ATMOSPHERIC IMPACT REPORT:
Combined-Cycle Gas Turbine Power Plant at Kelvin Power Station

Project done on behalf of **Environmental Impact Management Services (Pty) Ltd**

Project Compiled by:
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Report Details

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Revision Record

Revision Number	Date	Reason for Revision
Rev 0	July 2024	For internal review
Rev 1	July 2024	Editorial changes
Rev 2	July 2024	For client review
Rev 3	August 2024	Incorporation of client's comments

Abbreviations

AEL	Atmospheric Emissions Licence
AIR	Atmospheric Impact Report
Airshed	Airshed Planning Professionals (Pty) Ltd
Anergi	Anergi group
AMS	American Meteorological Society
APPA	Atmospheric Pollution Prevention Act
AQA	Air Quality Act
AQIA	Air Quality Impact Assessment
AQMS	Air Quality Monitoring Stations
AQO	Air Quality Officer
ARM	Ambient Ratio Method
ASTM	American Society of the International Association for Testing and Materials
CCGT	Combined Cycle Gas Turbine
DFFE	Department of Forestry, Fisheries and Environmental
DTIC	Department of Trade, Industry and Competition
EHV	Extra High Voltage
EIA	Environmental Impact Assessment
EIMS	Environmental Impact Management Services (Pty) Ltd
EMPr	Environmental Management Programme
GG	Government gazette
GN	Government notice
HPA	Highveld Priority Area
HRSG	Heat Recovery Steam Generators
Kelvin	Kelvin Power (Pty) Ltd
LNG	Liquified Natural Gas
MES	(National) Minimum Emission Standard(s) (as defined in Section 21 of the National Environmental Management: Air Quality Act)
NAAQS	National Ambient Air Quality Standards
NACA	National Association for Clean Air
NEMA	National Environmental Management Act
NEM:AQA	National Environmental Management: Air Quality Act 2004
NDCR	National Dust Control Regulations
pdf	Probability density function
PIC	Public Investment Corporation
SACNASP	South African Council for Natural Scientific Professions
SAWS	South African Weather Service
US EPA	United States Environmental Protection Agency
WRF	Weather Research and Forecasting model

Glossary

Air pollution[(a)]	The presence of substances in the atmosphere, particularly those that do not occur naturally
Dispersion[(a)]	The spreading of atmospheric constituents, such as air pollutants
Dust[(a)]	Solid materials suspended in the atmosphere in the form of small irregular particles, many of which are microscopic in size
Frequency of exceedance	Permissible margin of tolerance of the Limit Concentration
Instability[(a)]	A property of the steady state of a system such that certain disturbances or perturbations introduced into the steady state will increase in magnitude, the maximum perturbation amplitude always remaining larger than the initial amplitude
Limit Concentration	Maximum allowable concentration of a pollutant applicable for an applicable averaging period
Mechanical mixing[(a)]	Any mixing process that utilizes the kinetic energy of relative fluid motion
Oxides of nitrogen (NO_x)	The sum of nitrogen oxide (NO) and nitrogen dioxide (NO_2) expressed as nitrogen dioxide (NO_2)
Particulate matter (PM)	Total particulate matter, that is solid matter contained in the gas stream in the solid state as well as insoluble and soluble solid matter contained in entrained droplets in the gas stream
$PM_{2.5}$	Particulate Matter with an aerodynamic diameter of less than 2.5 µm
PM_{10}	Particulate Matter with an aerodynamic diameter of less than 10 µm
Stability[(a)]	The characteristic of a system if sufficiently small disturbances have only small effects, either decreasing in amplitude or oscillating periodically; it is asymptotically stable if the effect of small disturbances vanishes for long time periods
Standard	A combination of the Limit Concentration and the allowable frequency of exceedance

Notes:

(a) Definition from American Meteorological Society's glossary of meteorology (AMS, 2014)

Symbols and Units

°C	Degree Celsius
C_6H_6	Benzene
Cl^-	Chlorides
CO	Carbon monoxide
g	Gram(s)
ha	Hectar
HAP	Hazardous air pollutants
HCOOH	Formic acid
HNO_3	Nitric acid
km	Kilometre
K	Temperature in Kelvin
m	Metre
m/s	Metres per second
µg	Microgram(s)
$µg/m^3$	Micrograms per cubic metre
m^2	Square metre
m^3	Cubic metre
m^3/hr	Cubic metre per hour
$mg/m^2/day$	Milligram per square metre per day
mg/Am^3	Milligram per actual cubic metre
mg/Nm^3	Milligram per normal cubic metre (normalised at 273 K; 101.3 kpa)
MW	Mega Watt
NH_3	Ammonia
NO	Nitric oxide
NO_2	Nitrogen dioxide
NO_3	Particulate nitrate
NO_x	Oxides of nitrogen
O_3	Ozone
pb	Lead
ppb	Parts per billion
ppm	Parts per million
PM	Particulate matter
$PM_{2.5}$	Inhalable particulate matter (aerodynamic diameter less than 2.5 µm)
PM_{10}	Thoracic particulate matter (aerodynamic diameter less than 10 µm)
RNO_3	Organic nitrates
SO_2	Sulfur dioxide
SO_4	Sulfates
t/a	Tonnes per annum
TSP	Total suspended particulates
VOC	Volatile organic compounds
%	Percent

Note:
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)"

Executive Summary

Introduction

Kelvin Power Pty Ltd ("Kelvin") is a coal fired power plant situated in Kempton Park, Johannesburg, South Africa, owned by the Anergi group ("Anergi") and Public Investment Corporation ("PIC"). The existing power plant comprises of: (i) the still operational B Station which was built in the 1960s and includes seven 60 MW steam turbines and eight pulverised coal boilers, and (ii) the now decommissioned A Station which was built in the 1950s. The A station ceased operations in 2012 and a Basic Assessment has been approved for its demolition.

A pre-feasibility study was concluded in 2023 to assess the various technology options available to generate 450 MW to 650 MW on the current A Station site. The pre-feasibility study's objective was to identify proven technology available for power generation on the available site considering the infrastructure available. The study concluded that a combined-cycle gas turbine (CCGT) Power Plant with a net output of approximately 600 MW comprising one H class gas turbine, a heat recovery boiler and a steam turbine, would be the optimum technology for this site (hereafter referred to as the project). It should be noted that the current Station B operations will cease before the project is in operation.

Airshed Planning Professionals (Pty) Ltd (Airshed) was commissioned by Environmental Impact Management Services (Pty) Ltd (EIMS) to undertake an Air Quality Impact Assessment for the proposed project.

The aim of the investigation was to quantify the possible impacts resulting from the project activities on the surrounding environment and human health. To achieve this, a good understanding of the local dispersion potential of the site is necessary and subsequently an understanding of existing sources of air pollution in the region and the resulting air quality.

Study Approach and Methodology

The investigation followed the methodology required for a specialist report, as prescribed in the National Environmental Management Act (Act 107 of 1998) (NEMA) Environmental Impact Assessment (EIA) Regulations (Government Notice [GN] R982 in Government Gazette [GG] 38282 of 14 December 2014). The format of the assessment also meets the prescribed format of an Atmospheric Impact Report (AIR), as set out in the Regulations gazetted on 11th of October 2013 (GG 36904). Typically, an AIR would accompany the application for, an Atmospheric Emissions License (AEL).

Baseline Assessment

The baseline study encompassed the identification of air quality sensitive receptors, atmospheric dispersion potential and ambient air quality within the study area.

Air quality sensitive receptors were identified from available satellite imagery.

Measured ambient ground level concentrations were assessed from the nearest Air Quality Monitoring Stations (AQMS) within the study area for the period 2023.

Impact Assessment Criteria

In the evaluation of ambient air quality impacts reference is made to National Ambient Air Quality Standards (NAAQS). These standards apply only to certain common air pollutants, collectively known as criteria pollutants. Criteria pollutants include sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), inhalable particulate matter (PM) (including thoracic PM with an aerodynamic diameter of equal to or less than 10 µm or PM_{10} and inhalable PM with an aerodynamic diameter equal to or less than 2.5 µm or $PM_{2.5}$), benzene, ozone (O_3) and lead.

SO_2, NO_2 and PM represent the main pollutants of concern in the assessment of the project. For the current assessment, the impacts were assessed against published NAAQS and National Dust Control Regulations (NDCR).

Emissions Inventory

The establishment of a comprehensive emissions inventory formed the basis for the assessment of the air quality impacts from the project. Use was made of the applicable Minimum Emission Standards (MES) and United States Environmental Protection Agency (US EPA) emission factors.

Impact Prediction Study

Gaseous concentrations due to the proposed operations were simulated using the US EPA CALPUFF dispersion modelling suite. Ambient concentrations were simulated to ascertain highest hourly, highest daily and annual averaging levels occurring due to project operations. These were then compared to NAAQS and NDCR (legal limits for criteria pollutants).

Management of Uncertainties

The main assumptions, exclusions and limitations are summarised below:

- The AIR is limited to the proposed facility during construction and normal operations only. The gas supply pipeline to the boundary fence; and the associated powerline development did not form part of the scope of this assessment as this project focuses only on the footprint activities inside the proposed project boundary fence.
- Emissions associated with the construction phase were based on the conservative US EPA emission factor.
    - The average monthly area in which construction would occur was calculated assuming the full facility extent (18 ha) and the planned number of months of construction.
    - It was assumed that construction would extend over a 36 to 42-month period based on 10 hours per day (7am to 5pm) and 5 days per week (Monday to Friday).
- Current Station B operations were quantified and simulated. This included stack emissions only and did not account for the coal transport and handling.
- Only normal project operations were assessed. The impacts due to emergency activities were not modelled.
- The project will operate at a 65% capacity. The general daily operations were provided as follows:
    - Morning peak between 6am and 9am;
    - Evening peak between 5pm and 7pm.
- The plant is designed for hot starts liquid natural gas (LNG) and black starts using diesel generators. Hot starts and black starts many be required under emergency conditions and do not form part of normal operations for the project. The plant is, however, required to run the diesel generator (10 MW) once a month for an hour for testing. Impacts due to the monthly testing was quantified and simulated. It was assumed that the generator would operate at MES and would emit off-gasses through the Bypass Stack 1.

- Sufficient information was not available to include building downwash associated with the main- and by-pass stacks, however, due to their height, they are unlikely to have substantive building downwash effects.
- The sulfur content in the liquified natural gas (LNG) was provided as 10 ppm.

Findings

The findings from the baseline assessment are as follows:

- The flow field is dominated by winds from the northwestern sector with calm conditions of 2%.
- Potential sensitive receptors within 5 km from the project include residential areas, i.e. Esther Park, Edleen, Cresslawn, Kelvin Estate, Croydon, Eden Glen and Illiondale. Residential areas within 10 km from the site include Edenvale, Kempton Park, and Lethabong.
- AQMS within the study area include Buccleugh AQMS (~11.5 km northwest of the project) and Alexandra AQMS (~7.8 km west of the project) owned by the City of Johannesburg; and Bedfordview AQMS (~8.8 km southwest of the project) owned by the Ekurhuleni Metropolitan.
- Non-compliance of the daily and annual NAAQS for PM_{10} and $PM_{2.5}$ were recorded for the period 2023 at the Alexandra AQMS.

The findings from the air quality impact assessment due to project operations are as follows:

- The project was assessed for the operational phase:
  - **Scenario 1:** Normal operations assuming MES where off-gas goes through the main stacks.
  - **Scenario 2:** Normal operations assuming USEPA emission factors for SO_2 (assuming sulfur content of 10 ppm). This scenario was included to understand the range in SO_2 ground level concentrations based on emission factors designed for gas turbines and sulfur content of the natural gas being used.
  - **Scenario 3:** Normal operations assuming MES where off-gas goes through the main stacks and gas generators running for 1 hour per month assuming MES where off-gas goes through the main stack (when normal operations are not taking place). Only short-term impacts were assessed, i.e. highest hourly and highest daily (99th percentile).
  - **Scenario 4:** Normal operations assuming USEPA emission factors for SO_2 and gas generators running for 1 hour per month assuming MES (when normal operations are not taking place). Only short-term impacts were assessed for SO_2, i.e. highest hourly and highest daily (99th percentile).
- Simulated SO_2 concentrations for the project operations complied with NAAQS across the modelling domain for all scenarios.
- Simulated NO_2 concentrations for the project operations complied with NAAQS across the modelling domain for all scenarios.
- Simulated PM concentrations for the project operations complied with PM_{10} and $PM_{2.5}$ NAAQS across the modelling domain for all scenarios.
- Annual SO_2 and NO_2 concentrations due to project operations were below critical levels for vegetation throughout the domain for all scenarios.
- Simulated dust fallout due to project operations was well within the NDCR over the modelling domain.

Impact Assessment Rating

The impact significance rating for the construction, operation and closure phases for the project was “low”.

Conclusion

The proposed CCGT Power Plant has lower air quality impacts that the existing coal fired power station (Station B) and will provide an improvement on air quality in the area. From an air quality perspective, it is recommended that the project go ahead on condition that:

- Emissions due to construction activities be mitigated using good practise guidelines.
- The emissions from the project comply with MES.

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PREFACE

Background and Context

Kelvin Power Pty Ltd ("Kelvin") is a coal fired power plant situated in Kempton Park, Johannesburg, South Africa, owned by the Anergi group ("Anergi") and Public Investment Corporation ("PIC"). The existing power plant comprises of: (i) the still operational B Station which was built in the 1960s and includes seven 60 MW steam turbines and eight pulverised coal boilers, and (ii) the now decommissioned A Station which was built in the 1950s. The A station ceased operations in 2012 and a Basic Assessment has been approved for its demolition.

A pre-feasibility study was concluded in 2023 to assess the various technology options available to generate 450 MW to 650 MW on the current A Station site. The pre-feasibility study's objective was to identify proven technology available for power generation on the available site considering the infrastructure available. The study concluded that a combined-cycle gas turbine (CCGT) Power Plant with a net output of approximately 600 MW comprising one H class gas turbine, a heat recovery boiler and a steam turbine, would be the optimum technology for this site (hereafter referred to as the project). A process description is provided in Section 2.2.

Airshed Planning Professionals (Pty) Ltd (Airshed) was commissioned by Environmental Impact Management Services (Pty) Ltd (EIMS) to undertake an Air Quality Impact Assessment (AQIA) for the proposed project.

The investigation followed the methodology required for a specialist report, as prescribed in the National Environmental Management Act (Act 107 of 1998) (NEMA) Environmental Impact Assessment (EIA) Regulations (Government Notice [GN] R982 in Government Gazette [GG] 38282 of 14 December 2014). The format of the assessment also meets the prescribed format of an Atmospheric Impact Report (AIR), as set out in the Regulations gazetted on 11th of October 2013 (GG 36904). Typically, an AIR would accompany the application for, an Atmospheric Emissions License (AEL).

Terms of Reference for the Environmental Impact Assessment

The Terms of Reference, as a list of tasks, for the Air Quality Study portion of the EIA phase of the project will include:

- The compilation of a baseline emissions inventory for existing Kelvin Power Station operations;
- The establishment of an emissions inventory by referring to minimum emissions standards (MES) and emission factors for combustion processes, fuel storage; and, fugitive dust;
- Atmospheric dispersion simulations for the baseline and proposed Kelvin Power Station operations using the CALPUFF atmospheric dispersion model;
- A human health risk and nuisance impact screening assessment based on dispersion simulation results;
- A comprehensive air quality impact assessment report in the format prescribed by the Department of Forestry, Fisheries and Environment (DFFE) in support of the Atmospheric Emission License (AEL) application.
- Impact Significance rating according to the method provided by EIMS.

Specialist Details

Statement of Independence

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.

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

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

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

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

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

A comprehensive curriculum vitae of Reneé von Gruenewaldt is provided in Appendix A. The declaration of independence for Reneé von Gruenewaldt is provided in Annexure B.

Approach and Methodology

The methodology followed in the AQIA is discussed below. The general tasks included:

- The establishment of the baseline air quality (based on available information);
- Quantification of air emissions from the project;
- Obtaining and discussing meteorological parameters required to establish the atmospheric dispersion potential;
- Simulation of the ambient air concentrations for the pollutants of concern and dust fallout using a suitable atmospheric dispersion model;
- Assessment of the significance of the impact through the comparison of simulated air concentrations (and fallout rates) with local standards (for legal compliance);
- Recommendations for mitigation and monitoring.

Potential Air Emissions from the Proposed Project

The air pollution associated with the project mainly includes off gases emitted from stacks.

Regulatory Requirements and Assessment Criteria

In the evaluation of ambient air quality impacts reference is made to National Ambient Air Quality Standards (NAAQS). These standards apply only to certain common air pollutants, collectively known as criteria pollutants. Criteria pollutants include sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), inhalable particulate matter (PM) (including thoracic PM with an aerodynamic diameter of equal to or less than 10 µm or PM_{10} and inhalable PM with an aerodynamic diameter equal to or less than 2.5 µm or $PM_{2.5}$), benzene, ozone (O_3) and lead.

SO_2, NO_2 and PM represent the main pollutants of concern in the assessment of the project. For the current assessment, the impacts were assessed against published NAAQS and National Dust Control Regulations (NDCR).

Description of the Baseline Environment

The baseline study encompassed the analysis of air quality sensitive receptors, atmospheric dispersion potential and ambient air quality within the study area.

Air quality sensitive receptors were identified from available satellite imagery.

The dispersion potential was assessed by means of measured meteorological data from the South African Weather Service (SAWS) station at OR Tambo (for the period 2020 to 2022) and the calculated WRF[1] data for the study area (for the period 2021 to 2023).

The available ambient air quality data for the study area included SO_2, CO, O_3 and PM measured at the Air Quality Monitoring Stations (AQMS) within the study area (i.e. Buccleugh AQMS, Alexandra AQMS and Bedfordview AQMS) for the period 2023.

Emissions Inventory

The establishment of a comprehensive emissions inventory formed the basis for the assessment of the air quality impacts from the project. Use was made of MES and United States Environmental Protection Agency (US EPA) emission factors.

Atmospheric Dispersion Modelling

In the calculation of ambient air pollutant concentrations and dustfall rates for the project, use was made of the US EPA CALPUFF modelling system.

Management of Uncertainties

The main assumptions, exclusions and limitations are summarised below:

- The AIR is limited to the proposed facility during construction and normal operations only. The gas supply pipeline to the boundary fence; and the associated powerline development did not form part of the scope of this assessment as this project focuses only on the footprint activities inside the proposed project boundary fence.
- Emissions associated with the construction phase were based on the conservative US EPA emission factor.

[1] The Weather Research and Forecasting (WRF) Model is a state-of-the-art mesoscale numerical weather prediction system designed for both atmospheric research and operational forecasting applications.

    - The average monthly area in which construction would occur was calculated assuming the full facility extent (18 ha) and the planned number of months of construction.
    - It was assumed that construction would extend over a 36 to 42-month period based on 10 hours per day (7am to 5pm) and 5 days per week (Monday to Friday).
- Current Station B operations were quantified and simulated. This included stack emissions only and did not account for the coal transport and handling.
- Only normal project operations were assessed. The impacts due to emergency activities were not modelled.
- The project will operate at a 65% capacity. The general daily operations were provided as follows:
    - Morning peak between 6am and 9am;
    - Evening peak between 5pm and 7pm.
- The plant is designed for hot starts liquid natural gas (LNG) and black starts using diesel generators. Hot starts and black starts many be required under emergency conditions and do not form part of normal operations for the project. The plant is, however, required to run the diesel generator (10 MW) once a month for an hour for testing. Impacts due to the monthly testing was quantified and simulated. It was assumed that the generator would operate at MES and would emit off-gasses through the Bypass Stack 1.
- Sufficient information was not available to include building downwash associated with the main- and by-pass stacks, however, due to their height, they are unlikely to have substantive building downwash effects.
- The sulfur content in the liquified natural gas (LNG) was provided as 10 ppm.

1 ENTERPRISE DETAILS

1.1 Enterprise Details

The details of the proposed project operations are summarised in Table 1-1. The contact details of the responsible person are provided in Table 1-2.

Table 1-1: Enterprise details

Enterprise Name	Kelvin Power (Pty) Ltd
Trading as	Kelvin Power (Pty) Ltd
Company Registration Number	2000/003611/07
Registered Address	3 Zuurfontein Road, Kempton Park, 1620
Telephone Number (General)	011 573 2500
Industry Type/Nature of Trade	Power generation
Land Use Zoning as per Town Planning Scheme	Industrial
Land Use Rights if Outside Town Planning Scheme	n/a

Table 1-2: Contact details of responsible person

Responsible Person	Oupa Seopa
Telephone Number	011 573 2500/2607
Cell Number	073 278 9684
Fax Number	086 274 9293
Email Address	Lavhelesani.Nelwamondo@kelvinpower.com
After Hours Contact Details	011 573 2500/2508/2588

1.2 Location and Extent of the Plant

Table 1-3: Location and extent of the plant

Physical Address of the Plant	3 Zuurfontein Road, Kempton Park, 1620
Description of Site (Where no Street Address)	3 Zuurfontein Road, Kempton Park, 1620
Coordinates of Approximate Centre of Operations	26.114629°S; 28.192981°E
Extent	226.18 ha
Elevation Above Sea Level	~1650 m
Province	Gauteng
Metropolitan/District Municipality	City of Ekurhuleni
Local Municipality	Kempton Park Customer Care Centre
Designated Priority Area	Highveld Priority Area

1.3 Description of Surrounding Land Use (within 5 km radius)

Potential sensitive receptors within 5 km from the project include residential areas, i.e., Esther Park, Edleen, Cresslawn, Kelvin Estate, Croydon, Eden Glen and Illiondale (Figure 1-1). Residential areas within 10 km from the project site include Edenvale, Kempton Park, and Lethabong (Figure 1-2). The list of hospitals and schools within the study area is provided in Table 3-1.

Figure 1-1: Potential sensitive receptors within 5 km from the project

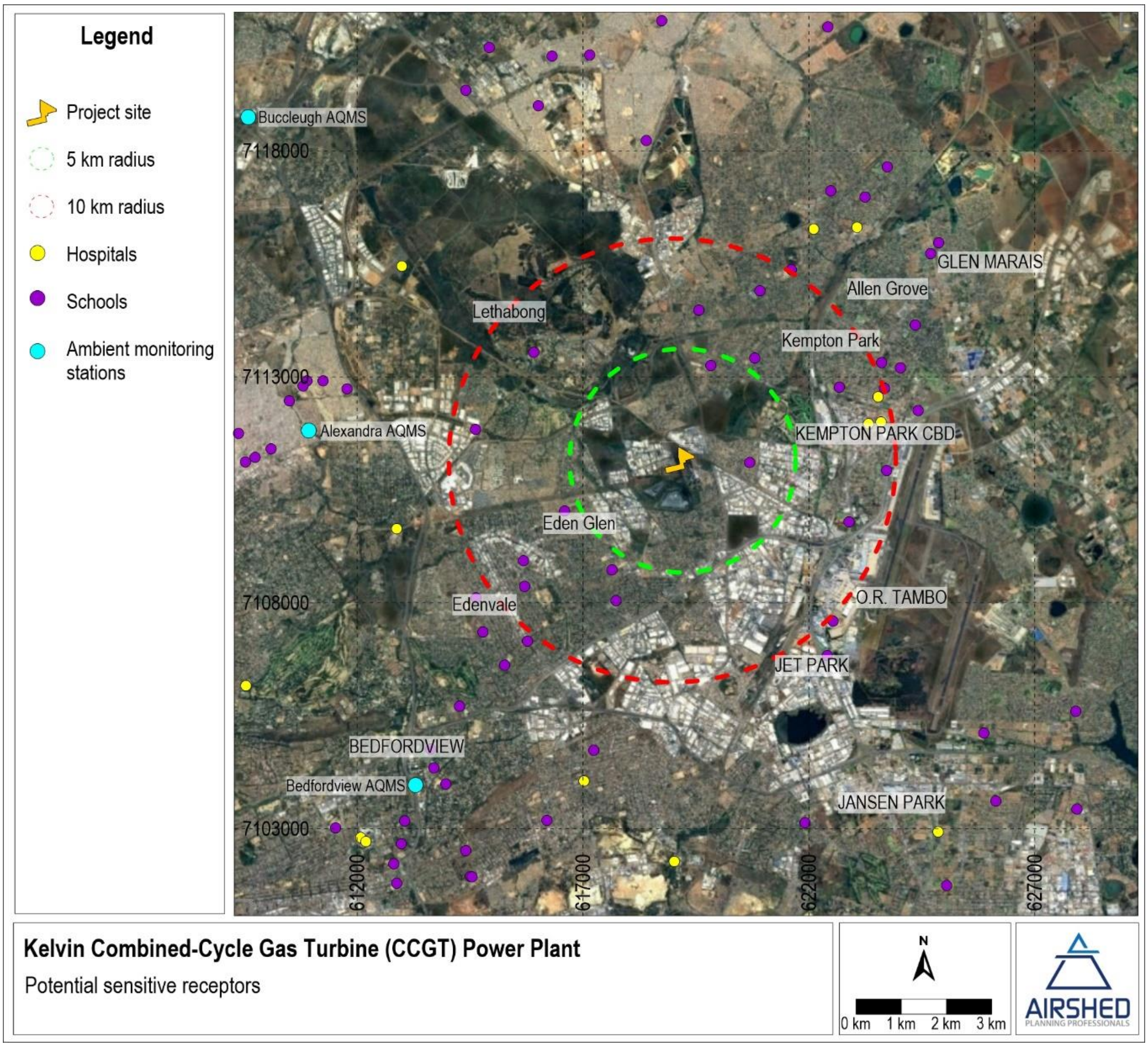

Figure 1-2: Potential sensitive receptors and ambient monitoring stations within the study area

Table 1-4: Location of Air Quality Monitoring Stations (AQMS), hospitals and schools within the study area

ID	UTM WGS84 (35S)		Name	Distance from project centre (m)
	Easting	Northing		
AQMS				
1	611016	7111989	Alexandra AQMS	8 312
2	609936	7118870	Buccleugh AQMS	12 092
3	613234	7104036	Bedfordview AQMS	9 389
Hospitals				
4	624862	7102933	Advanced East Rand Day Hospital	9 976
5	623594	7112000	Arwyp Medical Centre	4 374
6	623070	7116306	Birchleigh Clinic	6 345
7	622101	7116267	Birchmed Day Hospital	5 786
8	612993	7115449	Busamed Modderfontein Private Hospital Orthopaedic & Oncology Centre	7 593
9	612872	7109642	Edenvale Hospital	6 608
10	623539	7112561	Ekurhuleni Surgiklin Day Hospital	4 458
11	619019	7102272	Knights Chest Hospital	8 941
12	612076	7102809	Life Bedford Gardens Hospital - Emergency Unit	11 073
13	612190	7102722	Life Bedford Gardens Private Hospital - Medical Ward	11 066
14	617028	7104065	Life Roseacres Hospital	7 494
15	623313	7111960	Marymount Hospital	4 091
16	609544	7106167	Netcare Linksfield Hospital	10 974
Schools				
17	624359	7114148	Aston Manor Primary School	5 858
18	613050	7103178	Bedfordview Academy	10 171
19	612812	7102223	Bedfordview High School	11 079
20	613966	7103999	Bedfordview Primary School	8 964
21	622415	7106840	Benoni Secondary School	5 370
22	609736	7111223	Bovet Primary School	9 555
23	614264	7105711	Crawford International - Bedfordview	7 450
24	620686	7111104	Cresslawn Primary School	1 398
25	617734	7108045	Curro Edenvale High School	3 527
26	624026	7113206	Destiny Independent School Kempton Park	5 138
27	614632	7108111	Dowerglen High School	5 595
28	615265	7106627	Dunvegan Primary School	6 100
29	610891	7112912	East Bank High School	8 571
30	615684	7108937	Eastleigh Primary School	4 264
31	617640	7108732	Edenglen High School	2 977
32	614783	7107361	Edenvale High School	5 928
33	619831	7113255	Edleen Primary	2 116
34	626139	7103620	Eduvu - Remedial School / Academy	10 221
35	609376	7111753	Ekukhanyisweni Primary School	9 930
36	612979	7102665	Elandspark School	10 622
37	616012	7118999	Gideon Rambuwani Primary School	8 452
38	623732	7117645	Hoërskool Birchleigh	7 819
39	621615	7115369	Hoërskool Jeugland	4 765
40	614505	7101949	Hoërskool Primrose	10 424
41	615778	7107158	Holy Rosary School for Girls	5 362
42	610500	7112467	Ikage Primary School	8 881
43	609526	7111117	Inkanyezi Waldorf Centre	9 766
44	616591	7110033	Jacaranda Academy	2 945
45	623609	7113318	Kempton Park Primary School	4 805
46	611247	7112919	Kwabhekilanga Secondary School	8 224
47	623238	7116981	Laerskool Birchleigh	6 992
48	620801	7113420	Laerskool Edleen	2 678
49	623724	7110930	Laerskool Kempton Park FSS	4 441
50	623673	7112744	Laerskool Kreft	4 643

ID	UTM WGS84 (35S)		Name	Distance from project centre (m)
	Easting	Northing		
51	624700	7115735	Laerskool Kruinsig	7 052
52	620920	7114905	Laerskool Van Riebeeckpark	4 039
53	627936	7103441	Laerskool Westwood	11 622
54	610800	7112802	M.C. Weiler Primary School	8 640
55	616321	7120101	Maphutha Secondary School	9 375
56	624876	7115967	Maranatha Christian School	7 337
57	625053	7101750	Martin Primary School	11 075
58	617148	7120125	Mayibuye Primary School - New	9 170
59	614406	7119337	Midrend Primary School	9 484
60	622540	7107594	Moduopo Primary School	4 860
61	614622	7111838	Nobel Primary School	4 711
62	622479	7117114	Norkem Park Primary School	6 710
63	610097	7111410	Pholosho Primary School	9 197
64	618406	7118236	Phomolong Secondary School	7 083
65	615908	7113541	Pinnacle College Founders Hill	4 109
66	614408	7102517	Primrose Hill Primary School	9 969
67	616195	7103186	Primrose Primary School	8 599
68	614540	7101933	Primrose Technical High School	10 422
69	611524	7103025	Reddam House Bedfordview	11 284
70	622888	7109793	Rhodesfield High School	3 865
71	622678	7112774	Sir Pierre van Reyneveld High School	3 730
72	611780	7112738	Skeen Primary School	7 665
73	613624	7104762	St Benedict's College	8 584
74	613703	7104351	St Benedict's Junior Preparatory School	8 846
75	615706	7108363	Success College Primary	4 578
76	627902	7105597	Summerfields Primary School	10 278
77	617239	7104746	Sunnyridge Primary School.	6 781
78	614919	7120295	Taal-Net Midrand School	10 083
79	624414	7112252	Taalnet Primary & High School Kempton Park	5 228
80	618745	7120880	Tembisa West Secondary School	9 687
81	622421	7120743	Thuthuka Primary School	10 035
82	619570	7114484	Westside Primary School	3 287
83	621920	7103141	Wit Deep Primary School	8 485
84	625874	7105122	Woodlands International College	8 965
85	612872	7101800	Wychwood Primary School	11 390

1.4 Atmospheric Emission Licence and other Authorisations

Kelvin Power Station has an existing AEL (AEL Number: 14/1/7/1/66/Kelvin/Kemp). The proposed project, however, is a new facility and does not yet have an AEL. As a gas-fired power station with capacity greater than 50 MW, the project will require an AEL to operate (Subcategory 1.4; Section 21 of the National Environmental Management: Air Quality Act (NEM:AQA)). Emissions from the proposed power station will be required to comply with the new plant Minimum Emission Standards (MES). The applicable listed activities categories will include: Subcategory 1.4 (Gas Combustion Installations), and during emergency periods Subcategory 1.5 (Reciprocating Engines) when diesel will be used. The storage and handling of diesel does not qualify as a listed activity, due to the diesel storage proposed (24 000 litres or 24 m³). Subcategory 2.4., Section 21 is only applicable for a combined storage capacity of greater than 1000 m³.

2 NATURE OF THE PROCESS

2.1 Listed Activities

All potential listed activities, as per Section 21 of NEM:AQA, proposed for the project are given in Table 2-1.

Table 2-1: Listed activities at the proposed project

Section 21 Subcategory	Listed Process Description:
1.4	Gas combustion installations
1.5	Reciprocating Engines (when combusting diesel during the monthly testing of the generators and in emergency events)

2.2 Process Description

The main structures at the plant would consist of:

- Gas turbine building;
- Steam turbine building;
- Heat Recovery Steam Generator (HRSG);
- Mechanical draft cooling tower;
- Extra High Voltage (EHV) substation;
- Auxiliary buildings;
- Administration buildings; and,
- Exhaust stacks.

The site allocated to the new plant is in the area of the redundant A Station auxiliary plant, formerly occupied by the A Station dry coal store, coal tipplers, coal stockpile and cooling towers. In addition to the construction area of the permanent plant, other construction facilities such as laydown areas, fabrication shops, warehousing, construction offices, and welfare facilities would be required. The A Station auxiliary plant area is large enough to accommodate both the permanent plant and the construction facilities outlined above.

Cooling water would be sourced from the existing Kelvin water supply pipelines. Treated sewage wastewater (grey water) would be supplied to the power plant from Diepsloot (~37 km away) for use as cooling water. Approximately 52 033 m³ per day of such water has previously been supplied to the Kelvin power plant and as such, quantity would be available for the new plant. The new plant is expected to consume approximately 11 000 m³ per day of water per day when operating as a mid-merit plant with a capacity factor of 50%. The Diepsloot pump house and water pipeline to the plant is the responsibility of, and is maintained by, Kelvin Power. The grey water is dosed with biocides, algaecides, and a corrosion inhibitor.

In addition to the new plant that would be constructed on the Kelvin site, an electrical connection to an Eskom / City Power substation and a gas pipeline to the Sasol gas pipeline system would be required. Should the new plant be connected to the City Power Sebenza substation, a transmission line of approximately 1 km would be required. Alternatively, if the connection was to the Eskom North Rand substation, a transmission line of approximately 5 km would be required. Construction of this transmission line would be the responsibility of Kelvin. A new 25 km gas supply pipeline connecting the new plant to the Sasol high pressure gas transmission system would be required. Construction of this gas supply pipeline would be the responsibility of Sasol.

Figure 2-1: CCGT layout

From an air quality perspective, the CCGT involves the installation and operation of gas turbine units, heat recovery steam generators (HRSGs) and steam turbines for a total installed generating capacity of 600 MW. The operation of the power station will include the following:

- **Gas Turbines** using natural gas as fuel to generate electricity, where compressed air is mixed with combustion fuel to produce very high temperature combustion gases. The hot combustion gases pass through the gas turbine blades, making them spin. The fast-spinning turbines drive a generator that converts a portion of the spinning energy into electricity. Each gas turbine is proposed to have a 60-metre-high by-pass stack for use during emergency events (refer to Section 4.4).
- During normal operations a **Heat Recovery Steam Generator** (HRSG) will capture heat from the combustion gas stream to produce high temperature and high-pressure dry steam, which is then supplied to a steam turbine. The combustion gases will be discharged into the atmosphere via the main exhaust stacks (60 metres high).
- The **Steam turbine** uses the dry steam to drive its turbine to generate electrical power. The condenser will convert exhaust steam from the steam turbine back into water through a cooling process.

Diesel, to be used as back-up fuel, will be off-loaded by truck and stored in on-site storage tanks which will hold sufficient capacity for 8 hours of operation. Two storage tanks, each with a capacity of 5 200 m³, are planned.

Primary pollutants from gas turbines will be oxides of nitrogen (NO_x), carbon monoxide (CO), and, to a lesser extent, volatile organic compounds (VOCs). PM is also a primary pollutant for gas turbines using liquid fuels. NO_x formation is strongly dependent on the high temperatures developed in the combustor. CO, VOC, hazardous air pollutants (HAP), and PM is primarily the result of incomplete combustion. Trace to low quantities of VOC, HAP and SO_2 are emitted from gas turbines. SO_2 emissions are directly related to the sulfur content of the fuel (US EPA, 2000). In addition to the above, VOC emissions will also be released from diesel storage tanks vents as well as the delivery, off-loading and handling of diesel fuel. Similarly, VOCs could be released from the natural gas should leaks develop along the length of the gas pipeline. Air pollutants associated with all phases of the proposed facility are given in Table 2-2.

Table 2-2: Identified air quality aspects

Aspect or Project Phase	Expected Atmospheric Sources of Emissions and Associated Pollutants						Rationale
	Source	CO	NO_x	PM[(a)]	SO_2	VOC	
The construction phase of the project	Fugitive dust from civil and building work such as excavations, buildings, etc.	n/a	n/a	✓	n/a	n/a	The nature of emissions from construction activities is highly variable in terms of temporal and spatial distribution and is also transient. Fugitive dust emissions are mostly generated by land-clearing and bulk earthworks.
	Exhaust gases from mobile diesel construction equipment and trucks delivering materials.	✓	✓	✓	✓	✓	
The normal operation phase of the project	Exhaust gases from the proposed generators and turbine units	✓	✓	✓[(c)]	✓	✓[(c)]	The project is designed to operate on natural gas. Natural gas will be used for normal operation. The focus of the assessment is on the operation of the proposed turbine units and monthly testing of diesel generators since it triggers Subcategory 1.4 and 1.5 MES.
	Diesel storage	n/a	n/a	n/a	n/a	✓[(d)]	
Decommissioning phase of the project	Fugitive dust from civil work such as rehabilitation and demolition.	n/a	n/a	✓	n/a	n/a	The nature of emissions from decommissioning activities is highly variable in terms of temporal and spatial distribution and is also transient. Detail regarding the extent of decommissioning activities and equipment movements was also not available for inclusion in the study. Fugitive dust emissions are however mostly generated by demolition and rehabilitation activities.
	Exhaust gases from diesel mobile equipment and trucks removing materials.	✓	✓	✓	✓	✓	

Notes:
(a) PM includes PM_{10} and $PM_{2.5}$
(b) n/a – not applicable
(c) negligible for natural gas
(d) negligible based on the quantity of fuel stored and impacts are expected to be localised and unlikely to extend beyond boundary

2.3 Unit Processes

The unit processes associated with the listed activities (as per Section 21 of NEM:AQA) and proposed for the project are listed in Table 2-3.

Table 2-3: The unit processes for the proposed project

Unit Process	Function of Unit Process	Batch or Continuous Process
Power Station Gas Turbines	Gas combustion to generate electricity	Batch (during peak power demand periods: 6am-9am and 5pm-7pm)
Power Station HRSGs	Combustion off-gas heat recovery	Batch (during peak power demand periods: 6am-9am and 5pm-7pm)
Power Station Steam turbines	Steam turbine uses recovered heat from HRSG to generate electricity	Batch (during peak power demand periods: 6am-9am and 5pm-7pm)
Water treatment	Processing of water to appropriate quality for use in turbines	Continuous
Diesel storage	Storage of diesel for emergency periods and monthly diesel generator testing (1 hour per month)	Continuous

3 TECHNICAL INFORMATION

Raw material consumption rates are tabulated in Table 3-1. The proposed project has an installed generation capacity of 600 MW of electricity, with waste streams of heated water and, off-gases.

3.1 Raw Material Consumption Rates

Table 3-1: Raw materials used

Raw Material Type Alternatives	Design Consumption Rate (Quantity)	Units (quantity/period)
Natural gas	574 000 000	m^3 per day
Diesel fuel	60 000	litres per year
Municipal-quality water	4 000 000	litres per year

3.2 Production Rates

Table 3-2: Future production rates

Production Name	Maximum Production Capacity Permitted (Quantity)	Design Production Capacity (Quantity)	Actual Production Capacity (Quantity)	Units (Quantity/Period)
Electricity	600	600	To be confirmed	MW

Table 3-3: By-products

By-Product Name	Maximum Production Capacity Permitted (Quantity)	Design Production Capacity (Quantity)	Actual Production Capacity (Quantity)	Units (Quantity/Period)
None				

4 ATMOSPHERIC EMISSIONS

The establishment of a comprehensive emissions inventory, for the project, formed the basis for the assessment of air quality impacts from the proposed project operations on the receiving environment. All stack parameters were provided by Hatch. The power station is planned to have three main stacks and three by-pass stacks. Normal operations were assessed in two emission scenarios: (1) at the Minimum Emission Standards, and (2) using Unted States Environmental Protection Agency (US EPA) emission factors for natural gas turbines, as representations of the maximum allowable emissions (without being considered an emergency) and typical operating emissions, respectively.

The following sections describe the location and parameters of the individual sources associated with the proposed project (as per the prescribed format of an AIR - Gazette No. 36904, 2013).

4.1 Point Sources

Three main stacks are proposed to vent off-gases from the facility under normal operations. Three by-pass stacks, one per gas turbine with stacks heights of 60 m, are proposed for use during emergency conditions.

Table 4-1: Parameters for point sources of atmospheric pollutant emissions at the proposed project

Point Source code	Source name	Latitude (decimal degrees)	Longitude (decimal degrees)	Height of Release Above Ground (m)	Diameter at Stack Tip / Vent Exit (m)	Actual Gas Exit Temperature (°C)	Actual Gas Volumetric Flow (m^3/hr)	Actual Gas Exit Velocity (m/s)
STACK1	Main stack 1[(a)]	-26.11264	28.19251	60	8	87	929.9	18.5
STACK2	Main stack 2[(b)]	-26.11338	28.19198	60	4	72	149.5	11.9
STACK3	Main stack 3[(b)]	-26.11339	28.19175	60	4	72	149.5	11.9
BY1	Bypass stack 1[(c)]	-26.11323	28.19275	60	8	623	2372.5	47.2
BY2	Bypass stack 2[(c)]	-26.11387	28.19190	60	4	595	377.0	30.0
BY3	Bypass stack 3[(c)]	-26.11374	28.19217	60	4	595	377.0	30.0

Notes:

(a) Based on Siemens SIPEP for 4000F

(b) Based on Siemens SIPEP for SCC 800

(c) Based on Siemens & GT PRO modelling

4.2 Point Source Maximum Emission Rates during Normal Operating Conditions - MES

Table 4-2: Atmospheric pollutant emission rates for the proposed project (MES)

Point Source code	Pollutant Name	Maximum Release Rate			Emissions Hours	Type of Emissions (Continuous / Routine but Intermittent / Emergency Only)
		mg/Nm³	g/s	Averaging period		
STACK1	Particulates	10	3.07	Hourly	6 am – 9 am and 5 pm – 7 pm	Routine but intermittent
	Sulfur dioxide (SO_2)	400	122.61	Hourly	6 am – 9 am and 5 pm – 7 pm	Routine but intermittent
	Oxides of Nitrogen (NO_X)	50	15.33	Hourly	6 am – 9 am and 5 pm – 7 pm	Routine but intermittent
STACK2	Particulates	10	0.49	Hourly	6 am – 9 am and 5 pm – 7 pm	Routine but intermittent
	Sulfur dioxide (SO_2)	400	19.64	Hourly	6 am – 9 am and 5 pm – 7 pm	Routine but intermittent
	Oxides of Nitrogen (NO_X)	50	2.46	Hourly	6 am – 9 am and 5 pm – 7 pm	Routine but intermittent
STACK3	Particulates	10	0.49	Hourly	6 am – 9 am and 5 pm – 7 pm	Routine but intermittent
	Sulfur dioxide (SO_2)	400	19.64	Hourly	6 am – 9 am and 5 pm – 7 pm	Routine but intermittent
	Oxides of Nitrogen (NO_X)	50	2.46	Hourly	6 am – 9 am and 5 pm – 7 pm	Routine but intermittent
STACK1 [(a)]	Particulates	50	46.50	Hourly	1 hour per month	Routine but intermittent
	Sulfur dioxide (SO_2)	1170	1088.10	Hourly	1 hour per month	Routine but intermittent
	Oxides of Nitrogen (NO_X)	2000	1860.00	Hourly	1 hour per month	Routine but intermittent

Notes:

(a) The diesel generators are tested once a month for an hour. It is assumed that the off-gas would be emitted through the main Stack 1.

Table 4-3: Point Source Emission Estimation Information during Normal Operating Conditions (MES)

Point Source code	Basis for Emission Rates
STACKS1-3	Minimum Emission Standards for Subcategory 1.4 – Gas Combustion Installations (as per Section 21 NEM:AQA)
STACK1	Minimum Emission Standards for Subcategory 1.5 – Reciprocating Engine Installations (as per Section 21 NEM:AQA)

4.3 Point Source Maximum Emission Rates during Normal Operating Conditions – Based on Emission Factors

Table 4-4: Atmospheric pollutant emission rates for the proposed project (Emission Factors)

Point Source code	Pollutant Name	Maximum Release Rate			Emissions Hours	Type of Emissions (Continuous / Routine but Intermittent / Emergency Only)
		mg/Nm³	g/s	Averaging period		
STACK1	Sulfur dioxide (SO_2)	15.4	14.32	Hourly	6 am – 9 am and 5 pm – 7 pm	Routine but intermittent
STACK2	Sulfur dioxide (SO_2)	15.4	2.29	Hourly	6 am – 9 am and 5 pm – 7 pm	Routine but intermittent
STACK3	Sulfur dioxide (SO_2)	15.4	2.29	Hourly	6 am – 9 am and 5 pm – 7 pm	Routine but intermittent

Table 4-5: Point Source Emission Estimation Information during Normal Operating Conditions (Emission Factors)

Point Source code	Basis for Emission Rates
STACK1-3	US EPA AP42 Section 3.1 Stationary Gas Turbines, April 2000; Table 3.1-2a.

4.4 Point Sources – Emergency Events

The plant will be designed to handle hot starts and black starts. Hot starts would be required if the plant is to start up quicker than its normal start-up and would last 30-40 minutes. Black starts are in the event that the entire grid is down and the CCGT plant would need to run diesel generators for 4 hours. Under these conditions the off gas would be released through the bypass stacks.

4.5 Point Source Maximum Emission Rates during Emergency Events

Table 4-6: Atmospheric pollutant emission rates for the proposed project

<table>
<tr><th rowspan="2">Point Source code</th><th rowspan="2">Fuel type</th><th rowspan="2">Pollutant Name</th><th colspan="2">Maximum Release Rate</th><th rowspan="2">Emissions Hours</th><th rowspan="2">Type of Emissions (Continuous / Routine but Intermittent / Emergency Only)</th></tr>
<tr><th>mg/Nm³</th><th>Averaging period</th></tr>
<tr><td rowspan="3">BY1-3</td><td rowspan="3">Natural gas</td><td>Particulates</td><td>10</td><td>Hourly per unit</td><td rowspan="3">Only in the event that the plant is required to start-up quickly (unplanned start-up)</td><td rowspan="4">Emergency only</td></tr>
<tr><td>Sulfur dioxide (SO_2)</td><td>400</td><td>Hourly per unit</td></tr>
<tr><td>Oxides of Nitrogen (NO_X)</td><td>50</td><td>Hourly per unit</td></tr>
<tr><td>BY1</td><td>Diesel</td><td>Particulates</td><td>50</td><td>Hourly all units</td><td></td></tr>
</table>

Point Source code	Fuel type	Pollutant Name	Maximum Release Rate		Emissions Hours	Type of Emissions (Continuous / Routine but Intermittent / Emergency Only)
			mg/Nm³	Averaging period		
		Sulfur dioxide (SO_2)	1170	Hourly all units	Plant designed for 5 black starts per year and will run for 4 hours per event	
		Oxides of Nitrogen (NO_X)	2000	Hourly all units		

Table 4-7: Point Source Emergency Event Emission Estimation Information

Point Source code	Fuel type	Basis for Emission Rates
BY1-3	Natural gas	Minimum Emission Standards for Subcategory 1.4 – Gas Combustion Installations (as per Section 21 NEM:AQA)
BY1	Diesel	Minimum Emission Standards for Subcategory 1.5 – Reciprocating Engine Installations (as per Section 21 NEM:AQA)

5 IMPACT OF ENTERPRISE ON THE RECEIVING ENVIRONMENT

5.1 Analysis of Emissions' Impact on Human Health

5.1.1 Study Methodology

The study methodology may conveniently be divided into a "preparatory phase" and an "execution phase".

The preparatory phase included the following basic steps prior to performing the actual dispersion modelling and analyses:

1. Understand Scope of Work
2. Review of legal requirements (e.g. dispersion modelling guideline) (see Section 5.1.2)
3. Decide on Dispersion Model (see Section 5.1.1.1)

The Regulations Regarding Air Dispersion Modelling (GG 37801 published 11 July 2014) was referenced for the dispersion model selection.

Three levels of assessment are defined in the Regulations regarding Air Dispersion Modelling of which a Level 3 assessment was suitable for the project since these assessments require more sophisticated dispersion models (and corresponding input data, resources and model operator expertise) in situations:

- 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, and 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 airshed; or,
- when assessing contaminants resulting from non-linear processes (e.g. deposition, ground-level ozone (O_3), particulate formation, visibility).

The models recommended for Level 3 assessments are CALPUFF or SCIPUFF. In this study, CALPUFF was selected for the following reasons:

- Since the dispersion model formulation in CALPUFF is based on a Lagrangian Gaussian Puff model, it is well-suited for complex modelling terrain when used in conjunction with CALMET. The latter code includes a diagnostic wind field model which contains treatment of slope flows, valley flows, terrain blocking effects and kinematic effects. This Lagrangian Gaussian Puff model is well suited to simulate low or calm wind speed conditions. Alternative regulatory models such as the US EPA AERMOD model treat all plumes as straight-line trajectories, which under calm wind conditions grossly over-estimate the plume travel distance.
- The dispersion of pollutants in CALPUFF is simulated as discrete "puffs" of pollutants emitted from the modelled sources. These puffs are tracked until they have left the modelling domain while calculating dispersion, transformation and removal along the way. An important effect of non-steady-state dispersion is that the puff can change direction with changing winds, allowing a curved trajectory. The winds can therefore vary spatially as well as with time; with the former typically as the result of topographical features.
- CALPUFF is able to perform chemical transformations, such as the conversion of nitrogen oxide (NO) to NO_2 and the secondary formation of particulate matter from SO_2 and NO_2 emissions.
- Stagnation conditions, i.e. when the wind is zero or near to zero.

The execution phase (i.e. dispersion modelling and analyses) involves gathering specific information in relation to the emission source(s) and site(s) to be assessed. This includes:

- Source information: Emission rate, exit temperature, volume flow, exit velocity, etc.;
- Site information: Site layout, terrain information, land use data;
- Meteorological data: Wind speed, wind direction, temperature, cloud cover, mixing height;
- Receptor information: Locations using discrete receptors and/or gridded receptors.

The model uses this 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 predicted time-averaged concentration at the receptor. These predicted concentrations are compared with the relevant ambient air quality standard or guideline. Post-processing can be carried out to produce percentile concentrations or contour plots that can be prepared for reporting purposes.

5.1.1.1 Dispersion Model Selection

The model is intended for use on scales from tens of metres to hundreds of kilometres from a source (US EPA, 1998). The CALPUFF model allows the user to select from many calculation options, including a choice of dispersion coefficient and chemical transformation formulations. The different dispersion coefficient approaches accommodated in the CALPUFF model include:

- stability-based empirical relationships such as the Pasquill-Gifford or McElroy-Pooler dispersion coefficients;
- turbulence-based dispersion coefficients (based on measured standard deviations of the vertical and crosswind horizontal components of the wind); and
- similarity theory to estimate the turbulent quantities using the micrometeorological variables calculated by CALMET

The most desirable approach is to use turbulence-based dispersion coefficients using measured turbulent velocity variances or intensity components, if such data are readily available and they are of good quality. However, since reliable turbulent measurements are generally not available, the next best recommendation is to use the similarity approach.

CALPUFF includes parameterized chemistry modules for the formation of secondary sulfate and nitrate from the oxidation of the emitted primary pollutants, SO_2 and NO_x. The conversion processes are assumed to be linearly dependent (first-order) on the relevant primary species concentrations. Two options are included, namely the MESOPUFF II and RIVAD/ARM3 chemistry options. In both options, a fairly simple stoichiometric thermodynamic model is used to estimate the partitioning of total inorganic nitrate between gas-phase nitric acid and particle-phase ammonium nitrate. Ammonia and ozone (O_3) concentrations are required as background values to the model.

5.1.1.2 Nitrogen Dioxide Formation

Of the several species of nitrogen oxides, only NO_2 is specified in the NAAQS. Since most sources emit varying ratios of these species and these ratios change further in the atmosphere due to chemical reactions, a method for determining the amount of NO_2 in the plume must be selected. Estimation of this conversion normally follows a tiered approach, as discussed in the Regulations Regarding Air Dispersion Modelling (GG 37804, published 11 July 2014), which presents a scheme for annual averages:

> *Tier 1: Total Conversion Method*
> *Use any of the appropriate models recommended to estimate the maximum annual average NO_2 concentrations by assuming a total conversion of NO to NO_2. If the maximum NO_x concentrations are less than the NAAQS for NO_2,*

then no further refinement of the conversion factor is required. If the maximum NO_x concentrations are greater than the NAAQS for NO_2, or if a more "realistic" estimate of NO_2 is desired, proceed to the second-tier level.

Tier 2: Ambient Ratio Method (ARM) - Multiply NO_x by a national ratio of NO_2/NO. = 0.80
Assume a wide area quasi-equilibrium state and multiply the Tier 1 empirical estimate NO_x by a ratio of NO_2/NO_x = 0.80. The ratio is recommended for South Africa as the conservative ratio based on a review of ambient air quality monitoring data from the country. If representative ambient NO and NO_2 monitoring data is available (for at least one year of monitoring), and the data is considered to represent a quasi-equilibrium condition where further significant changes of the NO/NO_2 ratio is not expected, then the NO/NO_2 ratio based on the monitoring data can be applied to derive NO_2 as an alternative to the national ratio of 0.80.

The Ambient Ratio Method (ARM), i.e. the second version of the DEA Tier 2 option, was selected for the proposed facility assuming the national NO_2/NO_x ratio of 0.8.

5.1.1.3 Wet and Dry Deposition

CALPUFF uses dry deposition velocities to calculate the dry deposition of gaseous and particulate pollutants to the surface. These dry deposition velocities can either be user-specified or calculated internally in CALPUFF. A resistance-based model is used for the latter option. For gaseous pollutants, the resistances that are considered are the atmospheric resistance, the deposition layer resistance, and the canopy resistance. For particles, a gravitational settling term is included, and the canopy resistance is assumed to be negligible. CALPUFF uses the scavenging coefficient approach to parameterize wet deposition of gases and particles. The scavenging coefficient depends on pollutant characteristics (e.g., solubility and reactivity), as well as the precipitation rate and type of precipitation. The model provides default values for the scavenging coefficient for various species and two types of precipitation (liquid and frozen); which were applied for the proposed facility.

CALPUFF also has the capability to model the effects of vertical wind shear by explicitly allowing different puffs to be independently advected by their local average wind speed and direction, as well as by optionally allowing well-mixed puffs to split into two or more puffs when across-puff shear becomes important. Another refinement is an option to use a probability density function (pdf) model to simulate vertical dispersion during convective conditions.

5.1.1.4 Secondary Particulates

CALPUFF includes two chemical transformation schemes for the calculation of sulfate and nitrate formation from SO_2 and NO_x emissions. These are the MESOPUFF II and the RIVAD / ARM3 chemical formulations. Whist the former scheme is not specifically restricted to urban or rural conditions; the latter was developed for use in rural conditions. Since the study area could be classified as urban, the RIVAD / ARM3 chemical formulations should not be used. The chemical transformation scheme chosen for this analysis was therefore the MESOPUFF II scheme. As described in the CALPUFF User Guide it is a "pseudo first-order chemical reaction mechanism" and involves five pollutant species namely SO_2, sulfates (SO_4), NO_x, nitric acid (HNO_3) and particulate nitrate (NO_3). CALPUFF calculates the rate of transformation of SO_2 to SO_4, and the rate of transformation of NO_x to NO_3, based on environmental conditions including the ozone concentration, atmospheric stability, solar radiation, relative humidity, and the plume NO_x concentration. The daytime reaction formulation depends on solar radiation and the transformation increases non-linearly with the solar radiation (see the SO_2 to SO_4 transformation rate equation (equation 2-253 in the CALPUFF User Guide). At night, the transformation rate defaults to a constant value of 0.2% per hour. Calculations based on these formulas show that the transformation rate can reach about 3 per cent per hour at noon on a cloudless day with 100 ppb of ozone.

With the MESOPUFF-II mechanism, NO_x transformation rates depend on the concentration levels of NO_x and O_3 (equations 2-254 and 2-255 in the CALPUFF User Guide) and both organic nitrates (RNO_3) and HNO_3 are formed. According to the scheme, the formation of RNO_3 is irreversible and is not subject to wet or dry deposition. The formation of HNO_3, however, is reversible and is a function of temperature and relative humidity. The formation of particulate nitrate is further determined through the reaction of HNO_3 and ammonia (NH_3). Background NH_3 concentrations are therefore required as input to calculate the equilibrium between HNO_3 and particulate nitrate. At night, the NO_x transformation rate defaults to a constant value of 2.0% per hour. Hourly average ozone and ammonia concentrations were included as input in the CALPUFF model to facilitate these sulfate and nitrate formation calculations. Background ozone concentrations used for this project in CALPUFF are provided in Appendix C. Default ammonia concentrations were used in the absence of available measured data for the site.

The limitation of the CALPUFF model is that each puff is treated in isolation, i.e. any interaction between puffs from the same or different points of emission is not accounted for in these transformation schemes. CALPUFF first assumes that ammonia reacts preferentially with sulfate, and that there is always sufficient ammonia to react with the entire sulfate present within a single puff. The CALPUFF model performs a calculation to determine how much NH_3 remains after the particulate sulfate has been formed and the balance would then be available for reaction with NO_3 within the puff. The formation of particulate nitrate is subsequently limited by the amount of available NH_3. Although this may be regarded a limitation, in this application the particulate formation is considered as a group and not necessarily per species.

5.1.1.5 CALPUFF Modelling System

The CALPUFF modelling system consists of several software components, as summarised in Table 5-1, however only CALMET and CALPUFF contain the simulation engines to calculate the three-dimensional atmospheric boundary layer conditions and the dispersion and removal mechanisms of pollutants released into this boundary layer. The other components are mainly used to assist with the preparation of input and output data. Table 5-1 also includes the development versions of each of the codes used in this investigation.

Table 5-1: Summary description of CALPUFF/CALMET model suite with versions used in the investigation

Module	Version	Description
CALMET	6.5.0	Three-dimensional, diagnostic meteorological model
CALPUFF	7.2.1	Non-steady-state Gaussian puff dispersion model with chemical removal, wet and dry deposition, complex terrain algorithms, building downwash, plume fumigation and other effects.
CALPOST	7.2.0	A post-processing program for the output fields of meteorological data, concentrations and deposition fluxes.
PRTMET	v 4.495(1)	Lists selected meteorological data from CALMET and creates plot files
POSTUTIL	7.1.0	Processes CALPUFF concentration and wet/dry flux files. Creates new species as weighted combinations of modelled species; merges species from different runs into a single output file; sums and scales results from different runs; repartitions nitric acid/nitrate based on total available sulfate and ammonia.
TERREL	7.0.0	Combines and grids terrain data
CTGPROC	7.0.0	Processes and grids land use data
MAKEGEO	3.2	Merges land use and terrain data to produce the geophysical data file for CALMET

Note (1): These modules indicate version number as listed on http://www.src.com/calpuff/download/mod6_codes.htm (for CALPro Plus v6) [version number not given in graphical interface or 'About' information].

A summary of the CALMET and CALPUFF control options used in this project are given in Appendices B and C, respectively.

5.1.2 Legal Requirements

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 and 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.

The Atmospheric Pollution Prevention Act (APPA) of 1965 was repealed and the new National Environmental Management: Air Quality Act (NEM:AQA) of 2005 was brought into full force on the 1st of April 2010. Previously under APPA, the focus was mainly on sourced based control with permits issued for Scheduled Processes. Scheduled processes, referred to in this Act, were processes which emit more than a defined quantity of pollutants per year, including combustion sources, smelting and inherently dusty industries. Although emission limits and ambient concentration guidelines were published, no provision was made under the APPA for ambient air quality standards or emission standards. NEM:AQA shifted the approach of air quality management from source-based control to the control of the receiving environment. The Act has also placed the responsibility of air quality management on the shoulders of local authorities that will be tasked with baseline characterisation, management and operation of ambient monitoring networks, licensing of listed activities, and emissions reduction strategies.

The National Framework for achieving the NEM:AQA was published in the Government Gazette on the 11th of September 2007 (and amended in 2018). The National Framework is a medium- to long term plan on how to implement the NEM:AQA to ensure the objectives of the act are met. The National Framework states that aside from the various spheres of government responsibility towards good air quality, industry too has a responsibility not to impinge on everyone's right to air that is not harmful to health and well-being. Industries therefore should take reasonable measures to prevent such pollution degradation from occurring, continuing, or recurring. In terms of NEM:AQA, certain industries have further responsibilities, including:

- Comply with any relevant national standards for emissions from point, non-point or mobile sources in respect of substances or mixtures of substances identified by the Minister, Member of the Executive Council (MEC) or municipality.
- Comply with the measurement requirements of identified emissions from point, non-point or mobile sources and the form in which such measurements must be reported and the organs of state to whom such measurements must be reported.
- Comply with relevant emission standards in respect of controlled emitters if an activity undertaken by the industry and/or an appliance used by the industry is identified as a controlled emitter.
- Comply with any usage, manufacture or sale and/or emissions standards or prohibitions in respect of controlled fuels if such fuels are manufactured, sold or used by the industry.
- Comply with the Minister's requirement for the implementation of a pollution prevention plan in respect of a substance declared as a priority air pollutant.
- Comply with an Air Quality Officer's (AQOs) legal request to submit an AIR in a prescribed form (if required).
- Take reasonable steps to prevent the emission of any offensive odour caused by any activity on their premises.

- Furthermore, industries identified as Listed Activities have further responsibilities, including:
  - Making application for an AEL and complying with its provisions.
  - Compliance with any minimum emission standards in respect of a substance or mixture of substances identified as resulting from a listed activity.
  - Designate an Emission Control Officer if required to do so.

5.1.2.1 National Minimum Emission Limits (MES)

The Minister, in terms of Section 21 of the NEM:AQA, published a list of activities which result in atmospheric emissions and which are believed to have significant detrimental effects on the environment, human health and social welfare. The Listed Activities and Minimum National Emission Standards were first published on the 31st of March 2010 (GG 33064), with a revision of the schedule on the 22nd of November 2013 (GG 37054) and an amendment of certain sections and annexure A on the 31st of October 2018 (GG 42013).

The project processes fall under Category 1: Combustion Installations. Based on the nature of the operations and wording in the latest Listed Activities and Minimum National Emission Standards, the proposed project at the site should trigger:

- Subcategories 1.4 of the listed activities (Table 5-2): **Gas Combustion Installations** – Gas combustion used primarily for steam raising or electricity generation (more than 50-megawatt (MW) heat input per unit). MES subcategory 1.4 is applicable during normal operating conditions using natural gas.
- Subcategories 1.5 of the listed activities (Table 5-3): **Reciprocating Engines** – All installations with design capacity equal to or greater than 10 MW heat input per unit, based on the lower calorific value of the fuel. MES subcategory 1.5 is applicable during emergency operating conditions using diesel.

Table 5-2: MES for gas combustion installations

Subcategory 1.4: Gas Combustion Installations		
Description	Gas combustion (including gas turbines burning natural gas) used primarily for steam raising or electricity generation.	
Application	All installations with design capacity equal to or greater than 50 MW heat input per unit based on the lower calorific value of the fuel used.	
Substance or mixture of substances		**mg/Nm^3 under normal conditions of 3% O_2, 273 K and 101.3 kPa**
Common Name	**Chemical Symbol**	**New plant**
Particulate matter (PM)	Not applicable	10
Sulfur dioxide	SO_2	400
Oxides of nitrogen	NO_x expressed as NO_2	50

Table 5-3: MES for reciprocating engines

Subcategory 1.5: Reciprocating engines		
Description	Liquid and gas fuel stationary engines used for electricity generation.	
Application	All installations with design capacity equal to or greater than 10 MW heat input per unit, based on the lower calorific value of the fuel used.	
Substance or mixture of substances		**mg/Nm^3 under normal conditions of 15% O_2, 273 K and 101.3 kPa**
Common Name	**Chemical Symbol**	**New plant**
Particulate matter (PM)	Not applicable	50
Sulfur dioxide	SO_2	1170
Oxides of nitrogen	NO_x expressed as NO_2	2000

5.1.2.2 *Atmospheric Impact Report*

According to the NEM:AQA, an AQO may require the submission of an AIR in terms of Section 30, if:

- The AQO reasonably suspects that a person has contravened or failed to comply with the Air Quality Act (AQA) or any conditions of an AEL and that detrimental effects on the environment occurred or there was a contribution to the degradation in ambient air quality.
- A review of a provisional AEL or an AEL is undertaken in terms of Section 45 of the AQA.

The format of the Atmospheric Impact Report is stipulated in the Regulations Prescribing the Format of the Atmospheric Impact Report, GG 36904, GN 747 of 2013 (11 October 2013), it's amendment stipulated in GG 38633, GN R284 (2 April 2015).

5.1.2.3 *Highveld Priority Area*

The Highveld Airshed (HPA) was declared the second priority area by the minister at the end of 2007. This required that an Air Quality Management Plan for the area be developed. The plan includes the establishment of an emissions reduction strategies and intervention programmes based on the findings of a baseline characterisation of the area. The implication of this is that all contributing sources in the area will be assessed to determine the emission reduction targets to be achieved over the following few years.

The proposed project is located within the footprint demarcated as the HPA. The DFFE published the management plan for the HPA in September 2011. Included in this management plan are seven goals, each of which has a further list of objectives that have to be met. The goals for the Highveld Priority area are as follows:

- **Goal 1:** By 2015, organisational capacity in government is optimised to efficiently and effectively maintain, monitor and enforce compliance with ambient air quality standards
- **Goal 2:** By 2020, industrial emissions are equitably reduced to achieve compliance with ambient air quality standards and dustfall limit values
- **Goal 3:** By 2020, air quality in all low-income settlements is in full compliance with ambient air quality standards
- **Goal 4:** By 2020, all vehicles comply with the requirements of the National Vehicle Emission Strategy
- **Goal 5:** By 2020, a measurable increase in awareness and knowledge of air quality exists
- **Goal 6:** By 2020, biomass burning and agricultural emissions will be 30% less than current
- **Goal 7:** By 2020, emissions from waste management are 40% less than current

A draft of the second-generation air quality management plan for the HPA was published in August 2023. The proposed strategies to reduce the industrial emissions within the HPA were developed in line with the 2020 MES and are summarised in Table 5-4.

Table 5-4: Emission Reduction Activities for Industrial Emissions

Objectives	Key Activities/ Opportunities	Responsibility
Reduce emissions from industries	Compliance with the minimum emission standards and other atmospheric emission licence condition	Identified stakeholders in regulation 3(1)(a) and 3(1)(b).
	Assessment of compliance monitoring reports	Identified stakeholders in regulation 3(1)(d): DFFE, Provinces, Metros, Districts and Local municipalities
	Development and Implementation of emission reduction plans	Identified stakeholders in regulation 3(1)(a) and 3(1)(b).
	Monitor and enforce compliance	Identified stakeholders in regulation 3(1)(d): DFFE, Provinces, Metros, Districts and Local municipalities
	Identify opportunities and incentive schemes to support industries to implement air quality improvement initiatives.	Identified stakeholders in regulation 3(1)(d): DTIC, DFFE, Provinces, Metros, Districts and Local municipalities
	Establish incentive schemes for energy efficiency improvements and fuel switching that directly reduce air emissions.	Identified stakeholders in regulation 3(1)(d): DTIC, DFFE, Provinces, Metros, Districts and Local municipalities
Notes: DTIC – Department of Trade, Industry and Competition, DFFE – Department of Forestry, Fisheries and the Environment		

5.1.2.4 Draft Ekurhuleni Metropolitan Municipality Air Quality Management Plan (2020)

The final draft City of Ekurhuleni (CoE) Air Quality Management Plan (AQMP) was recently (March 2020) developed by a team of specialists; local, provincial and national government stakeholders; and community representatives. The final draft AQMP has not yet been ratified by Council. It must be noted the CoE forms part of the HPA and is located within the Gauteng Province. Consequently, the objectives and goals of the draft AQMP have been aligned where appropriate with those of the HPA AQMP and the provincial AQMP. The overall objective and specific goals are briefly summarised below.

5.1.2.4.1 Objective

"Ambient air quality in the City of Ekurhuleni complies with all national ambient air quality standards and is maintained for the benefit of present and future generations."

5.1.2.4.2 Goals

The AQMP has ten (10) special goals that support its overall objective. The goals are:

- CoE Capacity Goals, which note that it is essential that sufficient capacity is implemented within the CoE to ensure that the municipality has the resources to effect its mandates in terms of NEM:AQA.
- Industrial Emissions Goals, which address reduction of industrial emissions such that compliance with applicable emission standards, and ambient air quality standards at fenceline, and dust fallout limit values are achieved by industrial stakeholders.
- Domestic Fuel Burning Emission Reduction Goals, which aim to understand the role of domestic fuel burning on human health within CoE and aim to develop interventions to reduce the emissions from this sector.

- Transport Emission Reduction Goals, which aim to measure vehicle emissions and ensure vehicles comply with national emissions strategies; and to develop public transport plans.
- Increase In Awareness and Knowledge of Air Quality Management Issues
- Veld Burning Emission Reduction Goals, which aim to quantify the scale impact of veld fires on air quality and to consider veld fire emission reduction plans.
- Waste Burning Emission Reduction Goals, which aim to quantify the scale and impact of waste burning in CoE; to develop waste burning emission reduction action plans and to ensure that refuse collection services serve all communities in accordance with the CoE waste management plan.
- Agricultural Emission Reduction Goals, by evaluating agricultural emission reduction options and rolling out an emission reduction action plan.
- Mining Emission Reduction Goals aim to quantify emissions from mine dumps, open cast operations and coal discard and to ensure that ambient air quality standards are met at source fence lines.
- Capacity development.

5.1.2.4.3 CoE Air Quality Management By-Law (2018)

The objectives of the draft CoE Air Quality Management By-Law (drafted 2018, not yet accepted by Council) are to:

- Give effect to the right contained in section 24 of the Constitution by regulating air pollution within the municipal area of the City;
- Provide, in conjunction with any other applicable legislation, an effective legal and administrative framework, within which the City can manage and regulate activities that have the potential to adversely impact the environment, public health and well-being; and
- Ensure that air pollution is avoided, or where it cannot be altogether avoided, mitigated or minimised.
- With specific reference to waste and waste disposal activities, the by-law prohibits:
    - The burning of any industrial, domestic or garden waste, on any land or premises, for the purpose of disposing of that waste, unless the industrial, domestic or garden waste is legally disposed of in terms of section 26 of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008); and,
  - The burning of any tyres, rubber products, cables or any other products, on any land or premises for any purpose, for the purpose of recovering the scrap metal or fibre reinforcements, or of disposing of tyres, of the rubber products or cables as waste.

In addition, the by-law stipulates that any occupier or owner of premises from which a nuisance emanates, or where a nuisance exists, must take measures to contain emissions that cause a nuisance. Any occupier or owner of premises that fails to take measures to contain nuisance causing emissions commits an offence.

5.1.2.5 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. South African NAAQS for SO_2, NO_2, PM_{10}, CO, O_3, benzene (C_6H_6), and lead (Pb) were published on 13 March 2009. Standards for $PM_{2.5}$ were published on 24 June 2012. All standards are listed in Table 5-5. Modelled concentrations were assessed against NAAQS (Table 5-5) as prescribed by South African legislation. Due to the operational lifetime of the proposed project the most stringent $PM_{2.5}$ NAAQS were referred to which are enforceable from 1 January 2030.

Table 5-5: National Ambient Air Quality Standards applicable for the assessment of the proposed facility

Pollutant	Averaging Period	Concentration (µg/m³)	Frequency of Exceedance	Compliance Date
Benzene (C_6H_6)	1 year	5	0	Currently enforceable
Carbon Monoxide (CO)	1 hour	30 000	88	Currently enforceable
	8 hour[(a)]	10 000	11	Currently enforceable
Nitrogen Dioxide (NO_2)	1 hour	200	88	Currently enforceable
	1 year	40	0	Currently enforceable
Inhalable particulate matter less than 2.5 µm in diameter ($PM_{2.5}$)	24 hours	40	4	Enforceable until 31 December 2029
	24 hours	25	4	1 January 2030
	1 year	20	0	Enforceable until 31 December 2029
	1 year	15	0	1 January 2030
Inhalable particulate matter less than 10 µm in diameter (PM_{10})	24 hours	75	4	Currently enforceable
	1 year	40	0	Currently enforceable
Sulfur Dioxide (SO_2)	10 minutes	500	526	Currently enforceable
	1 hour	350	88	Currently enforceable
	24 hours	125	4	Currently enforceable
	1 year	50	0	Currently enforceable

5.1.3 Atmospheric Dispersion Potential

Meteorological mechanisms govern the dispersion, transformation, and eventual removal of pollutants from the atmosphere. The analysis of hourly average meteorological data is necessary to facilitate a comprehensive understanding of the dispersion potential of the site. The horizontal 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.

This study accessed three sets of meteorological data: simulated meteorological data for the study area, and, measured meteorological data at the SAWS OR Tambo station. For the purposes of CALPUFF dispersion modelling, WRF data for the period 2021 to 2023 on a 12 km horizontal resolution for a 20 km by 20 km domain was used. The OR Tambo monitoring station was included for comparison to assess how representative the WRF data set is for the proposed project site.

5.1.3.1 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 the wind speed, in combination with the surface roughness (Tiwary & Colls, 2010).

Period and diurnal wind roses drawn from the simulated WRF meteorological data, is from the northern and north-western sector for the period 2021 – 2023 (Figure 5-1). Calm conditions occurred 3% of the time. The predominant wind direction for day- and night-time conditions was from the northwest and north-northeast respectively.

Period and diurnal wind roses drawn from the SAWS OR Tambo meteorological station data are shown in Figure 5-2. During the period January 2020 to December 2022, the dominant wind field was from the north-western sector. Calm conditions occurred 2% of the time. The predominant wind direction for day- and night-time conditions was from the northwest and north respectively.

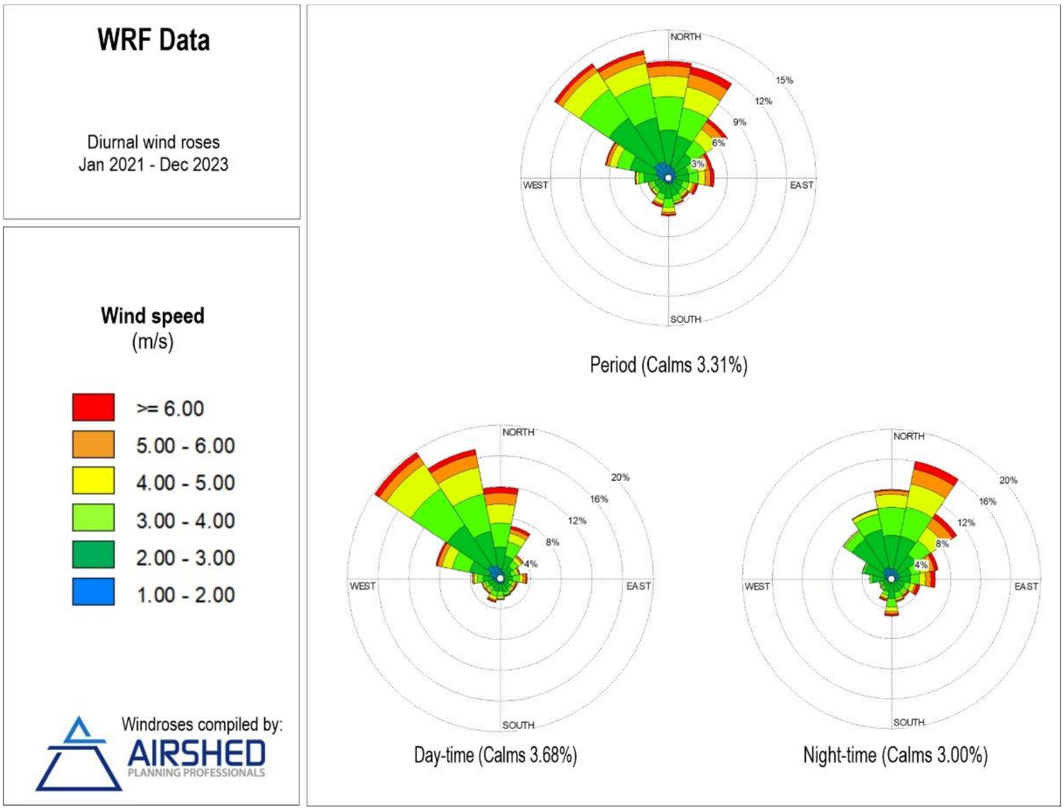

Figure 5-1: Diurnal wind-field for the proposed project site using the simulated WRF dataset (2021 - 2023)

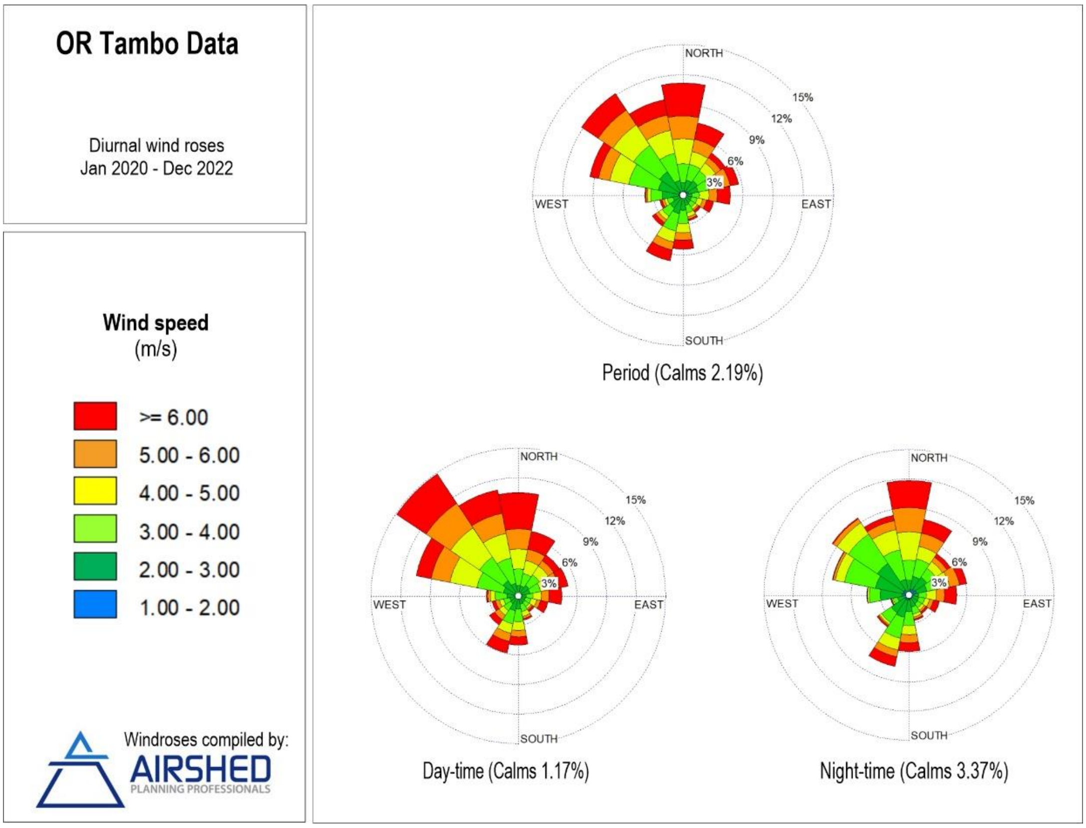

Figure 5-2: Diurnal wind-field measured at the SAWS OR Tambo station (2020-2022)

5.1.3.2 Ambient Temperature

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

Monthly mean, maximum and minimum temperatures for WRF data are given in Table 5-6. Diurnal temperature variability is presented in Figure 5-3. Average monthly temperatures ranged between 11.3°C and 22.2°C. During the day, temperatures increase to reach maximum at about 15:00 in the late afternoon. Ambient air temperature decreases to reach a minimum at between 05:00 and 06:00, i.e., just before sunrise.

Monthly mean, maximum and minimum temperatures are given in Table 5-7. Diurnal temperature variability is presented in Figure 5-4. Average monthly temperatures ranged between 10.6°C and 19.7°C. During the day, temperatures increase to reach maximum at about 15:00 in the late afternoon. Ambient air temperature decreases to reach a minimum at between 05:00 and 06:00, i.e., just before sunrise.

Table 5-6: Monthly average temperature summary (WRF data for the period January 2021 to December 2023)

Hourly Minimum, Hourly Maximum and Monthly Average Temperatures (°C)												
Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minimum	16.3	15.6	14.5	13.0	11.1	8.0	7.1	9.3	12.3	14.8	15.3	15.7
Average	22.2	21.8	20.8	18.2	15.0	12.1	11.3	14.4	18.8	20.9	21.5	21.9
Maximum	27.2	26.8	25.5	22.5	19.1	16.5	15.6	19.4	24.1	25.5	26.0	26.5

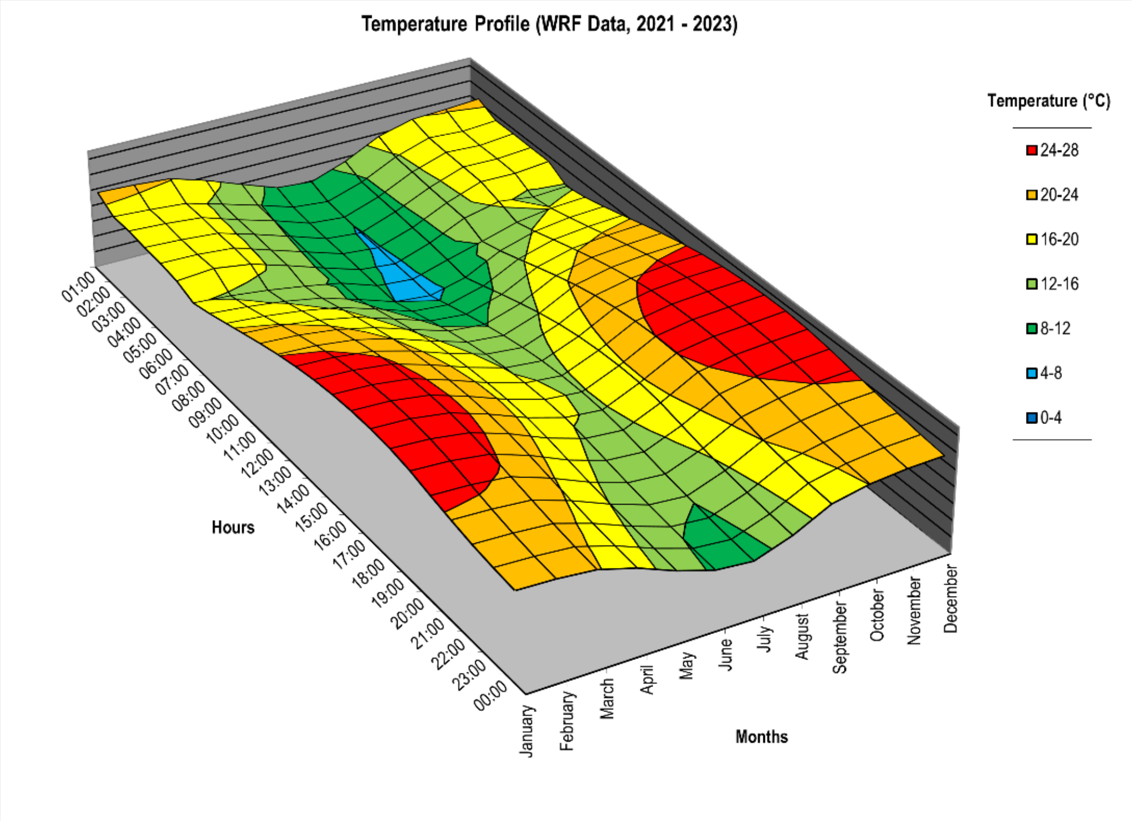

Figure 5-3: Diurnal temperature profile (WRF data)

Table 5-7: Monthly average temperature summary (OR Tambo meteorological station for the period January 2020 to December 2022)

Hourly Minimum, Hourly Maximum and Monthly Average Temperatures (°C)												
Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minimum	15.8	15.4	14.3	12.1	9.1	6.0	6.0	8.2	11.7	14.1	14.8	15.5
Average	19.7	19.5	18.3	16.0	13.8	10.6	10.9	13.3	17.7	19.0	18.9	19.2
Maximum	23.9	23.7	22.6	20.6	19.1	16.1	16.6	19.2	24.0	24.4	23.2	23.6

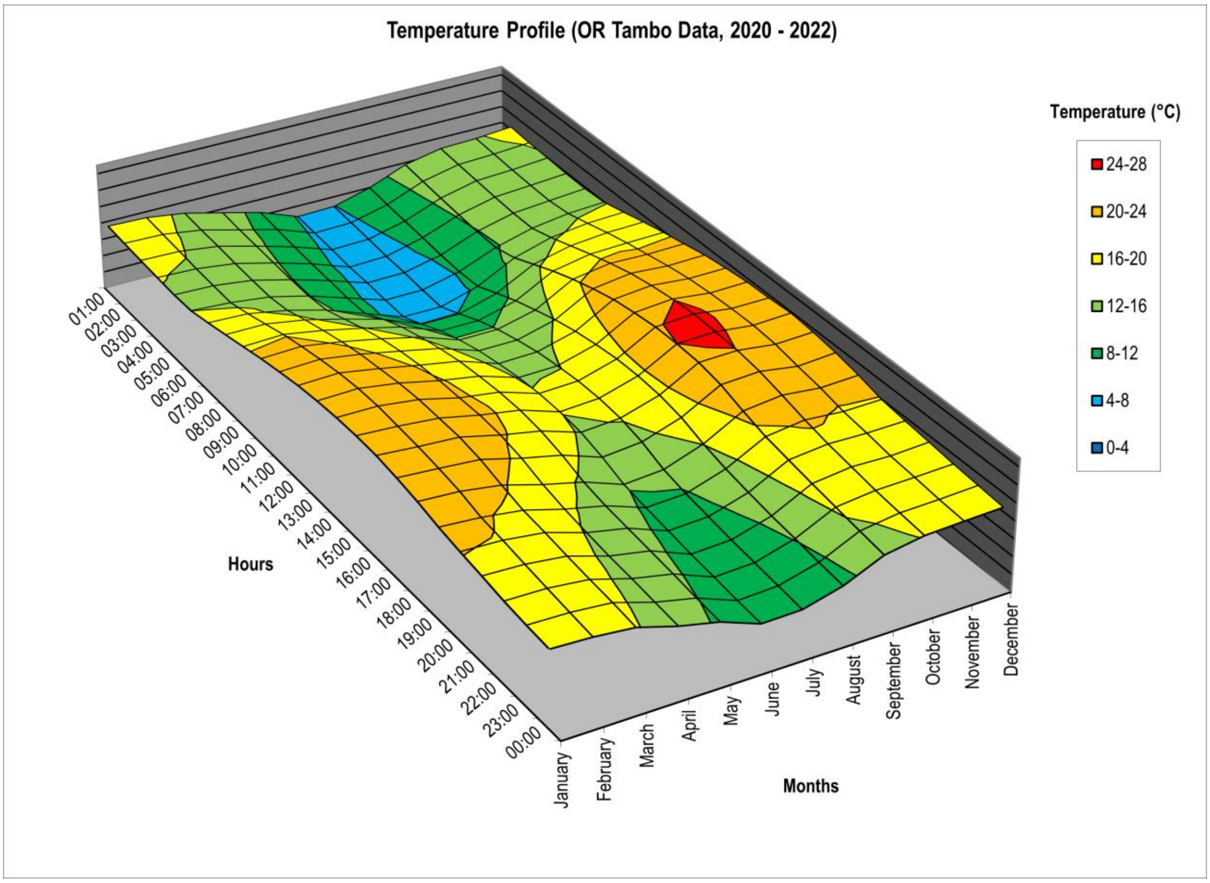

Figure 5-4: Diurnal temperature profile for OR Tambo meteorological station (2020-2022)

5.1.4 Ambient Air Quality Monitoring Data

AQMS within the study area include Buccleugh AQMS (~11.5 km northwest of the project) and Alexandra AQMS (~7.8 km west of the project) both owned by the City of Johannesburg; and Bedfordview AQMS (~8.8 km southwest of the project) owned by the Ekurhuleni Metropolitan Municipality (locations of the AQMS are provided in Figure 1-2).

A summary of the measured ambient air quality data for the period 2023 from the Buccleugh AQMS, Alexandra AQMS and Bedfordview AQMS is provided in Table 5-8. Data availability for the pollutants measured at Alexandra AQMS was more than 80%. The data availability for the pollutants measured at Buccleugh AQMS was less than 60% with availability at Bedfordview AQMS being less than 20%.

Table 5-8: Summary of the ambient measurements at the AQMS within the study area for the period 2023[(a)(b)]

AQMS	Data Availability	Hourly			Daily			Annual Average	No of recorded hourly exceedances	No of recorded daily exceedances
		Maximum	99th Percentile	50th Percentile	Maximum	99th Percentile	50th Percentile			
SO_2 (µg/m³)										
Criteria		*350 µg/m³*			*125 µg/m³*			*50 µg/m³*	*88 hours per year*	*4 days per year*
Alexandra	87%	268.2	78.8	7.2	59.6	44.4	8.9	12.0	0	0
Buccleugh	56%	233.2	57.4	6.2	43.3	23.0	4.2	10.0	0	0
Bedfordview	13%	193.3	107.5	19.2	67.6	59.6	23.2	25.6	0	0
O_3 (µg/m³)										
Criteria		*120 µg/m³*							*11 periods per year*	
Buccleugh	55%	139.5	108.4	28.6					**23**	
CO (µg/m³)										
Criteria		*30 000 µg/m³*			*10 000 µg/m³*				*88 hours per year*	*11 periods per year*
Buccleugh	46%	9 229.0	2 942.5	503.8	3 487.0	2 585.7	570.2		0	0
Bedfordview	12%	3 182.3	2 327.6	576.4	2 430.3	1 959.3	639.0		0	0
PM_{10} (µg/m³)										
Criteria					*75 µg/m³*			*40 µg/m³*		*4 days per year*
Alexandra	83%				179.5	**132.1**	54.5	**46.4**		**102**
Buccleugh	47%				131.4	66.0	27.2	28.9		2
Bedfordview	17%				68.5	68.4	39.8	41.5		0
$PM_{2.5}$ (µg/m³)										
Criteria					*40 µg/m³*			*20 µg/m³*		*4 days per year*
Alexandra	84%				118.1	**82.9**	28.2	**22.8**		**100**
Buccleugh	14%				42.1	40.1	17.2	19.2		2
Bedfordview	17%				38.5	38.5	21.7	21.9		0

Notes:

(a) Red text denotes less than 80% data availability

(b) Bold text denotes exceedance of the NAAQS

Non-compliance of the daily and annual NAAQS for PM_{10} and $PM_{2.5}$ were recorded for the period 2023 at the Alexandra AQMS. Compliance of PM NAAQS could not be determined at the Buccleugh and Bedfordview AQMS due to the low data availability.

5.1.5 Impacts due to Baseline Operations at Kelvin Power Station

5.1.5.1 Emissions Inventory

The current Kelvin Power Station operations was assessed, assuming continuous operations and based on stack parameters and emission measurements conducted by Rayton in March 2024 (Rayten Engineering Solutions, 2024) (Table 5-9).

Table 5-9: Stack parameters and emission rates for the current Station B operations at Kelvin Power Station

Parameters	Units	Stack ID		
		South Concrete Stack	Middle Concrete Stack	North Concrete Stack
Co-ordinates	x	619426	619406	619394
	y	7110767	7110835	7110876
Stack height	m	73	73	73
Stack diameter	m	0.5	6.6	6.6
Exit Temperature	°C	111.7	121	116.8
	K	384.84	394.14	389.94
Exit Velocity	m/s	4.1	4.9	6.4
Volumetric Flow Rate	Nm³/min	26.5	5 510.10	7 154.10
	Nm³/s	0.44	91.84	119.24
	m³/min	47.80	10 072.59	13 086.13
Particulate Matter (PM)	mg/Nm³	32.53	41.32	86.03
	kg/yr	330.18	81 238.38	324 731.38
	kg/hr	0.04	9.27	37.07
	g/s	0.01	2.58	10.30
Sulfur dioxide (SO_2)	mg/Nm³	431.20	1 268.75	672.85
	kg/yr	4 361.88	2 518 658.00	2 547 956.77
	kg/hr	0.50	287.52	290.86
	g/s	0.14	79.87	80.80
Oxides of nitrogen (NOx)	mg/Nm³	1 158.50	1 355.17	1 334.48
	kg/yr	11 780.19	2 696 469.74	5 054 277.67
	kg/hr	1.34	307.82	576.97
	g/s	0.37	85.50	160.27

5.1.5.2 Simulated SO_2 Concentrations

The simulated hourly, daily and annual average SO_2, due to current Station B operations, comply with the NAAQS across the domain, where the highest concentrations are expected close to Kelvin Estate (Figure 5-5 to Figure 5-7 and Table 5-10).

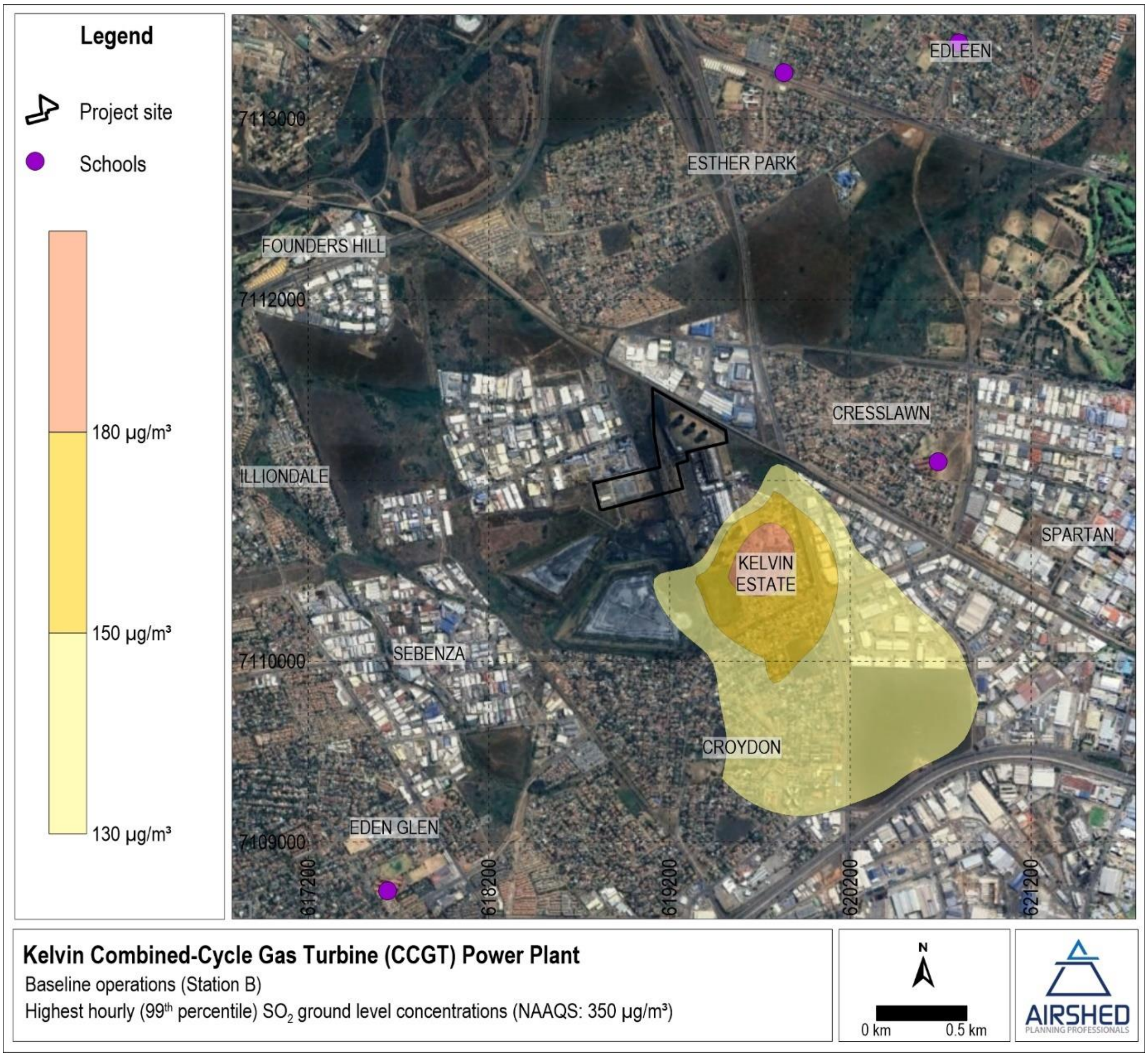

Figure 5-5: Simulated highest hourly SO_2 concentrations for baseline operations (Station B)

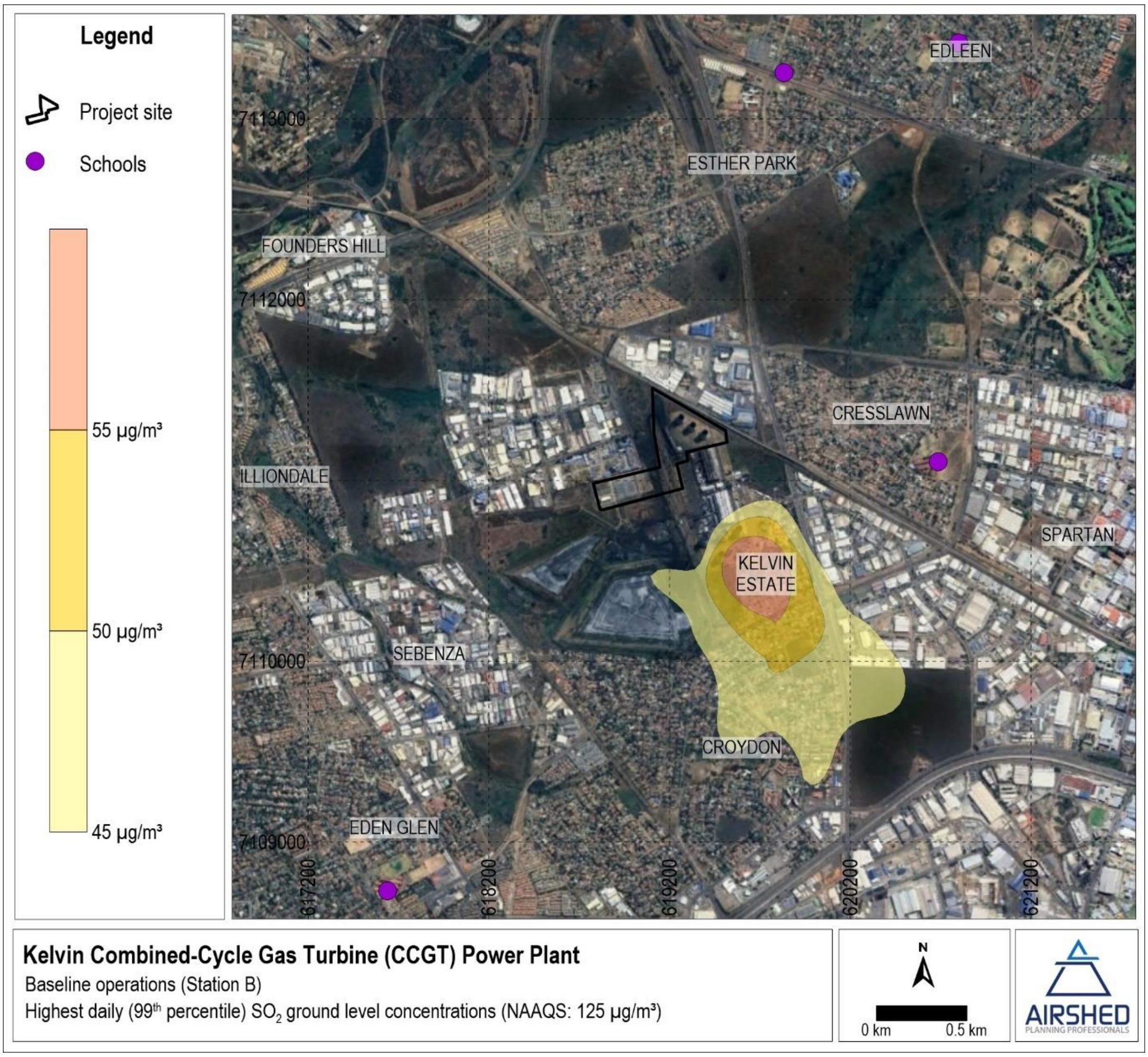

Figure 5-6: Simulated highest daily SO_2 concentrations for baseline operations (Station B)

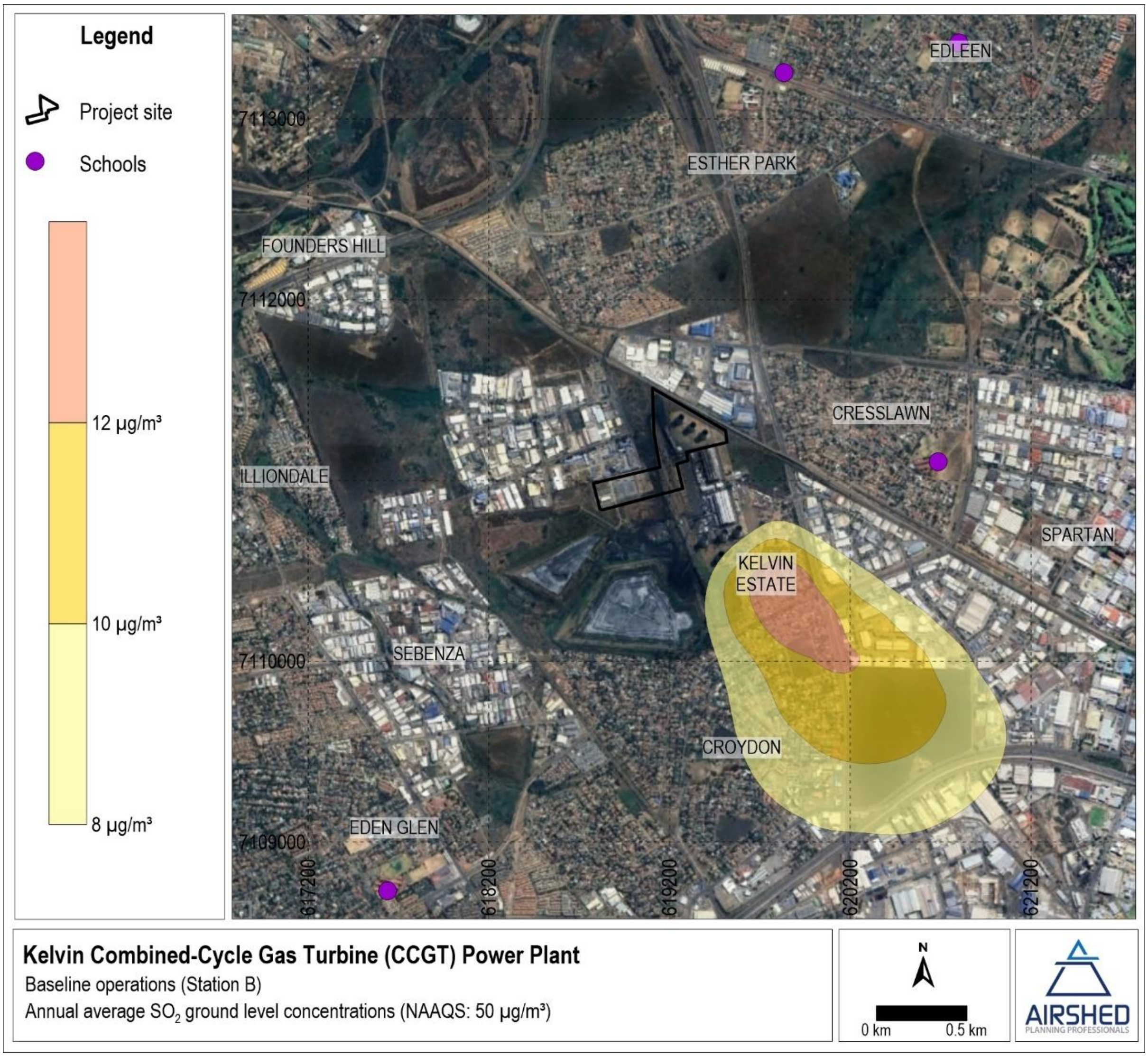

Figure 5-7: Simulated annual average SO_2 concentrations for baseline operations (Station B)

Table 5-10: Simulated SO_2 ground level concentrations at selected sensitive receptors within the study area (i.e. AQMS, hospitals and schools) due to baseline (Station B) operations[(a)]

Receptor	Name	SO_2 Ground Level Concentrations (µg/m³)		
		Highest Hourly (99th percentile) (NAAQS: 350 µg/m³)	Highest Daily (99th percentile) (NAAQS: 125 µg/m³)	Annual Average (NAAQS: 50 µg/m³)
AQMS	Alexandra AQMS	7.32	3.64	0.26
	Buccleugh AQMS	4.46	2.47	0.15
	Bedfordview AQMS	9.42	3.89	0.39
Hospitals	Advanced East Rand Day Hospital	13.81	4.42	0.80
	Arwyp Medical Centre	20.53	7.32	0.69
	Birchleigh Clinic	10.71	5.63	0.35
	Birchmed Day Hospital	11.49	5.16	0.37
	Busamed Modderfontein Private Hospital Orthopaedic & Oncology Centre	6.27	4.02	0.23
	Edenvale Hospital	9.37	4.41	0.35
	Ekurhuleni Surgiklin Day Hospital	17.38	7.88	0.63
	Knights Chest Hospital	14.94	4.17	0.65
	Life Bedford Gardens Hospital - Emergency Unit	8.06	3.32	0.34
	Life Bedford Gardens Private Hospital - Medical Ward	7.78	3.27	0.34
	Life Roseacres Hospital	18.57	9.35	0.82
	Marymount Hospital	23.36	8.37	0.78
	Netcare Linksfield Hospital	6.62	3.33	0.23
Schools	Aston Manor Primary School	11.23	4.53	0.40
	Bedfordview Academy	9.45	4.13	0.38
	Bedfordview High School	8.92	4.17	0.39
	Bedfordview Primary School	10.91	5.30	0.47
	Benoni Secondary School	34.73	12.43	2.18
	Bovet Primary School	6.42	3.26	0.23
	Crawford International - Bedfordview	12.92	5.30	0.52
	Cresslawn Primary School	96.56	30.66	3.27
	Curro Edenvale High School	43.76	16.46	1.63
	Destiny Independent School Kempton Park	13.32	4.71	0.50
	Dowerglen High School	13.55	5.12	0.50
	Dunvegan Primary School	17.60	6.97	0.67
	East Bank High School	6.74	3.85	0.24
	Eastleigh Primary School	17.91	7.86	0.66
	Edenglen High School	46.32	17.54	1.71
	Edenvale High School	16.70	5.46	0.60
	Edleen Primary	41.19	19.01	1.24
	Eduvu - Remedial School / Academy	14.73	5.11	0.83
	Ekukhanyisweni Primary School	6.00	3.27	0.23
	Elandspark School	8.77	4.46	0.40
	Gideon Rambuwani Primary School	6.05	3.62	0.23
	Hoërskool Birchleigh	7.63	4.18	0.26
	Hoërskool Jeugland	15.87	7.03	0.49
	Hoërskool Primrose	13.89	4.74	0.60
	Holy Rosary School for Girls	20.37	7.55	0.77
	Ikage Primary School	6.92	3.65	0.23
	Inkanyezi Waldorf Centre	6.24	3.14	0.23
	Jacaranda Academy	32.93	12.64	0.97
	Kempton Park Primary School	14.76	5.68	0.53
	Kwabhekilanga Secondary School	7.41	3.98	0.25
	Laerskool Birchleigh	9.11	4.98	0.30

Receptor	Name	SO_2 Ground Level Concentrations (µg/m³)		
		Highest Hourly (99th percentile) (NAAQS: 350 µg/m³)	Highest Daily (99th percentile) (NAAQS: 125 µg/m³)	Annual Average (NAAQS: 50 µg/m³)
	Laerskool Edleen	35.88	14.31	1.05
	Laerskool Kempton Park FSS	20.80	7.75	0.83
	Laerskool Kreft	16.18	6.60	0.59
	Laerskool Kruinsig	8.81	3.35	0.30
	Laerskool Van Riebeeckpark	19.60	8.53	0.62
	Laerskool Westwood	11.00	4.37	0.62
	M.C. Weiler Primary School	6.61	3.80	0.23
	Maphutha Secondary School	5.38	3.12	0.20
	Maranatha Christian School	8.37	3.28	0.28
	Martin Primary School.	13.18	3.93	0.68
	Mayibuye Primary School - New	6.30	3.16	0.24
	Midrend Primary School	5.40	2.68	0.20
	Moduopo Primary School	40.81	13.44	2.52
	Nobel Primary School	18.43	8.18	0.56
	Norkem Park Primary School	9.02	3.98	0.31
	Pholosho Primary School	6.89	3.64	0.24
	Phomolong Secondary School	8.68	4.21	0.31
	Pinnacle College Founders Hill	15.33	9.16	0.50
	Primrose Hill Primary School	15.02	5.62	0.63
	Primrose Primary School	16.73	6.99	0.75
	Primrose Technical High School	13.91	4.85	0.60
	Reddam House Bedfordview	8.51	3.38	0.35
	Rhodesfield High School	36.08	11.52	1.61
	Sir Pierre van Reyneveld High School	20.89	8.01	0.75
	Skeen Primary School	7.96	4.28	0.27
	St Benedict's College	10.87	4.54	0.44
	St Benedict's Junior Preparatory School	10.69	4.43	0.42
	Success College Primary	19.25	6.18	0.69
	Summerfields Primary School	11.50	4.50	0.65
	Sunnyridge Primary School.	20.94	9.54	0.94
	Taal-Net Midrand School	4.97	3.10	0.20
	Taalnet Primary & High School Kempton Park	14.95	5.71	0.52
	Tembisa West Secondary School	5.46	2.59	0.20
	Thuthuka Primary School	5.52	2.80	0.19
	Westside Primary School	23.84	12.30	0.78
	Wit Deep Primary School	17.57	5.46	0.92
	Woodlands International College	16.02	5.26	0.90
	Wychwood Primary School	9.45	4.28	0.42

(a) Exceedances of NAAQS provided in bold.

5.1.5.3 Simulated NO_2 Concentrations

Annual average NO_2 was simulated to comply with the NAAQS across the domain for baseline Kelvin Power Station operations (Figure 5-8 and Table 5-9). Highest hourly NO_2 concentrations exceed the NAAQS over the residential sensitive receptors of Kelvin Estate and Croydon (Figure 5-8) but are within the NAAQS at AQMS, schools and hospitals in the study area (Table 5-11).

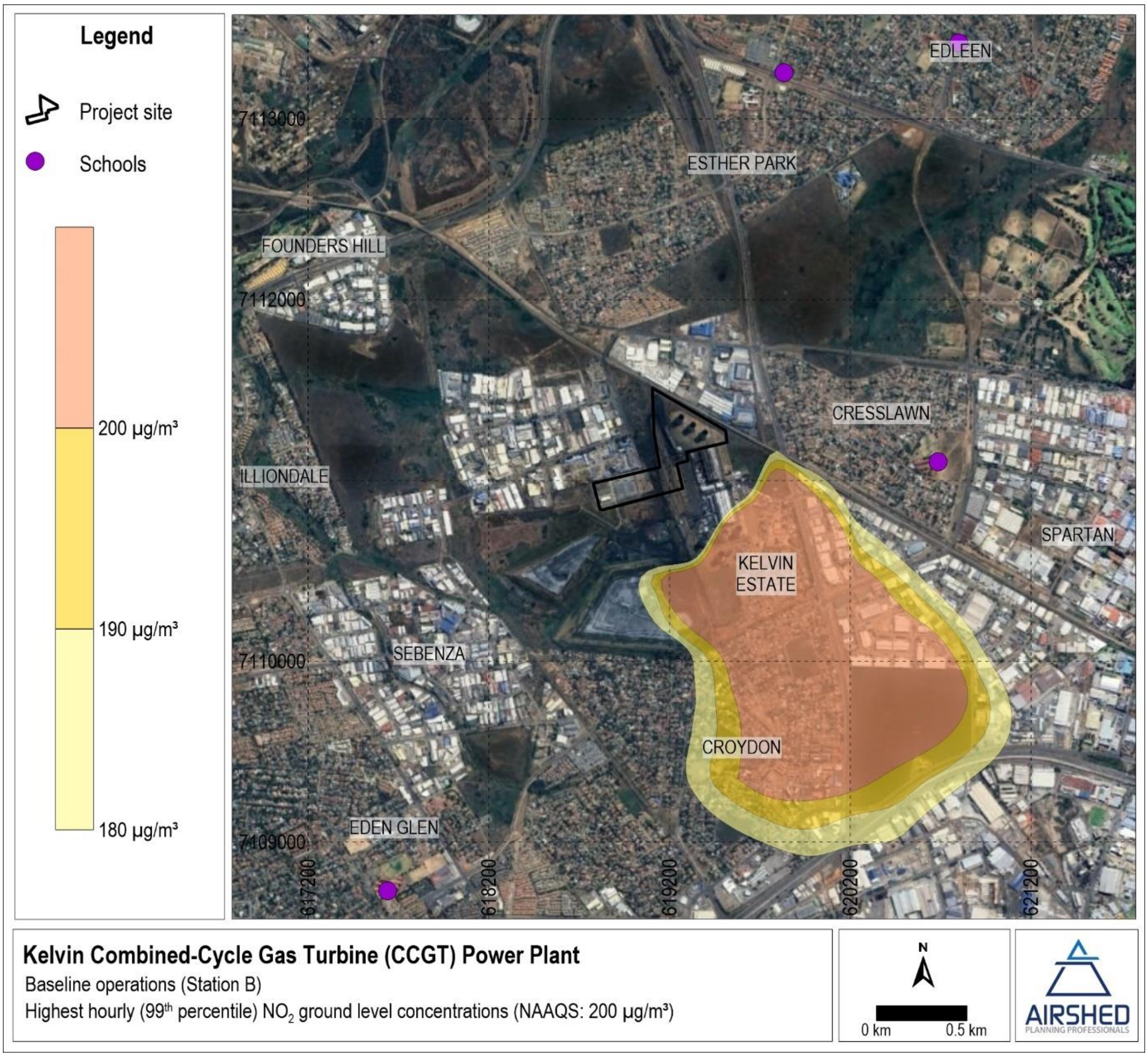

Figure 5-8: Simulated hourly (99th percentile) NO_2 concentrations for baseline operations (Station B)

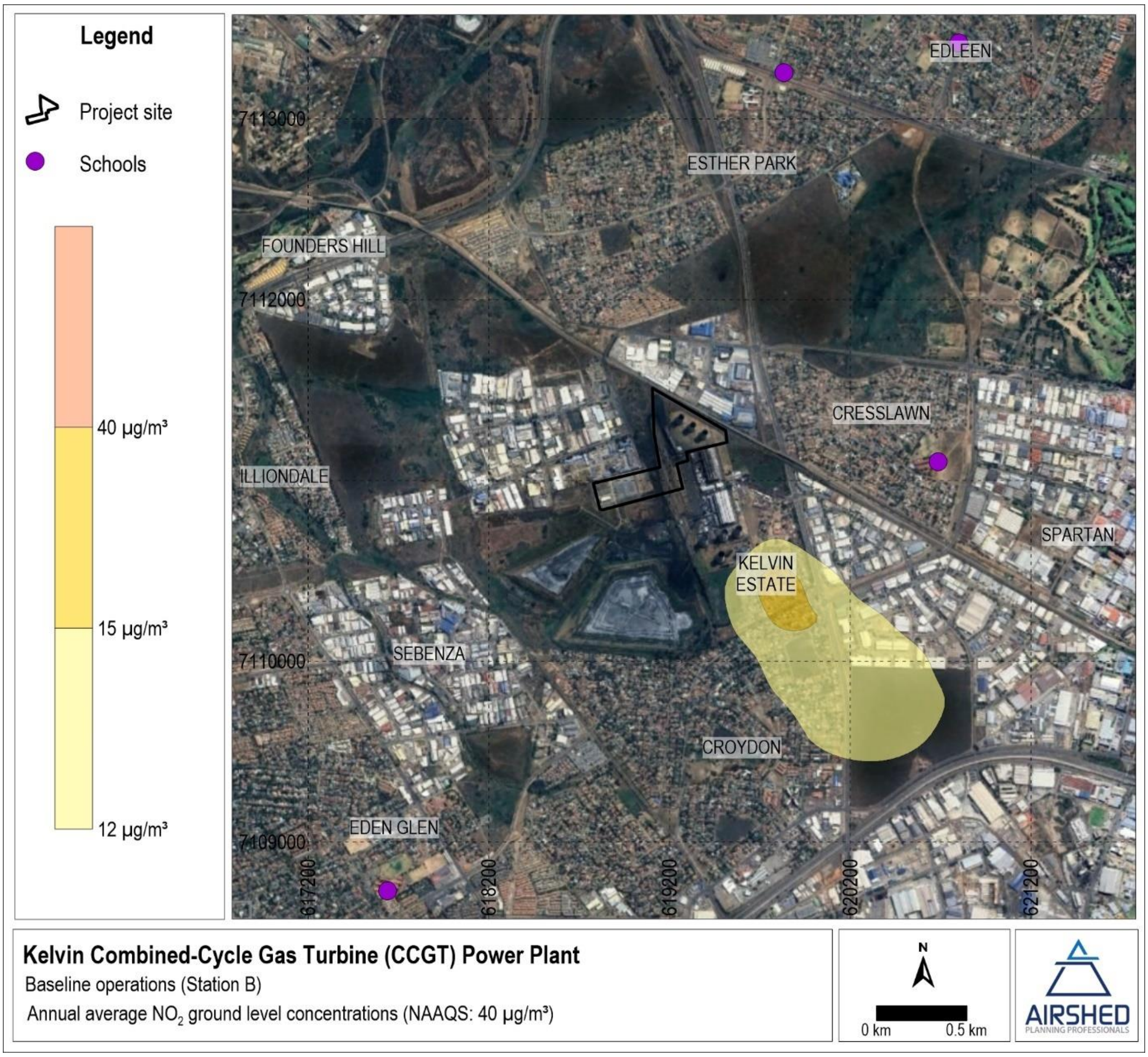

Figure 5-9: Simulated annual average NO_2 concentrations for baseline operations (Station B)

Table 5-11: Simulated NO_2 ground level concentrations at selected sensitive receptors within the study area (i.e. AQMS, hospitals and schools) due to baseline (Station B) operations[(a)]

Receptor	Name	NO_2 Ground Level Concentrations ($\mu g/m^3$)	
		Highest Hourly (99^{th} percentile) (NAAQS: 200 $\mu g/m^3$)	Annual Average (NAAQS: 40 $\mu g/m^3$)
AQMS	Alexandra AQMS	10.88	0.38
	Buccleugh AQMS	5.93	0.22
	Bedfordview AQMS	14.08	0.57
Hospitals	Advanced East Rand Day Hospital	20.83	1.17
	Arwyp Medical Centre	30.81	1.02
	Birchleigh Clinic	16.00	0.52
	Birchmed Day Hospital	17.30	0.55
	Busamed Modderfontein Private Hospital Orthopaedic & Oncology Centre	8.90	0.33
	Edenvale Hospital	14.00	0.51
	Ekurhuleni Surgiklin Day Hospital	25.98	0.92
	Knights Chest Hospital	22.74	0.96
	Life Bedford Gardens Hospital - Emergency Unit	12.09	0.49
	Life Bedford Gardens Private Hospital - Medical Ward	11.65	0.49
	Life Roseacres Hospital	27.95	1.21
	Marymount Hospital	35.63	1.15
	Netcare Linksfield Hospital	9.59	0.33
Schools	Aston Manor Primary School	16.50	0.58
	Bedfordview Academy	13.68	0.55
	Bedfordview High School	13.19	0.57
	Bedfordview Primary School	16.31	0.69
	Benoni Secondary School	53.20	3.27
	Bovet Primary School	9.64	0.34
	Crawford International - Bedfordview	19.24	0.76
	Cresslawn Primary School	144.00	4.87
	Curro Edenvale High School	65.42	2.44
	Destiny Independent School Kempton Park	19.65	0.72
	Dowerglen High School	19.99	0.73
	Dunvegan Primary School	26.91	0.98
	East Bank High School	9.79	0.34
	Eastleigh Primary School	26.50	0.97
	Edenglen High School	70.18	2.55
	Edenvale High School	25.06	0.89
	Edleen Primary	61.88	1.86
	Eduvu - Remedial School / Academy	22.05	1.22
	Ekukhanyisweni Primary School	9.19	0.34
	Elandspark School	13.07	0.57
	Gideon Rambuwani Primary School	8.86	0.33
	Hoërskool Birchleigh	11.55	0.39
	Hoërskool Jeugland	23.83	0.72
	Hoërskool Primrose	20.90	0.87
	Holy Rosary School for Girls	31.09	1.13
	Ikage Primary School	10.59	0.34
	Inkanyezi Waldorf Centre	9.07	0.33
	Jacaranda Academy	49.89	1.45
	Kempton Park Primary School	21.85	0.78
	Kwabhekilanga Secondary School	10.92	0.36
	Laerskool Birchleigh	13.82	0.45
	Laerskool Edleen	54.24	1.58
	Laerskool Kempton Park FSS	31.51	1.22

Receptor	Name	NO_2 Ground Level Concentrations (µg/m³)	
		Highest Hourly (99th percentile) (NAAQS: 200 µg/m³)	Annual Average (NAAQS: 40 µg/m³)
	Laerskool Kreft	23.92	0.86
	Laerskool Kruinsig	13.24	0.44
	Laerskool Van Riebeeckpark	29.69	0.92
	Laerskool Westwood	16.60	0.91
	M.C. Weiler Primary School	9.85	0.34
	Maphutha Secondary School	7.80	0.28
	Maranatha Christian School	12.63	0.42
	Martin Primary School.	19.75	0.99
	Mayibuye Primary School - New	9.07	0.34
	Midrend Primary School	7.64	0.29
	Moduopo Primary School	62.57	3.79
	Nobel Primary School	27.95	0.83
	Norkem Park Primary School	13.56	0.45
	Pholosho Primary School	10.27	0.35
	Phomolong Secondary School	12.71	0.45
	Pinnacle College Founders Hill	22.57	0.75
	Primrose Hill Primary School	22.10	0.92
	Primrose Primary School	25.50	1.10
	Primrose Technical High School	21.04	0.88
	Reddam House Bedfordview	12.64	0.50
	Rhodesfield High School	55.10	2.42
	Sir Pierre van Reyneveld High School	31.63	1.11
	Skeen Primary School	11.55	0.40
	St Benedict's College	16.31	0.63
	St Benedict's Junior Preparatory School	16.17	0.61
	Success College Primary	28.57	1.02
	Summerfields Primary School	17.37	0.95
	Sunnyridge Primary School.	31.20	1.39
	Taal-Net Midrand School	7.33	0.29
	Taalnet Primary & High School Kempton Park	22.74	0.76
	Tembisa West Secondary School	7.84	0.29
	Thuthuka Primary School	8.09	0.27
	Westside Primary School	34.90	1.16
	Wit Deep Primary School	26.02	1.35
	Woodlands International College	23.88	1.33
	Wychwood Primary School	13.75	0.61

(a) Exceedances of NAAQS provided in bold.

5.1.5.4 Simulated PM Concentrations

The simulated daily and annual average PM, due to current Station B operations (excluding the transport and handling of coal), comply with the NAAQS across the domain, where the highest concentrations are expected close to Kelvin Estate (Figure 5-10 to Figure 5-11 and Table 5-12).

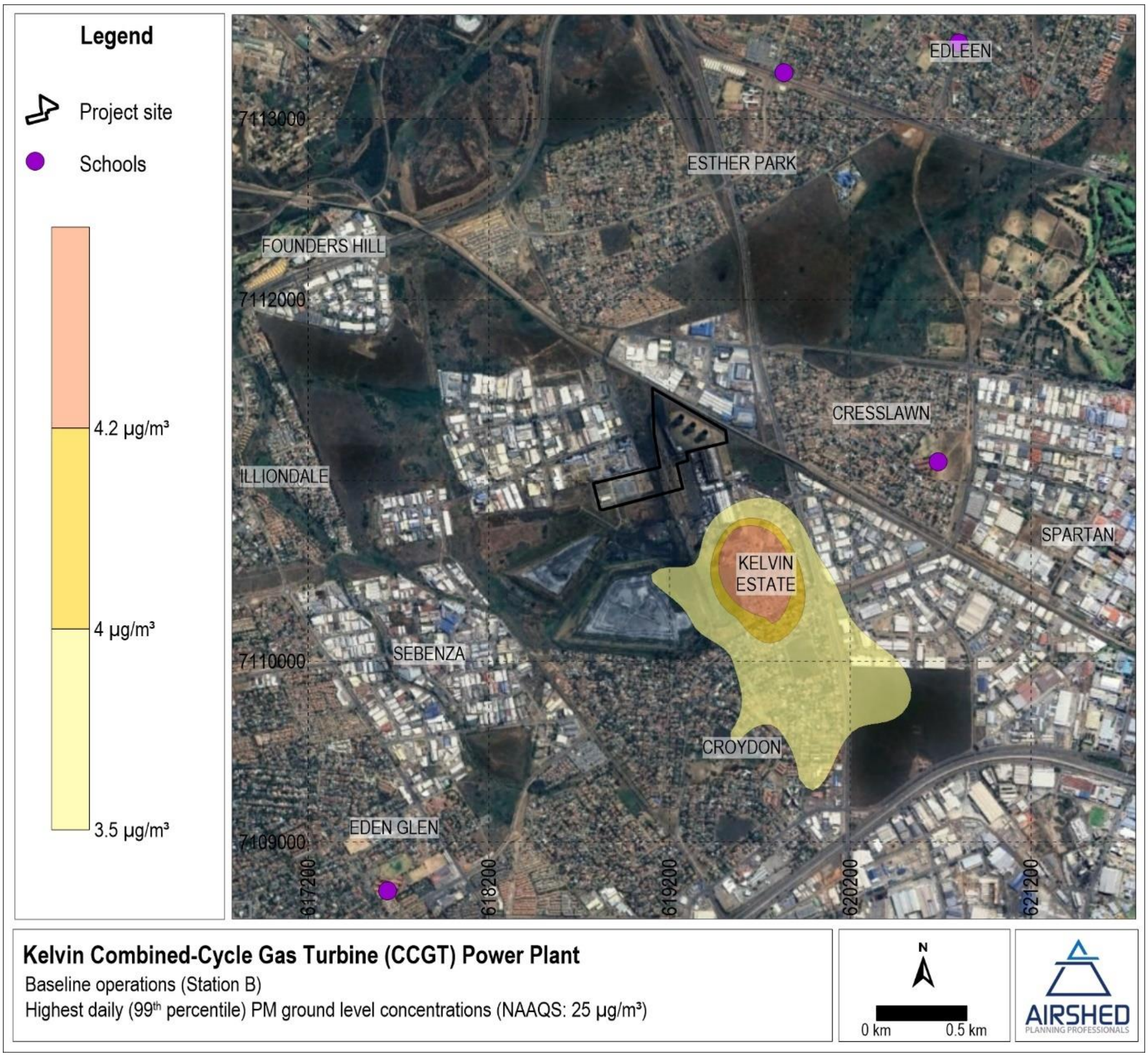

Figure 5-10: Simulated highest daily PM concentrations for baseline operations (Station B)

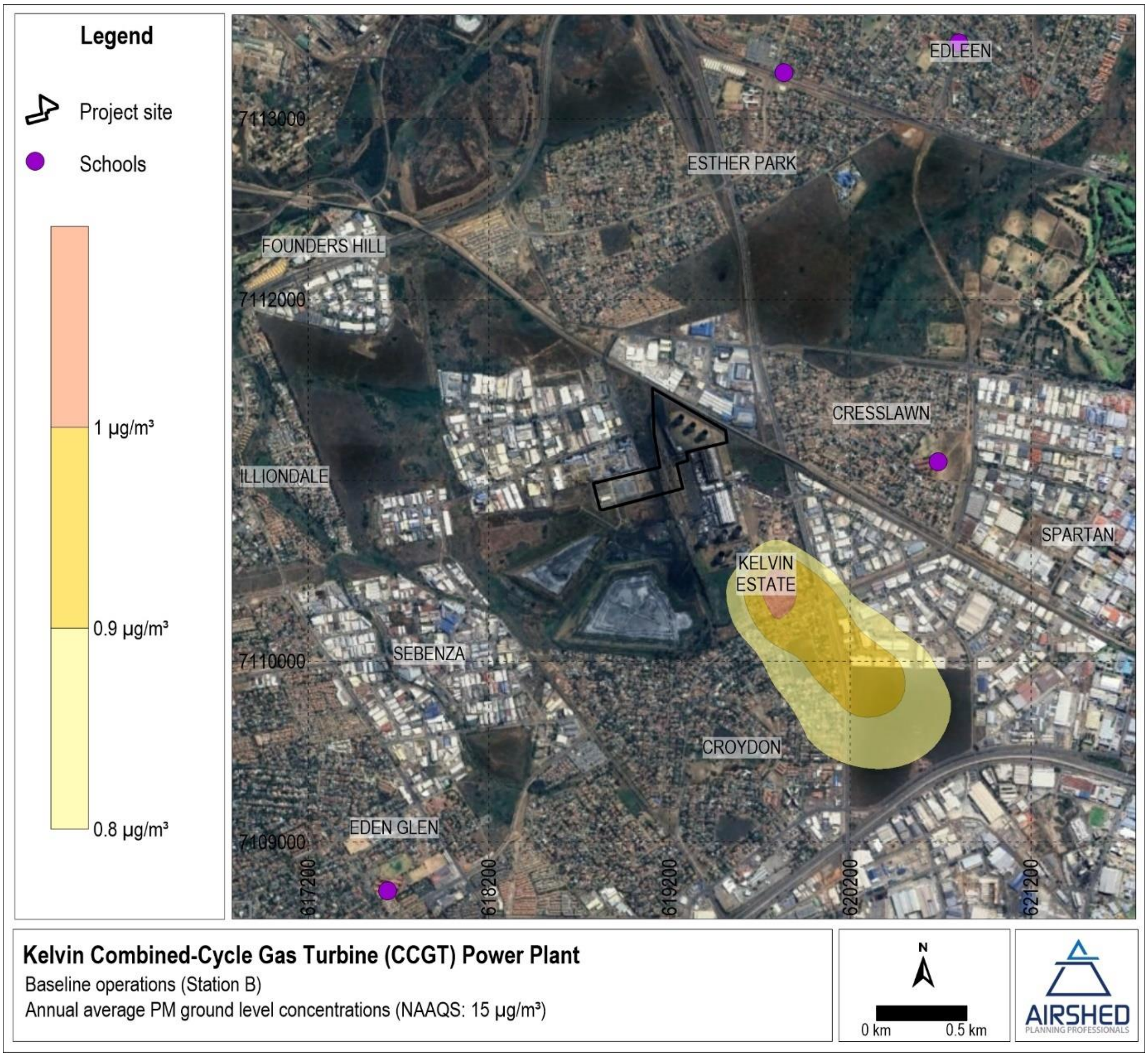

Figure 5-11: Simulated annual average PM concentrations for baseline operations (Station B)

Table 5-12: Simulated PM ground level concentrations at selected sensitive receptors within the study area (i.e. AQMS, hospitals and schools) due to baseline (Station B) operations[(a)]

Receptor	Name	PM Ground Level Concentrations ($\mu g/m^3$)	
		Highest Daily (99th percentile) (NAAQS: 25 $\mu g/m^3$)	Annual average (NAAQS: 15 $\mu g/m^3$)
AQMS	Alexandra AQMS	0.46	0.03
	Buccleugh AQMS	0.37	0.02
	Bedfordview AQMS	0.45	0.05
Hospitals	Advanced East Rand Day Hospital	0.67	0.09
	Arwyp Medical Centre	0.77	0.07
	Birchleigh Clinic	0.53	0.04
	Birchmed Day Hospital	0.54	0.04
	Busamed Modderfontein Private Hospital Orthopaedic & Oncology Centre	0.56	0.03
	Edenvale Hospital	0.54	0.04
	Ekurhuleni Surgiklin Day Hospital	0.78	0.07
	Knights Chest Hospital	0.48	0.07
	Life Bedford Gardens Hospital - Emergency Unit	0.41	0.04
	Life Bedford Gardens Private Hospital - Medical Ward	0.41	0.04
	Life Roseacres Hospital	0.76	0.09
	Marymount Hospital	0.82	0.08
	Netcare Linksfield Hospital	0.38	0.03
Schools	Aston Manor Primary School	0.54	0.05
	Bedfordview Academy	0.47	0.05
	Bedfordview High School	0.53	0.05
	Bedfordview Primary School	0.57	0.06
	Benoni Secondary School	1.13	0.21
	Bovet Primary School	0.44	0.03
	Crawford International - Bedfordview	0.50	0.06
	Cresslawn Primary School	2.33	0.28
	Curro Edenvale High School	1.44	0.16
	Destiny Independent School Kempton Park	0.70	0.06
	Dowerglen High School	0.59	0.06
	Dunvegan Primary School	0.61	0.07
	East Bank High School	0.52	0.03
	Eastleigh Primary School	0.77	0.07
	Edenglen High School	1.68	0.16
	Edenvale High School	0.55	0.07
	Edleen Primary	1.57	0.12
	Eduvu - Remedial School / Academy	0.67	0.09
	Ekukhanyisweni Primary School	0.44	0.03
	Elandspark School	0.51	0.05
	Gideon Rambuwani Primary School	0.41	0.03
	Hoërskool Birchleigh	0.41	0.03
	Hoërskool Jeugland	0.62	0.05
	Hoërskool Primrose	0.53	0.07
	Holy Rosary School for Girls	0.70	0.08
	Ikage Primary School	0.50	0.03
	Inkanyezi Waldorf Centre	0.42	0.03
	Jacaranda Academy	1.18	0.10
	Kempton Park Primary School	0.72	0.06
	Kwabhekilanga Secondary School	0.54	0.03
	Laerskool Birchleigh	0.45	0.04
	Laerskool Edleen	1.25	0.10
	Laerskool Kempton Park FSS	0.72	0.08

Receptor	Name	PM Ground Level Concentrations ($\mu g/m^3$)	
		Highest Daily (99th percentile) (NAAQS: 25 $\mu g/m^3$)	Annual average (NAAQS: 15 $\mu g/m^3$)
	Laerskool Kreft	0.75	0.06
	Laerskool Kruinsig	0.41	0.04
	Laerskool Van Riebeeckpark	0.86	0.06
	Laerskool Westwood	0.48	0.07
	M.C. Weiler Primary School	0.51	0.03
	Maphutha Secondary School	0.41	0.03
	Maranatha Christian School	0.40	0.03
	Martin Primary School.	0.55	0.08
	Mayibuye Primary School - New	0.42	0.03
	Midrend Primary School	0.40	0.03
	Moduopo Primary School	1.21	0.24
	Nobel Primary School	0.90	0.06
	Norkem Park Primary School	0.43	0.04
	Pholosho Primary School	0.46	0.03
	Phomolong Secondary School	0.55	0.04
	Pinnacle College Founders Hill	0.81	0.05
	Primrose Hill Primary School	0.58	0.07
	Primrose Primary School	0.67	0.08
	Primrose Technical High School	0.53	0.07
	Reddam House Bedfordview	0.41	0.04
	Rhodesfield High School	1.05	0.15
	Sir Pierre van Reyneveld High School	0.89	0.08
	Skeen Primary School	0.55	0.03
	St Benedict's College	0.46	0.05
	St Benedict's Junior Preparatory School	0.46	0.05
	Success College Primary	0.66	0.07
	Summerfields Primary School	0.52	0.07
	Sunnyridge Primary School.	0.82	0.10
	Taal-Net Midrand School	0.36	0.03
	Taalnet Primary & High School Kempton Park	0.62	0.06
	Tembisa West Secondary School	0.43	0.02
	Thuthuka Primary School	0.32	0.02
	Westside Primary School	1.03	0.08
	Wit Deep Primary School	0.61	0.10
	Woodlands International College	0.60	0.10
	Wychwood Primary School	0.57	0.05

(a) Exceedances of NAAQS provided in bold.

5.1.6 Impacts due to the Proposed Facility (Project)

It should be noted that current baseline operations (Station B) will have ceased by the time proposed project operations commence. Thus, impacts for proposed operations consist of project activities only. The scales used for the isopleth plots in this section has different levels and colours to that of baseline as the concentrations are much lower and not comparable to baseline operations.

5.1.6.1 Construction Phase

5.1.6.1.1 Emissions Inventory

Construction operations are potentially significant sources of dust emissions that may have a substantial temporary impact on local air quality. Emissions during construction would result from general site preparation for the development, where activities contributing would typically include material handling, wheel entrainment, operation of diesel or petrol engines, etc. If not properly mitigated, construction sites could generate high levels of dust, and this has the potential to travel for large distances.

Large quantities of the dust emissions result from construction vehicle traffic over temporary and/or unpaved roads at construction sites. Dust emissions can also vary substantially from day to day, depending on the level of activity, the specific operations, and the prevailing meteorological conditions. It is therefore often necessary to estimate area-wide construction emissions, without regard to the actual plans of any individual construction process.

The US EPA has defined an emissions factor with the aim of providing a general rule-of-thumb as to the magnitude of emissions which may be anticipated from construction operations. The quantity of dust emissions is assumed to be proportional to the area of land being worked and the level of construction activity. Based on field measurements of total suspended particulate (TSP) concentrations surrounding construction projects, the generalised emission factor for construction activity is given as:

$$E_{TSP} = 2.69 \text{ Mg/hectare/month of activity } (269 \text{ g/m}^2\text{/month})$$

The PM_{10} (particulate matter with an aerodynamic diameter of less than 10 µm) fraction is given as approximately 35% of the US-EPA total suspended particulate factor. These emission factors are most applicable to construction operations with (i) medium activity levels, (ii) moderate silt contents, and (iii) semiarid climates. The emission factor is based on 42 hours of work per week of construction activity. Test data were not sufficient to derive the specific dependence of dust emissions on correction parameters. Because the above emission factor is referenced to TSP, use of this factor to estimate PM_{10} emissions will result in conservatively high estimates. Also, because derivation of the factor assumes that construction activity occurs 30 days per month, the above estimate is somewhat conservatively high for TSP as well.

Construction was given to occur for 10-hours per day (equivalent to 50 hours per week) from Monday to Friday and for a period between 36 and 42 months, where annual emissions because of construction activities are given in Table 5-13. Mitigation using watering, especially on open areas and unpaved roads was assumed to control emissions by 50% during construction operations for quantification and modelling. All potential mitigation options are discussed in the relevant sections below.

Table 5-13: Annual emissions due to construction activities

Annual emissions	TSP	PM_{10}
(tonnes/annum)	589	44

Impact due to the construction phase was not assessed quantitatively, as this activity would be of a relatively short-term duration and of local impact.

5.1.6.1.2 Mitigation Measures Recommended

The implementation of effective controls during this phase would serve to set the precedent for mitigation during the operational phase.

Dust control measures which may be implemented during the construction phase are outlined in Table 5-14. Control techniques for fugitive dust sources generally involve watering.

Table 5-14: Dust control measures that can be implemented during construction activities

Construction Activity	Recommended Control Measure(s)
Debris handling	Wet suppression (hourly watering recommended)
Truck transport and road dust entrainment	Wet suppression (hourly watering recommended) or chemical stabilization of unpaved roads.
	Haul trucks to be restricted to specified haul roads using the most direct route.
	Reduction of unnecessary traffic
	Strict on-site speed control (i.e. 40 km/hr for haul trucks)
Materials storage, handling and transfer operations	Wet suppression where feasible, possibly using continuous sprays

5.1.6.2 Operational Phase

5.1.6.2.1 Emissions Inventory

Impact of the operational phase was simulated using the parameters and emission rates given in Sections 4.1, Section 4.2, Section 4.3, Section 4.4 and Section 4.5 (Table 4-1, Table 4-2, and Table 4-6).

5.1.6.2.2 Simulation Scenarios

The following scenarios were assessed for the operational phase:

- **Scenario 1:** Normal operations assuming MES where off-gas goes through the main stacks.
- **Scenario 2:** Normal operations assuming USEPA emission factors for SO_2 (assuming the sulfur content of 10 ppm). This scenario was included to understand the range in SO_2 ground level concentrations based on emission factors designed for gas turbines and sulfur content of the natural gas being used.
- **Scenario 3:** Normal operations assuming MES where off-gas goes through the main stacks and gas generators running for 1 hour per month assuming MES where off-gas goes through the main stack (when normal operations are not taking place). Only short-term impacts were assessed, i.e. highest hourly and highest daily (99th percentile).
- **Scenario 4:** Normal operations assuming USEPA emission factors for SO_2 and gas generators running for 1 hour per month assuming MES (when normal operations are not taking place). Only short-term impacts were assessed for SO_2, i.e. highest hourly and highest daily (99th percentile).

A summary of the isopleth plots presented in this section is provided in Table 5-15.

Table 5-15: Isopleth plots provided for the project operational phase

Scenario	Pollutant	Averaging Period	Figure
Scenario 1: Normal operations assuming MES	SO_2	Highest hourly (99th percentile)	5-12
		Highest daily (99th percentile)	5-16
		Annual average	5-20
	NO_2	Highest hourly (99th percentile)	5-22
		Annual average	5-24
	PM	Highest daily (99th percentile)	5-25
		Annual average	5-27
Scenario 2: Normal operations assuming USEPA emission factors for SO_2	SO_2	Highest hourly (99th percentile)	5-13
		Highest daily (99th percentile)	5-17
		Annual average	5-21
Scenario 3: Normal operations assuming MES and the running of the diesel generator for 1 hour during the day assuming MES	SO_2	Highest hourly (99th percentile)	5-14
		Highest daily (99th percentile)	5-18
	NO_2	Highest hourly (99th percentile)	5-23
	PM	Highest daily (99th percentile)	5-26
Scenario 4: Normal operations assuming USEPA emission factors for SO_2 and the running of the diesel generator for 1 hour during the day assuming MES	SO_2	Highest hourly (99th percentile)	5-15
		Highest daily (99th percentile)	5-19

5.1.6.2.3 Simulated SO_2 Concentrations

Normal operation of the project was simulated based on MES and calculated US EPA emission factors (Section 4.2 and Section 4.3). Simulated SO_2 concentrations for the project operations comply with NAAQS across the modelling domain with hourly (domain maximum: 69.2 µg/m³ for worst case Scenario 3), daily (domain maximum: 19.9 µg/m³ for worst case Scenario 3) and annual (domain maximum: 1.3 µg/m³ for Scenario 1) averaging periods. Assuming US EPA emission factors (Scenario 2) the simulated SO_2 concentrations are much lower for hourly (domain maximum: 6.1 µg/m³), daily (domain maximum: 1.2 µg/m³) and annual (domain maximum: 0.15 µg/m³) averaging periods.

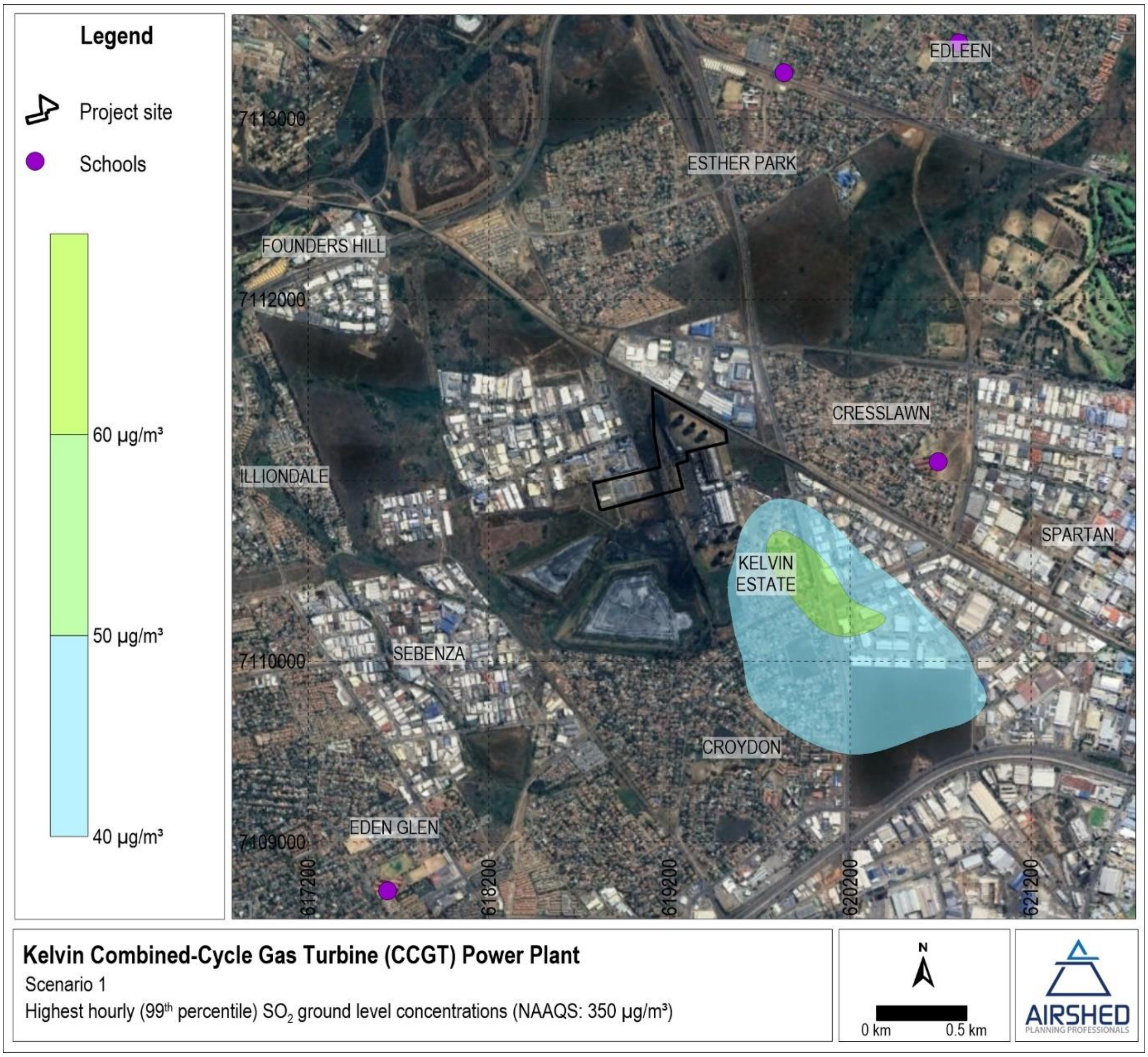

Figure 5-12: Simulated hourly (99th percentile) SO_2 ground level concentrations due to project operations (Scenario 1: Normal operations assuming MES)

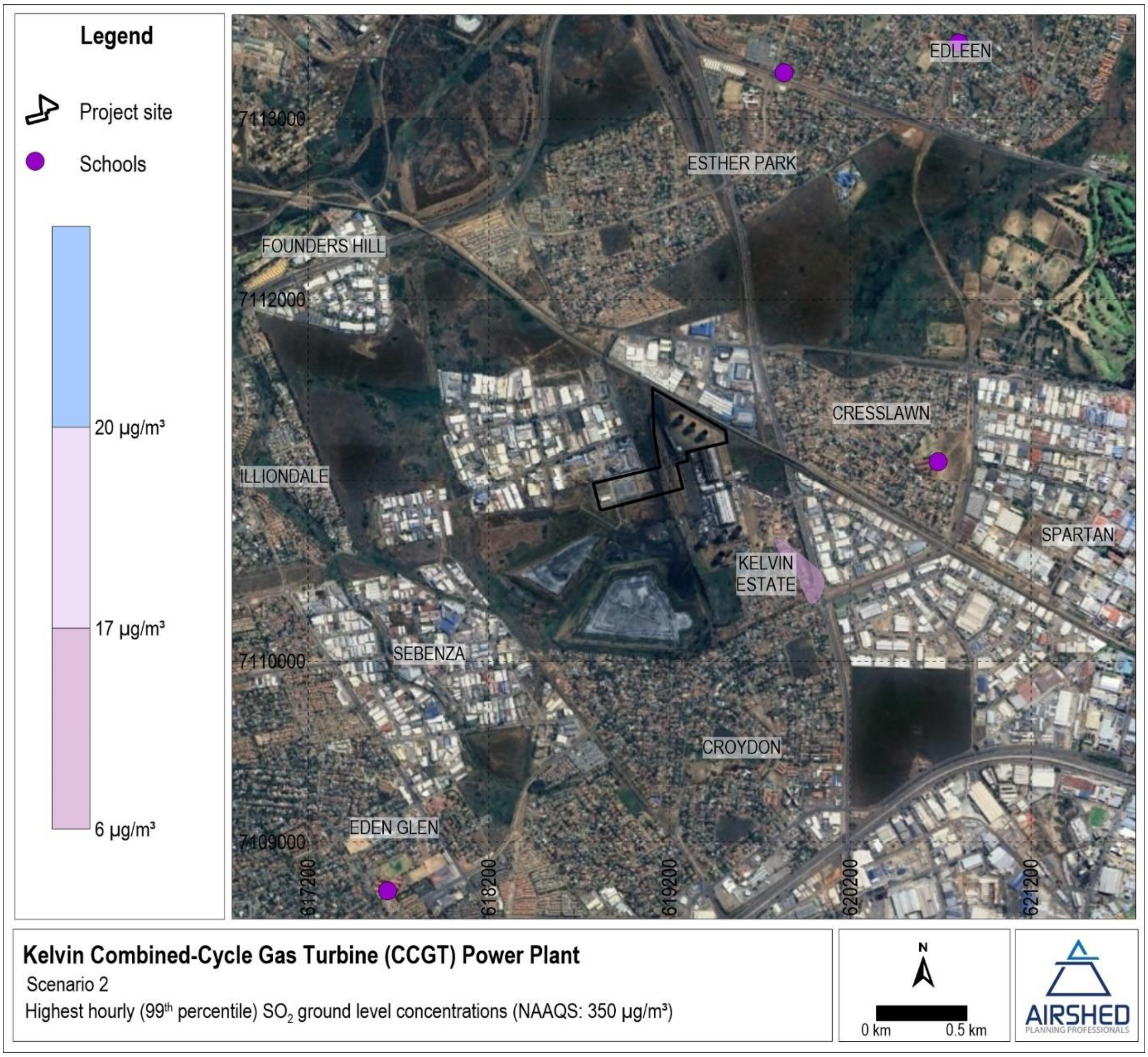

Figure 5-13: Simulated hourly (99th percentile) SO_2 ground level concentrations due to project operations (Scenario 2: Normal operations assuming USEPA emission factors for SO_2)

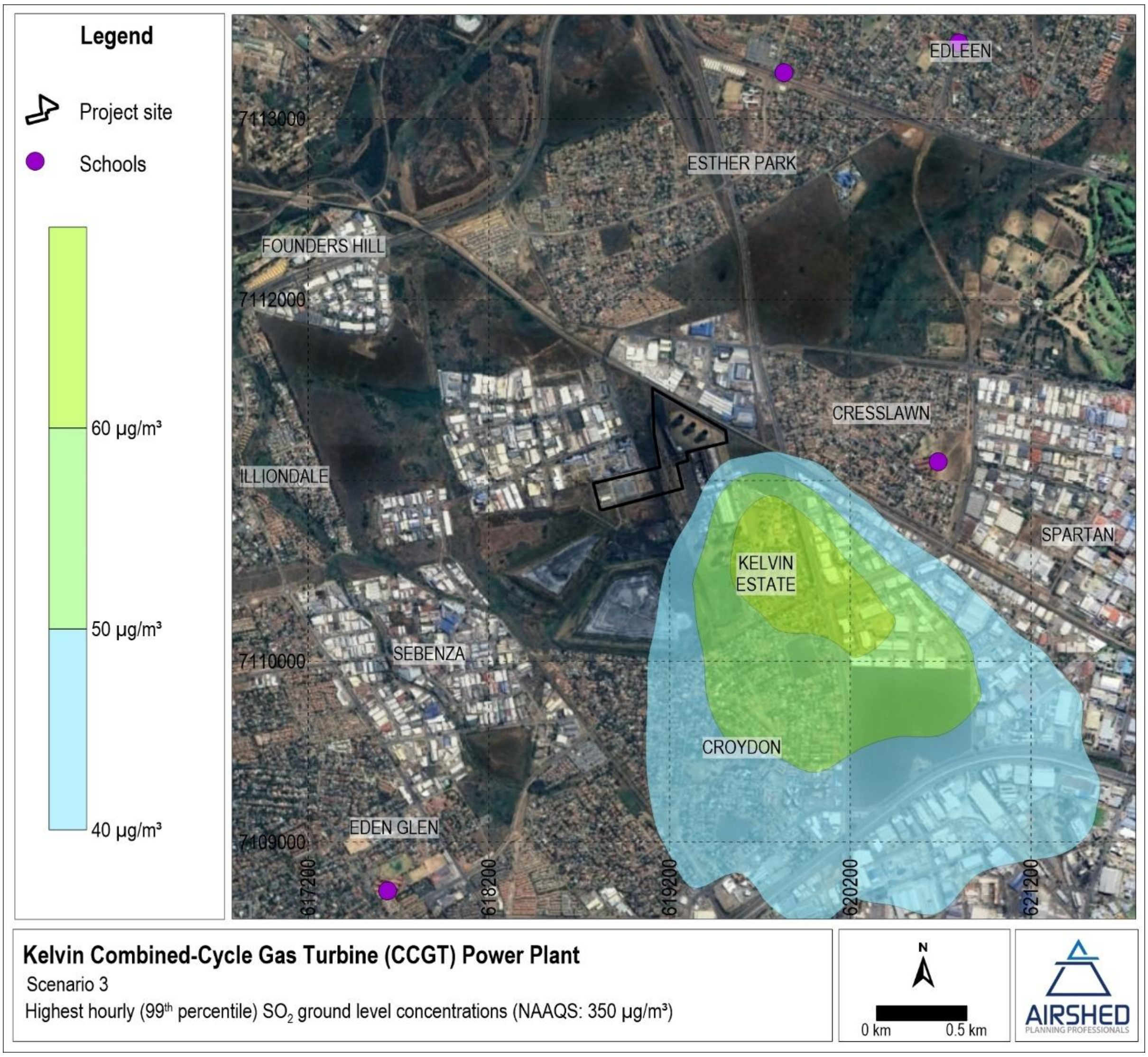

Figure 5-14: Simulated hourly (99th percentile) SO_2 ground level concentrations due to project operations (Scenario 3: Normal operations assuming MES and the running of the diesel generator for 1 hour during the day assuming MES)

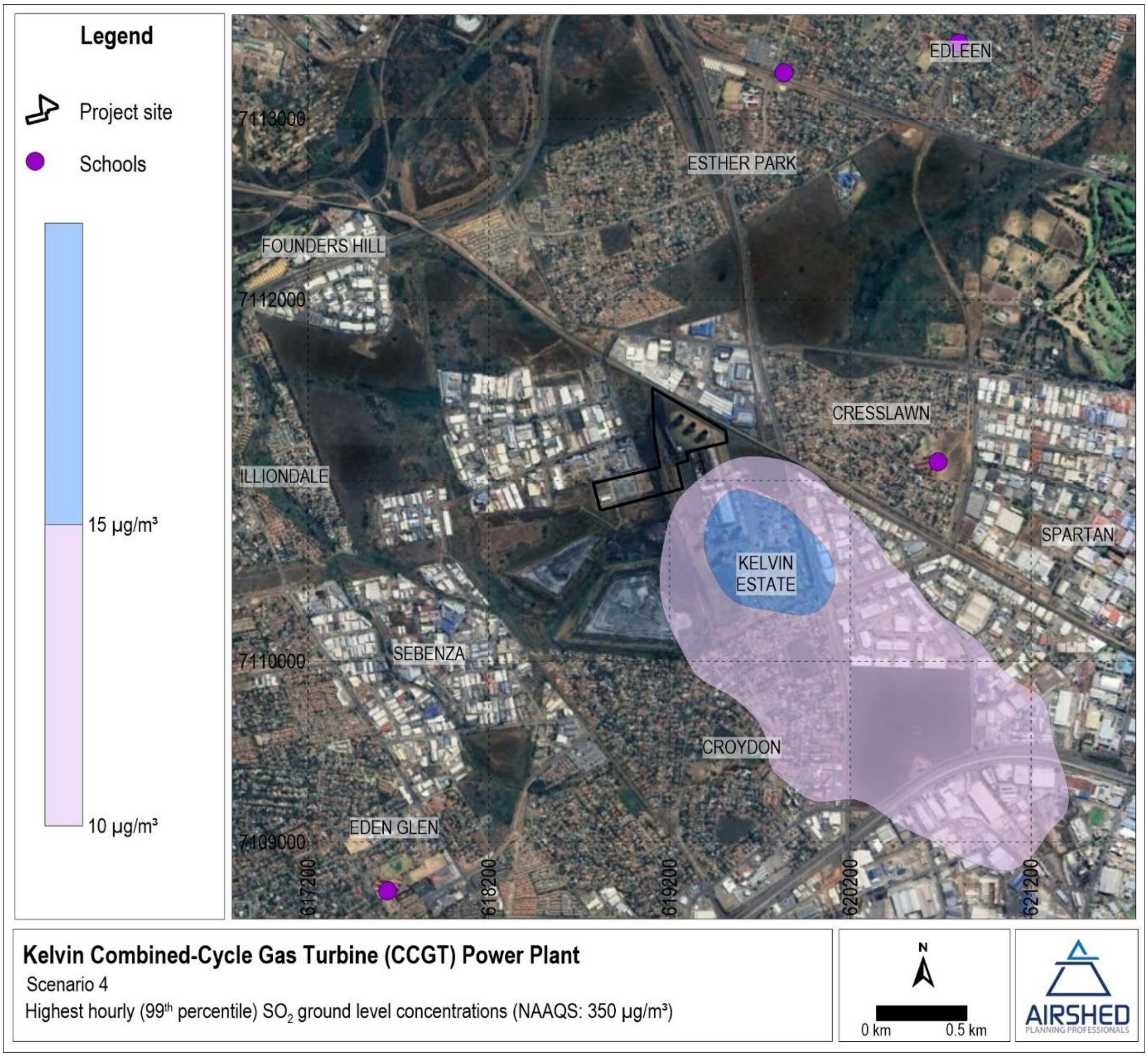

Figure 5-15: Simulated hourly (99th percentile) SO_2 ground level concentrations due to project operations (Scenario 4: Normal operations assuming USEPA emission factors for SO_2 and the running of the diesel generator for 1 hour during the day assuming MES)

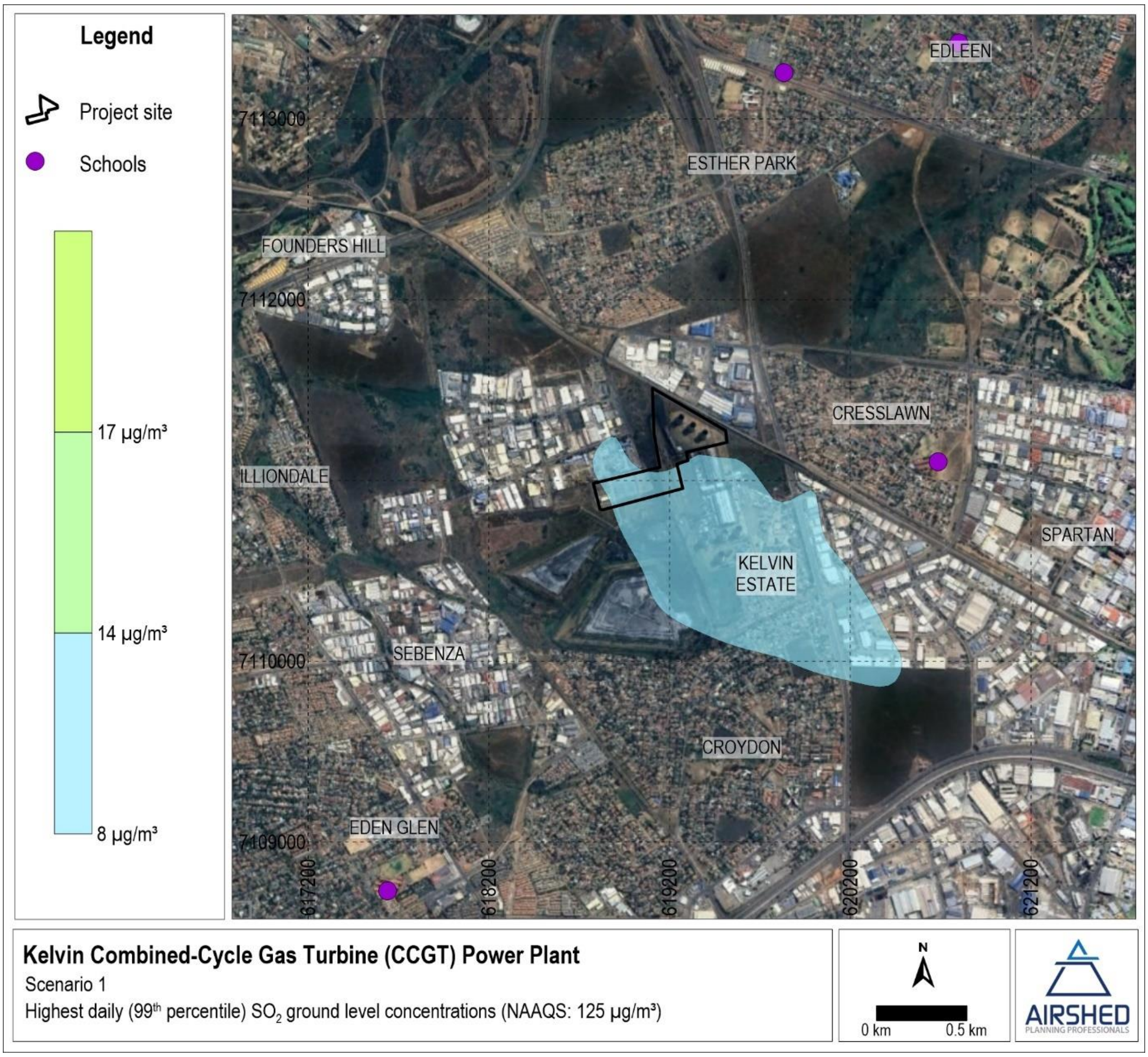

Figure 5-16: Simulated daily (99th percentile) SO_2 ground level concentrations due to project operations (Scenario 1: Normal operations assuming MES)

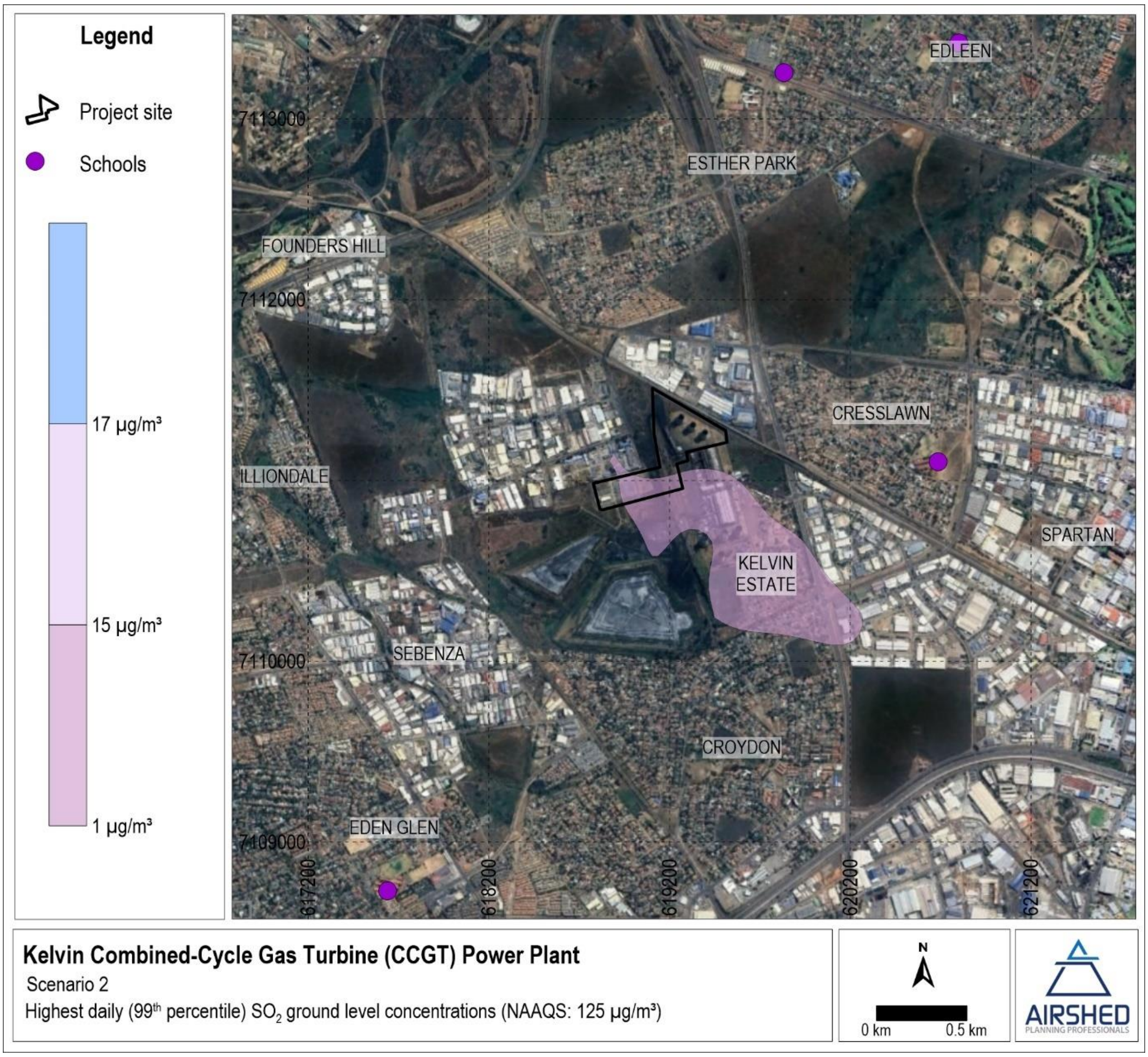

Figure 5-17: Simulated daily (99th percentile) SO_2 ground level concentrations due to project operations (Scenario 2: Normal operations assuming USEPA emission factors for SO_2)

Figure 5-18: Simulated daily (99th percentile) SO_2 ground level concentrations due to project operations (Scenario 3: Normal operations assuming MES and the running of the diesel generator for 1 hour during the day assuming MES)

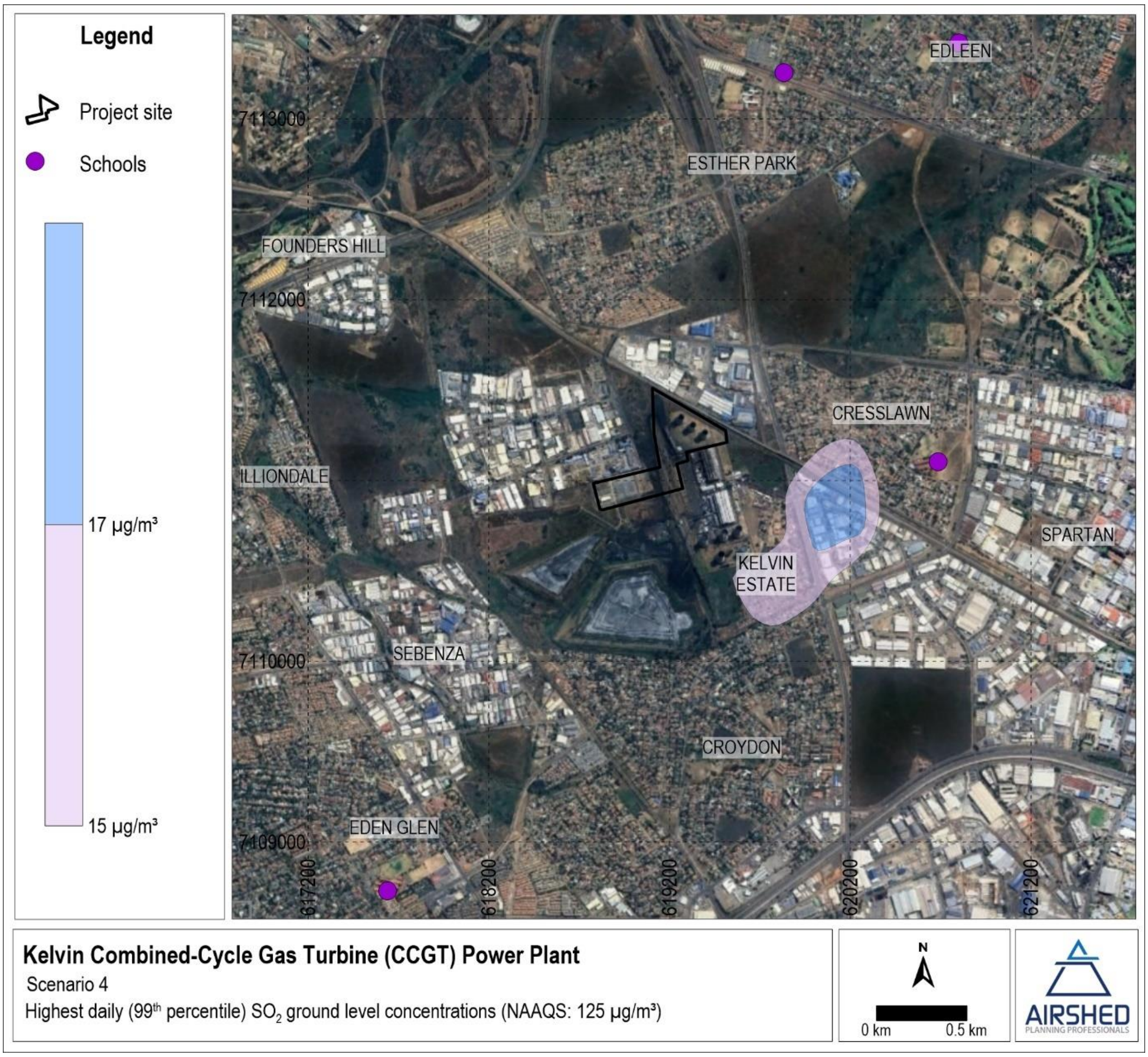

Figure 5-19: Simulated daily (99th percentile) SO_2 ground level concentrations due to project operations (Scenario 4: Normal operations assuming USEPA emission factors for SO_2 and the running of the diesel generator for 1 hour during the day assuming MES)

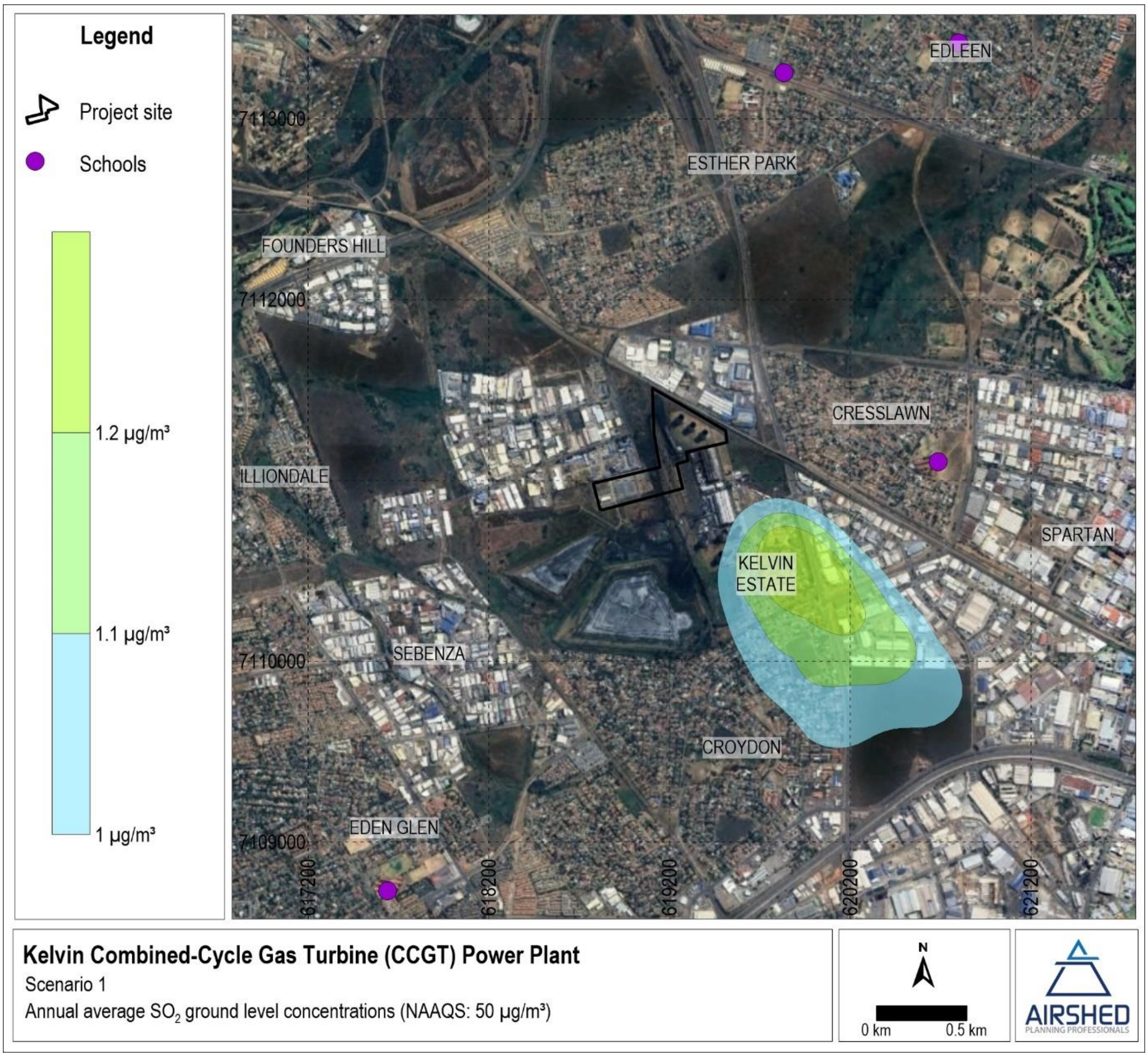

Figure 5-20: Simulated annual average SO_2 ground level concentrations due to project operations (Scenario 1: Normal operations assuming MES)

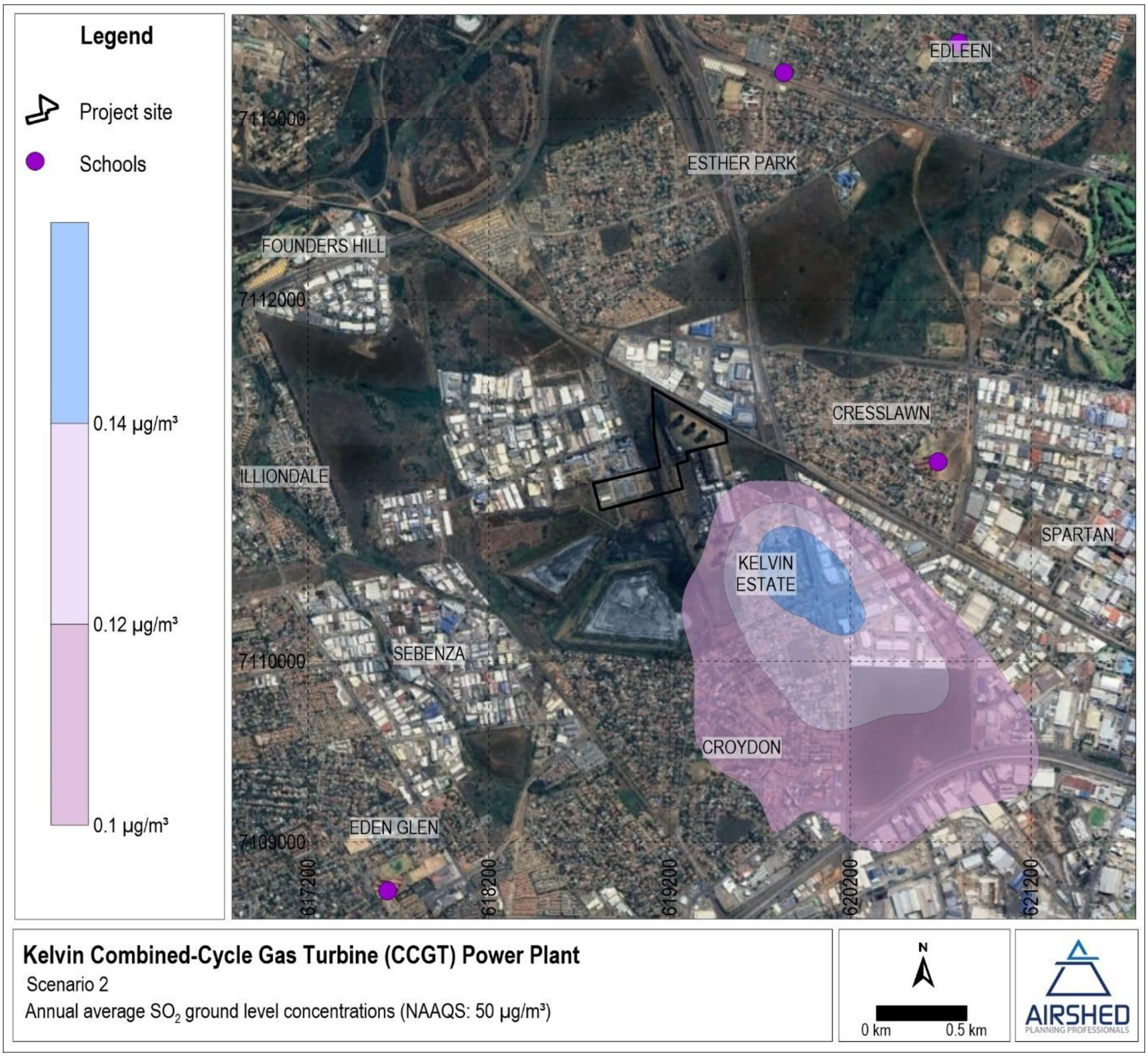

Figure 5-21: Simulated annual average SO_2 ground level concentrations due to project operations (Scenario 2: Normal operations assuming USEPA emission factors for SO_2)

Table 5-16: Simulated SO_2 ground level concentrations at selected sensitive receptors within the study area (i.e. AQMS, hospitals and schools) due to project operations[(a)]

Receptor	Name	Highest Hourly (99th percentile) (NAAQS: 350 µg/m³)				Highest Daily (99th percentile) (NAAQS: 125 µg/m³)				Annual Average (NAAQS: 50 µg/m³)	
		Scenario 1[(b)]	Scenario 2[(c)]	Scenario 3[(d)]	Scenario 4[(e)]	Scenario 1[(b)]	Scenario 2[(c)]	Scenario 3[(d)]	Scenario 4[(e)]	Scenario 1[(b)]	Scenario 2[(c)]
AQMS	Alexandra AQMS	2.40	0.28	4.39	1.41	1.65	0.19	3.52	3.07	0.10	0.01
	Buccleugh AQMS	0.86	0.10	2.86	1.56	1.38	0.16	3.19	3.16	0.06	0.01
	Bedfordview AQMS	2.60	0.30	6.25	2.32	1.33	0.16	4.01	4.01	0.10	0.01
Hospitals	Advanced East Rand Day Hospital	7.16	0.84	15.65	12.95	1.84	0.21	6.14	5.47	0.24	0.03
	Arwyp Medical Centre	4.29	0.50	11.25	6.28	2.00	0.23	6.31	5.32	0.15	0.02
	Birchleigh Clinic	2.35	0.27	5.71	2.45	1.32	0.15	4.59	3.89	0.09	0.01
	Birchmed Day Hospital	2.09	0.24	6.17	2.53	1.67	0.19	5.33	4.93	0.10	0.01
	Busamed Modderfontein Private Hospital Orthopaedic & Oncology Centre	1.25	0.15	3.72	1.64	2.42	0.28	3.96	3.89	0.08	0.01
	Edenvale Hospital	1.90	0.22	6.28	1.79	1.69	0.20	4.35	4.35	0.10	0.01
	Ekurhuleni Surgiklin Day Hospital	3.25	0.38	12.07	5.05	1.85	0.22	5.36	4.52	0.14	0.02
	Knights Chest Hospital	7.25	0.85	13.71	7.13	2.15	0.25	6.30	5.51	0.22	0.03
	Life Bedford Gardens Hospital - Emergency Unit	2.03	0.24	4.93	2.00	1.01	0.12	3.66	3.66	0.08	0.01
	Life Bedford Gardens Private Hospital - Medical Ward	2.08	0.24	5.22	2.09	1.07	0.12	3.51	3.51	0.08	0.01
	Life Roseacres Hospital	7.18	0.84	13.88	5.55	2.20	0.26	5.62	4.84	0.24	0.03
	Marymount Hospital	4.37	0.51	11.43	5.96	2.19	0.26	6.86	5.76	0.17	0.02
	Netcare Linksfield Hospital	1.30	0.15	3.92	1.31	1.28	0.15	2.86	2.84	0.06	0.01
Schools	Aston Manor Primary School	2.21	0.26	7.38	3.31	1.64	0.19	4.59	3.65	0.09	0.01
	Bedfordview Academy	2.68	0.31	7.05	2.42	1.34	0.16	3.36	3.36	0.10	0.01
	Bedfordview High School	2.90	0.34	6.85	2.54	1.38	0.16	3.01	2.64	0.10	0.01
	Bedfordview Primary School	3.39	0.40	8.21	2.88	1.65	0.19	3.60	3.60	0.13	0.01
	Benoni Secondary School	14.05	1.64	26.45	14.46	3.29	0.38	8.31	7.30	0.43	0.05
	Bovet Primary School	1.71	0.20	3.61	1.21	1.26	0.15	3.30	2.96	0.07	0.01
	Crawford International - Bedfordview	2.79	0.33	6.81	2.69	1.50	0.17	5.72	5.72	0.12	0.01
	Cresslawn Primary School	11.51	1.34	25.68	7.10	5.49	0.64	8.84	7.17	0.44	0.05
	Curro Edenvale High School	12.40	1.45	21.87	5.76	3.60	0.42	5.97	5.46	0.37	0.04
	Destiny Independent School Kempton Park	2.60	0.30	10.09	4.19	1.56	0.18	4.50	4.29	0.11	0.01
	Dowerglen High School	3.01	0.35	6.97	2.84	2.09	0.24	5.44	5.44	0.12	0.01
	Dunvegan Primary School	3.79	0.44	8.94	3.13	2.08	0.24	5.23	5.23	0.15	0.02

Receptor	Name	Highest Hourly (99th percentile) (NAAQS: 350 µg/m³)				Highest Daily (99th percentile) (NAAQS: 125 µg/m³)				Annual Average (NAAQS: 50 µg/m³)	
		Scenario 1[(b)]	Scenario 2[(c)]	Scenario 3[(d)]	Scenario 4[(e)]	Scenario 1[(b)]	Scenario 2[(c)]	Scenario 3[(d)]	Scenario 4[(e)]	Scenario 1[(b)]	Scenario 2[(c)]
	East Bank High School	1.75	0.20	3.42	1.28	1.92	0.22	3.89	3.33	0.08	0.01
	Eastleigh Primary School	3.61	0.42	8.18	3.31	2.29	0.27	4.91	4.63	0.15	0.02
	Edenglen High School	11.24	1.31	19.81	5.47	3.96	0.46	6.92	5.34	0.37	0.04
	Edenvale High School	3.59	0.42	7.27	2.70	2.57	0.30	6.96	6.64	0.13	0.02
	Edleen Primary	3.83	0.45	11.46	4.65	4.39	0.51	7.25	5.52	0.25	0.03
	Eduvu - Remedial School / Academy	6.99	0.82	17.11	11.35	1.97	0.23	5.79	5.39	0.23	0.03
	Ekukhanyisweni Primary School	1.92	0.22	3.45	1.20	1.43	0.17	2.77	2.23	0.08	0.01
	Elandspark School	3.03	0.35	6.90	2.65	1.38	0.16	2.99	2.89	0.11	0.01
	Gideon Rambuwani Primary School	1.56	0.18	4.81	2.55	1.91	0.22	4.09	3.40	0.08	0.01
	Hoërskool Birchleigh	1.70	0.20	5.25	2.11	1.06	0.12	3.98	3.71	0.07	0.01
	Hoërskool Jeugland	2.39	0.28	6.91	2.99	2.07	0.24	5.09	4.34	0.13	0.01
	Hoërskool Primrose	4.58	0.53	8.33	2.99	1.43	0.17	4.62	4.51	0.13	0.02
	Holy Rosary School for Girls	4.13	0.48	10.47	3.43	2.39	0.28	5.11	5.11	0.17	0.02
	Ikage Primary School	1.99	0.23	3.70	1.30	1.49	0.17	4.79	4.06	0.08	0.01
	Inkanyezi Waldorf Centre	1.59	0.19	3.61	1.17	1.21	0.14	3.33	3.00	0.07	0.01
	Jacaranda Academy	3.67	0.43	8.97	3.79	3.06	0.36	5.97	4.90	0.20	0.02
	Kempton Park Primary School	2.61	0.30	10.66	3.75	1.64	0.19	4.74	4.46	0.12	0.01
	Kwabhekilanga Secondary School	1.82	0.21	3.64	1.27	2.13	0.25	3.74	3.22	0.08	0.01
	Laerskool Birchleigh	1.97	0.23	5.13	2.29	1.21	0.14	4.10	3.65	0.08	0.01
	Laerskool Edleen	3.89	0.45	9.65	4.10	2.86	0.33	5.54	4.69	0.21	0.02
	Laerskool Kempton Park FSS	5.35	0.62	15.16	9.77	2.42	0.28	8.48	7.81	0.18	0.02
	Laerskool Kreft	3.06	0.36	11.09	4.54	1.76	0.21	4.85	4.51	0.13	0.02
	Laerskool Kruinsig	1.90	0.22	5.74	2.36	1.15	0.13	3.27	3.21	0.08	0.01
	Laerskool Van Riebeeckpark	2.92	0.34	8.48	3.44	2.78	0.32	5.24	3.74	0.15	0.02
	Laerskool Westwood	6.30	0.74	15.05	11.04	1.54	0.18	4.76	4.29	0.19	0.02
	M.C. Weiler Primary School	1.68	0.20	3.65	1.22	1.59	0.19	4.28	3.63	0.08	0.01
	Maphutha Secondary School	1.27	0.15	4.41	2.33	1.41	0.16	3.63	3.15	0.07	0.01
	Maranatha Christian School	1.79	0.21	5.48	2.21	1.10	0.13	3.12	3.07	0.08	0.01
	Martin Primary School.	7.61	0.89	14.36	11.53	1.63	0.19	4.61	4.31	0.23	0.03
	Mayibuye Primary School - New	1.34	0.16	4.85	2.46	1.19	0.14	4.14	3.96	0.07	0.01
	Midrend Primary School	1.43	0.17	5.14	2.03	1.38	0.16	2.63	2.63	0.08	0.01
	Moduopo Primary School	15.77	1.84	31.03	18.36	3.79	0.44	9.06	8.34	0.49	0.06
	Nobel Primary School	3.00	0.35	5.96	1.99	2.43	0.28	5.23	4.68	0.15	0.02

Receptor	Name	Highest Hourly (99th percentile) (NAAQS: 350 µg/m³)				Highest Daily (99th percentile) (NAAQS: 125 µg/m³)				Annual Average (NAAQS: 50 µg/m³)	
		Scenario 1[(b)]	Scenario 2[(c)]	Scenario 3[(d)]	Scenario 4[(e)]	Scenario 1[(b)]	Scenario 2[(c)]	Scenario 3[(d)]	Scenario 4[(e)]	Scenario 1[(b)]	Scenario 2[(c)]
	Norkem Park Primary School	1.73	0.20	6.05	2.33	1.41	0.16	4.58	4.50	0.09	0.01
	Pholosho Primary School	1.63	0.19	3.70	1.21	1.44	0.17	3.17	2.80	0.08	0.01
	Phomolong Secondary School	2.08	0.24	6.24	2.63	1.45	0.17	5.37	5.36	0.09	0.01
	Pinnacle College Founders Hill	1.85	0.22	4.63	2.39	2.84	0.33	6.73	6.63	0.14	0.02
	Primrose Hill Primary School	4.58	0.53	8.82	2.97	1.50	0.17	4.17	4.17	0.14	0.02
	Primrose Primary School	5.62	0.66	11.59	4.44	2.10	0.24	6.02	5.28	0.19	0.02
	Primrose Technical High School	4.39	0.51	8.41	3.14	1.43	0.17	4.65	4.61	0.14	0.02
	Reddam House Bedfordview	1.94	0.23	4.53	1.92	1.11	0.13	4.09	4.09	0.07	0.01
	Rhodesfield High School	10.42	1.22	22.51	12.87	3.26	0.38	9.34	8.40	0.34	0.04
	Sir Pierre van Reyneveld High School	3.36	0.39	11.30	4.26	2.01	0.23	4.50	4.28	0.16	0.02
	Skeen Primary School	1.91	0.22	3.84	1.41	2.07	0.24	4.17	3.49	0.09	0.01
	St Benedict's College	2.64	0.31	6.29	2.33	1.33	0.16	4.60	4.60	0.11	0.01
	St Benedict's Junior Preparatory School	2.88	0.34	7.35	2.42	1.54	0.18	4.19	4.19	0.11	0.01
	Success College Primary	3.86	0.45	8.95	3.35	2.78	0.32	6.52	6.10	0.16	0.02
	Summerfields Primary School	6.30	0.74	13.63	10.30	1.68	0.20	4.86	4.67	0.18	0.02
	Sunnyridge Primary School.	8.23	0.96	15.70	5.59	2.60	0.30	6.21	5.33	0.26	0.03
	Taal-Net Midrand School	1.24	0.14	4.27	2.33	1.60	0.19	3.42	2.43	0.08	0.01
	Taalnet Primary & High School Kempton Park	3.85	0.45	10.23	5.31	1.49	0.17	5.37	4.58	0.13	0.01
	Tembisa West Secondary School	1.10	0.13	4.16	2.26	0.97	0.11	3.28	3.13	0.06	0.01
	Thuthuka Primary School	1.21	0.14	3.82	1.95	1.45	0.17	3.06	3.04	0.06	0.01
	Westside Primary School	3.27	0.38	9.71	3.80	3.28	0.38	6.67	5.74	0.17	0.02
	Wit Deep Primary School	8.87	1.04	17.27	11.43	2.11	0.25	6.48	6.18	0.26	0.03
	Woodlands International College	8.03	0.94	19.32	14.42	1.87	0.22	5.86	5.16	0.25	0.03
	Wychwood Primary School	3.03	0.35	7.00	2.82	1.46	0.17	3.13	3.13	0.10	0.01

Notes:

(a) Exceedances of NAAQS provided in bold.

(b) Scenario 1: Normal operations assuming MES

(c) Scenario 2: Normal operations assuming USEPA emission factors for SO_2

(d) Scenario 3: Normal operations assuming MES and the running of the diesel generator for 1 hour during the day assuming MES

(e) Scenario 4: Normal operations assuming USEPA emission factors for SO_2 and the running of the diesel generator for 1 hour during the day assuming MES

5.1.6.2.4 Simulated NO_2 Concentrations

NOx was simulated with 100% of the highest hourly concentrations assumed to be hourly NO_2 concentrations and 80% of the annual NOx concentrations assumed to be annual average NO_2 concentrations as per Tier 2 ARM method described in the Regulations Regarding Air Dispersion Modelling.

No exceedances of the hourly (200 µg/m³) and annual (40 µg/m³) NO_2 NAAQS were simulated across the modelling domain due to the project operations. The simulated hourly concentrations (99th percentile) was less than 53 µg/m³ (Scenario 3, worst case scaenario)(less than 27% of the hourly NO_2 NAAQS). Annual concentrations were simulated to be less than 0.13 µg/m³ across the domain (less than 1% of the annual NO_2 NAAQS).

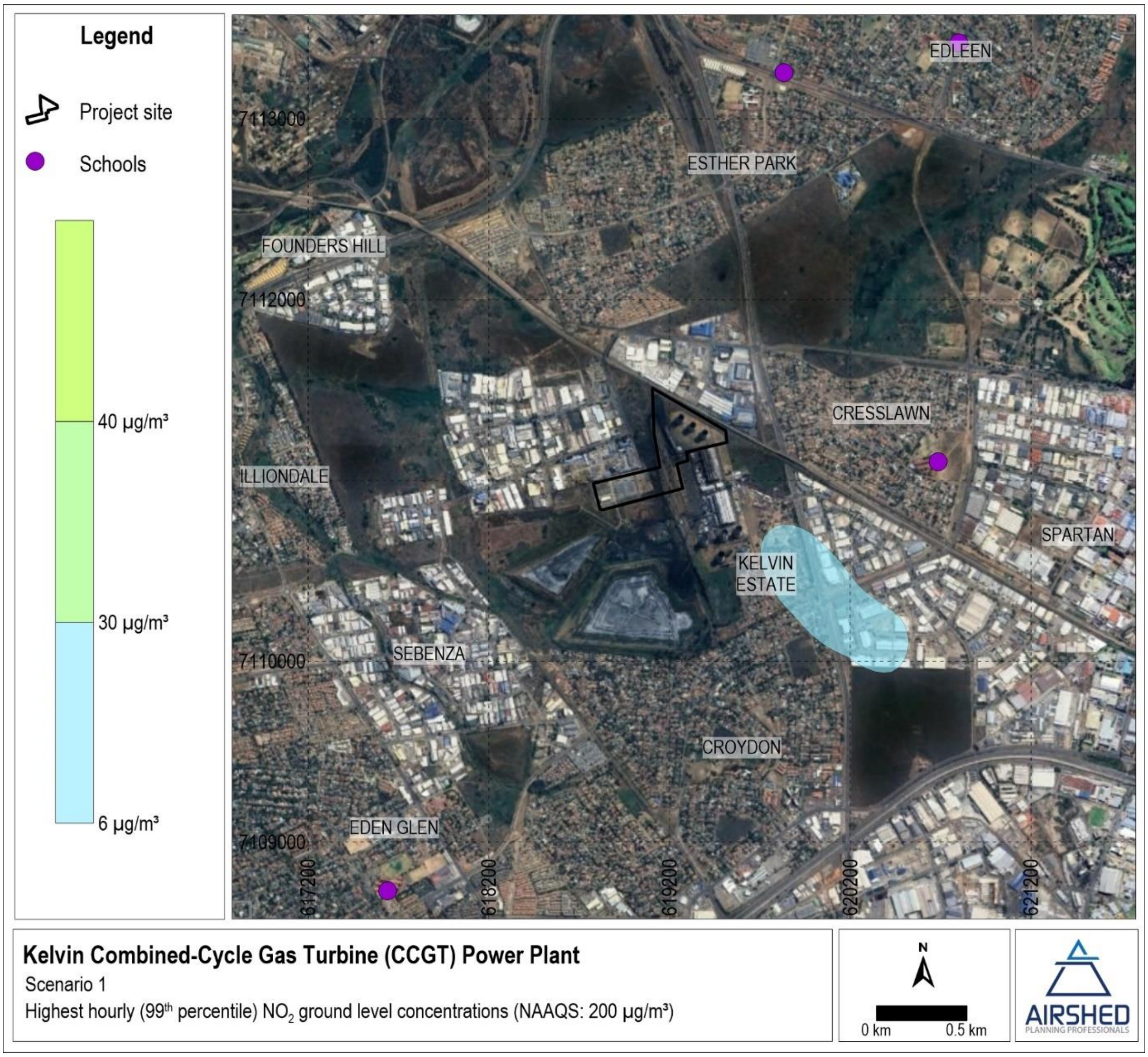

Figure 5-22: Simulated hourly (99th percentile) NO_2 ground level concentrations due to project operations (Scenario 1: Normal operations assuming MES)

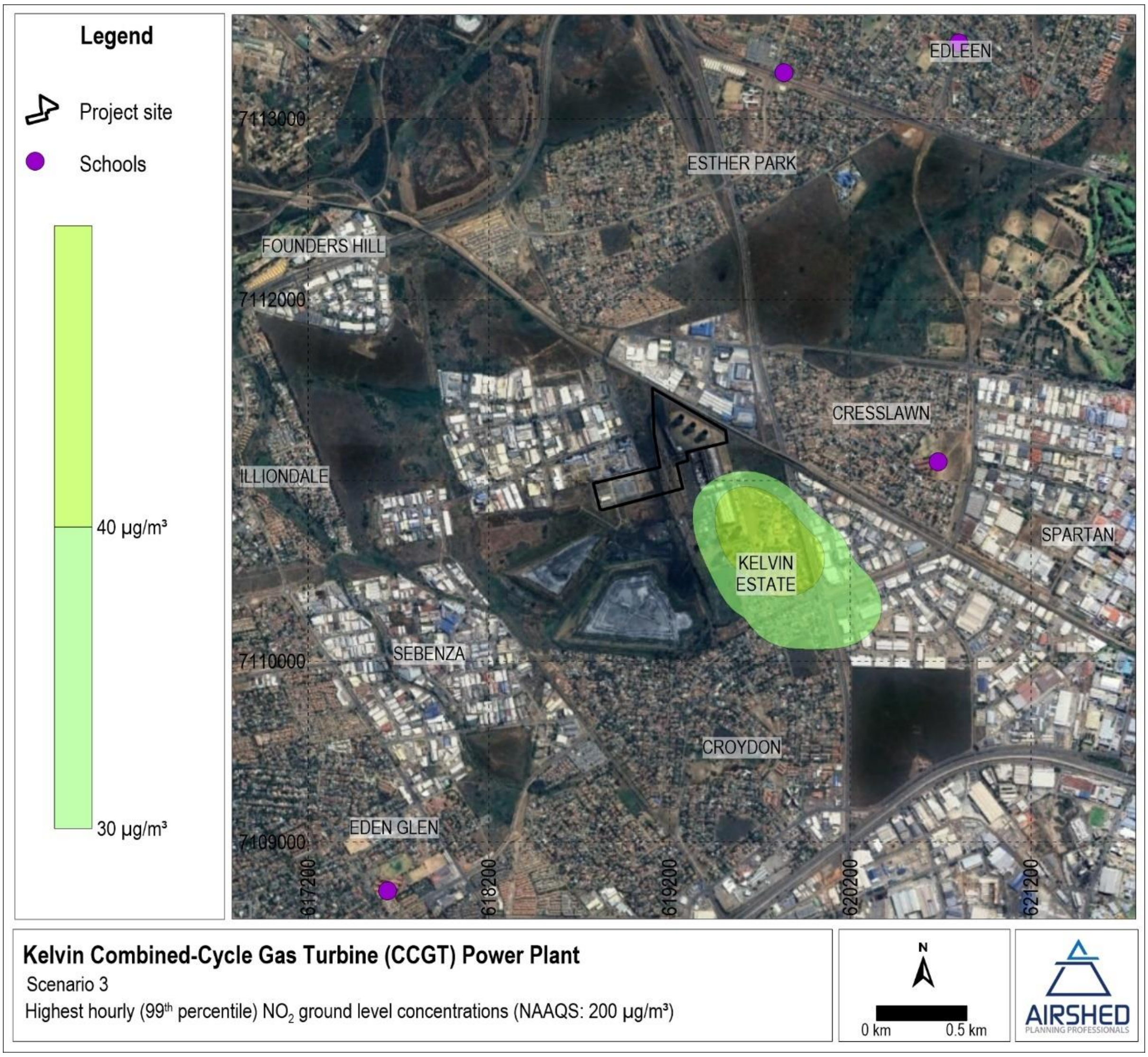

Figure 5-23: Simulated hourly (99th percentile) NO_2 ground level concentrations due to project operations (Scenario 3: Normal operations assuming MES and the running of the diesel generator for 1 hour during the day assuming MES)

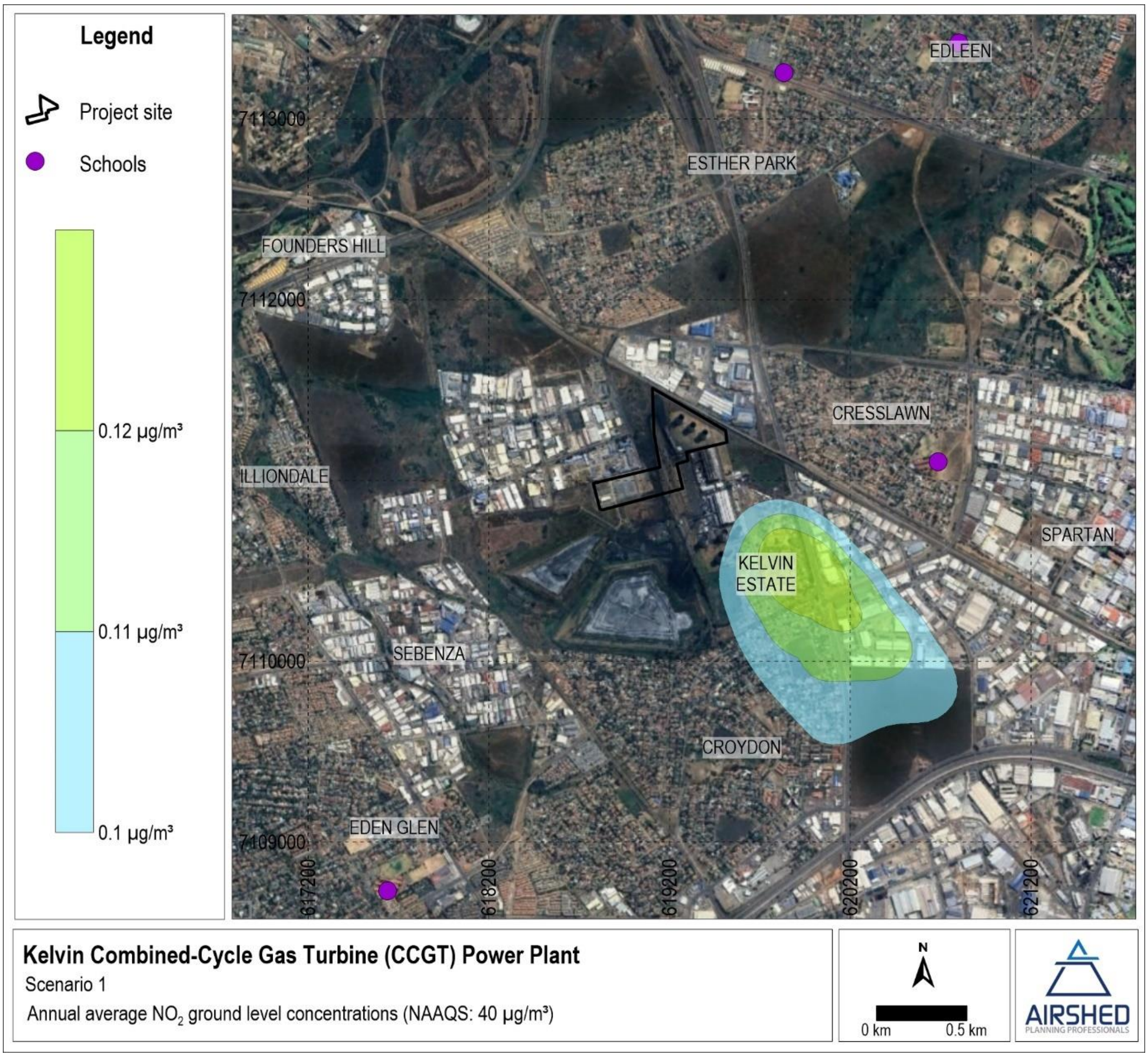

Figure 5-24: Simulated annual average NO_2 ground level concentrations due to project operations (Scenario 1: Normal operations assuming MES)

Table 5-17: Simulated NO_2 ground level concentrations at selected sensitive receptors within the study area (i.e. AQMS, hospitals and schools) due to project operations[(a)]

Receptor	Name	Highest Hourly (99th percentile) (NAAQS: 200 µg/m³)		Annual Average (NAAQS: 40 µg/m³)
		Scenario 1[(b)]	Scenario 3[(c)]	Scenario 1[(b)]
AQMS	Alexandra AQMS	0.27	1.68	0.01
	Buccleugh AQMS	0.09	1.80	0.01
	Bedfordview AQMS	0.30	2.90	0.01
Hospitals	Advanced East Rand Day Hospital	0.85	21.62	0.03
	Arwyp Medical Centre	0.50	10.21	0.02
	Birchleigh Clinic	0.26	3.44	0.01
	Birchmed Day Hospital	0.24	3.43	0.01
	Busamed Modderfontein Private Hospital Orthopaedic & Oncology Centre	0.14	2.24	0.01
	Edenvale Hospital	0.22	2.59	0.01
	Ekurhuleni Surgiklin Day Hospital	0.40	7.45	0.02
	Knights Chest Hospital	0.88	10.75	0.03
	Life Bedford Gardens Hospital - Emergency Unit	0.23	2.76	0.01
	Life Bedford Gardens Private Hospital - Medical Ward	0.24	2.82	0.01
	Life Roseacres Hospital	0.88	7.85	0.03
	Marymount Hospital	0.53	10.17	0.02
	Netcare Linksfield Hospital	0.14	1.94	0.01
Schools	Aston Manor Primary School	0.23	4.80	0.01
	Bedfordview Academy	0.32	3.15	0.01
	Bedfordview High School	0.34	3.67	0.01
	Bedfordview Primary School	0.39	3.88	0.02
	Benoni Secondary School	1.70	24.24	0.05
	Bovet Primary School	0.19	1.55	0.01
	Crawford International - Bedfordview	0.34	3.89	0.01
	Cresslawn Primary School	1.43	9.12	0.05
	Curro Edenvale High School	1.54	8.31	0.05
	Destiny Independent School Kempton Park	0.30	6.44	0.01
	Doweglen High School	0.36	3.69	0.01
	Dunvegan Primary School	0.46	4.65	0.02
	East Bank High School	0.20	1.63	0.01
	Eastleigh Primary School	0.44	4.34	0.02
	Edenglen High School	1.37	6.95	0.05
	Edenvale High School	0.44	3.90	0.02
	Edleen Primary	0.46	5.96	0.03
	Eduvu - Remedial School / Academy	0.84	18.42	0.03
	Ekukhanyisweni Primary School	0.21	1.60	0.01
	Elandspark School	0.35	3.59	0.01
	Gideon Rambuwani Primary School	0.18	3.30	0.01
	Hoërskool Birchleigh	0.18	2.76	0.01
	Hoërskool Jeugland	0.28	4.00	0.02
	Hoërskool Primrose	0.55	4.40	0.02
	Holy Rosary School for Girls	0.51	5.04	0.02
	Ikage Primary School	0.22	1.66	0.01
	Inkanyezi Waldorf Centre	0.19	1.53	0.01
	Jacaranda Academy	0.45	4.57	0.02
	Kempton Park Primary School	0.31	5.68	0.01
	Kwabhekilanga Secondary School	0.20	1.69	0.01
	Laerskool Birchleigh	0.21	3.03	0.01
	Laerskool Edleen	0.47	5.41	0.03
	Laerskool Kempton Park FSS	0.66	16.22	0.02
	Laerskool Kreft	0.37	7.24	0.02
	Laerskool Kruinsig	0.22	3.15	0.01

Receptor	Name	Highest Hourly (99th percentile) (NAAQS: 200 µg/m³)		Annual Average (NAAQS: 40 µg/m³)
		Scenario 1[b]	Scenario 3[c]	Scenario 1[b]
	Laerskool Van Riebeeckpark	0.35	4.68	0.02
	Laerskool Westwood	0.74	18.67	0.02
	M.C. Weiler Primary School	0.20	1.64	0.01
	Maphutha Secondary School	0.14	3.16	0.01
	Maranatha Christian School	0.22	3.01	0.01
	Martin Primary School.	0.92	19.34	0.03
	Mayibuye Primary School - New	0.14	3.22	0.01
	Midrend Primary School	0.16	2.54	0.01
	Moduopo Primary School	1.95	27.71	0.06
	Nobel Primary School	0.35	2.66	0.02
	Norkem Park Primary School	0.19	3.14	0.01
	Pholosho Primary School	0.20	1.64	0.01
	Phomolong Secondary School	0.25	3.41	0.01
	Pinnacle College Founders Hill	0.21	2.98	0.02
	Primrose Hill Primary School	0.55	4.29	0.02
	Primrose Primary School	0.67	6.49	0.02
	Primrose Technical High School	0.54	4.37	0.02
	Reddam House Bedfordview	0.23	2.43	0.01
	Rhodesfield High School	1.27	21.83	0.04
	Sir Pierre van Reyneveld High School	0.40	6.59	0.02
	Skeen Primary School	0.23	1.88	0.01
	St Benedict's College	0.31	3.29	0.01
	St Benedict's Junior Preparatory School	0.35	3.09	0.01
	Success College Primary	0.48	4.40	0.02
	Summerfields Primary School	0.73	16.54	0.02
	Sunnyridge Primary School.	1.01	8.51	0.03
	Taal-Net Midrand School	0.14	2.75	0.01
	Taalnet Primary & High School Kempton Park	0.44	7.75	0.01
	Tembisa West Secondary School	0.12	2.92	0.01
	Thuthuka Primary School	0.14	2.42	0.01
	Westside Primary School	0.39	5.12	0.02
	Wit Deep Primary School	1.08	19.07	0.03
	Woodlands International College	0.96	23.54	0.03
	Wychwood Primary School	0.34	3.82	0.01

Notes:

(a) Exceedances of NAAQS provided in bold.

(b) Scenario 1: Normal operations assuming MES

(c) Scenario 3: Normal operations assuming MES and the running of the diesel generator for 1 hour during the day assuming MES

5.1.6.2.5 Simulated PM Concentrations

For particulate matter, NAAQS are available for PM_{10} and $PM_{2.5}$. Ambient air quality impacts for both particulate fractions (i.e. PM_{10} and $PM_{2.5}$) thus need to be considered. Simulated concentrations of particulate matter (PM), including secondary particulates (as per the explanation in Section 5.1.1.4), are conservatively assumed to be entirely either PM_{10} or $PM_{2.5}$.

Simulated PM concentrations for the project operations comply with PM_{10} (75 µg/m³ for daily and 40 µg/m³ for annual averages) and $PM_{2.5}$ (25 µg/m³ for daily and 15 µg/m³ for annual averages enforceable from 1 January 2030) NAAQS across the modelling domain with daily (domain maximum: 1.0 µg/m³ for worst case Scenario 3), and annual (domain maximum: 0.036 µg/m³ for Scenario 1) averaging periods.

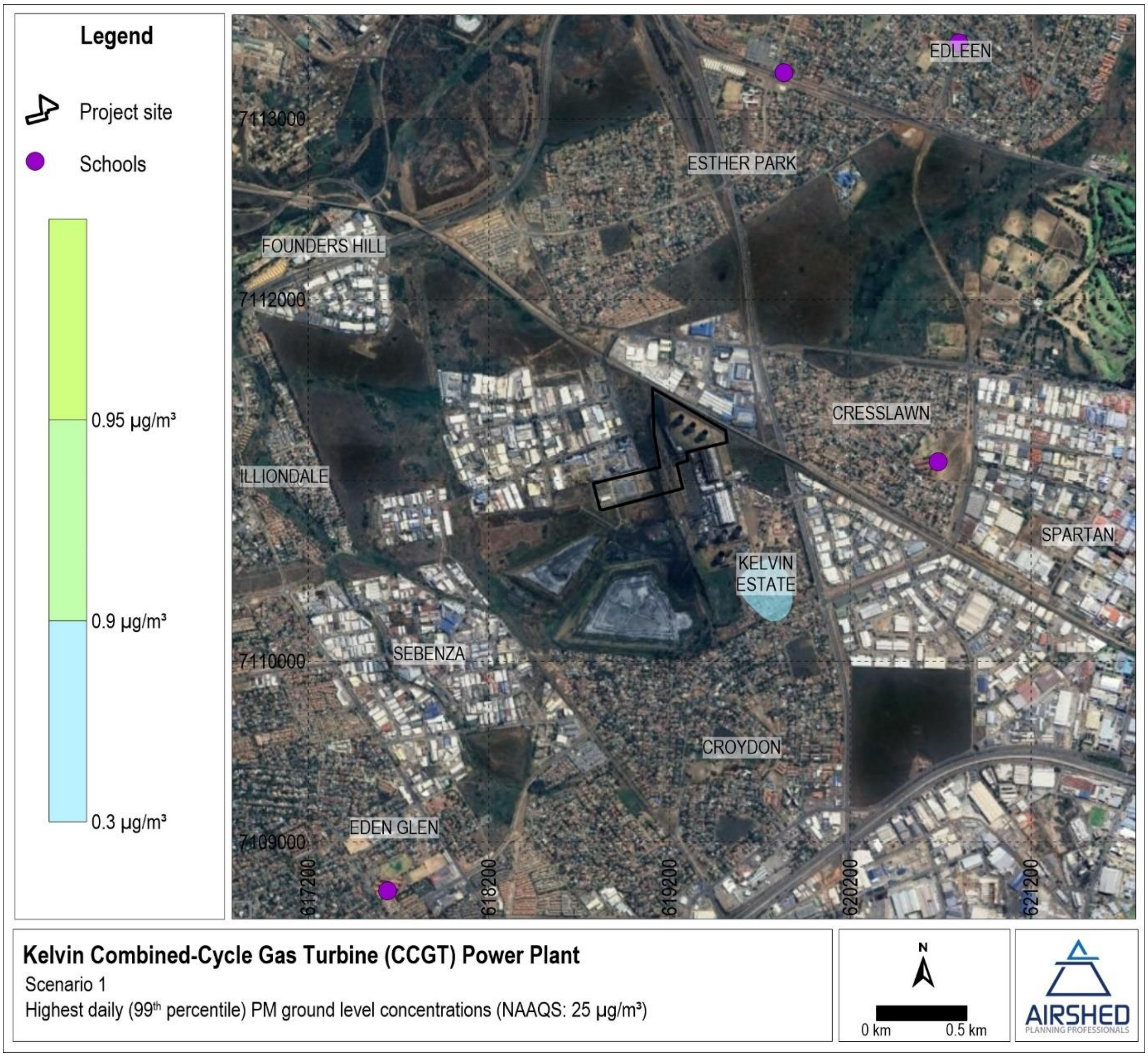

Figure 5-25: Simulated daily (99th percentile) PM ground level concentrations due to project operations (Scenario 1: Normal operations assuming MES)

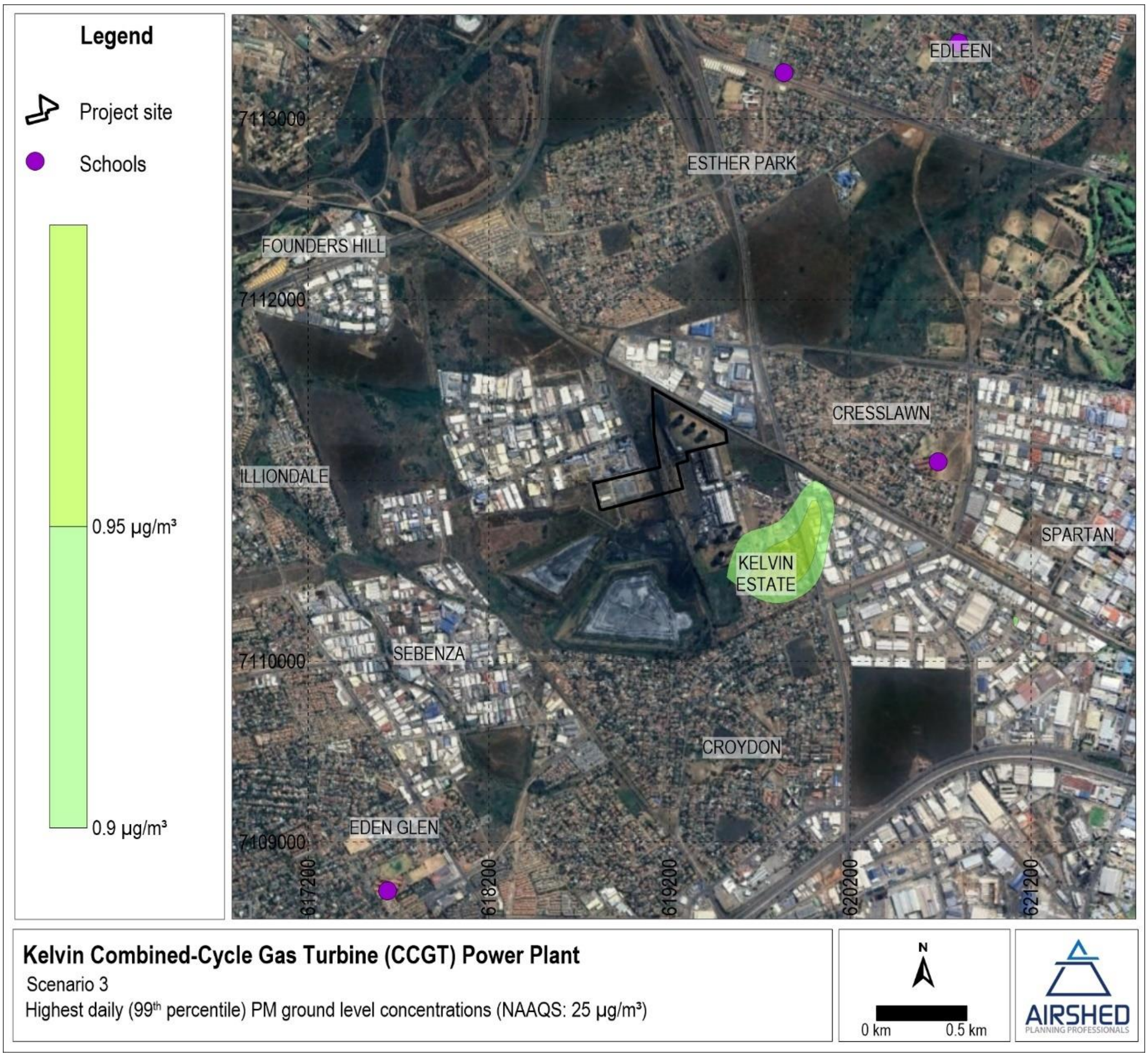

Figure 5-26: Simulated daily (99th percentile) PM ground level concentrations due to project operations (Scenario 3: Normal operations assuming MES and the running of the diesel generator for 1 hour during the day assuming MES)

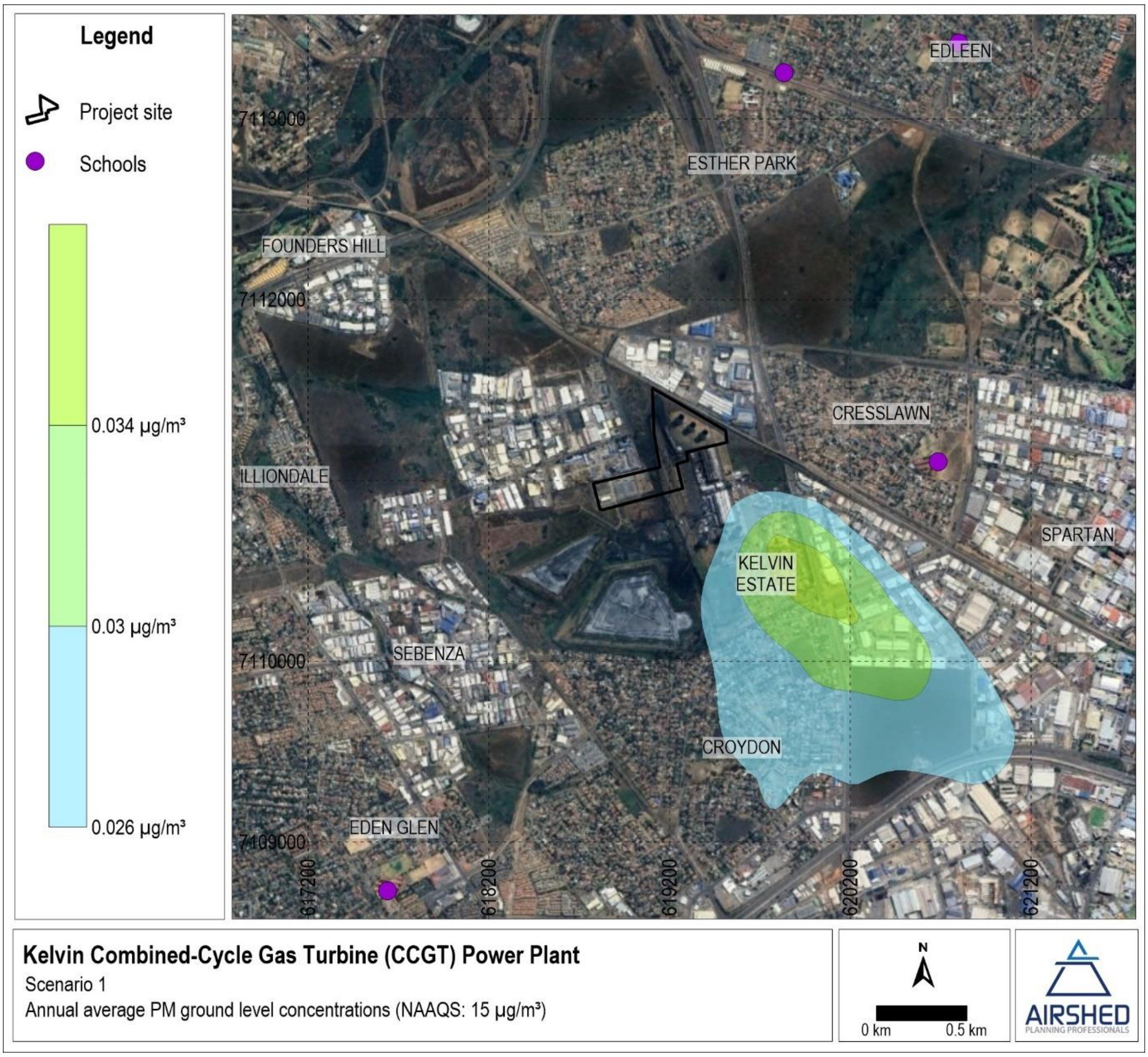

Figure 5-27: Simulated annual average PM ground level concentrations due to project operations (Scenario 1: Normal operations assuming MES)

Table 5-18: Simulated PM ground level concentrations at selected sensitive receptors within the study area (i.e. AQMS, hospitals and schools) due to project operations[(a)]

Receptor	Name	Highest Daily (99th percentile) (NAAQS: 75 µg/m³ for PM_{10} and 25 µg/m³ for $PM_{2.5}$)		Annual Average (NAAQS: 40 µg/m³ for PM_{10} and 15 µg/m³ for $PM_{2.5}$))
		Scenario 1[(b)]	Scenario 3[(c)]	Scenario 1[(b)]
AQMS	Alexandra AQMS	0.07	0.23	0.00
	Buccleugh AQMS	0.07	0.28	0.00
	Bedfordview AQMS	0.06	0.36	0.00
Hospitals	Advanced East Rand Day Hospital	0.07	0.40	0.01
	Arwyp Medical Centre	0.07	0.41	0.01
	Birchleigh Clinic	0.05	0.32	0.00
	Birchmed Day Hospital	0.05	0.31	0.00
	Busamed Modderfontein Private Hospital Orthopaedic & Oncology Centre	0.11	0.39	0.00
	Edenvale Hospital	0.08	0.32	0.00
	Ekurhuleni Surgiklin Day Hospital	0.07	0.36	0.01
	Knights Chest Hospital	0.11	0.55	0.01
	Life Bedford Gardens Hospital - Emergency Unit	0.04	0.33	0.00
	Life Bedford Gardens Private Hospital - Medical Ward	0.05	0.33	0.00
	Life Roseacres Hospital	0.10	0.48	0.01
	Marymount Hospital	0.08	0.42	0.01
	Netcare Linksfield Hospital	0.06	0.29	0.00
Schools	Aston Manor Primary School	0.06	0.32	0.00
	Bedfordview Academy	0.09	0.36	0.00
	Bedfordview High School	0.09	0.35	0.00
	Bedfordview Primary School	0.10	0.38	0.01
	Benoni Secondary School	0.13	0.54	0.01
	Bovet Primary School	0.06	0.20	0.00
	Crawford International - Bedfordview	0.08	0.40	0.00
	Cresslawn Primary School	0.14	0.46	0.01
	Curro Edenvale High School	0.11	0.49	0.01
	Destiny Independent School Kempton Park	0.07	0.35	0.00
	Dowerglen High School	0.07	0.44	0.00
	Dunvegan Primary School	0.09	0.49	0.01
	East Bank High School	0.06	0.28	0.00
	Eastleigh Primary School	0.08	0.42	0.01
	Edenglen High School	0.13	0.49	0.01
	Edenvale High School	0.08	0.53	0.01
	Edleen Primary	0.12	0.43	0.01
	Eduvu - Remedial School / Academy	0.08	0.42	0.01
	Ekukhanyisweni Primary School	0.06	0.19	0.00
	Elandspark School	0.09	0.36	0.00
	Gideon Rambuwani Primary School	0.10	0.37	0.00
	Hoërskool Birchleigh	0.05	0.30	0.00
	Hoërskool Jeugland	0.06	0.33	0.00
	Hoërskool Primrose	0.07	0.35	0.01
	Holy Rosary School for Girls	0.10	0.52	0.01
	Ikage Primary School	0.06	0.26	0.00
	Inkanyezi Waldorf Centre	0.06	0.20	0.00
	Jacaranda Academy	0.11	0.46	0.01
	Kempton Park Primary School	0.07	0.36	0.00
	Kwabhekilanga Secondary School	0.07	0.27	0.00
	Laerskool Birchleigh	0.05	0.32	0.00
	Laerskool Edleen	0.08	0.36	0.01
	Laerskool Kempton Park FSS	0.08	0.52	0.01

Receptor	Name	Highest Daily (99th percentile) (NAAQS: 75 µg/m³ for PM_{10} and 25 µg/m³ for $PM_{2.5}$)		Annual Average (NAAQS: 40 µg/m³ for PM_{10} and 15 µg/m³ for $PM_{2.5}$))
		Scenario 1[(b)]	Scenario 3[(c)]	Scenario 1[(b)]
	Laerskool Kreft	0.06	0.37	0.00
	Laerskool Kruinsig	0.05	0.28	0.00
	Laerskool Van Riebeeckpark	0.07	0.32	0.01
	Laerskool Westwood	0.09	0.34	0.01
	M.C. Weiler Primary School	0.06	0.31	0.00
	Maphutha Secondary School	0.09	0.31	0.00
	Maranatha Christian School	0.05	0.27	0.00
	Martin Primary School.	0.08	0.33	0.01
	Mayibuye Primary School - New	0.06	0.38	0.00
	Midrend Primary School	0.06	0.30	0.00
	Moduopo Primary School	0.13	0.55	0.02
	Nobel Primary School	0.08	0.55	0.01
	Norkem Park Primary School	0.05	0.30	0.00
	Pholosho Primary School	0.05	0.21	0.00
	Phomolong Secondary School	0.06	0.39	0.00
	Pinnacle College Founders Hill	0.10	0.60	0.01
	Primrose Hill Primary School	0.07	0.36	0.01
	Primrose Primary School	0.09	0.44	0.01
	Primrose Technical High School	0.07	0.35	0.01
	Reddam House Bedfordview	0.04	0.38	0.00
	Rhodesfield High School	0.10	0.57	0.01
	Sir Pierre van Reyneveld High School	0.07	0.37	0.01
	Skeen Primary School	0.07	0.30	0.00
	St Benedict's College	0.07	0.37	0.00
	St Benedict's Junior Preparatory School	0.08	0.37	0.00
	Success College Primary	0.09	0.45	0.01
	Summerfields Primary School	0.07	0.32	0.01
	Sunnyridge Primary School.	0.10	0.50	0.01
	Taal-Net Midrand School	0.08	0.30	0.00
	Taalnet Primary & High School Kempton Park	0.06	0.40	0.00
	Tembisa West Secondary School	0.04	0.28	0.00
	Thuthuka Primary School	0.05	0.25	0.00
	Westside Primary School	0.09	0.40	0.01
	Wit Deep Primary School	0.09	0.44	0.01
	Woodlands International College	0.10	0.39	0.01
	Wychwood Primary School	0.09	0.34	0.01

Notes:

(a) Exceedances of NAAQS provided in bold.

(b) Scenario 1: Normal operations assuming MES

(c) Scenario 3: Normal operations assuming MES and the running of the diesel generator for 1 hour during the day assuming MES

5.1.6.2.6 Mitigation Measures Recommended

The project will need an AEL which will stipulate that the facility will need to comply with MES. Compliance with MES will be proven by means of stack emission monitoring. The AEL will stipulate the pollutants that need to be measured and the frequency of the emission monitoring.

5.1.6.3 Decommissioning and Closure Phase

5.1.6.3.1 Identification of Environmental Aspects

It is assumed that all the project operations will have ceased by its closure phase. Aspects and activities associated with the decommissioning phase of the project are listed in Table 5-19.

Table 5-19: Activities and aspects identified for the decommissioning phase

Impact	Source	Activity
Generation of $PM_{2.5}$ and PM_{10}	Open surfaces	Dust generated during rehabilitation activities
Generation of $PM_{2.5}$ and PM_{10}	Structures	Demolition of the structures
Gas emissions	Vehicles	Vehicle entrainment and tailpipe emissions from vehicles utilised during the closure phase

The same mitigation measures for the construction phase can be implemented for the decommissioning phase. For long-term rehabilitation, mitigation measures are provided in Section 5.1.6.3.2. Simulations of the decommissioning and closure phases were not included in the current study due to its temporary impacting nature.

5.1.6.3.2 Mitigation Measures Recommended

Dust control measures for open areas can consist of wet suppression, chemical suppressants, vegetation, wind breaks, etc. Wet suppressants and chemical suppressants are generally applied over the short-term. For long-term control measures vegetation cover frequently represents the most cost-effective and efficient control.

Vegetation cover retards erosion by binding the soil with a root network, by sheltering the soil surface and by trapping material already eroded. Sheltering occurs by reducing the wind velocity close to the surface, thus reducing the erosion potential and volume of material removed. The trapping of the material already removed by wind and in suspension in the air is an important secondary effect. Vegetation is also considered the most effective control measure in terms of its ability to also control water erosion. In investigating the feasibility of vegetation types, the following properties are normally taken into account: indigenous plants; ability to establish and regenerate quickly; proven effective for reclamation elsewhere; tolerant to the climatic conditions of the area; high rate of root production; easily propagated by seed or cuttings; and nitrogen-fixing ability. The long-term effectiveness of suitable vegetation selected for the site will be dependent on the nature of the cover.

The NPI (2011) provided the following control efficiencies for vegetation cover:

- 30% for primary rehabilitation;
- 40% for vegetation established but not demonstrated to be self-sustaining. Weed control and grazing control;
- 60% for secondary rehabilitation;
- 90% for revegetation; and
- 100% for fully rehabilitated vegetation.

5.2 Analysis of Emissions' Impact on the Environment

In the absence of a prescribed methodology (in the Regulations Prescribing the Format of the Atmospheric Impact Report, Government Gazette No. 36904, Notice Number 747 of 2013; 11 October 2013), the impact of emissions from the proposed facility on the environment was assessed using the pollutant critical levels that may affect vegetative productivity, and nuisance dustfall. The same dispersion modelling approach was used as in the assessment of impact of the facility on human health (described in Section 5.1.1).

5.2.1 Critical Levels for Vegetation

The impact of emissions from the proposed facility on surrounding vegetation was assessed by comparing the simulated annual SO_2 and NO_2 concentrations for the operational phase scenario 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 5-20).

Table 5-20: 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 period. It is also noted that long-term effects of NO_X are more significant than short-term effects (CLRTAP, 2015).

The simulated off-site annual concentrations of SO_2 for baseline Kelvin Power Station operations (Station B) will exceed the critical level for lichens (Figure 5-7). The area of exceedance is over built-up residential districts to the southeast of the site.

The simulated off-site annual concentrations of SO_2 for all proposed project emission scenarios are unlikely to exceed the critical levels (Table 5-20) for the most sensitive vegetation type (lichen) across the domain (domain maximum: 1.3 µg/m³ for Scenario 1).

Off-site NO_2 concentrations for baseline Kelvin Power Station operations (Station B) (Figure 5-9) and the proposed project are likely to be below the critical levels for all vegetation types across the domain (data not plotted although Figure 5-9 shows simulated off-site annual average NO_2 concentrations for baseline below 20 µg/m³ and the domain maximum for simulated NO_2 annual concentrations for the project was 0.13 µg/m³).

5.2.2 Dustfall Rates

5.2.2.1 National Dust Control Regulations

The NDCR was gazetted on 1 November 2013 (GG 36974) with updated NDCR gazetted on 8 March 2024 (GG 50272). The purpose of the regulations is to prescribe general measures for the control of dust in residential and non-residential areas. The standard for acceptable dustfall rate is set out in Table 5-21. The method to be used for measuring dustfall rate and the guideline for locating sampling points shall be in accordance with the latest version of the South African National Standard 1137. It is important to note that dustfall is assessed for nuisance impact and not inhalation health impact.

Table 5-21: Acceptable dustfall rates

Restriction Area	Dustfall Rate (mg/m^2.day; 30-day average)	Permitted Frequency of Exceeding Dustfall Rate
Residential area [(a)]	D≤600	Twice within a year, not occurring on sequential months.
Non-residential area [(b)]	D≤1200	Twice within a year, not occurring on sequential months.

Notes:

(a) Applicable to any area that is used for the purposes as prescribed under schedule 2 of the Spatial Planning and Land Use Management Act, 2013 (Act No 16 of 2013) excluding the land that is scheduled for agricultural, industrial and mining purposes.

(b) Applicable to any area that is scheduled for agricultural, industrial and mining purposes as prescribed under schedule 2 of the Spatial Planning and Land Use Management Act, 2013 (Act No 16 of 2013).

5.2.2.2 Simulated Dustfall Rates

Dustfall deposition rates were estimated from PM emissions during the operations phases of the project. The simulated PM concentrations were converted to deposition rates by assuming a settling velocity of 3.62 cm/s (based on a 10 µm particle) (Zhu, Liu, Cong, & Zhang, 2016).

Daily dustfall rates as a result of baseline Kelvin Power Station (Station B) operations and proposed project operations are likely to be lower than 15 mg/m^2/day and 2 mg/m^2/day respectively, where the source will be from off gases. This is well below the acceptable dustfall rates as recommended by the NDCR.

5.2.3 Corrosion

5.2.3.1 Factors Affecting Corrosion

The most important corrosion stimulators are water (humidity) and air pollutants, such as SO_2, NH_3, and acids such as HCl and formic acid (HCOOH), as well as aerosols and particles containing chlorides (Cl^-), nitrates (NO_3^-), and sulfates (SO_4^{2-}). The presence of a moisture film on the surface allows these pollutants to dissolve and dissociate into its respective positive and negative ions, and therefore constitutes the electrolyte for corrosion to take place. The thickness of this aqueous layer depends on the relative humidity and surface properties and is typically a few to a few tens of nanometres (nm) at room temperature (Phipps & Rice, 1979).

Dry deposition near emission sources in urban and industrial areas consists largely of the adsorption of criteria pollutants such as SO_2 and oxides of nitrogen (NO_X) on surfaces, with the deposited amount proportional to the content in air. The deposition rate is high at elevated humidity, especially on some metals, e.g., steel and zinc (Sydberger & Vannerberg, 1972). Corrosion due to SO_2 exposure is perhaps the most significant. Although NO_X may also contribute to corrosion of metals, it is considerably less significant. Like SO_2, this pollutant is mainly emitted from combustion processes such as boilers, power stations, motor vehicle exhausts, etc. It is predominantly emitted as nitrogen oxide (NO) and oxidised in the atmosphere to nitrogen dioxide (NO_2). This oxidation process is a relatively fast process, but further oxidation of NO_2 to nitric acid (HNO_3), i.e. the form conducive for corrosion, occurs at a slow rate and therefore exposure is normally at comparatively low concentrations.

In coastal areas, chloride deposition is most important variable affecting corrosion rates (Chico et al., 2017). The first major study of atmospheric degradation of metals by HCl was carried out by Feitknecht (1952) who exposed zinc, iron and copper to HCl vapours at varying humidity's between 50% and 95%. Feitknecht found that HCl reacted with metals only when a critical relative humidity was exceeded, which he linked to the vapour pressure of a saturated solution of the metal chloride formed during corrosion. He regards the mechanism as electrochemical, with the oxide-film as cathodes and small areas of metal exposed at breaks as anodes; the interaction between the hydroxide ions (OH^- ions), formed by the cathodic reduction of oxygen, and the metal ions, formed by the anodic reaction, leads to hydroxide or basic chloride. Barton and Bartonova (1969) carried out an extensive investigation of the corrosive effect of HCl gas at concentrations between 7 and 10 ppm on zinc, mild steel, and copper at temperatures between 20°C and 50°C and at relative humidity's of 70% and 95%. Two distinct stages were seen in the behaviour:

- Stage 1 was characterized by a non-linear increase in mass loss with time; termed the "indication period for steady-state corrosion".
- Stage 2, after about 16 days' exposure, showed steady-state corrosion with a linear increase in mass-loss with time.

The primary corrosion products found on iron were FeO(OH), Fe_3O_4 and $FeCl_2$, whilst those found on zinc were $4Zn(OH)_2$. $ZnCl_2$, $Zn(OH)_2$ and ZnO. The amount of chloride in the corrosion product tended to decrease slowly with time. After the steady state corrosion stage had been reached, the composition of the corrosion product remained unchanged.

Barton and Bartonova (1969) measured the corrosion rate at different temperatures in the steady state region. For zinc, the corrosion rate decreased as the temperature increased; for iron, the corrosion rate increased with temperatures up to 40°C, but decreased at 50°C. The rate of the reactions did not appear to depend on the diffusion of HCl to the surface since the corrosion rate was similar in flowing and stationery atmospheres. The implication is that the corrosion rate is dependent on chemical reaction rate. The kinetics of corrosion is controlled by the transfer of HCl to the corrosion product atmosphere interface, its adsorption and the subsequent production of soluble $ZnCl_2$. The corrosion rate also depends on the hydroxide / chloride ratio in the corrosion product as the hydroxides are more protective than the chlorides.

Most literature on chloride exposures discusses the corrosion rates associated with marine environments. Whilst the chemical reactions may be similar, it is not clear whether an assumption of equivalence may be made between hydrochloric acid and sodium chloride. Whilst both are donors of chloride ions, the former would also reduce the pH of the moisture layer on the metal surface. Given these limitations, and in an attempt to provide an indication of the corrosion potential that the proposed facility may have on the surrounding environment, it was decided to make reference to the International Standard Organisation (ISO) corrosion classification which considers SO_2 and chloride deposition rates to establish the rate of corrosion of a number of different metal types.

5.2.3.2 International Standard Organisation

The ISO provides a classification scheme that can directly be used for technical and economic analyses of corrosion damage due to atmospheric SO_2 and chlorides, and for the rational choice of protection measures (ISO 9223:2012[2]). As such, the corrosivity of the atmosphere is divided into five categories (C1 to C5), ranging from very low to very high corrosivity. These

[2]https://www.iso.org/standard/53499.html

corrosivity categories are estimated using a combination of the meteorological parameters, sulfate deposition and airborne salinity (chloride ion). These are discussed below.

5.2.3.2.1 Time of Wetness

Relative humidity, rain, dew, and temperature are determinants of the so-called time of wetness (TOW), defined (ISO 9223) as the fraction of time with relative humidity in excess of 80%, at temperatures above freezing (>0°C). The TOW of a corroding surface is a key parameter, directly determining the duration of the electrochemical corrosion processes. This is a complex variable, since all the means of formation and evaporation of the surface electrolyte solution must be considered. The TOW refers to the period of time during which the atmospheric conditions are favourable for the formation of a surface layer of moisture on a metal or alloy. As pointed in the previous section, this moisture film is extremely important from the point of view of the chemical mechanisms of the corrosion process.

Meteorological data from the OR Tambo international airport (for the period 2020 to 2022) were used to calculate the TOW. The TOW was calculated to be on average 560 hours per year. According to the ISO 9233 classification (Table 5-21), the TOW class represented by these weather conditions is **T3**.

Table 5-22: ISO 9223 Classification of the Time of Wetness

Category	Time of Wetness	Example of Occurrence	Comment
	Hours per Year	Percentage	
T1	T≤10	T≤0.1	Indoor with climate control
T2	10<T≤250	0.1<T≤3	Indoor without climate control
T3	**250<T≤2500**	**3<T≤30**	**Outdoor atmospheres in dry, cold climates and part of temperate climates**
T4	2 500<T≤5 500	30<T≤60	Outdoor atmospheres in all climates except for dry and cold climates
T5	5 500<T	60<T	Some zones of damp climates

5.2.3.2.2 Atmospheric Pollutants

As indicated by the ISO standard, corrosion due to atmospheric pollution is dominated by sulfur dioxide (urban environments) and chlorides (marine environments). This is also evident from open literature where the focus of atmospheric corrosion of metals has predominantly been described through the impact of these two pollutants.

<u>Sulfur Dioxide</u>

Sulfate ions are formed in the surface moisture layer by the oxidation of sulfur dioxide and their formation is considered to be the main corrosion accelerating effect from sulfur dioxide. Sulfur dioxide may be expressed either in terms of a deposition rate or an airborne concentration. The method of determining the deposition rate in this instance followed the ISO 9223 Method, where the corrosion potential due to SO_2 is classified according to the long-term (annual) deposition rate or air concentration of SO_2, as summarised in Table 5-22. Any concentration of SO_2 within category P0 is considered to be the background concentration and is insignificant from the point of view of corrosive attack. Pollution by SO_2 within category P3 is considered extreme and is typical of operational microclimates beyond the scope of the International Standard. The annual ground-level SO_2 concentrations, as a result of emissions from the Kelvin Power Station, fall into the P1 for baseline operations and P0 categories for project operations (Table 5-23).

Table 5-23: ISO 9223 classification of pollution by sulfur-containing substances represented by SO_2

Category	Concentration of SO_2	Deposition Rate of SO_2
	µg/m³	mg/(m².day)
P0	**$P_c \leq 5$**	**$P_d \leq 4$**
P1	**$5 < P_c \leq 30$**	**$4 < P_d \leq 24$**
P2	$30 < P_c \leq 90$	$24 < P_d \leq 80$
P3	$90 < P_c \leq 250$	$80 < P_d \leq 200$

Table 5-24: ISO 9223 classification of pollution by sulfur-containing substances represented by SO_2 as a result of Kelvin Power Station

Criterion	Scenario	
	Baseline operations (Station B)	Proposed project operations (Scenario 1: assuming MES)
Maximum annual SO_2 concentration (µg/m³)	14	1.3
ISO corrosivity category for SO_2	P1	P0

Airborne Chloride

The ISO 9223 classification of pollution by chloride containing substances is provided in Table 5-24. A range of chloride deposition rates were estimated based on rainfall chloride content measured in an urban Highveld context and the Vaal Triangle regions of South Africa (van Wyk, van Tonder, & Vermeulen, 2012; Kok, et al., 2021), with average rainfall at OR Tambo for the period 2020 to 2022. The estimated chloride deposition rate ranged between 0.42 and 2.2 mg/m²/day is classified as category S0 (Table 5-25). Other industrial sources in the vicinity may also contribute to the HCl deposition load, however, this contribution is unknown.

Table 5-25: ISO 9223 classification of pollution by airborne chloride containing substances

Category	Deposition Rate of Chloride (mg/m².day)
S0	**$S \leq 3$**
S1	$3 < S \leq 60$
S2	$60 < S \leq 300$
S3	$300 < S \leq 1500$

Table 5-26: ISO 9223 classification of pollution by airborne chloride containing substances for the area

Criterion	Scenario	
	Low chloride deposition rate	Low chloride deposition rate
Chloride deposition (mg/m².day)	0.42	2.2
ISO corrosivity category for Cl	S0	

5.2.3.2.3 Corrosivity Potential

Having calculated the TOW, the classification of pollution by sulfate and chloride containing substances, the corrosivity category (C1 to C5) for individual metals can be estimated according to ISO 9223, as shown in Table 5-26, and specific corrosivity categories associated with the Kelvin Power Station are summarised for the simulated scenarios in Table 5-27. Once the corrosivity category has been determined, the corrosion rate for carbon and weathered steel, zinc, copper and aluminium can be estimated using the rates given in Table 5-28.

Table 5-27: Estimated corrosivity categories of the atmosphere

	Unalloyed carbon steel														
	T1			T2			**T3**			T4			T5		
	S_0-S_1	S_2	S_3	S_0-S_1	S_2	S_3	**S_0-S_1**	S_2	S_3	S_0-S_1	S_2	S_3	S_0-S_1	S_2	S_3
P_0-P_1	1	1	1/2	1	2	3/4	**2/3**	3/4	4	3	4	5	3/4	5	5
P_2	1	1	1/2	1/2	2/3	3/4	3/4	3/4	4/5	4	4	5	4/5	5	5
P_3	1/2	1/2	2	2	3	4	4	4/	5	5	5	5	5	5	5
	Zinc and copper														
	T1			T2			**T3**			T4			T5		
	S_0-S_1	S_2	S_3	S_0-S_1	S_2	S_3	**S_0-S_1**	S_2	S_3	S_0-S_1	S_2	S_3	S_0-S_1	S_2	S_3
P_0-P_1	1	1	1	1	1/2	3	**3**	3	3/4	3	4	5	3/4	5	5
P_2	1	1	1/2	1/2	2	3	3	3/4	4	3/4	4	5	4/5	5	5
P_3	1	1/2	2	2	3	3/4	3	3/4	4	4/5	5	5	5	5	5
	Aluminium														
	T1			T2			**T3**			T4			T5		
	S_0-S_1	S_2	S_3	S_0-S_1	S_2	S_3	**S_0-S_1**	S_2	S_3	S_0-S_1	S_2	S_3	S_0-S_1	S_2	S_3
P_0-P_1	1	2	2	1	2/3	4	**3**	3/4	4	3	3/4	5	4	5	5
P_2	1	2	2/3	1/2	3/4	4	3	4	4/5	3/4	4	5	4/5	5	5
P_3	1	2/3	3	3/4	4	4	3/4	4/5	5	4/5	5	5	5	5	5

Note: Corrosivity is expressed as the numerical part of the corrosivity category code (for example: 1 instead of C1).

Table 5-28: Estimated corrosivity categories of the atmosphere associated with Kelvin Power Station

Metal type	Scenario	
	Baseline operations (Station B)	Proposed project operations (Scenario 1: assuming MES)
Unalloyed carbon steel	C2 or 3	C2 or 3
Zinc and copper	C3	C3
Aluminium	C3	C3

Table 5-29: Average and steady state corrosion rates for different metals and corrosivity categories

Metal	Average corrosion rate (r_{av}) during the first 10 years for the following corrosivity categories (µm/annum)				
	C1	C2	C3	C4	C5
Carbon steel	$r_{av} \leq 0.5$	**$0.5 < r_{av} \leq 5$**	**$5 < r_{av} \leq 12$**	$12 < r_{av} \leq 30$	$30 < r_{av} \leq 100$
Weathering steel	$r_{av} \leq 0.1$	**$0.1 < r_{av} \leq 2$**	**$2 < r_{av} \leq 8$**	$8 < r_{av} \leq 15$	$15 < r_{av} \leq 80$
Zinc	$r_{av} \leq 0.1$	$0.1 < r_{av} \leq 0.5$	**$0.5 < r_{av} \leq 2$**	$2 < r_{av} \leq 4$	$4 < r_{av} \leq 10$
Copper	$r_{av} \leq 0.01$	$0.01 < r_{av} \leq 0.1$	**$0.1 < r_{av} \leq 1.5$**	$1.5 < r_{av} \leq 3$	$3 < r_{av} \leq 5$
Aluminium	$r_{av} \approx 0.01$	$r_{av} \leq 0.025$	**$0.01 < r_{av} \leq 0.1$**	(5)	(5)
Metal	**Steady state corrosion rate (r_{lin}) for the following corrosivity categories (µm/annum)**				
	C1	**C2**	**C3**	**C4**	**C5**
Carbon steel	$r_{av} \leq 0.1$	**$0.1 < r_{av} \leq 1.5$**	**$1.5 < r_{av} \leq 8$**	$8 < r_{av} \leq 20$	$20 < r_{av} \leq 90$
Weathering steel	$r_{av} \leq 0.1$	**$0.1 < r_{av} \leq 1$**	**$1 < r_{av} \leq 5$**	$5 < r_{av} \leq 10$	$10 < r_{av} \leq 80$
Zinc	$r_{av} \leq 0.05$	$0.1 < r_{av} \leq 0.5$	**$0.5 < r_{av} \leq 2$**	$2 < r_{av} \leq 4$	$4 < r_{av} \leq 10$
Copper	$r_{av} \leq 0.01$	$0.01 < r_{av} \leq 0.1$	**$0.1 < r_{av} \leq 1$**	$1 < r_{av} \leq 3$	$3 < r_{av} \leq 5$
Aluminium	negligible	$0.01 < r_{av} \leq 0.02$	**$0.02 < r_{av} \leq 0.2$**	(5)	(5)

Notes

1) The corrosion rate of carbon steel is not constant during the first 10 years.
2) The corrosion rate of weathering steel is strongly dependent on the combination of various influencing factors (alternation between wet and dry periods). In atmospheres with sulfur dioxide (SO_2) pollution, a more protective rust layer is formed. Rain protected surfaces in marine atmospheres heavily polluted with chlorides may have much higher corrosion rates than freely exposed surfaces.
3) Applies also to the copper-zinc, copper-tin and similar alloys with a copper content of at least 60 %.
4) The rates shown are based on commercially pure aluminium (purity> 99.5%) which, like most aluminium alloys, corrodes in the atmosphere at a rate that decreases with time. However, these rates are based on average mass loss results while the corrosion attack is usually manifested as pitting. Consequently, the rates shown do not represent rates of penetration. Penetration rates for pitting also decrease with exposure time. Commercially pure aluminium, aluminium alloys containing magnesium, manganese and/or silicon as the major alloying elements, and Alclad products generally have better corrosion resistance than aluminium alloys containing significant quantities of copper, zinc and/or iron. Alloys with significant quantities of magnesium, zinc, copper and/or iron may also be subject to other forms of localized corrosion such as stress corrosion cracking, exfoliation and intergranular attack.
5) In atmospheres defined by corrosivity categories C4 and C5, a marked increase in corrosion rate may be expected and local corrosion effects become important. For these two corrosivity categories, the data concerning general corrosion may be misleading.

5.2.3.3 ISOCORRAG Atmospheric Corrosion Model

The ISOCORRAG equation was developed to predict the annual corrosion rate resulting from atmospheric corrosion for several metals. The equation was created by the multiple linear regressions of corrosion data from several sites around the globe. With ISOCORRAG, the annual corrosion rate is expressed as (Knotkova, Boschek, & Kreislova, 1995):

$$K = a + b_1[SO_2] + b_2[Cl^-] + b_3[TOW]$$

Equation 1

Where the constants *a*, b_1, b_2, and b_3, differ according to the type of metal, shape of the specimen, and exposure conditions. Table 5-29 is a summary of constants for flat metal specimens. The deposition of SO_2 is expressed as an equivalent concentration, i.e. µg/m³; the deposition of chloride pollutants [Cl^-] is expressed in in mg/m²/day, and time of wetness [TOW] in hours per year.

Table 5-30: ISOCORRAG regression model constants (Knotkova et al., 1995)

Metal	Regression Constants for ISOCORRAG model			
	a	b_1	b_2	b_3
Steel	1.3269	0.4313	0.1384	0.0057
Zinc	0.2098	0.0232	0.0059	0.00027
Copper	0.9556	0.0065	0.00393	0.0000538
Aluminium	0.0069	0.00638	0.000558	0.0000650

Using simulated concentrations of SO_2 as a result of Kelvin Power Station (i.e. baseline and project operations) and wet deposition rates of chloride (based on rainfall chemistry) (as in Section 5.2.3.2 above) the rate of corrosion (K) was calculated (using Equation 1) across the dispersion modelling domain. The domain average TOW (as described earlier) was used. A summary of the findings is presented in Table 5-30. The corrosion rates calculated using the ISOCORRAG method are within the ranges presented for the ISO method (Table 5-28 compared with Table 5-30).

Table 5-31: Corrosion rate of metals associated with Kelvin Power Station calculated using the ISOCORRAG method

Scenario	Criteria	Corrosion rate (K) [µm/annum]			
		Steel	Zinc	Copper	Aluminium
Baseline operations (Station B)	Min	4.63	0.37	0.99	0.04
	Max	10.90	0.70	1.09	0.13
Project operations (Scenario 1: operating at MES)	Min	4.59	0.36	0.99	0.04
	Max	5.40	0.40	1.00	0.05

5.3 Impact Assessment Rating

The impact significance of the project is provided below and follows the method provided by EIMS (Appendix E). The project is expected to have the following significance rating:

- Construction Phase:
    - Without mitigation: low negative significance rating.
    - With Mitigation: low negative significance rating.
- Operation Phase:
    - Without mitigation: low negative significance rating.
    - With Mitigation: low negative significance rating.
- Decommissioning Phase:
    - Without mitigation: low negative significance rating.
    - With Mitigation: low negative significance rating.

Table 5-32: Significance rating for potential air quality impacts due to the project activities

Impact Description		Pre-Mitigation						Pre-mitigation environmental risk	Post Mitigation						Post-mitigation environmental risk	Confidence	Priority Factor Criteria		Priority Factor	Final score
Impact	Phase	Nature	Extent	Duration	Magnitude	Reversibility	Probability		Nature	Extent	Duration	Magnitude	Reversibility	Probability			Cumulative Impact	Irreplaceable loss		
Increase in noise levels	Construction	-1	3	2	2	2	3	-6.75 (low)	-1	3	2	2	2	2	-4.5 (low)	Medium	1	1	1.00	-4.5
Increase in noise levels	Operation	-1	3	4	2	2	3	-8.25 (low)	-1	3	4	2	2	3	-8.25 (low)	Medium	1	1	1.13	-8.25
Increase in noise levels	Decommis-sioning	-1	3	2	3	2	3	-7.5 (low)	-1	3	2	3	2	2	-5 (low)	Medium	1	1	1.00	-5

6 MAIN FINDINGS AND CONCLUSIONS

6.1 Findings

The findings from the baseline assessment are as follows:

- The flow field is dominated by winds from the northwestern sector with calm conditions of 2%.
- Potential sensitive receptors within 5 km from the project include residential areas, i.e. Esther Park, Edleen, Cresslawn, Kelvin Estate, Croydon, Eden Glen and Illiondale. Residential areas within 10 km from the site include Edenvale, Kempton Park, and Lethabong.
- AQMS within the study area include Buccleugh AQMS (~11.5 km northwest of the project) and Alexandra AQMS (~7.8 km west of the project) owned by the City of Johannesburg and Bedfordview AQMS (~8.8 km southwest of the project) owned by the Ekurhuleni Metropolitan.
- Non-compliance of the daily and annual NAAQS for PM_{10} and $PM_{2.5}$ were recorded for the period 2023 at the Alexandra AQMS.

The findings from the air quality impact assessment due to project operations are as follows:

- The project was assessed for the operational phase:
  - **Scenario 1:** Normal operations assuming MES where off-gas goes through the main stacks.
  - **Scenario 2:** Normal operations assuming USEPA emission factors for SO_2 (assuming sulfur content of 10 ppm). This scenario was included to understand the range in SO_2 ground level concentrations based on emission factors designed for gas turbines and sulfur content of the natural gas being used.
  - **Scenario 3:** Normal operations assuming MES where off-gas goes through the main stacks and gas generators running for 1 hour per month assuming MES where off-gas goes through the main stack (when normal operations are not taking place). Only short-term impacts were assessed, i.e. highest hourly and highest daily (99th percentile).
  - **Scenario 4:** Normal operations assuming USEPA emission factors for SO_2 and gas generators running for 1 hour per month assuming MES (when normal operations are not taking place). Only short-term impacts were assessed for SO_2, i.e. highest hourly and highest daily (99th percentile).
- Simulated SO_2 concentrations for the project operations complied with NAAQS across the modelling domain for all scenarios.
- Simulated NO_2 concentrations for the project operations complied with NAAQS across the modelling domain for all scenarios.
- Simulated PM concentrations for the project operations complied with PM_{10} and $PM_{2.5}$ NAAQS across the modelling domain for all scenarios.
- Annual SO_2 and NO_2 concentrations due to project operations were below critical levels for vegetation throughout the domain for all scenarios.
- Simulated dust fallout due to project operations was well within the NDCR over the modelling domain.

6.2 Conclusion

The proposed CCGT Power Plant has lower air quality impacts that the existing coal fired power station (Station B) and will provide an improvement on air quality in the area. From an air quality perspective, it is recommended that the project go ahead on condition that:

- Emissions due to construction activities be mitigated using good practise guidelines.

- The emissions from the project comply with MES.

7 ANNEXURE A

DECLARATION OF ACCURACY OF INFORMATION – APPLICANT

Name of Enterprise: ____

Declaration of accuracy of information provided:

Atmospheric Impact Report in terms of section 30 of the Act.

I, [*duly authorised*], declare that the information provided in this atmospheric impact report is, to the best of my knowledge, in all respects factually true and correct. I am aware that the supply of false or misleading information to an air quality officer is a criminal offence in terms of section 51(1)(g) of the National Environmental Management: Air Quality Act (Act No. 39 of 2004).

Signed at on this day of

SIGNATURE

CAPACITY OF SIGNATORY

8 ANNEXURE B

forestry, fisheries & the environment

Department:
Forestry, Fisheries and the Environment
REPUBLIC OF SOUTH AFRICA

Private Bag X447, Pretoria, 0001, Environment House, 473 Steve Biko Road, Pretoria, 0002 Tel: +27 12 399 9000, Fax: +27 86 625 1042

SPECIALIST DECLARATION FORM – AUGUST 2023

Specialist Declaration form for assessments undertaken for application for authorisation in terms of the National Environmental Management Act, Act No. 107 of 1998, as amended and the Environmental Impact Assessment (EIA) Regulations, 2014, as amended (the Regulations)

REPORT TITLE
Atmospheric Impact Report: Combined-Cycle Gas Turbine Power Plant at Kelvin Power Station

Kindly note the following:

1. This form must always be used for assessment that are in support of applications that must be subjected to Basic Assessment or Scoping & Environmental Impact Reporting, where this Department is the Competent Authority.
2. This form is current as of August 2023. It is the responsibility of the Applicant / Environmental Assessment Practitioner (EAP) to ascertain whether subsequent versions of the form have been published or produced by the Competent Authority. The latest available Departmental templates are available at https://www.dffe.gov.za/documents/forms.
3. An electronic copy of the signed declaration form must be appended to all Draft and Final Reports submitted to the department for consideration.
4. The specialist must be aware of and comply with '*the Procedures for the assessment and minimum criteria for reporting on identified environmental themes in terms of sections 24(5)(a) and (h) and 44 of the act, when applying for environmental authorisation - GN 320/2020)*', where applicable.

1. SPECIALIST INFORMATION

Title of Specialist Assessment	Air Quality Impact Assessment
Specialist Company Name	Airshed Planning Professionals (Pty) Ltd
Specialist Name	Reneé von Gruenewaldt
Specialist Identity Number	7805130128080
Specialist Qualifications:	MSc.(Earth Sciences)
Professional affiliation/registration:	South African Council for Natural Scientific Professionals: 400304/07
Physical address:	62 Constantia Ave, Pretoria
Postal address:	PostNet Suite #18, Private Bag x59
Postal address	Halfway House, 1685
Telephone	011 805 1940
Cell phone	083 222 6916
E-mail	renee@airshed.co.za

SPECIALIST DECLARATION FORM – AUGUST 2023

2. DECLARATION BY THE SPECIALIST

I, Reneé von Gruenewaldt declare that –

- I act as the independent specialist in this application;
- I am aware of the procedures and requirements for the assessment and minimum criteria for reporting on identified environmental themes in terms of sections 24(5)(a) and (h) and 44 of the National Environmental Management Act (NEMA), 1998, as amended, when applying for environmental authorisation which were promulgated in Government Notice No. 320 of 20 March 2020 (i.e. "the Protocols") and in Government Notice No. 1150 of 30 October 2020.
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing –
  - any decision to be taken with respect to the application by the competent authority; and;
  - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 48 and is punishable in terms of section 24F of the NEMA Act.

Signature of the Specialist

Airshed Planning Professionals (Pty) Ltd

Name of Company:

28 July 2024

Date

SPECIALIST DECLARATION FORM – AUGUST 2023

3. UNDERTAKING UNDER OATH/ AFFIRMATION

I, _ Reneé von Gruenewaldt swear under oath / affirm that all the information submitted or to be submitted for the purposes of this application is true and correct.

Signature of the Specialist

Airshed Planning Professionals (Pty) Ltd

Name of Company

28/07/2024.

Date

Signature of the Commissioner of Oaths

2024.07.28

Date

2024 -07- 2 8

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9 References

Barton, K., & Bartonova, Z. (1969). Evaluation of atmospheric corrosion tests with iron, copper, and zinc, extending over three years, at Czechoslovakian testing stations. *Werkst. Korros. (Weinheim), 20*(2), 87-93.

Callaghan, B. (1991). *Atmospheric corrosion testing in Southern Africa – results of a twenty-year national programme.* Pretoria: Scientia Publishers. Retrieved from https://researchspace.csir.co.za/dspace/bitstream/handle/10204/10635/Atmospheric%20corrosion%20testing%20in%20Southern%20Africa.%20Results%20of%20a%20twenty%20year%20national%20exposure%20programme.pdf?sequence=1&isAllowed=y

Carslaw, D. (2015). *The openair manual - open-source tools for analysing air pollution data. Manual for version 1.1-4.* King's College London.

Carslaw, D., & Ropkins, K. (2012). openair - an R package for air quality data analysis. *Environmental Modelling and Software, 27-28*, 52 - 61.

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.* Bilthoven, The Netherlands: UNECE Convention on Long-range Transboundary Air Pollution (http://www.icpmapping.org/). Retrieved 02 07, 2018, from http://www.rivm.nl/media/documenten/cce/manual/binnenop17Juni/Ch3-MapMan-2016-05-03_vf.pdf

Feitknecht, W. (1952). Über den Zusammenbruch der Oxydfilme auf Metalloberflächen in Sauren Dämpfen und den Mechanismus der atmosphärischen Korrosion. *Chimia, 6*, 3-13.

Janse van Rensberg, D. T., Cornish, L. A., & van der Merwe, J. (2019). Corrosion map of South Africa's macro atmosphere. *South African Journal of Science, 118*(7/8), 8 pages. doi:https://doi.org/10.17159/sajs.2019/4901

Knotkova, D., Boschek, P., & Kreislova, K. (1995). Results of ISO CORRAG Program: Processing of One-Year Data in Respect to Corrosivity Classification. In: Atmospheric Corrosion. *ASTM International*, 38-55.

Kok, L., van Zyl, P., Beukes, J., Swartz, J.-S., Burger, R., Ellis, S., . . . Kulmala, M. (2021). Chemical composition of rain at a regional site on the South African Highveld. *Water SA, 47*(3). doi:https://doi.org/10.17159/wsa/2021.v47.i3.11861

NPI. (2008). *Emission Estimation Technique Manual for Combustion Engines. Version 3.*

NPI. (2011). *Emission Estimation Technique Manual for Mining. Version 3.* Australian Government Department of Sustainability, Environment, Water, Population and Communities.

NSW-EPA. (2006a). *Technical Framework: Assessment and management of odour from stationary sources in NSW.* Sydney: New South Wales Environmental Protection Authority.

NSW-EPA. (2006b). *Technical Notes: Assessment and management of odour from stationary sources in NSW.* Sydney: New South Wales Environmental Protection Authority.

Phipps, P., & Rice, D. (1979). The Role of Water in Atmospheric Corrosion. *Corrosion Chemistry*, 235-261. doi:DOI:10.1021/bk-1979-0089.ch008

Rayten Engineering Solutions. (2024). *Stack Emissions Monitoring Report 2024.*

Scire, J., & Borissova, M. (2011). An Emperical Method for Modeling Short-term and Annual NO2 Concentrations in Regulatory Models. *TRC Energy and Environment Conference (EUEC).* Phoenix, Arizona.

Sydberger, T., & Vannerberg, N.-G. (1972). The influence of the relative humidity and corrosion products on the adsorption of sulfur dioxide on metal surfaces. *Corrosion Science, 12*(10), 775-784. doi:https://doi.org/10.1016/S0010-938X(72)90274-0

Tiwary, A., & Colls, J. (2010). *Air pollution: Measurement modelling and mitigation. 3rd edition.* London and New York: Routledge.

US EPA. (1998). *Interagency Workgroup on Air Quality Modeling (IWAQM) Phase 2 Summary Report and Recommendations for Modeling Long-Range Transport Impacts.* Research Triangle Park, NC.: U.S. Environmental Protection Agency EPA-454/R-98-019.

US EPA. (2000). *AP42, 5th Edition, Volume 1, Chapter 3: Stationary Internal Combustion Sources, 3.1 Stationary Gas Turbines.*

US EPA. (2011). *AP 42, 5th Edition, Volume I, Chapter 13: Miscellaneous Sources, 13.2.1 Paved Roads.* Retrieved from http://www.epa.gov/ttn/chief/ap42/

van Wyk, E., van Tonder, G., & Vermeulen, D. (2012). Characteristics of local groundwater recharge cycles in South African semi-arid hard rock terrains: Rainfall–groundwater interaction. *Water SA, 38*(5), 747 - 754. doi:http://dx.doi.org/10.4314/wsa.v38i5.14

Verschueren, K. (1996). *Environmental Data on Organic Chemicals* (3rd ed.). New York: John Wileyu & Sons. Inc.

Warner, J. X., Wei, Z., Strow, L., Dickerson, R., & Nowak, J. (2016). The global tropospheric ammonia distribution as seen in the 13-year AIRS measurement record. *Atmospheric Chemistry and Physics, 16*, 5467 - 5479. doi:10.5194/acp-16-5467-2016

Zhu, L., Liu, J., Cong, L., & Zhang, Z. (2016). Spatiotemporal characteristics of particulate matter and dry deposition flux in the Ciuhu Wetland of Beijing. *PLos One*.

APPENDIX A – CURRICULUM VITAE

FULL CURRICULUM VITAE

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

MEMBERSHIP OF PROFESSIONAL SOCIETIES

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

KEY QUALIFICATIONS

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

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

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

RELEVANT EXPERIENCE (AIR QUALITY)

Mining and Ore Handling

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

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

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

Metal Recovery

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

Chemical Industry

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

Petrochemical Industry

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

Pulp and Paper Industry

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

Power Generation

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

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

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

Waste Disposal

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

Cement Manufacturing

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

Management Plans

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

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

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

Mining and Tailings Storage Facilities

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

Gas to Power Plants

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

RELEVANT EXPERIENCE (NOISE)

Mining

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

Power Generation

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

Process Operations

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

Transport

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

Gas Pipelines

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

Baseline Noise Surveys

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

OTHER EXPERIENCE (2001)

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

EDUCATION

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

ADDITIONAL COURSES

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

COUNTRIES OF WORK EXPERIENCE

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

EMPLOYMENT RECORD

January 2002 - Present

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

2001

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

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

1999 - 2000

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

CONFERENCE AND WORKSHOP PRESENTATIONS AND PAPERS

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

LANGUAGES

	Speak	Read	Write
English	Excellent	Excellent	Excellent
Afrikaans	Fair	Fair	Fair

CERTIFICATION

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

______________________	29/07/2024
Signature of staff member	Date (Day / Month / Year)

Full name of staff member: Reneé Georgeinna von Gruenewaldt

Appendix B – CALMET Model Control Options

The CALMET run type selected for this assessment is summarised in Table B-1 below. Readily available terrain and land cover data was obtained from via the United States Geological Survey (USGS) via the Earth Explorer website (U.S. Department of the Interior, U.S. Geological Survey, 2016). Shuttle Radar Topography Mission (SRTM) (30 m resolution, 1 arc-sec) data and Global Land Cover Characterisation (GLCC) data for Africa were used.

Table B-1: CALMET model control options

Run Type	Description of Run Type	Ease of Use and Representativeness	Data availability	Advantages	Disadvantages
No Observations	•Prognostic model data, such as WRF to drive CALMET. •No surface or upper air observations input at all.	•Relatively simple to implement in model •Representative of regional meteorological conditions	WRF data (Lakes Environmental) for 2021, 2022 and 2023 at 12 km resolution for 50 km by 50 km study area.	•Simple to implement •Full spatial and temporal variability •No overwater data required •Cloud cover has spatial distribution •Eliminates need for complicated 7 user-input site-specific variables •Ideal as screening run as gives very good estimate	Resolution of prognostic data may potentially be too coarse to be representative of local conditions

Table B-2: CALMET vertical and horizontal resolutions

<table>
<tr><th>Dimension</th><th colspan="11">Resolution</th></tr>
<tr><td>Horizontal resolution</td><td colspan="11">WRF native resolution 12 km
CALMET refined resolution 1 km</td></tr>
<tr><td rowspan="2">Vertical resolution</td><td colspan="11">CALMET run with 11 vertical levels (m above surface):</td></tr>
<tr><td>0</td><td>20</td><td>40</td><td>80</td><td>160</td><td>300</td><td>600</td><td>1 000</td><td>1 500</td><td>2 200</td><td>3 500</td></tr>
</table>

APPENDIX C – CALPUFF MODEL CONTROL OPTIONS

The CALPUFF set-up parameters selected for this assessment are summarised in Table C-1 below. Due to the size of the modelling domain; limitations of CALPUFF; and, to assess air quality impacts due to Kelvin Power Station (i.e. baseline and project operations), a nested grid was used with a 200 m resolution for 20 km x 20 km centred over the Kelvin Power Station and sensitive receptors and AQMS included as discreet receptors.

Table C-1: CALPUFF model control options

Run Type	Description of Run Type	Ease of Use and Representativeness	Data availability	Model inputs used
Sampling Function Puff	This sampling scheme employs radically symmetric Gaussian puffs and is suitable for far field.			
Dispersion coefficients MDISP = 2	• Dispersion coefficients are computed from internally-calculated sigma-v, sigma-w using micrometeorological variables (u*, w*, L, etc.).	• This option can simulate AERMOD-type dispersion when the user also selects the use of PDF method for dispersion in the convective boundary layer (MPDF = 1). Note that when simulating AERMOD-type dispersion, the input meteorological data must be from CALMET and cannot be ISC-type ASCII format data. The user should also be aware that under this option the CALPUFF model will be more sensitive to the appropriateness of the land use characterization.	• The data is obtained from WRF input information.	• The coefficients are derived from other parameters.
Chemical transformation MESOPUFF II	• Pseudo-first-order chemical mechanism for SO_2, SO_4^{2-}, NO_x, HNO_3, and NO_3 – (MESOPUFF II method)	• MESOPUFF II is a 5-species scheme in which all emissions of nitrogen oxides are simply input as NO_x. • In the MESOPUFF II scheme, the conversion of SO2 to sulfates is dependent on relative humidity (RH), with an enhanced conversion rate at high RH. • The conversion of NO_x to nitrates is RH-dependent.	• The MESOPUFF II scheme assumes an immediate conversion of all NO to NO_2. • Two options are specified for the ozone concentrations: (1) hourly ozone concentrations from a network of stations, or (2) a single user defined ozone value.	• Monthly average ozone measured at the Buccleugh AQMS for the year 2023 was used (Table C-2). • Monthly average ammonia (NH_3) concentration defaults were used. • NO to NO_2 conversion is not included in the model.

Run Type	Description of Run Type	Ease of Use and Representativeness	Data availability	Model inputs used
			• The background ammonia concentrations required for the HNO_3 /NH_4NO_3 equilibrium calculation can be user-specified or a default value will be used.	

Table C-2: Monthly average ozone concentrations used in the CALPUFF simulations

Pollutant	Month of year											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ozone (measured in ppb)	15.5	16.1	14.2	13.0	8.6	10.1	11.1	15.3	21.9	22.0	24.2	21.3

Appendix D – Comparison with Regulations

D.2 Regulations Regarding Report Writing for Environmental Impact Assessments

This report complies with the requirements of the National Environmental Management Act, 1998 (NEMA, No. 107 of 1998) and 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). The table below provides a summary of the requirements, with cross references to the report sections where these requirements have been addressed.

Table D-1: Specialist report requirements in terms of Appendix 6 of the 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)

A specialist report prepared in terms of the Environmental Impact Regulations must contain:	Relevant section in report
Details of the specialist who prepared the report	Preface
The expertise of that person to compile a specialist report including a curriculum vitae	Preface Appendix A
A declaration that the person is independent in a form as may be specified by the competent authority	Preface Addendum B
An indication of the scope of, and the purpose for which, the report was prepared	Preface
An indication of the quality and age of base data used for the specialist report;	Section 5.1.3 Section 5.1.4
A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 5.1.5 Section 5.1.6
The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	Section 5.1.3 Section 5.1.4
A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Preface Section 5.1.1
Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternative;	Section 1.3 Section 2.2
An identification of any areas to be avoided, including buffers	Section 1.3
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;	Section 5.1
A description of any assumptions made and any uncertainties or gaps in knowledge;	Preface
A description of the findings and potential implications of such findings on the impact of the proposed activity or activities	Section 5.1
Any mitigation measures for inclusion in the EMPr	Section 5.1.6.1.2 Section 5.1.6.2.6 Section 5.1.6.3.2
Any conditions for inclusion in the environmental authorisation	Conditions will be included in the AEL
Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Monitoring requirements will be stipulated in the AEL
A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	Section 6.2
Regarding the acceptability of the proposed activity or activities; and	Section 5.1

A specialist report prepared in terms of the Environmental Impact Regulations must contain:	Relevant section in report
	Section 5.2
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 5.1.6.1.2 Section 5.1.6.2.6 Section 5.1.6.3.2 Section 6.2
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	Recorded by the Environmental Assessment Practitioner
Any other information requested by the competent authority.	None received

D.2 Regulations Regarding Atmospheric Impact Reports

The Regulations prescribing the format of the Atmospheric Impact Report (AIR) (Government Gazette No 36094; published 11 October 2013) were referenced for the air dispersion modelling approach used in this study. Table D-2 compares the AIR Regulations with the approach used.

Table D-1: Comparison of Regulations for the AIR with study approach

Chapter	Name	AIR regulations requirement	Status in AIR
1	Enterprise details	• Enterprise Details • Location and Extent of the Plant • Atmospheric Emission Licence and other Authorisations	Enterprise details included. Location of plant included. New facility (authorisation process on-going)
2	Nature of process	• Listed Activities • Process Description • Unit Processes	All detail included in the regulated format
3	Technical Information	• Raw Materials Used and Production Rates • Appliances and Abatement Equipment Control Technology	Section 3.1 and 3.2. Details of abatement equipment details not yet available.

4	Atmospheric Emissions	• Point Source Emissions
		  • Point Source Parameters
		  • Point Source Maximum Emission Rates during Normal Operating Conditions
		  • Point Source Maximum Emission Rates during Start-up, Maintenance and/or Shut-down
		• Fugitive Emissions
		• Emergency Incidents
			Maximum release rates from point sources assumed to be the MES limits defined for the facility (Section 4.2).
			Types of emergency events were identified, and typical emission rates quantified (Section 4.5).

5	Impact of enterprise on receiving environment		
5.1	Analysis of emissions impact on human health	Must conduct dispersion modelling, must be done in accordance with Regulations; must use NAAQS	Completed as set out by the Regulations.
5.2	Analysis of emissions impact on environment	Must be undertaken at discretion of Air Quality Officer.	Impact on vegetation, nuisance dustfall and corrosion was quantified for the operational phase of the project (Section 5.2.1)
6	Complaints	Details on complaints received for last two years	Proposed facility, no complaints received yet.
7	Current or planned air quality management interventions	Interventions currently being implemented and scheduled and approved for next 5 years.	Proposed facility; best available technology planned for development.

Chapter	Name	AIR regulations requirement	Status in AIR
8	Compliance and enforcement history	Must set out all air quality compliance and enforcement actions undertaken against the enterprise in the last 5 years. Includes directives, compliance notices, interdicts, prosecution, fines	Proposed facility; no compliance and enforcement actions yet.
9	Additional information		Dispersion modelling results for the baseline Kelvin Power Station (Station B) included.

D.3 Regulations Regarding Air Dispersion Modelling

The promulgated Regulations regarding Air Dispersion Modelling (Gazette No. 37804, vol. 589; 11 July 2014) were consulted to ensure that the dispersion modelling process used in this assessment agreed with the regulations. Table D-3 compares the Air Dispersion Modelling Regulations with the approach used in Section 5.

Table D-3: Comparison of Regulations regarding the Air Dispersion Modelling with study approach

AIR Regulations	Compliance with Regulations	Comment
Levels of assessment		
• 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: requires more sophisticated dispersion models (and corresponding input data, resources and model operator expertise) in situations: – 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, and 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 airshed; or, – when assessing contaminants resulting from non-linear processes (e.g. deposition, ground-level ozone (O_3), particulate formation, visibility)	Level 3 assessment using CALPUFF	This Lagrangian Gaussian Puff model is well suited to simulate low or calm wind speed conditions. CALPUFF is able to perform chemical transformations. In this study the conversion of NO to NO_2 and the secondary formation of particulate matter were accounted for in the simulations.
Model Input		
Source characterisation	Yes	Source characterisation provided in Section 4.
Emission rates: For new or modified existing sources the maximum allowed amount, volume, emission rates and	Yes	Emission rates used for each scenario are provided in 4.

AIR Regulations	Compliance with Regulations	Comment
concentration of pollutants that may be discharged to the atmosphere should be used		
Meteorological data		
Full meteorological conditions are recommended for regulatory applications.	Yes	WRF modelled meteorology (including upper air) (Section 5.1.3 and Appendix B – CALMET Model Control Options).
Data period	Yes	3 years (2021 to 2023)
Geographical Information		
Topography and land-use		Required for CALMET 3D meteorological file preparation (Section 5.1.3 and Appendix B – CALMET Model Control Options)
Domain and co-ordinate system	Yes	• Dispersion modelling domain: 20 x 20 km • UTM co-ordinate system (WGS84) (Section 5.1.3 and Appendix B – CALMET Model Control Options)
General Modelling Considerations		
Ambient Background Concentrations, including estimating background concentrations in multi-source areas	Yes	Section 5.1.4
NAAQS analyses for new or modified sources: impact of source modification in terms of ground-level concentrations should be assessed within the context of the background concentrations and the	Yes	Model predicted, 99th percentile ground-level concentrations compared against NAAQS (Section 5.1.5 and Section 5.1.6)
Land-use classification	Yes	Section 5.1.1.1 and Appendix B – CALMET Model Control Options
Surface roughness	Yes	Computed from Land-use categories in the CALMET pre-processing step (Appendix B – CALMET Model Control Options).
Albedo	Yes	Computed from Land-use categories in the CALMET pre-processing step (Appendix B – CALMET Model Control Options).
Temporal and spatial resolution		
Receptors and spatial resolutions	Yes	Sections 1.3
Building downwash	Yes	Insufficient building detail was available to include building down wash for main and by-pass stacks. Main and by-pass stacks will be approximately 50 m higher than nearest buildings. Pollutant dispersion is therefore not likely to be affected by building downwash.
Chemical transformations	Yes	Sections 5.1.1, 5.1.5.4 and 5.1.6.2.5
General Reporting Requirements		
Model accuracy and uncertainty	No	
Plan of study	Yes	Section 5.1.1
Air Dispersion Modelling Study Reporting Requirements	Yes	As per the Regulations Prescribing the Format of the Atmospheric Impact Report, Government Gazette No. 36904,

AIR Regulations	Compliance with Regulations	Comment
		Notice Number 747 of 2013 (11 October 2013) and as per the Regulations Regarding Air Dispersion Modelling (Government Gazette No. 37804 Notice R533, 11 July 2014).
Plotted dispersion contours	Yes	Sections 5.1.5 and 5.1.6.2

APPENDIX E – IMPACT ASSESSMENT METHODOLOGY

The impact significance rating methodology, as presented herein and utilised for all EIMS Impact Assessment Projects, is guided by the requirements of the NEMA EIA Regulations 2014 (as amended). The broad approach to the significance rating methodology is to determine the environmental risk (ER) by considering the consequence (C) of each impact (comprising Nature, Extent, Duration, Magnitude, and Reversibility) and relate this to the probability/ likelihood (P) of the impact occurring. The ER is determined for the pre- and post-mitigation scenario. In addition, other factors, including cumulative impacts and potential for irreplaceable loss of resources, are used to determine a prioritisation factor (PF) which is applied to the ER to determine the overall significance (S). The impact assessment will be applied to all identified alternatives.

<u>Determination of Environmental Risk:</u>

The significance (S) of an impact is determined by applying a prioritisation factor (PF) to the environmental risk (ER). The environmental risk is dependent on the consequence (C) of the particular impact and the probability (P) of the impact occurring. Consequence is determined through the consideration of the Nature (N), Extent (E), Duration (D), Magnitude (M), and Reversibility (R) applicable to the specific impact.

For the purpose of this methodology the consequence of the impact is represented by:

$$C = \frac{(E + D + M + R) * N}{4}$$

Each individual aspect in the determination of the consequence is represented by a rating scale as defined in Table E-1 below.

Table E-1: Criteria for determining impact consequence

Aspect	Score	Definition
Nature	- 1	Likely to result in a negative/ detrimental impact
	+1	Likely to result in a positive/ beneficial impact
Extent	1	Activity (i.e. limited to the area applicable to the specific activity)
	2	Site (i.e. within the development property boundary),
	3	Local (i.e. the area within 5 km of the site),
	4	Regional (i.e. extends between 5 and 50 km from the site
	5	Provincial / National (i.e. extends beyond 50 km from the site)
Duration	1	Immediate (<1 year)
	2	Short term (1-5 years),
	3	Medium term (6-15 years),
	4	Long term (the impact will cease after the operational life span of the project),
	5	Permanent (no mitigation measure of natural process will reduce the impact after construction).
Magnitude/ Intensity	1	Minor (where the impact affects the environment in such a way that natural, cultural and social functions and processes are not affected),
	2	Low (where the impact affects the environment in such a way that natural, cultural and social functions and processes are slightly affected),
	3	Moderate (where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way),

Aspect	Score	Definition
	4	High (where natural, cultural or social functions or processes are altered to the extent that it will temporarily cease), or
	5	Very high / don't know (where natural, cultural or social functions or processes are altered to the extent that it will permanently cease).
Reversibility	1	Impact is reversible without any time and cost.
	2	Impact is reversible without incurring significant time and cost.
	3	Impact is reversible only by incurring significant time and cost.
	4	Impact is reversible only by incurring prohibitively high time and cost.
	5	Irreversible Impact

Once the C has been determined the ER is determined in accordance with the standard risk assessment relationship by multiplying the C and the P. Probability is rated/scored as per Table E-2.

Table E-2: Probability scoring

Probability	1	Improbable (the possibility of the impact materialising is very low as a result of design, historic experience, or implementation of adequate corrective actions; <25%),
	2	Low probability (there is a possibility that the impact will occur; >25% and <50%),
	3	Medium probability (the impact may occur; >50% and <75%),
	4	High probability (it is most likely that the impact will occur- > 75% probability), or
	5	Definite (the impact will occur),

The result is a qualitative representation of relative ER associated with the impact. ER is therefore calculated as follows:

$$ER = C \times P$$

Table E-3: Determination of environmental risk

Consequence	5	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5
		1	2	3	4	5
	Probability					

The outcome of the environmental risk assessment will result in a range of scores, ranging from 1 through to 25. These ER scores are then grouped into respective classes as described in Table E-4.

Table E-4: Significance classes

Environmental Risk Score	
Value	**Description**
< 9	Low (i.e. where this impact is unlikely to be a significant environmental risk),
≥9; <17	Medium (i.e. where the impact could have a significant environmental risk),
≥ 17	High (i.e. where the impact will have a significant environmental risk).

The impact ER will be determined for each impact without relevant management and mitigation measures (pre-mitigation), as well as post implementation of relevant management and mitigation measures (post-mitigation). This allows for a prediction in the degree to which the impact can be managed/mitigated.

Impact Prioritisation:

Further to the assessment criteria presented in the section above, it is necessary to assess each potentially significant impact in terms of:

- Cumulative impacts; and
- The degree to which the impact may cause irreplaceable loss of resources.

To ensure that these factors are considered, an impact prioritisation factor (PF) will be applied to each impact ER (post mitigation). This prioritisation factor does not aim to detract from the risk ratings but rather to focus the attention of the decision-making authority on the higher priority/significance issues and impacts. The PF will be applied to the ER score based on the assumption that relevant suggested management/mitigation impacts are implemented.

Table E-5: Criteria for determining prioritisation

Public response (PR)	Low (1)	Issue not raised in public response.
	Medium (2)	Issue has received a meaningful and justifiable public response.
	High (3)	Issue has received an intense meaningful and justifiable public response.
Cumulative Impact (CI)	Low (1)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.
	Medium (2)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.
	High (3)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is highly probable/definite that the impact will result in spatial and temporal cumulative change.
Irreplaceable loss of resources (LR)	Low (1)	Where the impact is unlikely to result in irreplaceable loss of resources.
	Medium (2)	Where the impact may result in the irreplaceable loss (cannot be replaced or substituted) of resources but the value (services and/or functions) of these resources is limited.
	High (3)	Where the impact may result in the irreplaceable loss of resources of high value (services and/or functions).

The value for the final impact priority is represented as a single consolidated priority, determined as the sum of each individual criteria represented in Table E-5. The impact priority is therefore determined as follows:

$$Priority = Cl + LR$$

The result is a priority score which ranges from 2 to 6 and a consequent PF ranging from 1 to 1.5 (refer to Table E-6).

Table E-6: Determination of prioritisation factor

Priority	Prioritisation Factor
2	1
3	1.125
4	1.25
5	1.375
6	1.5

In order to determine the final impact significance, the PF is multiplied by the ER of the post mitigation scoring. The ultimate aim of the PF is an attempt to increase the post mitigation environmental risk rating by a factor of 0.5, if all the priority attributes are high (i.e., if an impact comes out with a high medium environmental risk after the conventional impact rating, but there is significant cumulative impact potential and significant potential for irreplaceable loss of resources, then the net result would be to upscale the impact to a high significance).

Table E-7: Final environmental significance rating

Significance Rating	Description
≥-17	High negative (i.e. where the impact must have an influence on the decision process to develop in the area).
≥-17, ≤-9	Medium negative (i.e. where the impact could influence the decision to develop in the area).
>-9, <0	Low negative (i.e. where this impact would not have a direct influence on the decision to develop in the area).
0	No impact
>0, <9	Low positive (i.e. where this impact would not have a direct influence on the decision to develop in the area).
≥9, ≤17	Medium positive (i.e. where the impact could influence the decision to develop in the area).
>17	High positive (i.e. where the impact must have an influence on the decision process to develop in the area).

The significance ratings and additional considerations applied to each impact will be used to provide a quantitative comparative assessment of the alternatives being considered. In addition, professional expertise and opinion of the specialists and the environmental consultants will be applied to provide a qualitative comparison of the alternatives under consideration. This process will identify the best alternative for the proposed project.