impacts perspective is discussed below.

Two potential direct decommissioning phase impacts on the air quality of the area were identified:

- C1: Potential impact on human health from pollutant concentrations associated with decommissioning activities;
- C2: Nuisance dustfall rates associated with decommissioning activities;

Two potential direct closure phase impacts on the air quality of the area were identified:

- D1: Potential impact on human health from pollutant concentrations associated with closure activities;
- D2: Nuisance dustfall rates associated with closure activities;

C1 and D1 would likely impact on human health whereas C2 and D2 would impact on amenities.

8.2.1 Potential Impact C1: Potential Impact on Human Health from Pollutant Concentrations Associated with Decommissioning Activities

The sources of emissions would include the demolition of infrastructure and removal of material; topsoil reclaiming and covering of exposed areas; re-vegetation; and the operation of mechanical equipment. It is unlikely that the long-term and short-term NAAQS will be exceeded at AQSRs. The decommissioning operations are likely to last for a few years but impacts at AQSRs are likely to be intermittent. The significance rating is “very low” without mitigation applied and “insignificant” with mitigation measures applied (Table 45).

8.2.2 Potential Impact C2: Nuisance Dustfall Rates Associated with Decommissioning Activities

The sources of emissions would include the demolition of infrastructure and removal of material; topsoil reclaiming and covering of exposed areas; re-vegetation; and the operation of mechanical equipment. It is probable that the NDCR limit for residential areas will not be exceeded at AQSRs (with and without mitigation). The decommissioning operations are likely to last for a few years but impacts at AQSRs are likely to be intermittent. The significance rating is “very low” without mitigation applied and “insignificant” with mitigation measures applied (Table 46).

8.2.3 Potential Impact D1: Impaired Human Health from Pollutant Concentrations Associated with Closure Activities

The sources of emissions would include the site inspections and where necessary the addition of topsoil and vegetation; and the operation of mechanical equipment. It is unlikely that the long-term and short-term NAAQS will be exceeded at AQSRs (with and without mitigation). The operations will likely occur for less more than 5 year but less than 10 years but impacts at AQSRs are likely to be intermittent. The significance rating is “insignificant” without and with design mitigation measures applied (Table 47).

8.2.4 Potential Impact D2: Nuisance Dustfall Rates Associated with Closure Activities

The sources of emissions would include the site inspections and where necessary the addition of topsoil and vegetation; and the operation of mechanical equipment. It is probable that the NDCR limit for residential areas will not be exceeded at AQSRs (with and without mitigation). The operations will likely occur for less more than 5 year but less than 10 years but impacts at AQSRs are likely to be intermittent. The significance rating is “insignificant” without and with design mitigation measures applied (Table 48).

Table 45: Health risk impact significance summary table for the decommissioning operations

Air Quality	Description	Rating
Project activity or issue	Decommissioning	N/A
Potential impact	Increased health risk at AQSRs	N/A
	Nature of the Impact	
Positive or negative	Negative due to increase in $PM_{2.5}$, PM_{10}, SO_2, NO_x and CO concentrations at AQSRs	-
	Significance Before Mitigation	
Intensity	Minor (Slight) change, disturbance or nuisance. Associated with minor consequences or deterioration. Targets, limits and thresholds of concern rarely exceeded. Require only minor interventions or clean-up actions. Sporadic complaints could be expected.	L
Duration	Short-term, occurs for more than 1 but less than 5 years. Reversible over time.	L
Extent	A part of the site/property.	VL
Consequence	Very Low.	
Probability	Conceivable.	L
Significance	**It will not have an influence on the decision. Does not require any mitigation.**	**Very Low**
	Significance After Mitigation	
Intensity	Negligible change, disturbance or nuisance. Associated with very minor consequences or deterioration. Targets, limits and thresholds of concern never exceeded. No interventions or clean-up actions required. No complaints anticipated.	VL
Duration	Short-term, occurs for more than 1 but less than 5 years. Reversible over time.	L
Extent	A part of the site/property.	VL
Consequence	Low.	
Probability	Conceivable.	L
Significance	**Inconsequential, not requiring any consideration.**	**Insignificant**

Air Quality	Description	Rating
Potential mitigation measures	• Reduction of fugitive PM emissions through the watering of roads, stockpiles and inactive open areas and the use of screens. • Reductions of vehicle exhaust emissions through the use of better-quality diesel; and inspection and maintenance programs.	N/A

Table 46: Nuisance impact significance summary table for the decommissioning operations

Air Quality	Description	Rating
Project activity or issue	Decommissioning	N/A
Potential impact	Nuisance dustfall rates at AQSRs	N/A
Nature of the Impact		
Positive or negative	Negative due to increase in dustfall rates at AQSRs	-
Significance Before Mitigation		
Intensity	Minor (Slight) change, disturbance or nuisance. Associated with minor consequences or deterioration. Targets, limits and thresholds of concern rarely exceeded. Require only minor interventions or clean-up actions. Sporadic complaints could be expected.	L
Duration	Short-term, occurs for more than 1 but less than 5 years. Reversible over time.	L
Extent	A part of the site/property.	VL
Consequence	Very Low.	
Probability	Conceivable.	L
Significance	**It will not have an influence on the decision. Does not require any mitigation.**	**Very Low**
Significance After Mitigation		
Intensity	Negligible change, disturbance or nuisance. Associated with very minor consequences or deterioration. Targets, limits and thresholds of concern never exceeded. No interventions or clean-up actions required. No complaints anticipated.	VL
Duration	Short-term, occurs for more than 1 but less than 5 years. Reversible over time.	L

Air Quality	Description	Rating
Extent	A part of the site/property.	VL
Consequence	Low.	
Probability	Conceivable.	L
Significance	**Inconsequential, not requiring any consideration.**	**Insignificant**
Potential mitigation measures	• Reduction of fugitive PM emissions through the watering of roads, stockpiles and inactive open areas and the use of screens. • Reductions of vehicle exhaust emissions through the use of better-quality diesel; and inspection and maintenance programs.	N/A

Table 47: Health risk impact significance summary table for the closure operations

Air Quality	Description	Rating
Project activity or issue	Closure	N/A
Potential impact	Increased health risk at AQSRs	N/A
Nature of the Impact		
Positive or negative	Negative due to increase in $PM_{2.5}$, PM_{10}, SO_2, NO_x and CO concentrations at AQSRs	-
Significance Before Mitigation		
Intensity	Negligible change, disturbance or nuisance. Associated with very minor consequences or deterioration. Targets, limits and thresholds of concern never exceeded. No interventions or clean-up actions required. No complaints anticipated.	VL
Duration	Medium-term, 5 to 10 years.	M
Extent	A part of the site/property.	VL
Consequence	Very Low.	
Probability	Unlikely/ improbable.	VL
Significance	**Inconsequential, not requiring any consideration.**	**Insignificant**
Significance After Mitigation		

Air Quality	Description	Rating
Intensity	Negligible change, disturbance or nuisance. Associated with very minor consequences or deterioration. Targets, limits and thresholds of concern never exceeded. No interventions or clean-up actions required. No complaints anticipated.	VL
Duration	Medium-term, 5 to 10 years.	M
Extent	A part of the site/property.	VL
Consequence	Very Low.	
Probability	Unlikely/ improbable.	VL
Significance	**Inconsequential, not requiring any consideration.**	**Insignificant**
Potential mitigation measures	Reductions of vehicle exhaust emissions through the use of better-quality diesel; and inspection and maintenance programs.	N/A

Table 48: Nuisance impact significance summary table for the closure operations

Air Quality	Description	Rating
Project activity or issue	Closure	N/A
Potential impact	Nuisance dustfall rates at AQSRs	N/A
	Nature of the Impact	
Positive or negative	Negative due to increase in dustfall rates at AQSRs	-
	Significance Before Mitigation	
Intensity	Negligible change, disturbance or nuisance. Associated with very minor consequences or deterioration. Targets, limits and thresholds of concern never exceeded. No interventions or clean-up actions required. No complaints anticipated.	VL
Duration	Medium-term, 5 to 10 years.	M
Extent	A part of the site/property.	VL
Consequence	Very Low.	

Air Quality	Description	Rating
Probability	Unlikely/ improbable.	VL
Significance	**Inconsequential, not requiring any consideration.**	**Insignificant**
	Significance After Mitigation	
Intensity	Negligible change, disturbance or nuisance. Associated with very minor consequences or deterioration. Targets, limits and thresholds of concern never exceeded. No interventions or clean-up actions required. No complaints anticipated.	VL
Duration	Medium-term, 5 to 10 years.	M
Extent	A part of the site/property.	VL
Consequence	Very Low.	
Probability	Unlikely/ improbable.	VL
Significance	**Inconsequential, not requiring any consideration.**	**Insignificant**
Potential mitigation measures	Reductions of vehicle exhaust emissions through the use of better-quality diesel; and inspection and maintenance programs.	N/A

9 IMPACT ASSESSMENT: CUMULATIVE INCLUDING OTHER OPERATIONS IN THE REGION

9.1 Elevated Pollutant Concentrations and Dustfall Rates

Land use in the region includes residences, farming, mining, industrial operations and wilderness. The mining and processing operations (other companies), farming activities, domestic fires, vehicle exhaust emissions and dust entrained by vehicles on public roads without the addition of the proposed operations will likely result in elevated ambient air pollutant concentrations and dustfall rates compared to an area where there are no anthropogenic emission sources. It is difficult to predict the location and contribution of the sources from residences, farming and wilderness to existing air quality. The potential cumulative scenario includes the following atmospheric emissions:

a. Particulate emissions from Impala operations;
b. Miscellaneous fugitive dust sources including vehicle entrainment on roads and wind-blown dust from open areas;
c. Particulate emissions from vehicle exhaust emissions;
d. Particulate emissions from household fuel burning; and
e. Particulate emissions from biomass burning (e.g. wild fires).

Based on the measured results there is likely to be exceedances of the long-term and short-term $PM_{2.5}$ and PM_{10} NAAQS at AQSRs near Impala as a result of the cumulative operations.

9.2 Impact Significance Rating – Cumulative Activities

Two potential cumulative air quality impacts for the area were identified:

- E1: Potential impact on human health from elevated pollutant concentrations due to existing activities and proposed flash dryer operations; and
- E2: Increased nuisance dustfall rates associated with the existing activities and proposed flash dryer operations.

9.2.1 Potential Impact E1: Potential Impact on Human Health from Elevated Pollutant Concentrations Associated with the Cumulative Activities

The long-term and short-term $PM_{2.5}$ and PM_{10} NAAQS are likely to be exceeded at AQSRs. Assuming that the pollutant concentrations from the existing activities will remain the same throughout the entire operation of the proposed flash dryer operational phase, the significance rating is “high” without and with design mitigation measures applied to the proposed flash dryer (Table 49).

9.2.2 Potential Impact E2: Increased Nuisance Dustfall Rates Associated with the Cumulative Activities

It is unlikely that the NDCR limit for residential areas will be exceeded at AQSRs (with and without mitigation). Assuming that the dustfall rates from the existing activities will remain the same throughout the entire operation of the proposed flash dryer operational phase, the significance rating is “low” without and with design mitigation measures applied to the proposed flash dryer (Table 50).

Table 49: Health risk impact significance summary table for the cumulative activities

Air Quality	Description	Rating
Project activity or issue	Cumulative activities	N/A
Potential impact	Health risk at AQSRs	N/A
Nature of the Impact		
Positive or negative	Negative due to potentially elevated $PM_{2.5}$ and PM_{10} concentrations at AQSRs	-
Significance Before Mitigation		
Intensity	Prominent change, disturbance or degradation. Associated with real and substantial consequences. May result in illness or injury. Targets, limits and thresholds of concern regularly exceeded. Will definitely require intervention. Threats of community action. Regular complaints can be expected when the impact takes place.	H
Duration	Long term, between 10 and 20 years (likely to cease at the end of the operational life of the activity).	H
Extent	Beyond the site boundary, affecting immediate neighbours.	M
Consequence	High.	
Probability	Probable.	H
Significance	**It must have an influence on the decision. Substantial mitigation will be required.**	**High**
Significance After Design Mitigation		
Intensity	Prominent change, disturbance or degradation. Associated with real and substantial consequences. May result in illness or injury. Targets, limits and thresholds of concern regularly exceeded. Will definitely require intervention. Threats of community action. Regular complaints can be expected when the impact takes place.	H
Duration	Long term, between 10 and 20 years (likely to cease at the end of the operational life of the activity).	H
Extent	Beyond the site boundary, affecting immediate neighbours.	M

Air Quality	Description	Rating
Consequence	High.	
Probability	Probable.	H
Significance	**It must have an influence on the decision. Substantial mitigation will be required.**	**High**
Design mitigation measures	Baghouse.	N/A

Table 50: Nuisance impact significance summary table for the cumulative activities

Air Quality	Description	Rating
Project activity or issue	Cumulative activities	N/A
Potential impact	Nuisance dustfall rates at AQSRs	N/A
Nature of the Impact		
Positive or negative	Negative due to elevated dustfall rates at AQSRs	-
Significance Before Mitigation		
Intensity	Moderate change, disturbance or discomfort. Associated with real but not substantial consequences. Targets, limits and thresholds of concern may occasionally be exceeded. Likely to require some intervention. Occasional complaints can be expected.	M
Duration	Long term, between 10 and 20 years (likely to cease at the end of the operational life of the activity).	H
Extent	Beyond the site boundary, affecting immediate neighbours.	M
Consequence	Medium.	
Probability	Possible/ frequent.	M
Significance	**Unlikely that it will have a real influence on the decision. Limited mitigation is likely to be required.**	**Low**
Significance After Mitigation		

Air Quality	Description	Rating
Intensity	Moderate change, disturbance or discomfort. Associated with real but not substantial consequences. Targets, limits and thresholds of concern may occasionally be exceeded. Likely to require some intervention. Occasional complaints can be expected.	M
Duration	Long term, between 10 and 20 years (likely to cease at the end of the operational life of the activity).	H
Extent	Beyond the site boundary, affecting immediate neighbours.	M
Consequence	Medium.	
Probability	Possible/ frequent.	M
Significance	**Unlikely that it will have a real influence on the decision. Limited mitigation is likely to be required.**	**Low**
Design mitigation measures	Baghouse.	N/A

10 IMPACT ASSESSMENT: NO GO OPTION

10.1 Potential State of the Air Quality

Should the no go option be embarked on, none of the proposed activities will occur in the area. Thus, the potential for an increase in ambient air pollutant concentrations and dustfall rates is small. The current sources within the area are likely to cease at some stage and the ambient air quality will improve. There is the possibility of a reduction in ambient air quality in close proximity to the operations should there be any additional mining, industrial and farming operations, vehicle entrainment on roads, wind-blown dust from open areas, vehicle exhaust, household fuel burning and biomass burning.

11 AIR QUALITY MANAGEMENT PLAN

Based on the findings of the impact assessment, the following mitigation, management and monitoring recommendations are made.

11.1 Air Quality Management Objectives

The main objective of the proposed air quality management measures for the project is to ensure that operations at the facility cumulatively result in ambient air concentrations that are within the relevant ambient air quality criteria off-site.

11.1.1 Source Monitoring

Under Section 21 of the NEM:AQA it is compulsory for the Impala facility to measure PM, SO_2 and NO_x expressed as NO_2 emissions from the dryers, tailgas scrubber and fugitive scrubber stacks. It further requires the holder of an AEL to submit emission report(s) in the format specified by the National Air Quality Officer or Licensing Authority. It is therefore recommended that emissions testing for PM, SO_2, and NO_x expressed as NO_2 continue to be conducted as per the AEL requirements. It should be noted that Impala is also required to report annual emissions on the NAEIS system. It is further recommended that exhaust emissions testing be done on all mobile and stationary diesel combustion sources as part of equipment maintenance schedules.

11.1.2 Ambient Air Quality Monitoring

Ambient air quality monitoring can serve to meet various objectives, such as:

- Compliance monitoring;
- Validate dispersion model results;
- Use as input for health risk assessment;
- Assist in source apportionment;
- Temporal trend analysis;
- Spatial trend analysis;
- Source quantification; and,
- Tracking progress made by control measures.

It is recommended that the Impala current dustfall sampling continue to be conducted and that the ambient monitoring is continued at the existing AQMS as part of the project's air quality management plan. The equipment must be maintained and kept in good working order to reduce downtime and the quantity of missing data.

11.2 Record-keeping, Environmental Reporting and Community Liaison

11.2.1 Periodic Inspections and Audits

Periodic inspections and external audits are essential for progress measurement, evaluation and reporting purposes. It is recommended that site inspections and progress reporting be undertaken at regular intervals (at least quarterly), with annual environmental audits being conducted. Annual environmental audits should be continued at least until closure. Results from site inspections and monitoring efforts should be combined to determine progress against source- and receptor-based performance indicators. Progress should be reported to authorities.

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

11.2.2 Liaison Strategy for Communication with I&APs

Stakeholder forums provide possibly the most effective mechanisms for information dissemination and consultation. Management plans should stipulate specific intervals at which forums will be held and provide information on how people will be notified of such meetings. For operations in which un-rehabilitated or partly rehabilitated impoundments are located in close proximity (within 3 km) from community areas, it is recommended that such meetings be scheduled and held at least on a bi-annual basis. A complaints register must be kept at all times.

11.2.3 Budgeting

The budget should provide a clear indication of the capital and annual maintenance costs associated with dust control measures and dust monitoring plans. It may be necessary to make assumptions about the duration of aftercare prior to obtaining closure. This assumption must be made explicit so that the financial plan can be assessed within this framework. Costs related to inspections, audits, environmental reporting and I&AP liaison should also be indicated where applicable. Provision should also be made for capital and running costs associated with dust control contingency measures and for security measures.

12 Findings and Recommendations

12.1 Main Findings

An air quality impact assessment was conducted for activities proposed as part of the project. The main objective of this study was to establish baseline air quality in the study area and to quantify the extent to which ambient pollutant levels will change as a result of the proposed operations. The baseline and impact study then informed the air quality management and mitigation measures recommended as part of the Air Quality Management Plan (AQMP). This section summarises the main findings of the baseline and impact assessments.

The main findings of the baseline assessment are:

- The AQSRs within a 10 km radius of the proposed operations include Luka to the north, Phokeng to the south-west and south, Freedom Park to the south-east, and Meriting to the south-east.
- The main sources likely to contribute to baseline pollutant emissions include mining and processing operations, vehicle entrained dust from local roads, vehicle exhaust and windblown dust from exposed areas.
- Other sources of pollutants include farm activities, occasional biomass burning and household fuel burning in the individual residences.
- The area is dominated by winds from the southerly sectors. The average wind speed for 2019 was 1.35 m/s.
- The $PM_{2.5}$ and PM_{10} monitored data shows exceedances of the annual and 24-hour NAAQS. The SO_2 monitored data shows no exceedances of the annual, daily and hourly NAAQS.
- The simulations for the current operations (all existing mining and smelter complex operations) at impala had the following results:
    - $PM_{2.5}$ concentrations as a result of mitigated Impala current operations are not in compliance with the future NAAQS at Kelekitso Early Learning Centre and Impala Platinum Hospital over the short-term; and Impala Platinum Hospital over the long-term.
    - PM_{10} concentrations as a result of mitigated Impala current operations are not in compliance with the NAAQS at Impala Platinum Hospital over the short-term but are in compliance with the long-term NAAQS as at AQSRs.
    - SO_2 concentrations as a result of mitigated Impala current operations are within compliance at all AQSRs. The simulated annual average SO_2 concentrations as a result of mitigated Impala proposed future operations are below the critical levels for all vegetation types at all AQSRs except Kelekitso Early Learning Centre, where there is a potential for impacts on cyanobacterial lichens according to European limits.
    - NO_x concentrations as a result of mitigated Impala current operations are not in compliance with the NO_2 NAAQS at Impala Platinum Hospital over the short-term but are in compliance with the long-term NO_2 NAAQS as at AQSRs. The simulated annual average NO_x concentrations as a result of mitigated Impala operations including the proposed operations are below the critical levels (European limits) for all vegetation types at all AQSRs except Impala Platinum Hospital.
- The operations off-site dustfall rates sampled complies in terms of the NDCR.

The main findings of the impact assessment are as follows:

- Construction phase:
  - The significance of construction related inhalation health and nuisance impacts are likely to have a “very low” rating without mitigation and “insignificant” rating with mitigation.
- Operational phase:
  - $PM_{2.5}$, PM_{10}, SO_2, NO_x, CO and TSP emissions and impacts were quantified.
  - $PM_{2.5}$, PM_{10}, SO_2, NO_x and CO concentrations as a result of mitigated proposed operations are within compliance with NAAQS off-site and at all AQSRs.
  - The simulated annual average SO_2 and NO_x concentrations as a result of mitigated proposed project operations are likely to be below the critical levels for all vegetation types across the domain.
  - Simulated dustfall rates as a result of mitigated proposed project operations are below the NDCR limits for non-residential areas on-site and beyond the boundary (off-site); and the simulated dustfall rates are below the NDCR limits for residential areas at all AQSRs and below 400 mg/m²-day at all agricultural areas.
  - The significance of proposed project operations related to inhalation health impacts is likely to be “low” without mitigation measures applied and becomes “very low” with design mitigation measures applied (baghouse). The significance of operations related to nuisance impacts are likely to be “very low” without and with design mitigation.
  - $PM_{2.5}$, PM_{10}, SO_2, NO_x and CO concentrations as a result of mitigated proposed future Smelter Complex operations (all existing smelter complex operations inclusive of the proposed project operations) are within compliance with NAAQS off-site and at all AQSRs.
  - The simulated annual average SO_2 and NO_x concentrations as a result of mitigated proposed future Smelter Complex operations (all existing smelter complex operations inclusive of the proposed project operations) are likely to be below the critical levels for all vegetation types across the domain.
  - Simulated dustfall rates as a result of mitigated proposed future Smelter Complex operations (all existing smelter complex operations inclusive of the proposed project operations) are below the NDCR limits for non-residential areas on-site and beyond the boundary (off-site); and the simulated dustfall rates are below the NDCR limits for residential areas at all AQSRs and below 400 mg/m²-day at all agricultural areas.
  - $PM_{2.5}$ concentrations as a result of mitigated Impala proposed future operations (all existing mining and smelter complex operations inclusive of the proposed project operations) are not in compliance with the future NAAQS at Kelekitso Early Learning Centre and Impala Platinum Hospital over the short-term; and Impala Platinum Hospital over the long-term. The source group with the greatest contribution to the simulated concentrations at Kelekitso Early Learning Centre is crushing and screening. The source group with the greatest contribution to the simulated concentrations at Impala Platinum Hospital is vehicles travelling on paved roads.
  - PM_{10} concentrations as a result of mitigated Impala proposed future operations (all existing mining and smelter complex operations inclusive of the proposed project operations) are not in

compliance with the NAAQS at Impala Platinum Hospital over the short-term but are in compliance with the long-term NAAQS as at AQSRs. The source group with the greatest contribution to the simulated concentrations at Impala Platinum Hospital is vehicles travelling on paved roads.

    - SO_2 concentrations as a result of mitigated Impala proposed future operations (all existing mining and smelter complex operations inclusive of the proposed project operations) are within compliance at all AQSRs. The simulated annual average SO_2 concentrations as a result of mitigated Impala proposed future operations are below the critical levels for all vegetation types at all AQSRs except Kelekitso Early Learning Centre, where there is a potential for impacts on cyanobacterial lichens according to European limits.
    - NO_x concentrations as a result of mitigated Impala proposed future operations (all existing mining and smelter complex operations inclusive of the proposed project operations) are not in compliance with the NO_2 NAAQS at Impala Platinum Hospital over the short-term but are in compliance with the long-term NO_2 NAAQS as at AQSRs. The simulated annual average NO_x concentrations as a result of mitigated Impala operations including the proposed operations are below the critical levels (European limits) for all vegetation types at all AQSRs except Impala Platinum Hospital. The source group with the greatest contribution to the simulated concentrations at Impala Platinum Hospital is vehicles exhausts.
    - The significance of mitigated Impala proposed future operations (all existing mining and smelter complex operations inclusive of the proposed project operations) related to inhalation health impacts is likely to be “high” without mitigation measures applied and becomes “medium” with design mitigation measures applied. The significance of operations related to nuisance impacts are likely to be “medium” without mitigation measures applied and becomes “low” with design mitigation measures applied.
- Decommissioning and closure phases:
    - The significance of decommissioning operations related inhalation health and nuisance impacts are likely to have a “very low” rating without mitigation and “insignificant” rating with mitigation.
    - The significance of closure operations related inhalation health and nuisance impacts are likely “insignificant”.

12.2 Air Quality Recommendations

To ensure the lowest possible impact on AQSRs and environment it is recommended that the air quality management plan as set out in this report should be adopted. This includes:

- The management of all operations (existing and proposed); resulting in the mitigation of associated air quality impacts;
- Source emissions monitoring;
- The ambient air quality monitoring; and
- Record keeping and community liaison procedures.

Based on these findings and provided the measures recommended are in place, it is the specialist opinion that the project may be authorised.

13 References

ADE. (2008). *Emission Estimation Technique Manual for Combustion Engines. Version 3.* Australian Depertment of the Environment.

ADE. (2012). *Emission Estimation Technique Manual for Mining. Version 3.1.* Canberra: Australian Department of the Environment.

Burger, L., & Held, G. S. (1997). *Revised User's Manual for the Airborne Dust Dispersion Model from Area Sources (ADDAS).* Eskom TSI Report No. TRR/T97?066.

C & M Consulting Engineers. (2018). *Emissions Survey: Impala Mineral Processes; Rustenburg, North West (Smelter Section), Report No. 415/18.* Pretoria: C & M Consulting Engineers.

C & M Consulting Engineers. (2020). *Emissions Survey: Impala Mineral Processes; Rustenburg, North West (Smelter Section), Report No. 495/19.* Pretoria: C & M Consulting Engineers.

CERC. (2004). *ADMS Urban Training. Version 2. Unit A.*

CLRTAP. (2015). *Mapping Critical Levels for Vegetation, Chapter III of Manual on methodologies and criteria for modelling and mapping critical loads and levels and air pollution effects, risks and trends.* UNECE Convention on Long-range Transboundary Air Pollution (www.icpmapping.org). Retrieved 12 12, 2016, from http://www.rivm.nl/media/documenten/cce/manual/binnenop17Juni/Ch3-MapMan-2016-05-03_vf.pdf

Dewitt, T. W. (1980). *Control of Copper Smelter Fugitive Emissions, Report No. EPA-600/2-80-079.* Cincinnati: US EPA.

Ehrlich, C., Noll, G., Kalkoff, W. D., Baumbach, G., & Dreiseidler, A. (2007). PM10, PM2.5 and PM1.0—Emissions from Industrial Plants—Results from Measurement Programmes in Germany. *Atmospheric Environment 41*, 6236–6254.

Farmer, A. M. (1993). The Effects of Dust on Vegetation – A Review. *Environmental Pollution, 79*, 63-75.

Goldreich, Y., & Tyson, P. (1988). Diurnal and Inter-Diurnal Variations in Large-Scale Atmospheric Turbulence over Southern Africa. *South African Geographical Journal*, 48-56.

Grobler, N. (2018). *Air Dispersion Modelling Study - Impala Platinum Limited Smelter and Acid Plant Stacks, Report No. 17IMP03.* Johannesburg: Airshed Planning Professionals (Pty) Ltd.

Hanna, S. R., Egan, B. A., Purdum, J., & Wagler, J. (1999). *Evaluation of ISC3, AERMOD, and ADMS Dispersion Models with Observations from Five Field Sites.*

IFC. (2007). *General Environmental, Health and Safety Guidelines.* World Bank Group.

Naidoo, K. (2018). *Impala Platinum Mine November 2018 Monthly Dust Deposition Report, Refrence No. EN086 38.873 M_IMP, Status: Amended.* Johannesburg: SGS.

Tiwary, A., & Colls, J. (2010). *Air pollution: measurement, monitoring and mitigation* (3rd Edition ed.). Oxon: Routledge.

U.S. Department of the Interior, U.S. Geological Survey. (2018, February 2). *Digital Elevation: SRTM 1 Arc-Second Global*. Retrieved from EarthExplorer: http://earthexplorer.usgs.gov

US EPA. (1992). *Protocol for Determining the Best Performing Model. EPA-454/R-92-025.* Research Triangle Park, 2 NC.: United States Environmental Protection Agency.

US EPA. (1995). *AP 42, 5th Edition, Volume 1, Chapter 13: Miscellaneous, 13.2.3 Heavy Construction Operations.* Retrieved from https://www3.epa.gov/ttn/chief/ap42/ch13/final/c13s0203.pdf

US EPA. (1998). *AP 42, 5th Edition, Volume 1, Chapter 11: Mineral Products Industry, 11.9 Western Surface Coal Mining.* Retrieved from https://www3.epa.gov/ttn/chief/ap42/ch11/final/c11s09.pdf

US EPA. (2005). Revision to the Guideline on Air Quality Models: Adoption of a Preferred General Purpose (Flat and Complex Terrain) Dispersion Model and Other Revisions; Final Rule. *Federal Register no. 68218 / Vol. 70, No. 216 / Wednesday, November 9, 2005 / Rules and Regulations*. Washington: United States Environmental Protection Agency.

US EPA. (2006a). *AP 42, 5th Edition, Volume 1, Chapter13: Miscellaneous Sources, 13.2.4 Introduction to Fugitive Dust Sources, Aggregate Handling and Storage Piles.* Retrieved from https://www3.epa.gov/ttn/chief/ap42/ch13/final/c13s0204.pdf

US EPA. (2006b). *AP42, 5th Edition, Volume I, Chapter 13: Miscellaneous Sources, 13.2.2 Introduction to Fugitive Dust Sources, Unpaved Roads.* Retrieved from https://www3.epa.gov/ttn/chief/ap42/ch13/final/c13s0202.pdf

US EPA. (2011). *AP42, 5th Edition, Volume I, Chapter 13: Miscellaneous Sources, 13.2.1 Introduction to Fugitive Dust Sources, Paved Roads.* Retrieved from http://www.epa.gov/ttn/chief/ap42/ch13/final/c13s0201.pdf

US EPA. (2017). Revisions to the Guideline on Air Quality Models: Enhancements to the AERMOD Dispersion Modeling System and Incorporation of Approaches To Address Ozone and Fine Particulate Matter. *Federal Register no. 5182 / Vol. 82, No. 10 / Tuesday, January 17, 2017 / Rules and Regulations*. Washington: United States Environmental Protection Agency.

14 APPENDIX A: AUTHORS' CURRICULUM VITAE AND SACNASP CERTIFICATE

CURRICULUM VITAE

Name	Natasha Anne Shackleton (née Gresse)
Date of Birth	12 September 1988
Nationality	South African
Identification Number	880912 0054 081
Passport Number	A05514095
Employer	Airshed Planning Professionals (Pty) Ltd
Position	Senior Consultant
Profession	Meteorologist employed as an Air Quality and Noise Consultant
Years with Firm	9
E-mail Address	natasha@airshed.co.za
Contact Numbers	+27 11 8051940 (Work Switchboard)
	+27 10 500 1147 (Work Direct)

MEMBERSHIP OF SOCIETIES

- Registered Professional Natural Scientist (Registration Number 116335) with South African Council for Natural Scientific Professions (SACNASP), 2018 to present.
- National Association for Clean Air (NACA), 2011 to present
- South African Society for Atmospheric Sciences (SASAS), 2016 to present.
- American Meteorological Society (AMS), 2017 and 2018.
- Golden Key International Honour Society, 2011 to present.

EXPERIENCE

Natasha has several years of experience in air quality and noise impact assessments and management. She is an employee of Airshed Planning Professionals (Pty) Ltd and is tasked with completing air, noise, greenhouse gas and climate change studies involving ambient measurements; meteorological data processing and preparation; the compilation of emission inventories; undertaking of air dispersion and noise propagation modelling; impact and compliance assessment using her substantial knowledge of South African and international legislation and requirements pertaining to air quality and noise; air quality, noise, greenhouse gas and climate change management plan preparation and report writing. Many of her projects within various countries in Africa required international financing, providing her with an inclusive knowledge base of IFC guidelines and requirements pertaining to air quality.

PROJECTS COMPETED IN VARIOUS SECTORS ARE LISTED BELOW:

Mining Sector

- Coal mining: Argent Colliery, Commissiekraal Coal Mine, Estima Coal Project (Mozambique), Grootegeluk Coal Mine, Matla Coal Mine, Rietvlei Coal Mine, Vierfontein Coal Mine.
- Metalliferous mines: AngloGold Ashanti, Atlantic Sands, Bakubung Platinum Mine, Bannerman Uranium Mine (Namibia), Consol Industrial Minerals, Gold Fields' South Deep Gold Mine, Kitumba Copper Project (Zambia), Lehating Manganese Mine, Lesego Platinum Mine, Lofdal Mining Project (Namibia), Marula Platinum Mine, Maseve Platinum Mine, Mkuju River Uranium Project (Tanzania), Namakwa Sands Quartz Rejects Disposal and Mine, Otjikoto Gold Project (Namibia), Otjikoto Gold Mine's Wolfshag Project (Namibia), Pan Palladium Project, Perkoa Zinc Project (Burkina Faso), Storm Mountain Diamonds (Lesotho), Tete Iron Ore Project / Tete Steel and Vanadium Project (Mozambique), Thabazimbi Iron Ore's Infinity Project, Toliara Sands Project (Madagascar), Tormin Mineral Sands Mine, Trekkopje Uranium Mine (Namibia), Tri-K Project (Guinea), Tschudi Copper Mine (Namibia), Wayland Iron Ore Project, Zulti South Project, Impala Platinum Rustenburg Mine and Smelter.
- Quarries: AfriSam Saldanha Cement Project Limestone Quarry, Bundu Mining, Tete Iron Ore Project / Tete Steel and Vanadium Project (Mozambique).

Industrial Sector

AfriSam Saldanha Project; CAH Chlorine Caustic Soda and HCl Plant, Consol Industrial Minerals, Corobrik Driefontein, Metal Concentrators SA Paarden Eiland, Namakwa Sands Dryer, Otavi Rebar Manufacturing, Phakisa Project, Pan Palladium Project, PPC Riebeeck Cement, Rare Earth Elements Saldanha Separation Plant, Saldanha Steel, Siyanda Project, Tete Iron Ore Project / Tete Steel and Vanadium Project (Mozambique), Tri-K Project (Guinea), Tormin Mineral Sands MSP, Tronox Namakwa Sands Smelter, Tronox Namakwa Sands UMM Plant, Tronox Namakwa Sands MSP, ZMY Steel Recycling Plant, Nyanza TiO_2 Pilot Plant, Musina-Makhado SEZ, West African Resources Sanbrado Project (Burkina Faso), Impala Platinum Rustenburg Mine and Smelter.

Power Generation, Oil and Gas

H2 Energy Power Station, Hwange Thermal Power Station Project (Zimbabwe), Ibhubesi Gas Project, Expansion of Staatsolie Power Company, Suriname Operations (Suriname), Tri-K Project (Guinea), Tete Iron Ore Project / Tete Steel and Vanadium Project (Mozambique).

Waste Disposal and Treatment Sector

Fishwater Flats Waste Water Treatment Works, Khutala Water Treatment Project, Moz Environmental Industrial Landfill (Mozambique), Wolverand Crematorium.

Petroleum Sector

Chevron Refinery, Exol Oil Refinery, Puma South Africa's Fuel Storage Facility, Oilkol Depot, Astron Energy Cape Town Refinery.

Transport and Logistics Sector

Saldanha Port Project.

Ambient Air Quality and Noise Sampling/Monitoring

Gravimetric particulate matter (PM) sampling, Dustfall sampling, Passive diffusive gaseous pollutant sampling, Continuous ambient air quality monitoring, Environmental noise sampling.

SOFTWARE PROFICIENCY

Software utilised in conducting air and noise studies:

- WRPLOT (wind & pollution rose generation);
- OpenAir (ambient and meteorological data processing)
- ScreenView (screening model);
- AERMOD suite (air dispersion model);
- ADMS (air dispersion model);
- CALPUFF suite (air dispersion model);
- GRAL system (air dispersion model);
- TANKS (emission estimation model);
- GasSim (emission estimation model);
- DataKustic CadnaA (noise propagation model);

- CONCAWE (noise propagation model); and
- SANS 10201 (calculating and predicting road traffic noise).

EDUCATION

- 2016 to present - MSc: Applied Science (Environmental Technology) student at the University of Pretoria (Faculty of Engineering, Built Environment and Information Technology), Pretoria. Currently undertaking studies. Supervisor: Dr G Kornelius.
- 2010 to 2011 - BSc Honours (Meteorology) student at the University of Pretoria (Faculty of Natural and Agricultural Sciences), Pretoria. Completed 30 November 2011. Degree issued/conferred 13 April 2012. Research project supervisor: Dr S Venkataraman.
- 2007 to 2010 - BSc student at the University of Pretoria (Faculty of Natural and Agricultural Sciences), Pretoria. Completed 30 June 2010. Degree issued/conferred 2 September 2010.

CONFERENCES ATTENDED, ARTICLES PUBLISHED AND COURSES COMPLETED

- Conference: Innovation Bridge and Science Forum South Africa (December 2019), attended.
- Conference: NACA (October 2018), attended and presented a paper (Correlating Dust Concentration Measurements aloft with Opencast Mining Surface Operations).
- Conference: NACA (October 2017), attended and presented a paper (Correlating Dust Concentration Measurements aloft with Opencast Mining Surface Operations).
- Published Article: Beukes, JP; Van Zyl, PG; Sofiev, M; Soares, J; Liebenberg-Enslin, H; Shackleton, N; Sundstrom, AM (2018). The use of satellite observations of fire radiative power to estimate the availabilities (activity patterns) of pyrometallurgical smelters. Journal of the Southern African Institute of Mining and Metallurgy, 118(6), 619-624., co-author.
- Undergraduate courses passed: computer literacy (word processing, spreadsheet processing, Microsoft power point, Microsoft publisher, use of Internet and Microsoft front page); MATLAB; ArcGIS 9.0.; ERDAS Image; Aan Arbor; IDRISI TAIGA; GRADS; TITAN; SUMO 3.00; and Danny Rosenfeld 2007-01.

COUNTRIES OF WORK EXPERIENCE

South Africa, Botswana, Burkina Faso, Guinea, Lesotho, Mozambique, Madagascar, Namibia, Suriname, Tanzania, Zambia and Zimbabwe.

LANGUAGES

Language	Proficiency
English	Full professional proficiency
Afrikaans	Limited working proficiency

REFERENCES

Name	Position	Contact Number
Dr Gerrit Kornelius	Associate of Airshed Planning Professionals	+27 82 925 9569 gerrit@airshed.co.za
Dr Lucian Burger	Director at Airshed Planning Professionals	+27 11 805 1940 lucian@airshed.co.za
Dr Hanlie Liebenberg-Enslin	Managing Director at Airshed Planning Professionals	+27 11 805 1940 hanlie@airshed.co.za

CERTIFICATION

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

22/04/2020

SACNASP

South African Council for Natural Scientific Professions

herewith certifies that

Natasha Anne Shackleton

Registration Number: 116335

is a registered scientist

in terms of section 20(3) of the Natural Scientific Professions Act, 2003
(Act 27 of 2003)
in the following fields(s) of practice (Schedule 1 of the Act)

Physical Science (Professional Natural Scientist)

Effective **6 June 2018** Expires **31 March 2021**

Chairperson

Chief Executive Officer

To verify this certificate scan this code

15 APPENDIX B: COMPETENCIES FOR PERFORMING AIR DISPERSION MODELLING

All modelling tasks were performed by competent personnel. Table 51 is a summary of competency requirements. Apart from the necessary technical skills required for the calculations, personnel competency also include the correct attitude, behaviour, motive and other personal characteristic that are essential to perform the assigned job on time and with the required diligence as deemed necessary for the successful completion of the project.

The project technical team included a senior scientist with relevant experience of 9 years who undertook the study and one senior scientist with 8 years relevant experience who reviewed the report and verified the modelling results. The latter function requires a thorough knowledge of the

- meteorological parameters that influence the atmospheric dispersion processes and
- atmospheric chemical transformations that some pollutants may undergo during the dispersion process.

Table 51: Competencies for Performing Air Dispersion Modelling

Competency	Task, Knowledge and Experience
Context	Communication with field workers, technicians, laboratories, engineers and scientists and project managers during the process is important to the success of the model
	Familiar with terminology, principles and interactions
	Record keeping is important to support the accountability of the model - Understanding of data collection methods and technologies
Knowledge	Meteorology: Obtain, review and interpret meteorological data Understanding of meteorological impacts on pollutants Ability to identify and describe soil, water, drainage and terrain conditions Understanding of their interaction Familiarity with surface roughness` Ability to identify good and bad data points/sets Understanding of how to deal with incomplete/missing meteorological data
	Atmospheric Dispersion models Select appropriate dispersion model Prepare and execute dispersion model Understanding of model input parameters Interpret results of model
	Chemical and physical interactions of atmospheric pollutants Familiarity with fate and transport of pollutants in air Interaction of primary pollutants with other substances (natural or industrial) to form secondary pollutants
	Information relevant to the model Identify potential pollution (emission) sources and rates Gather physical information on sources such as location, stack height and diameter Gather operating information on sources such as mass flow rates, stack top temperature, velocity or volumetric flow rate Calculate emission rates based on collected information

Competency	Task, Knowledge and Experience
	Identify land use (urban/rural) Identify land cover/terrain characteristics Identify the receptor grid/site
	Legislation, regulations and guidelines in regard to National Environment Management: Air Quality Act (Act No 39 of 2004), including Minimum Emissions Standards (Section 21 of Act) National Atmospheric Emissions Reporting Regulations Regarding Air Dispersion Modelling National Ambient Air Quality Standards National Dust Control Regulations Air Quality Specialist Report Atmospheric Impact Report (AIR)
Abilities	Ability to read and understand map information
	Ability to prepare reports and documents as necessary
	Ability to review reports to ensure accuracy, clarity and completeness
	Communication skills
	Team skills

16 APPENDIX C: MANAGEMENT OF UNCERTAINTIES

Dispersion Model Uncertainties

In the US EPA Guideline on Air Quality Models (US EPA, 2017), the need to address the uncertainties associated with dispersion modelling is acknowledged as an important issue that should be considered. The US Guideline divides the uncertainty associated with dispersion model predictions into two main types (US EPA, 2017), as follows:

- Reducible uncertainty, which results from (1) Uncertainties in the input values of the known conditions (i.e., emission characteristics and meteorological data); (2) errors in the measured concentrations which are used to compute the concentration residuals; and (3) inadequate model physics and formulation. The ‘‘reducible’’ uncertainties can be minimized through better (more accurate and more representative) measurements and better model physics.
- Inherent uncertainty is associated with the stochastic (turbulent) nature of the atmosphere and its representation (approximation) by numerical models. Models predict concentrations that represent an ensemble average of numerous repetitions for the same nominal event. An individual observed value can deviate significantly from the ensemble value. This uncertainty may be responsible for a ± 50% deviation from the measured value.

Atmospheric dispersion models are often criticised for being inadequate since "*…it is only a model approximating reality*", and therefore include inherent uncertainty. Both reducible and inherent uncertainties mean that dispersion modelling results may over- or under-estimate measured ground-level concentrations at any specific time or place. However, the US EPA Guideline on Air Quality Models (US EPA, 2017) also states that:

"Models are more reliable for estimating longer time-averaged concentrations than for estimating short-term concentrations at specific locations; and the models are reasonably reliable in estimating the magnitude of highest concentrations occurring sometime, somewhere within an area. For example, errors in highest estimated concentrations of ± 10 to 40 percent are found to be typical, certainly well within the often-quoted factor-of-two accuracy that has long been recognized for these models."

To minimise the overall uncertainty, but specifically the "reducible uncertainty", the following simple principles were followed in the investigation:

- Understanding the objectives of the investigation;
- Demonstrating that the model inputs are as correct as possible;
- Understanding and stating the model performance limitations;
- Demonstrating that the modelling process has been conducted appropriately and in line with both local DEFF requirements and international practice;
- Including any validating information from monitoring that might be available; and,
- To be conservative in cases where there is greater uncertainty (e.g. conversion of NO to NO_2).

Although the existence of model uncertainty is well-accepted, it does not exclude the use of dispersion modelling results in making important air quality impact decisions. The uncertainties should simply be acknowledged and understood that, given their inherent uncertainty, current dispersion models are a “best-case” approximation of what are otherwise very complex physical processes in the atmosphere. An accepted dispersion model (i.e., AERMOD) was selected for the analysis to minimize some of these uncertainties. The US EPA states that when dispersion models such as AERMOD are used to assess ground-level concentration and when a sufficiently large number of meteorological conditions are considered, the modelling results should ideally fall well within the often quoted "factor of two" accuracy for these modelled (US EPA, 2017).

Validation of Predictions

Model verification and validation (V&V) are the primary processes for quantifying and building credibility in numerical models. There are distinct differences between the two processes, as described below:

- Verification is the process of determining that a model implementation accurately represents the developer’s conceptual description of the model and its solution.
- Validation is the process of determining the degree to which a model is an accurate representation of the real world from the perspective of the intended uses of the model.

Whilst V&V cannot prove that a model is correct and accurate for all possible scenarios, it can provide evidence that the model is sufficiently accurate for its intended use.

Scenario Simulations

Since the focus of the study has been to illustrate the relative changes with the introduction of new sources of emission related to the addition of a second Flash Dryer, whilst maintaining the same emissions and locality for current operations, it is expected that the model errors would mostly be carried between the different modelling scenarios (Impala current operations, proposed second Flash Dryer, existing smelter complex operations with the proposed second Flash Dryer, and Impala future operations). Therefore, expressing the changes as incremental and relative to the baseline scenario it is expected that these errors would mostly cancel each other out.

Ambient Monitoring Uncertainty

There is a degree of uncertainty with the ambient monitoring data concerning data availability and accuracy of measured concentrations.

Surface and Upper Air Meteorological Data

There is a lack of measured upper air meteorology for input into the AERMOD dispersion model. The lack of appropriate meteorological information is often the single most important limiting factor in modelling accuracy. It is also the most subjective in deciding just how many data are needed, from which location and how accurate they must be.

The AERMOD wind field model requires meteorological data from at one surface and upper soundings. This information is then used to “seed” the wind field with an initial solution of a relatively simple mass conservation model.

It is expected that a wind field developed using all the parameters that could influence the flow, thermal and turbulence mechanisms should improve the accuracy of the dispersion predictions. For upper air data, AERMET was used to create an extrapolated upper air profile from the surface station (measured) data.

Emission Inventory Uncertainty

In addition to meteorological input data, the uncertainty associated with the emissions inventory needs to be accommodated in the results. All smelter stack emissions used in the simulations of the baseline scenario were based on isokinetic measurements. The combination of emission factors and emission equations with materials rates and properties were used to determine all the fugitive sources emissions. The ventilation shaft emissions were based on South African OELs and the volumetric flow rates.

17 APPENDIX D: SLR METHODOLOGY FOR ASSESSING THE SIGNIFICANCE OF IMPACTS

PART A: DEFINITIONS AND CRITERIA*		
Definition of SIGNIFICANCE		**Significance = consequence x probability**
Definition of CONSEQUENCE		**Consequence is a function of intensity, spatial extent and duration**
Criteria for ranking of the INTENSITY of environmental impacts	**VH**	Severe change, disturbance or degradation. Associated with severe consequences. May result in severe illness, injury or death. Targets, limits and thresholds of concern continually exceeded. Substantial intervention will be required. Vigorous/widespread community mobilization against project can be expected. May result in legal action if impact occurs.
	H	Prominent change, disturbance or degradation. Associated with real and substantial consequences. May result in illness or injury. Targets, limits and thresholds of concern regularly exceeded. Will definitely require intervention. Threats of community action. Regular complaints can be expected when the impact takes place.
	M	Moderate change, disturbance or discomfort. Associated with real but not substantial consequences. Targets, limits and thresholds of concern may occasionally be exceeded. Likely to require some intervention. Occasional complaints can be expected.
	L	Minor (Slight) change, disturbance or nuisance. Associated with minor consequences or deterioration. Targets, limits and thresholds of concern rarely exceeded. Require only minor interventions or clean-up actions. Sporadic complaints could be expected.
	VL	Negligible change, disturbance or nuisance. Associated with very minor consequences or deterioration. Targets, limits and thresholds of concern never exceeded. No interventions or clean-up actions required. No complaints anticipated.
	VL+	Negligible change or improvement. Almost no benefits. Change not measurable/will remain in the current range.
	L+	Minor change or improvement. Minor benefits. Change not measurable/will remain in the current range. Few people will experience benefits.
	M+	Moderate change or improvement. Real but not substantial benefits. Will be within or marginally better than the current conditions. Small number of people will experience benefits.
	H+	Prominent change or improvement. Real and substantial benefits. Will be better than current conditions. Many people will experience benefits. General community support.

	VH+	Substantial, large-scale change or improvement. Considerable and widespread benefit. Will be much better than the current conditions. Favourable publicity and/or widespread support expected.
Criteria for ranking the DURATION of impacts	**VL**	Very short, always less than a year. Quickly reversible
	L	Short-term, occurs for more than 1 but less than 5 years. Reversible over time.
	M	Medium-term, 5 to 10 years.
	H	Long term, between 10 and 20 years. (Likely to cease at the end of the operational life of the activity)
	VH	Very long, permanent, +20 years (Irreversible. Beyond closure)
Criteria for ranking the EXTENT of impacts	**VL**	A part of the site/property.
	L	Whole site.
	M	Beyond the site boundary, affecting immediate neighbours
	H	Local area, extending far beyond site boundary.
	VH	Regional/National

PART B: DETERMINING CONSEQUENCE							
			EXTENT				
			A part of the site/property	Whole site	Beyond the site, affecting neighbours	Local area, extending far beyond site.	Regional/ National
			VL	**L**	**M**	**H**	**VH**
INTENSITY = VL							
DURATION	Very long	**VH**	**Low**	**Low**	**Medium**	**Medium**	**High**
	Long term	**H**	**Low**	**Low**	**Low**	**Medium**	**Medium**
	Medium term	**M**	**Very Low**	**Low**	**Low**	**Low**	**Medium**
	Short term	**L**	**Very low**	**Very Low**	**Low**	**Low**	**Low**

	Very short	VL	Very low	Very Low	Very Low	Low	Low
INTENSITY = L							
DURATION	Very long	VH	Medium	Medium	Medium	High	High
	Long term	H	Low	Medium	Medium	Medium	High
	Medium term	M	Low	Low	Medium	Medium	Medium
	Short term	L	Low	Low	Low	Medium	Medium
	Very short	VL	Very low	Low	Low	Low	Medium
INTENSITY = M							
DURATION	Very long	VH	Medium	High	High	High	Very High
	Long term	H	Medium	Medium	Medium	High	High
	Medium term	M	Medium	Medium	Medium	High	High
	Short term	L	Low	Medium	Medium	Medium	High
	Very short	VL	Low	Low	Low	Medium	Medium
INTENSITY = H							
DURATION	Very long	VH	High	High	High	Very High	Very High
	Long term	H	Medium	High	High	High	Very High
	Medium term	M	Medium	Medium	High	High	High
	Short term	L	Medium	Medium	Medium	High	High
	Very short	VL	Low	Medium	Medium	Medium	High
INTENSITY = VH							
DURATION	Very long	VH	High	High	Very High	Very High	Very High
	Long term	H	High	High	High	Very High	Very High
	Medium term	M	Medium	High	High	High	Very High

	Short term	L	Medium	Medium	High	High	High
	Very short	VL	Low	Medium	Medium	High	High

PART C: DETERMINING SIGNIFICANCE							
PROBABILITY (of exposure to impacts)	Definite/ Continuous	VH	Very Low	Low	Medium	High	Very High
	Probable	H	Very Low	Low	Medium	High	Very High
	Possible/ frequent	M	Very Low	Very Low	Low	Medium	High
	Conceivable	L	Insignificant	Very Low	Low	Medium	High
	Unlikely/ improbable	VL	Insignificant	Insignificant	Very Low	Low	Medium
			VL	L	M	H	VH
			CONSEQUENCE				

PART D: INTERPRETATION OF SIGNIFICANCE	
Significance	**Decision guideline**
Very High	Potential fatal flaw unless mitigated to lower significance.
High	It must have an influence on the decision. Substantial mitigation will be required.
Medium	It should have an influence on the decision. Mitigation will be required.
Low	Unlikely that it will have a real influence on the decision. Limited mitigation is likely to be required.
Very Low	It will not have an influence on the decision. Does not require any mitigation
Insignificant	Inconsequential, not requiring any consideration.

18 Appendix E: Comments and Responses

Table 52: Comments and responses table

Name and Surname	Issue Raised	Response given by Project Team
Kgosana Rapetsana/Rapebana	My main concern is air pollution, we are currently experiencing air pollution and the project will result to an increase in air pollution in the area. Please make sure that you monitor air pollution.	Current - The $PM_{2.5}$ and PM_{10} monitored data shows exceedances of the annual and 24-hour NAAQS. The SO_2 monitored data shows no exceedances of the annual, daily and hourly NAAQS. The operations off-site dustfall rates sampled complies in terms of the NDCR. The current pollutant concentrations and dustfall rates are shown in more detail in Section 5.3 (Existing Air Quality). Project operations – The simulated $PM_{2.5}$, PM_{10}, SO_2, NO_x and CO concentrations as a result of proposed operations are within compliance with NAAQS off-site and at all AQSRs. The simulated annual average SO_2 and NO_x concentrations as a result of proposed project operations are likely to be below the critical levels for all vegetation types across the domain. Simulated dustfall rates as a result of proposed project operations are below the NDCR limits for non-residential areas on-site and beyond the boundary (off-site); and the simulated dustfall rates are below the NDCR limits for residential areas at all AQSRs and below 400 mg/m²-day at all agricultural areas. The project related pollutant concentrations and dustfall rates are shown in more detail in Section 7.2 (Assessment of Impact – Proposed Flash Dryer Operations). Future operations - $PM_{2.5}$ concentrations as a result of mitigated Impala proposed future operations (all existing mining and smelter complex operations inclusive of the proposed project operations) are not in compliance with the future NAAQS at Kelekitso Early Learning Centre and Impala Platinum Hospital over the short-term; and Impala Platinum Hospital over the long-term. PM_{10} concentrations as a result of mitigated Impala proposed future operations (all existing mining and smelter complex operations inclusive of the proposed project operations) are not in compliance with the NAAQS at Impala Platinum Hospital over the short-term but are in compliance with the long-term NAAQS as at AQSRs. SO_2 concentrations as a result of mitigated Impala proposed future operations

Name and Surname	Issue Raised	Response given by Project Team
		(all existing mining and smelter complex operations inclusive of the proposed project operations) are within compliance at all AQSRs. The simulated annual average SO_2 concentrations as a result of mitigated Impala proposed future operations are below the critical levels for all vegetation types at all AQSRs except Kelekitso Early Learning Centre, where there is a potential for impacts on cyanobacterial lichens. NO_x concentrations as a result of mitigated Impala proposed future operations (all existing mining and smelter complex operations inclusive of the proposed project operations) are not in compliance with the NO_2 NAAQS at Impala Platinum Hospital over the short-term but are in compliance with the long-term NO_2 NAAQS as at AQSRs. The simulated annual average NO_x concentrations as a result of mitigated Impala operations including the proposed operations are below the critical levels for all vegetation types at all AQSRs except Impala Platinum Hospital. The potential future pollutant concentrations and dustfall rates are shown in more detail in Section 7.5 (Assessment of Impact – Impala Proposed Future Operations (All Existing Impala Operations and Proposed Second Flash Dryer Operations)). Monitoring – It is recommended that Impala continue to operate and maintain their existing ambient monitoring network.
Councillor Lefiedi	How will the project affect us positively and negatively? How will this benefit me? What are the benefits within the project so that I know how to participate?	The significance of proposed project operations related to inhalation health impacts is likely to be "low" without mitigation measures applied and becomes "very low" with design mitigation measures applied (baghouse). The significance of operations related to nuisance impacts are likely to be "very low" without and with design mitigation. The potential future pollutant concentrations and dustfall rates are shown in more detail in Section 7.2 (Assessment of Impact – Proposed Flash Dryer Operations) and the significance ranking in Section 7.3 (Impact Significance Rating – Proposed Flash Dryer Operations).

Name and Surname	Issue Raised	Response given by Project Team
Councillor Ntikelane	According to your presentation, the impacts with respect to noise and air are low. However, we must have control measures because the project results in additional air and noise emissions in relation to existing emissions in the area.	The project operations resulted in a minimal increase in simulated ambient pollutant concentrations and dustfall rates in comparison to what was simulated for existing operations. Project operations – The simulated $PM_{2.5}$, PM_{10}, SO_2, NO_x and CO concentrations as a result of proposed operations are within compliance with NAAQS off-site and at all AQSRs. The simulated annual average SO_2 and NO_x concentrations as a result of proposed project operations are likely to be below the critical levels for all vegetation types across the domain. Simulated dustfall rates as a result of proposed project operations are below the NDCR limits for non-residential areas on-site and beyond the boundary (off-site); and the simulated dustfall rates are below the NDCR limits for residential areas at all AQSRs and below 400 mg/m²-day at all agricultural areas. The project related pollutant concentrations and dustfall rates are shown in more detail in Section 7.2 (Assessment of Impact – Proposed Flash Dryer Operations). Future operations - $PM_{2.5}$ concentrations as a result of mitigated Impala proposed future operations (all existing mining and smelter complex operations inclusive of the proposed project operations) are not in compliance with the future NAAQS at Kelekitso Early Learning Centre and Impala Platinum Hospital over the short-term; and Impala Platinum Hospital over the long-term. PM_{10} concentrations as a result of mitigated Impala proposed future operations (all existing mining and smelter complex operations inclusive of the proposed project operations) are not in compliance with the NAAQS at Impala Platinum Hospital over the short-term but are in compliance with the long-term NAAQS as at AQSRs. SO_2 concentrations as a result of mitigated Impala proposed future operations (all existing mining and smelter complex operations inclusive of the proposed project operations) are within compliance at all AQSRs. The simulated annual average SO_2 concentrations as a result of mitigated Impala proposed future operations are below the critical levels for all vegetation types at all AQSRs except Kelekitso Early Learning Centre, where there is a potential for impacts on cyanobacterial lichens. NO_x concentrations as a

Name and Surname	Issue Raised	Response given by Project Team
		result of mitigated Impala proposed future operations (all existing mining and smelter complex operations inclusive of the proposed project operations) are not in compliance with the NO_2 NAAQS at Impala Platinum Hospital over the short-term but are in compliance with the long-term NO_2 NAAQS as at AQSRs. The simulated annual average NO_x concentrations as a result of mitigated Impala operations including the proposed operations are below the critical levels for all vegetation types at all AQSRs except Impala Platinum Hospital. The potential future pollutant concentrations and dustfall rates are shown in more detail in Section 7.5 (Assessment of Impact – Impala Proposed Future Operations (All Existing Impala Operations and Proposed Second Flash Dryer Operations)).
Kgosana Montsho	Of late, the clinics are full. This is because of emissions from the Impala plant. Has impala taken time to understand why people are sick? Life expectancy is questionable, and we don't have facts. Studies should be done to help us understand this, instead studies are only done to help Impala kill us.	Please see Section 5.3 (Existing Air Quality) for the major emission sources within the study area. The $PM_{2.5}$ and PM_{10} monitored data shows exceedances of the annual and 24-hour NAAQS. The SO_2 monitored data shows no exceedances of the annual, daily and hourly NAAQS. The operations off-site dustfall rates sampled complies in terms of the NDCR. The current pollutant concentrations and dustfall rates are shown in more detail in Section 5.3 (Existing Air Quality). The state of the air document published by the Department of Environmental Affairs (DEA), now DEFF says: "Air quality limits and thresholds are fundamental to effective air quality management. Ambient air quality limits serve to indicate what levels of exposure to pollution are generally safe for most people, including the very young and the elderly, over their lifetimes."[6]
Councillor Mputle	Studies should be done to determine the health impacts from the Impala operations	The scope of the study will be confined to the quantification of impacts due to exposures via the inhalation pathway only. Simulated ambient pollutant concentrations and fallout rates were compared to NAAQS, health risk screening levels, and NDCR, nuisance screening levels. Compliance was assessed, and a health risk/nuisance screening completed.

[6] https://www.environment.gov.za/sites/default/files/docs/stateofair_executive_iaiquality_standardsonjectives.pdf

Name and Surname	Issue Raised	Response given by Project Team
Kgosana Mothibe	Our women are miscarrying, reports like these will give us answers. Currently, the way the project is presented, its to help Impala make profit. As a community we will never get a cent from it. Do as you will	Airshed is an independent consulting firm with no interest in the project other than to fulfil the contract between the client and the consultant for delivery of specialised services as stipulated in the terms of reference. The terms of reference required the quantification of impacts due to exposures via the inhalation pathway. Simulated ambient pollutant concentrations and fallout rates were compared to NAAQS, health risk screening levels, and NDCR, nuisance screening levels. Compliance was assessed, and a health risk/nuisance screening completed. As stated above the NAAQS "serve to indicate what levels of exposure to pollution are generally safe for most people, including the very young and the elderly, over their lifetimes" (see footnote for document referenced). I, Natasha Anne Shackleton as the appointed independent air quality specialist for the Project, hereby declare that I: • acted as the independent specialist in this scoping assessment; • performed the work relating to the study in an objective manner; • regard the information contained in this report as it relates to my specialist input/study to be true and correct, • do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the Environmental Impact Assessment; • declare that there are no circumstances that may compromise my objectivity in performing such work; • have expertise in conducting the specialist report relevant to this application; • have no, and will not engage in, conflicting interests in the undertaking of the activity; • have no vested interest in the proposed activity proceeding; • undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing the decision of the competent authority; and

Name and Surname	Issue Raised	Response given by Project Team
		• all the particulars furnished by me in this specialist input/study are true and correct.
Councillor Mekgoe	What is the air quality monitoring programme? What new technologies that can be used to manage air pollution, which form part of Scenario 3 (Modelling scenario that takes into account emissions associated with the proposed project, smelter operations and all impala operations in the area) as per the finding of the air quality assessment undertaken.	The Impala air quality monitoring programme is made up of a network of continuous pollutant monitors measuring $PM_{2.5}$, PM_{10} and SO_2 concentrations and fallout dust samplers measuring the dustfall rates as a result of all sources of emissions in the area, this includes not only the Impala operations but also emissions from community activities and likely also other mining, processing and industrial operations in the region. Since fallout dust comprises of mostly larger particulate matter which will be deposited closer to the source of total suspended particulate emissions, the measured dustfall rates are mostly as a result of localised “dust” sources. Impala will consider sharing the monitoring results at the MCLEF in future. As part of the air quality impact assessment undertaken, over and above modelling only the incremental (project) operations, current Impala operations were modelled to determine the potential ground-level concentrations as a result of the Impala operations only and for model validation. Dispersion modelling was also undertaken to determine the potential ground-level concentrations as a result of all proposed smelter plant (current stacks and proposed second flash dryer stack), given that these sources are of greatest concern in terms of the NEM:AQA Section 21. The proposed future Impala operations (all existing Impala operations and proposed second flash dryer operation). The findings from the modelling indicate that there is a possibility of exceedances of $PM_{2.5}$ National Ambient Air Quality Standards in 10 years’ time provided that all Impala operations are run simultaneously and that the existing Impala operations, especially mining and processing rates remain similar the 2019 operations. The use of a second flash dryer with an associated baghouse could potentially reduce the smelter plant emissions in the future should the current spray dryers

Name and Surname	Issue Raised	Response given by Project Team
		throughputs be reduced by the operation of the second flash dryer with improved technology.
Councillor Masilo	Can the MCLEF be provided with more information on the air quality legislation (i.e. the National Air Quality Standard and Dust Control Regulations) as well as the findings of the Air Quality Study, which states that the project will not affect the community from an air quality perspective in writing.	The findings of the Air Quality Study will be included in the Basic Assessment Report (Impala), which will be provided to the MCLEF for review.