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ATMOSPHERIC IMPACT REPORT / AIR QUALITY IMPACT ASSESMENT

for

Assmang (Pty) Ltd. – Cato Ridge Development Company
2021 AQIA Cato Ridge Proposed Development Study Areas
(Cato Ridge, KwaZulu-Natal Province)

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For and on Behalf of EnviroNgaka (Pty) Ltd.

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Executive Summary

Assmang (Pty) Ltd (Assmang). and its subsidiary company, Cato Ridge Development Company (CRDC) have an operational manganese smelter, Assmang Limited Cato Ridge Alloys (Pty) Ltd. (ACRW), which is located north of the N3 highway between Durban and Pietermaritzburg in the Cato Ridge area of the eThekwini Municipality of KwaZulu-Natal, approximately 60km from Durban. The most densely populated formal residential area of Cato Ridge lies 3km to the south-west. Other less populated residential areas or isolated informal or formal residential properties are: Inchanga, located 4km (and beyond) east/south-east of ACRW, with other less formal residential areas and schools located in the hills less than 5km away to the north-east, north-west and west of ACRW. Several commercial and or industrial properties are located between 1km and 3km to the north-east of ACRW in the direction / vicinity of AVI Products, 1km to 2km to the south south-east / south-east of ACRW in the vicinity of the R103 / Eddie Hagan Drive intersection (e.g. Shu Powders, Metallica and Sangio Pipes), 1-1.5km to the south-west (Safal Steel and Cato Ridge Crematorium) and other activities farther west and south.

Assmang Limited established the Cato Ridge Works (formerly Feralloys Limited) in 1956 when construction was started on a ferromanganese smelter. The ferromanganese smelter was commissioned in 1959 and originally consisted of two 9MVA submerged electric arc furnaces. The operations at the site was expanded and upgraded over the years and currently operations are six submerged electric arc furnaces, a refinery operation known as Cato Ridge Alloys (CRA) and a Metal Recovery Plant. The site is also equipped with a Briquetting Plant which produces briquettes from recovered dust, ore and other materials, including binding agents. The High Carbon and the Refined (Low Carbon) Crushing & Screening Plants provide the final product for despatch by road and or rail to customers. Processed slag is deposited on the slag dump. Environmental authorisation was obtained in 2021 for a Sinter Plant at ACRW. The different processing units have gas cleaning equipment for the abatement of particulate matter emissions.
In light of specific products produced, raw materials consumed and or specific process, with respect to ferromanganese, ACRW is currently licenced to operate the following Listed Activities in terms of Section 21 of NEM:AQA:

1. Storage and handling of ore and coal (Subcategory 5.1);
2. Agglomeration operations (Subcategory 4.11);
3. Production of alloys of iron with chromium, manganese, silicon or vanadium, the separation of titanium slag from iron-containing minerals using heat (Subcategory 4.9);
4. Sinter Plant (Subcategory 4.5);

Assmang currently owns land adjacent to the ACRW smelter operation. The purpose of this study was to assess the potential impact of the ACRW operations on the quality of the ambient air over three portions of the land it owns, referred to as “Study Areas 1, 2 and 3” in this report to inform future land development (refer Figure 1.0, ACRW is the dotted demarcated area in the center of the figure). The investigation domain is limited to an overall area/domain of approximately 10km x 7km. In accordance with the approved Plan of Study for this assessment, the contribution of other industrial point sources from Listed Activities in terms of Section 21 of NEM:AQA within the 10km x 7km domain, were included in the study based on available information obtained from the eThekwini

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Municipality Licensing Authority. The sources included are AVI Products (bio filter), Cato Ridge Crematorium, Shu Powders and Safal Steel. Vehicle emissions emanating from traffic on the N3 which passes Cato Ridge was included in the assessment based on available traffic data obtained from Mikros Traffic Monitoring (Pty) Ltd. Emission data available for the period of 2017-2019 (pre COVID-19 2020-2021 National Lockdown levels) was utilised together with ambient air and meteorological monitoring data for this assessment. It is noted that there are other sources of emissions within the investigation domain which were not included in this assessment.

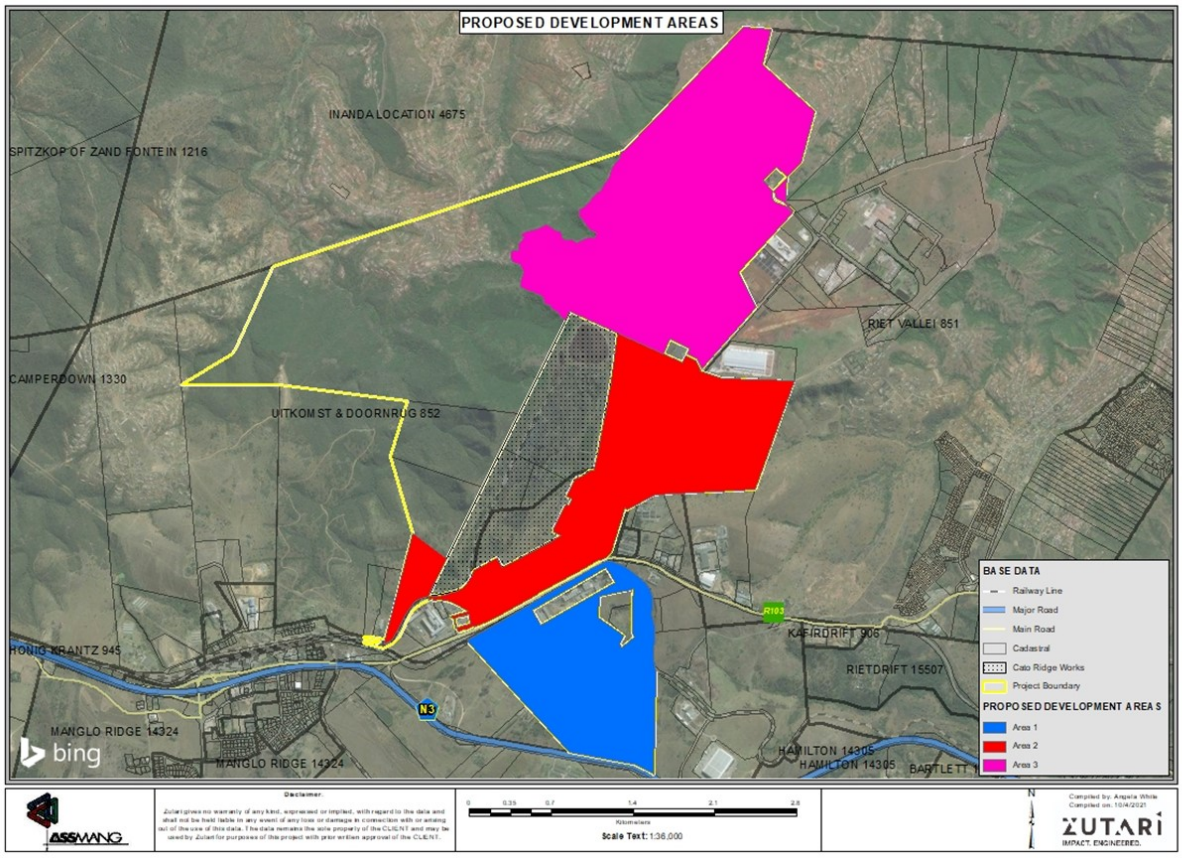


Figure 1.0: Cato Ridge Development Study Areas 1, 2 and 3

The purpose of this study was to assess the potential impact of the ACRW operation and other emissions sources for which information could be obtained, on the quality of the ambient air over three portions of the land it owns, referred to as "Study Areas 1, 2 and 3" in this report to inform future land development. On this basis, recommendations are made regarding future proposed land use options on the three (3) Proposed Development Areas, "Study Areas 1, 2 and 3". In view of the study conducted on behalf of Assmang, the ACRW operation is referenced in this report as the relevant Enterprise in terms of the required format of an Atmospheric Impact Report.

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Site-specific meteorological data was simulated for a period from January 2017 to December 2019 based on observed/monitored data from a meteorological station located approximately 323m southeast of the centre of the ACRW site, and utilised for the impact assessment and data interpretation. The location for the simulated meteorological monitoring data is located in close proximity to the entrance security gate of ACRW (bordering Proposed Development Area 2), approximately 399m southeast (29°43.0'S, 30°37.0'E) of the defined centre of ACRW at an elevation of approximately 793 mamsl, with the wind monitored at a height of 10m and the other parameters at 2m above ground level.

1. The following concluding comments and recommendations are limited to the Proposed Development Areas, referred to as "Study Areas 1, 2 and 3", based on the defined purpose / scope of the study, the information available for the assessment, inclusive of all the emission sources/operations considered in this investigation;
2. It is understood from pre-feasibility studies for the proposed land development project had indicated that *light industry*, *general industry*, *warehousing* and *logistics land* uses proved to be viable land use options from a market perspective and in terms of eThekwini Town Planning Regulations, use zones are described as follows:
   2.1) the light Industry, include light industrial and service industrial. Light Industry also comprises of the following special consent: Institution, Offices, Parking Garage, Petrol Service Station, Shop in terms of clause 6(31), Restaurant, Totalisator Depot, Special Building or use, any other use authorised in terms of clause 6;
   2.2) the General Industry, industrial purposes other than Extractive or Noxious are permitted. General Industry special consent are Institution, Offices, Parking Garage, Petrol Service Station, Shop in terms of clause 6(31), Restaurant, Totalisator Depot, Special Building or use, any other use authorised in terms of clause 6;
3. The available information was utilised to assess the potential impact to air quality over the defined study areas by means of dispersion modelling, limited to the data available and noting that other sources, not included in the study, will contribute to / impact on the quality of the ambient air over the study areas. It should also be noted that this is a theoretical / modelling assessment and it should always be considered that there are several factors which influence the resulting uncertainty of such a study, as flagged/indicated by means of the comments made throughout the content of this report. In terms of the dispersion modelling uncertainties provided in Appendix U, the assumptions made and the information contained in the report, the findings are made against a confidence rating of medium to high. Whilst all attempts are made to ensure objectivity and impartiality, the "assessment remains an act of judgement and can never escape the subjectivity inherent in attempting to define significance." The key findings are dealt with under the following points;
4. Subject to the aforementioned descriptions of potential land uses and the following key findings, it is considered/noted that:
   4.1) In light of the recent and unfortunate UPL South Africa (Pty) Ltd. warehouse fire in Cornubia, Umhlanga, that this investigation did not make provision for such an incident, that the findings and recommendations are made under the premise that an impact assessment(s) will be conducted for the specific land use as proposed by each applicant/tenant/land owner and that all preventative measures will be taken to prevent a re-occurrence of such an incident;
   4.2) It is "unlikely" that *light industry*, *general industry*, *warehousing* and *logistics land* uses will impact negatively on the surrounding communities and that it is "likely" that the ambient air quality standards could still be met over those sensitive receptors;

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4.3) It is recommended that the land should not be for residential use and that no persons/employees should reside on the land;

5. Key findings of the dispersion modelling results (Section 5.1) indicates the following matters, with reference to the National Ambient Air Quality Standards (NAAQS) being the South African National Ambient Air Quality Standards, in terms of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004), as published in Government Gazette No. 32816 on the 24th of December 2009 and the South African National Ambient Air Quality Standards for $PM_{2.5}$ (Particulate matter with an aerodynamic diameter less than 2.5µm), in terms of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004), as published in Government Gazette No. 35463 on the 29th of June 2012:

5.1) PM_{10} & $PM_{2.5}$:

5.1)1. Study Area 1: It is foreseen to be "likely" that the ambient air quality falls within the relevant standards for 24-hour and annual averages;

5.1)2. Study Area 2: It is foreseen to be "likely" that the ambient air quality over portions of study area 2 bordering ACRW (approximately 0-100m east of ACRW) will exceed the relevant National Ambient Air Quality Standards (NAAQS) for 24-hour and annual averages. It is noted that at present no Residential areas/Communities are located within this area of potential NAAQS exceedance;

5.1)3. Study Area 3: It is foreseen to be "very likely" that the ambient air quality over portions of study area 3 bordering ACRW (approximately 0-400m north of ACRW) will exceed the relevant NAAQS for 24-hour and annual averages;

5.1)4. It is further noted that data from the Radnor continuous ambient air monitoring station (located approximately 1 km to the east of ACRW) has suggested that source(s) east/south-east/south of the station is/are impacting on the ambient air quality at that location which in addition contribute to exceedances of standards, which implies that it is "as likely as not" for Study Areas 1, 2 and 3 to exceed the relevant 24-hour and annual average NAAQS;

5.1)5. Under the premise that these proposed development areas are to be zoned for light industry/general industry/warehousing/logistics and that the quality of the air over the areas need not meet with the NAAQS, it is recommended that development should be such that it limits further contribution to the airshed and not impact negatively on existing or potential neighbouring sensitive receptors (residential areas). It hence also implies that people/employees should not reside on the properties;

5.1)6. No threshold PM levels exist to indicate adverse negative effects on animals and plants. In this light it was decided to use the same screening criteria applied to human health, i.e. the NAAQS (refer to AQIA report, section 5.1). Based on the simulated ambient concentrations (sections 5.1.3.PM10 to 5.1.3.PM2.5) the same findings apply as referred to under 5.1)1-5.1)4;

5.1)7. On an ongoing basis ACRW investigates and/or implements additional options/measures to mitigate PM emissions;

5.2) SO_2:

5.2)1. Study Areas 1, 2 and 3: It is foreseen to be "very likely" that the ambient air quality falls within the relevant NAAQS for 1-hour, 24-hour and annual averages;

5.2)2. Most of the current studies focusing on the impact of SO_2 on animals concluded that immediate physiological response and/or significant or permanent damage occurs in the low to upper mg/m^3 concentration ranges. In this light it was decided to use the same screening criteria applied to

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human health, i.e. the NAAQS (refer to AQIA report, section 5.1). Based on the simulated ambient concentrations (sections 5.1.3.SO2) it is "likely" that the ambient concentrations fall within the NAAQS and the World Health Organisation (WHO) annual guidelines for some plant species;

5.3) NO_2:

5.3)1. Regardless of the other sources/operations included in this investigation, it is noted that the NO_X (as NO_2) emissions from ACRW and its impact on the surrounding ambient air quality could conservatively have been overstated (estimated secondary emissions), with investigations planned to assess and to consider options. The following points are subject to the potential overestimation;

5.3)2. Study Area 1: It is foreseen to be "likely" that the ambient air quality over portions of study area 1 (approximately 0-100m south of Study Area 2) could exceed the relevant NAAQS for a 1-hour average and falls within the NAAQS for the annual average period. It is noted that at present no Residential areas/Communities are located within this area of potential NAAQS exceedance;

5.3)3. Study Area 2: It is foreseen to be "likely" that the ambient air quality over portions of study area 2 bordering ACRW (approximately 0-800m south-east of ACRW and approximately 0-100m east of ACRW) could exceed the relevant NAAQS for a 1-hour average and falls within the NAAQS for the annual average period. It is noted that at present no Residential areas/Communities are located within this area of potential NAAQS exceedance;

5.3)4. Study Area 3: It is foreseen to be "likely" that the ambient air quality over study area 3 should fall within the relevant NAAQS, both 1-hour and annual averages;

5.3)5. It was decided to use the same screening criteria for the impact on animals as applied to human health, i.e. the NAAQS (refer to AQIA report, section 5.1). Based on the simulated ambient concentrations in the AQIA (sections 5.1.3.NO2) it is "likely" that the same findings apply as referred under 5.3)2-5.3)4;

5.3)6. Under the premise that these areas are to be zoned for light industry/general industry/warehousing/logistics and that the quality of the air over the study areas need not meet with the NAAQS, it is therefore recommended that development should be such that it limits further contribution to the airshed not impact negatively on existing or potential neighbouring sensitive receptors (residential areas). It hence also implies that people/employees should not reside on the properties;

5.3)7. The annual 4 $\mu g/m^3$, 8.5 $\mu g/m^3$ and 35.5 $\mu g/m^3$ NO_2 concentration isopleths are distinguishable in section 5.1.3.NO2-2. This concentration will give rise to approximate dry deposition loads of 2.6 kg NO_2/ha, 4.6 kg NO_2/ha and 15.1 kg NO_2/ha per year, respectively;

5.3)8. Excluding wet deposition and deposition of other "N" containing species, comparing the deposition loads of 2.6 kg NO_2/ha, 4.6 kg NO_2/ha and 15.1 NO_2/ha per year to Table 5.33 in terms of kg N/ha per year, it is "likely" that the ambient NO_2 concentrations beyond a distance of approximately 500m to the east and west of ACRW, will not have a significant adverse effect on vegetation and ecosystems. It is "likely" that the ambient NO_2 concentrations north and south of ACRW, will not have a significant adverse effect on vegetation and ecosystems.

5.4) CO:

5.4)1. Study Areas 1, 2 and 3: It is foreseen to be "likely" that the ambient air quality falls within the relevant NAAQS for 1-hour and 8-hour annual averages;

5.4)2. The impact of CO on animals Table 5.36 correlate with the South African NAAQS, thus the screening criteria applied to human health, i.e. the NAAQS will be used (section 5.1). Based on the simulated

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ambient concentrations in sections 5.1.3.CO it is "likely" that the ambient concentrations falls within the NAAQS as referred to under 5.4)1;

5.4)3. It was decided to use the same screening criteria on plants and ecosystems as applied to human health, i.e. the NAAQS (section 5.1). Based on the simulated ambient concentrations in sections 5.1.13.CO it is "likely" that the ambient concentrations falls within the NAAQS as referred to under 3.4)1.

5.5) NH_3:

5.5)1. In the absence of a national air quality standard, the 24-hour average US EPA Reference Concentration of 100$\mu g.m^{-3}$ was used as a reference;

5.5)2. Study Areas 1, 2 and 3: It is foreseen to be "likely" that the NH_3 ambient air quality falls well within the relevant reference;

5.5)3. Most of the current studies focusing on the impact of NH_3 reference the US EPA Reference Concentration. Based on the simulated ambient concentrations (section 5.1.3.NH3) exceedances didn't occur, therefore it is "likely" that the ambient concentrations falls within the reference and adverse effects on the health of animals are unlikely;

5.6) Benzene (C_6H_6) for VOC:

5.6)1. Study Areas 1, 2 and 3: It is foreseen to be "very likely" that the C_6H_6 ambient air quality falls within the relevant NAAQS for an annual average;

5.6)2. No threshold C_6H_6 levels exist to indicate adverse negative effect on animals and plants. In this light, it was decided to use the same screening criteria applied to human health, i.e. the NAAQS (refer to AQIA report, section 5.1). Based on the simulated ambient concentrations exceedances are "unlikely" to occur as referred to under 5.6)1.

5.7) Manganese (Mn):

5.7)1. In the absence of a national air quality standard, the annual average WHO ambient air quality guideline of 0.15$\mu g.m^{-3}$ for Mn was used as a reference;

5.7)2. Study Areas 1, 2 and 3: It is foreseen to be "very likely" that the Mn ambient air quality will be in excess of the relevant guideline;

5.7)3. Under the premise that these areas are to be zoned for light industry/general industry/warehousing/logistics and that the quality of the air over the study areas need not meet with the NAAQS, it is therefore recommended that development should be such that it limits further contribution of Mn to the airshed and not impact negatively on existing or potential neighbouring sensitive receptors (residential areas). It hence also implies that people/employees should not reside on the properties (a specialist health impact assessment would be required to determine specific potential health risks, where/when required);

5.8) Dust Fallout (DFO):

5.8)1. Based on the DFO monitoring data (since 2017) of ACRW, compliance of DFO levels with the National Dust Control Regulations (NDCR) (Government Notice 827, 01November 2013) is very good as indicated by the data. Fugitive and secondary emissions sources appear to be well controlled. It is also noted that other sources in the area are also contributing to DFO levels sampled by ACRW;

5.8)2. It is however also noted that the possibility of fugitive dust from secondary sources, such as roads and storage facilities, is foreseen to increase significantly during spring and some winter months;

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5.8)3. It is recommended that activities that could potentially be considered in any of the study areas should preferably not contribute further to levels of DFO in the airshed and that the NDCR should be complied with and that DFO monitoring be conducted for the proposed development areas;

5.9) Ambient Air Quality Monitoring:

5.9)1. Based on the analysis of the data obtained from two monitoring locations (the Radnor CAAQMS and the Cato Ridge Country Club CAAQMS), the quality of ambient air in the region is fairly good and there is good compliance of the gaseous compounds to the relevant ambient air quality standards;

5.9)2. The Radnor CAAQMS is located approximately 1 km east of ACRW. It is noted that there are occurrences of high 24-hour average PM_{10} and $PM_{2.5}$ concentrations, most of which are either related to source(s) east/south-east/south of the station which contribute to levels, a gravel road near the station and or to regional pre-frontal synoptic conditions;

5.9)3. It is also noted that the number of 24-hour average PM_{10} concentrations at the Cato Ridge Country Club CAAQMS which exceed the standard's concentration, have decreased in 2021;

5.10) Air Quality Management Actions/Plans:

5.10)1. With due consideration of the risk/impact assessment provided in Appendix E proposed air quality management actions/plans are provided in Appendix F, which includes the following items, whilst ensuring that legal requirements are met:

5.10)1.1. Maintaining measures to minimise the release of abnormal emissions (raw gas and tapping/casting fugitives) to an absolute minimum since the impact thereof is potentially significant;

5.10)1.2. Maintaining the application of efficient dust abatement and suppression techniques in order to minimise overall particulate emissions;

5.10)1.3. Limiting vehicle movement and associated diesel consumption as far as possible;

5.10)1.4. Limiting fugitive emissions;

5.10)1.5. Aforementioned points will individually and collectively minimise emissions and impact of manganese;

5.10)1.6. It is recommended that additional monitoring of DFO and noxious fumes be conducted to establish additional baseline ambient monitoring data prior to the commencement of construction of the proposed development and continue thereafter. In addition to current monitoring actions, Figure F.1 read with Table F.2 provides an indication of proposed additional ambient monitoring and locations.

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Nomenclature

amsl	Above Mean Sea Level
AEL	Atmospheric Emissions License
AERMOD	American Meteorological Society/Environmental Protection Agency Regulatory Model
AIR	Atmospheric Impact Report
ACRW	Assmang Limited Cato Ridge Alloys (Pty) Ltd.
APCE	Air Pollution Control Equipment
APPA	Atmospheric Pollution Prevention Act
AQA	National Environmental Management: Air Quality Act
AQIA	Air Quality Impact Assessment
AQMP	Air Quality Management Plan
CAAQMS	Continuous Ambient Air Quality Monitoring Station
ARM	African Rainbow Minerals
ASTM	American Society of Testing and Materials
BH	Bagfilter / Baghouse
BTEX	Benzene, Toluene, Ethyl benzene and Xylene
C&S	Crushing & Screening
CAAQMS	Continuous Ambient Air Quality Monitoring Station
CBD	Central Business District
CG	Clean Gas
CO	Carbon Monoxide
C_6H_6	Benzene
CO_2	Carbon Dioxide
Cr	Chromium
Cr(VI)	Hexavalent Chromium
DEFF	National Department of Environment, Forestry and Fisheries
(DEA)	(previously National Department of Environmental Affairs)
DME	National Department of Minerals and Energy
DFO	Dust Fallout in terms of the National Dust Control Regulation, GG36974 GN827, 01November2013
EAF	Electric Arc Furnace
EAP	Environmental Assessment Practitioner
EIA	Environmental Impact Assessment
EMP	Environmental Management Program
Enterprise	Assmang Limited Cato Ridge Alloys (Pty) Ltd.
EPA	United States Environmental Protection Agency
FeMn	Ferromanganese
I&AP	Interested and Affected Parties
ISO	International Organization for Standardization
I-TEQ	International Toxic Equivalent

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GN	General Notice
HC	Hydrocarbon
HC C&S	High Carbon Crushing & Screening
HCl	Hydrogen Chloride
HF	Hydrogen Fluoride
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organisation for Standardisation
LC C&S	Low Carbon Crushing & Screening
MEC	Member of Executive Council
MEP	Metal Extraction Plant
MRP	Metal Recovery Plant
Mn	Manganese
MS	Monitoring station / Ambient air monitoring station
MVA	Mega-Volt-Ampere
MW	MegaWatt
N/A	Not applicable
n/ap	Not applicable
n/av	Not available
NDCR	National Dust Control Regulation, GG36974 GN827, 01November2013
NEM:AQA	National Environmental Management: Air Quality Act
NH_3	Ammonia
NO	Nitrogen Oxide
NO_2	Nitrogen dioxide
NO_x	Oxides of Nitrogen (expressed as NO_2)
NPI	Australian National Pollutant Inventory
OHS	Occupational Health & Safety
PCDD	Dioxins
PCDF	Furans
PCDD/PCDF	Dioxins and Furans
PCDD/F	Dioxins and Furans
PFD	Process flow diagram
PM	Particulate Matter
PM_{10} / PM10	Particulate Matter with an aerodynamic diameter of ≤ 10 micrometers
$PM_{2.5}$ / PM2.5	Particulate Matter with an aerodynamic diameter of ≤ 2.5 micrometers
ppm	Parts per million (g/Mg)
PRIME	Plume Rise Model Enhancements
PSD	Particle Size Distribution
ROD	Record of Decision
ROM / R.O.M.	Run-of-mine ore
SA / S.A.	South Africa
SANS	South African National Standard
Site	Assmang Limited Cato Ridge Alloys (Pty) Ltd.
SO_2	Sulphur dioxide

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SO_x	Oxides of sulphur
Study Area 1	Proposed Development Area 1 (refer Figure 1.0)
Study Area 2	Proposed Development Area 2 (refer Figure 1.0)
Study Area 3	Proposed Development Area 3 (refer Figure 1.0)
TBD	To be determined
TOC	Total Organic Compounds
TP	Transfer point(s)
TSF	Tailings Storage Facility
TSP	Total Suspended Particulates – Also refers to Particulate Matter with reference to this report
t/d tpd	Tonne per day
t/h tph	Tonne per hour
tpa	Tonne per annum
t/m tpm	Tonne per month
UK	United Kingdom
US / USA	United States of America
UTM	Universal Transverse Mercator Coordinate System
V	Vanadium
VOC	Volatile Organic Compound
WHO	World Health Organization
WML	Waste Management License
WS	Wet Scrubber

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1. SITE/ENTERPRISE DETAILS

Assmang (Pty) Ltd (Assmang). and its subsidiary company, Cato Ridge Development Company (CRDC) have an operational manganese smelter, Assmang Limited Cato Ridge Alloys (Pty) Ltd. (ACRW), which is located north of the N3 highway between Durban and Pietermaritzburg in the Cato Ridge area of the eThekwini Municipality of KwaZulu-Natal, approximately 60km from Durban. The most densely populated formal residential area of Cato Ridge lies 3km to the south-west. Other less populated residential areas or isolated informal or formal residential properties are: Inchanga, located 4km (and beyond) east/south-east of ACRW, with other less formal residential areas and schools located in the hills less than 5km away to the north-east, north-west and west of ACRW. Several commercial and or industrial properties are located between 1km and 3km to the north-east of ACRW in the direction / vicinity of AVI Products, 1km to 2km to the south south-east / south-east of ACRW in the vicinity of the R103 / Eddie Hagan Drive intersection (e.g. Shu Powders, Metallica and Sangio Pipes), 1-1.5km to the south-west (Safal Steel and Cato Ridge Crematorium) and other activities farther west and south.

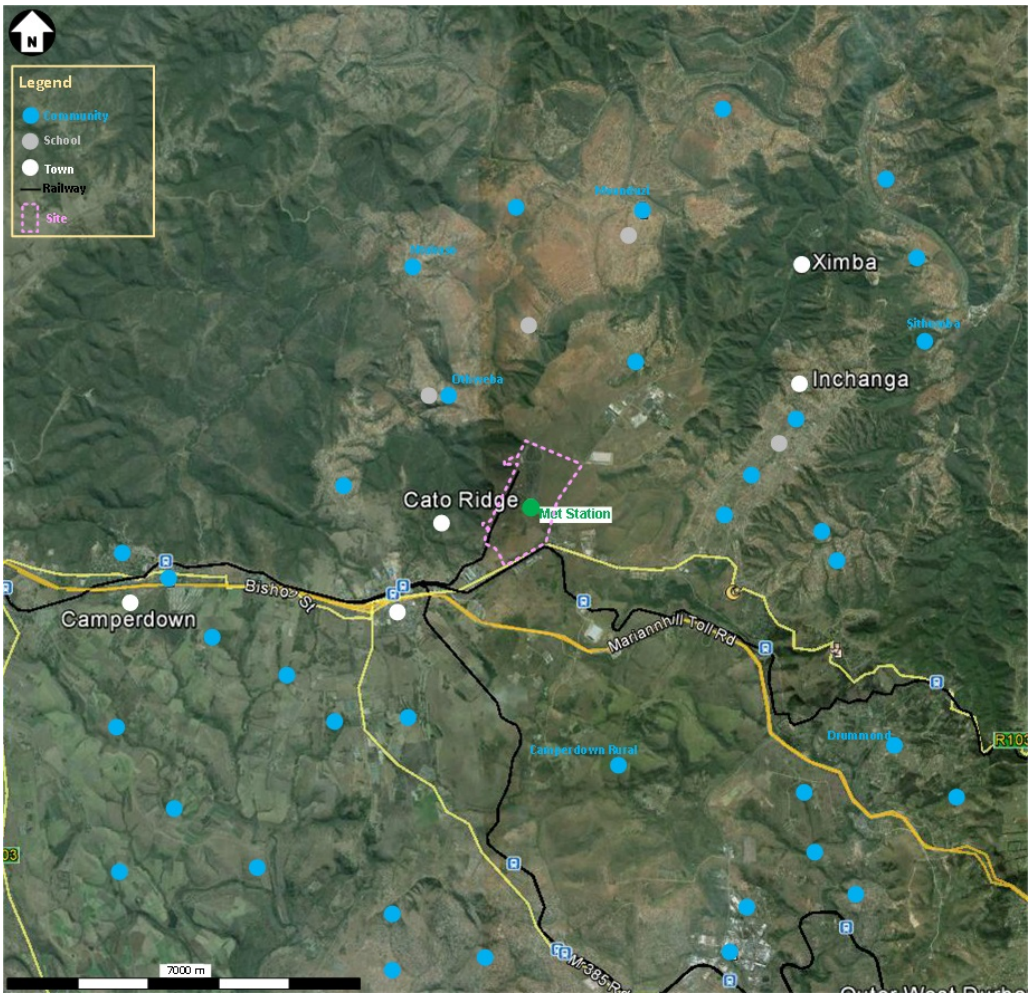


Figure 1.1: Location of Enterprise

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Assmang Limited established the Cato Ridge Works (formerly Feralloys Limited) in 1956 when construction was started on a ferromanganese smelter. The ferromanganese smelter was commissioned in 1959 and originally consisted of two 9MVA submerged electric arc furnaces. The operations at the site was expanded and upgraded over the years and currently operations are six submerged electric arc furnaces, a refinery operation known as Cato Ridge Alloys (CRA) and a Metal Recovery Plant. The site is also equipped with a Briquetting Plant which produces briquettes from recovered dust, ore and other materials, including binding agents. The High Carbon and the Refined (Low Carbon) Crushing & Screening Plants provide the final product for despatch by road and or rail to customers. Processed slag is deposited on the slag dump. Environmental authorisation was obtained in 2021 for a Sinter Plant at ACRW. The different processing units have gas cleaning equipment for the abatement of particulate matter emissions.

In light of specific products produced, raw materials consumed and or specific process, with respect to ferromanganese, ACRW is currently licenced to operate the following Listed Activities in terms of Section 21 of NEM:AQA:

1. Storage and handling of ore and coal (Subcategory 5.1);
2. Agglomeration operations (Subcategory 4.11);
3. Production of alloys of iron with chromium, manganese, silicon or vanadium, the separation of titanium slag from iron-containing minerals using heat (Subcategory 4.9);
4. Sinter Plant (Subcategory 4.5);

Assmang currently owns land adjacent to the ACRW smelter operation. The purpose of this study was to assess the potential impact of the ACRW operations on the quality of the ambient air over three portions of the land it owns, referred to as “Study Areas 1, 2 and 3” in this report to inform future land development (refer Figure 1.0, ACRW is the dotted demarcated area in the center of the figure). The investigation domain is limited to an overall area/domain of approximately 10km x 7km. In accordance with the approved Plan of Study for this assessment, the contribution of other industrial point sources from Listed Activities in terms of Section 21 of NEM:AQA within the 10km x 7km domain, were included in the study based on available information obtained from the eThekwini Municipality Licensing Authority. The sources included are AVI Products (bio filter), Cato Ridge Crematorium, Shu Powders and Safal Steel. Vehicle emissions emanating from traffic on the N3 which passes Cato Ridge was included in the assessment based on available traffic data obtained from Mikros Traffic Monitoring (Pty) Ltd. Emission data available for the period of 2017-2019 (pre COVID-19 2020-2021 National Lockdown levels) was utilised together with ambient air and meteorological monitoring data for this assessment. It is noted that there are other sources of emissions within the investigation domain which were not included in this assessment.

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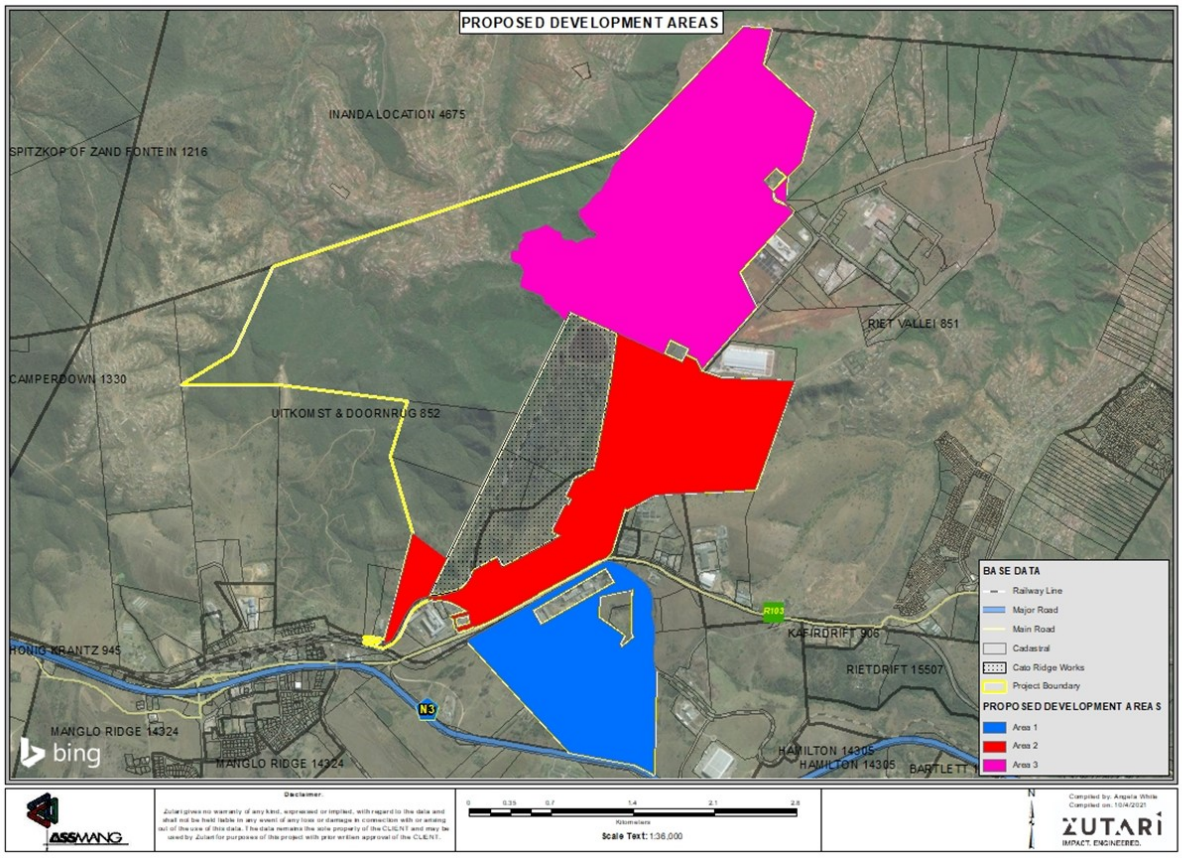


Figure 1.0: Proposed Development Areas – Study Areas 1, 2 and 3

The purpose of this study was to assess the potential impact of the ACRW operation and other emissions sources for which information could be obtained, on the quality of the ambient air over three portions of the land it owns, referred to as "Study Areas 1, 2 and 3" in this report to inform future land development. On this basis, recommendations are made regarding future proposed land use options on the three (3) Proposed Development Areas, "Study Areas 1, 2 and 3". In view of the study conducted on behalf of Assmang, the ACRW operation is referenced in this report as the relevant Enterprise in terms of the required format of an Atmospheric Impact Report.

1.1 Site/Enterprise Details

i) Company Name : Assmang Limited Cato Ridge Alloys (Pty) Ltd.

ii) Company Registration Number : Assmang Manganese Cato Ridge Works: 1935/007343/06
Cato Ridge Alloys (Pty) Ltd.: 97/00755/07

iii) Trading Name : Assmang Manganese Cato Ridge Works

iv) Contact details for the responsible person and his/her delegates

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Responsible Person Name or Emission Control Officer (where appointed):	:	Responsible Person:	Mr. Ashwin Santhilal (Acting General Works Manager)
		Emission Control Officer:	Mr. Wessel Oosthuizen (Emission Control Officer)
Telephone Number:	:	Mr. Ashwin Santhilal:	+27 (0) 31 782 5000
		Mr. Wessel Oosthuizen:	+27 (0) 31 782 5000
Cell Phone Number:	:	Mr. Wessel Oosthuizen:	+27 (0) 82 453 6361
Fax Number:	:	+27 (0) 86 632 5077	
E-mail Address:	:	Mr. Ashwin Santhilal:	ashwins@feralloys.co.za
		Mr. Wessel Oosthuizen:	wesselo@feralloys.co.za
After Hours Contact Details:	:	Mr. Wessel Oosthuizen:	+27 (0) 82 453 6361

v) Physical Address of the Head Office : 1 Eddie Hagan Drive
Cato Ridge
KwaZulu-Natal Province

vi) Postal Address of the Head Office : P.O. Box 21
Cato Ridge, KwaZulu-Natal
3680

1.2 Location and Extent

i) Physical Address of the Enterprise : 1 Eddie Hagan Drive
Cato Ridge
KwaZulu-Natal Province

ii) Physical Address of the Ancillary Enterprise : As above

iii) Description of Site (Erf) : 1 Eddie Hagan Drive
Cato Ridge
KwaZulu-Natal Province

iv) Coordinates of Approximate Centre of Operations : Latitude (North-South): 29.715252 S
Longitude (East-West): 30.612879 E

v) Extent (km^2) : 2.422 km^2 (extended fenced area)

vi) Elevation Above Mean Sea Level (m) : 790 m

vii) Province : KwaZulu Natal Province

viii) Metropolitan/District Municipality : eThekwini

ix) Local Municipality : Cato Ridge

x) Designated Priority Area (if applicable) : Not applicable

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Figures 1.2 to 1.7 hereafter provide the following illustrations:

1.2 Regional Area surrounding the Enterprise (50km x 50km)
1.3 Area surrounding the Enterpise (with 5km radius from centre of operations)
1.4 AQIA (Air Quality Impact Assessment) Investigation Domain
1.5 Enterprise Overview
1.6 Topography (relief contours in meters) of the area surrounding the Enterprise (20km x 20km)
1.7 Topography (surface profile) of the area surrounding the Enterprise (20km x 20km)

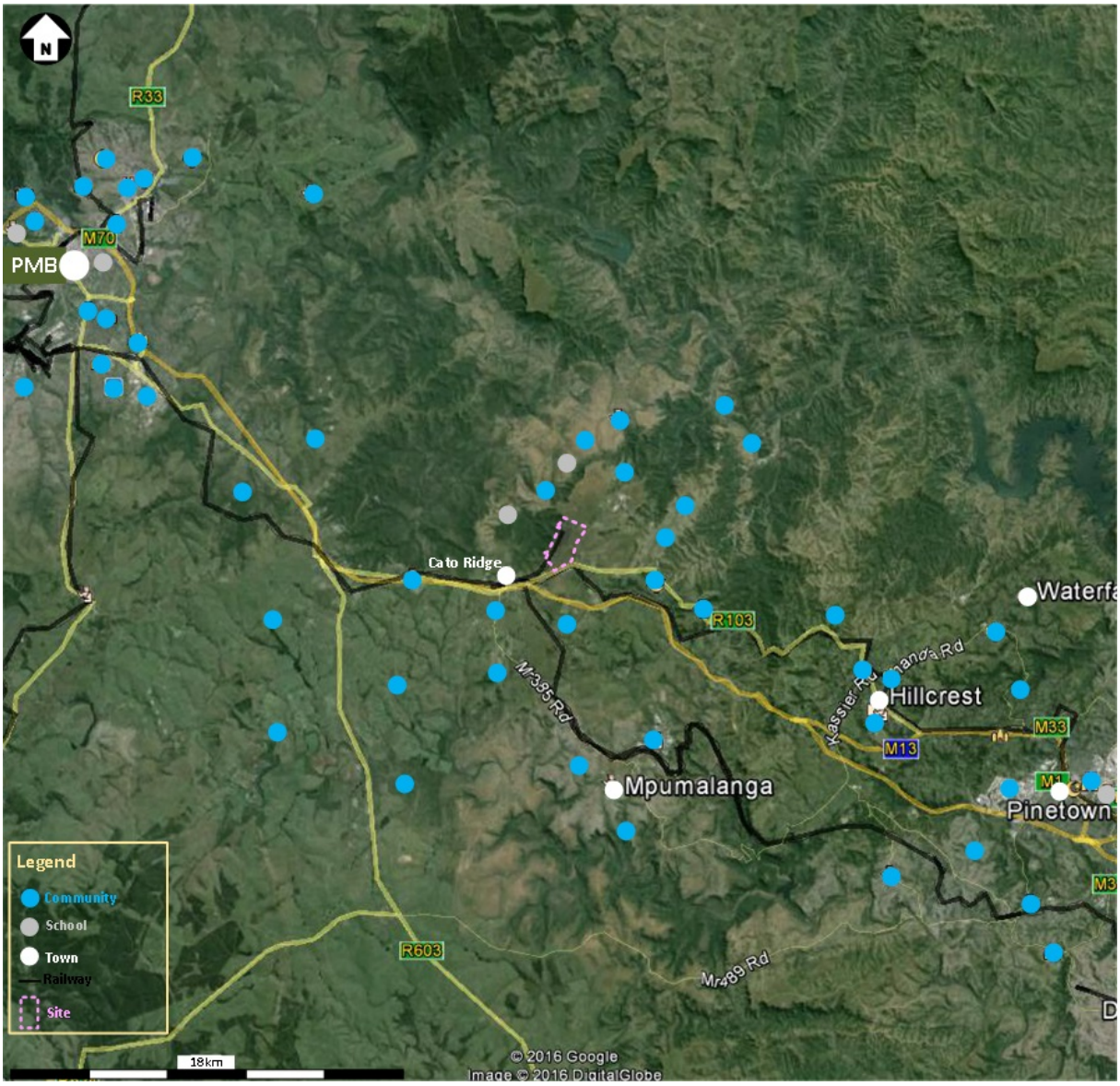


Figure 1.2: Regional Area surrounding the Enterprise (50km x 50km)

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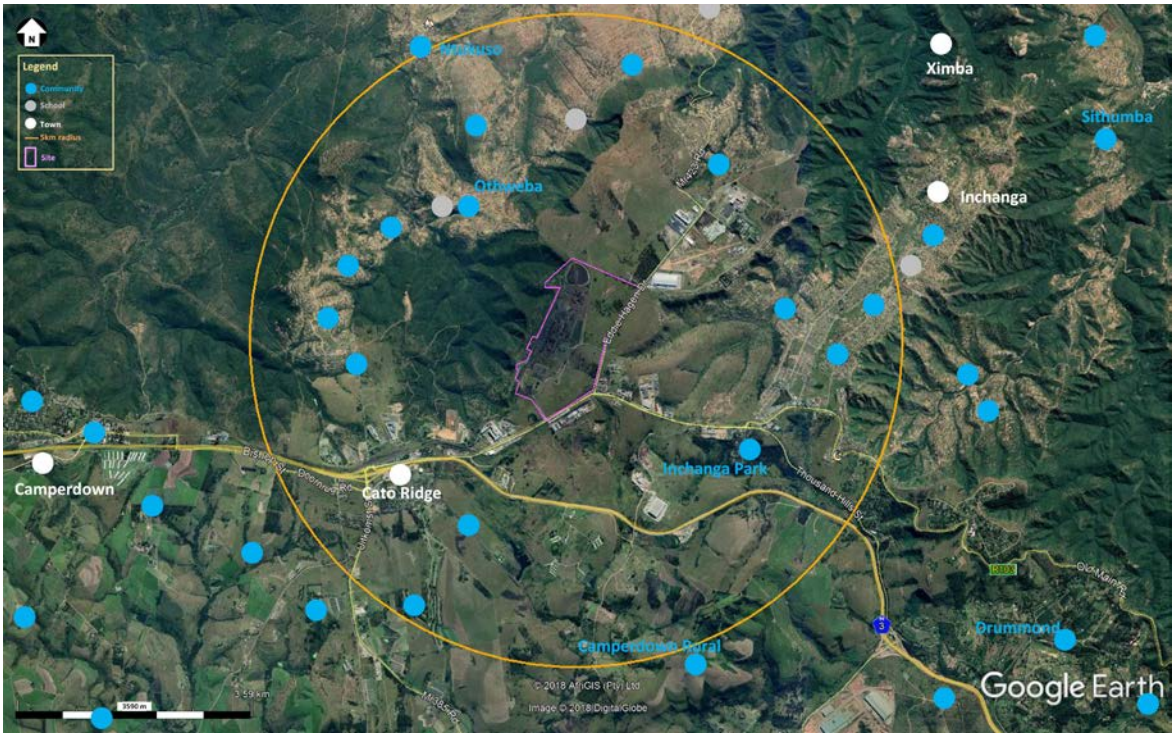


Figure 1.3: Area surrounding the Enterprise (with 5km radius from centre of operations)

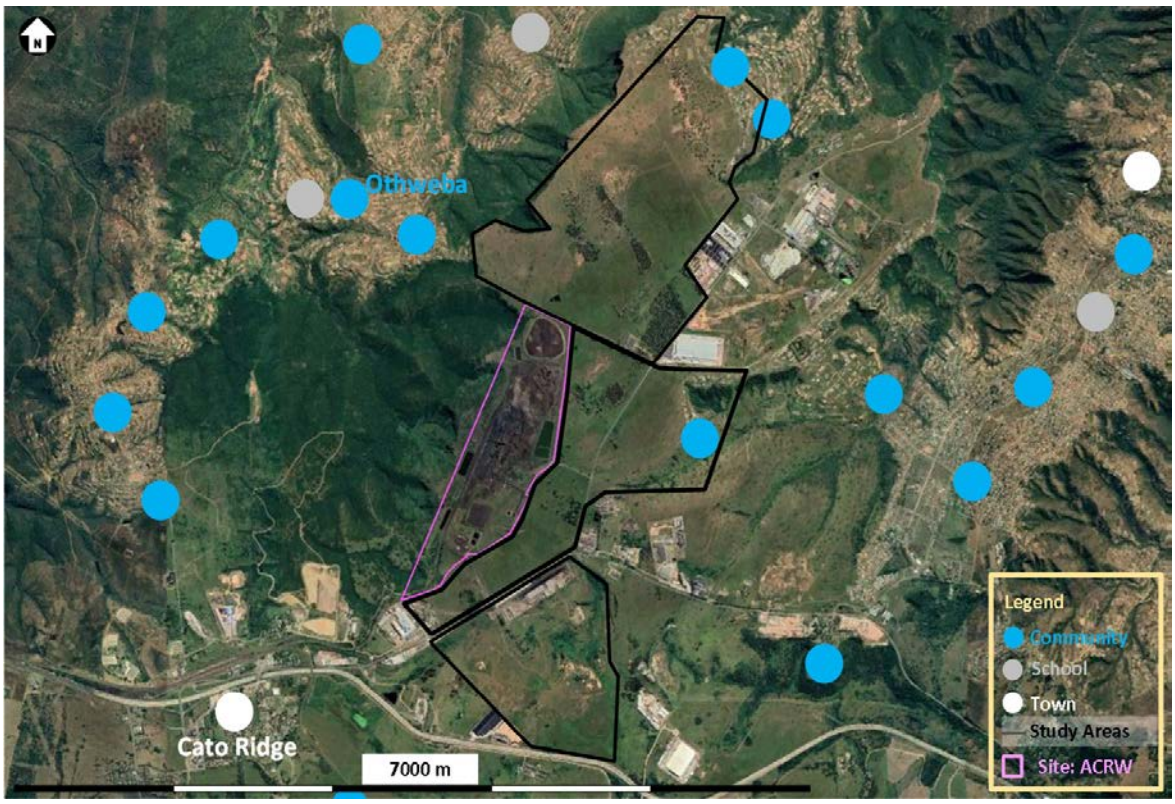


Figure 1.4: AQIA Investigation Domain

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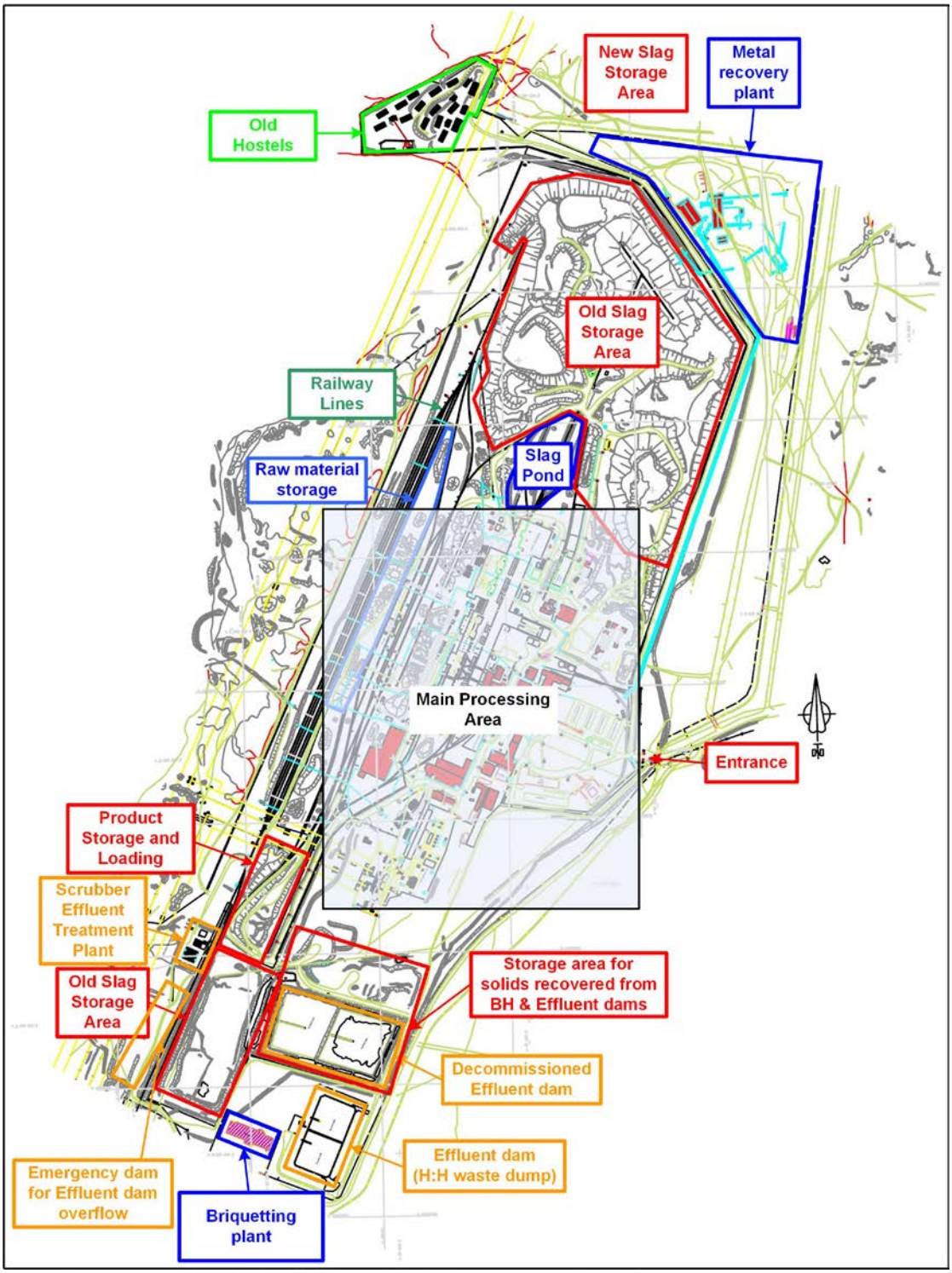


Figure 1.5: Enterprise Overview

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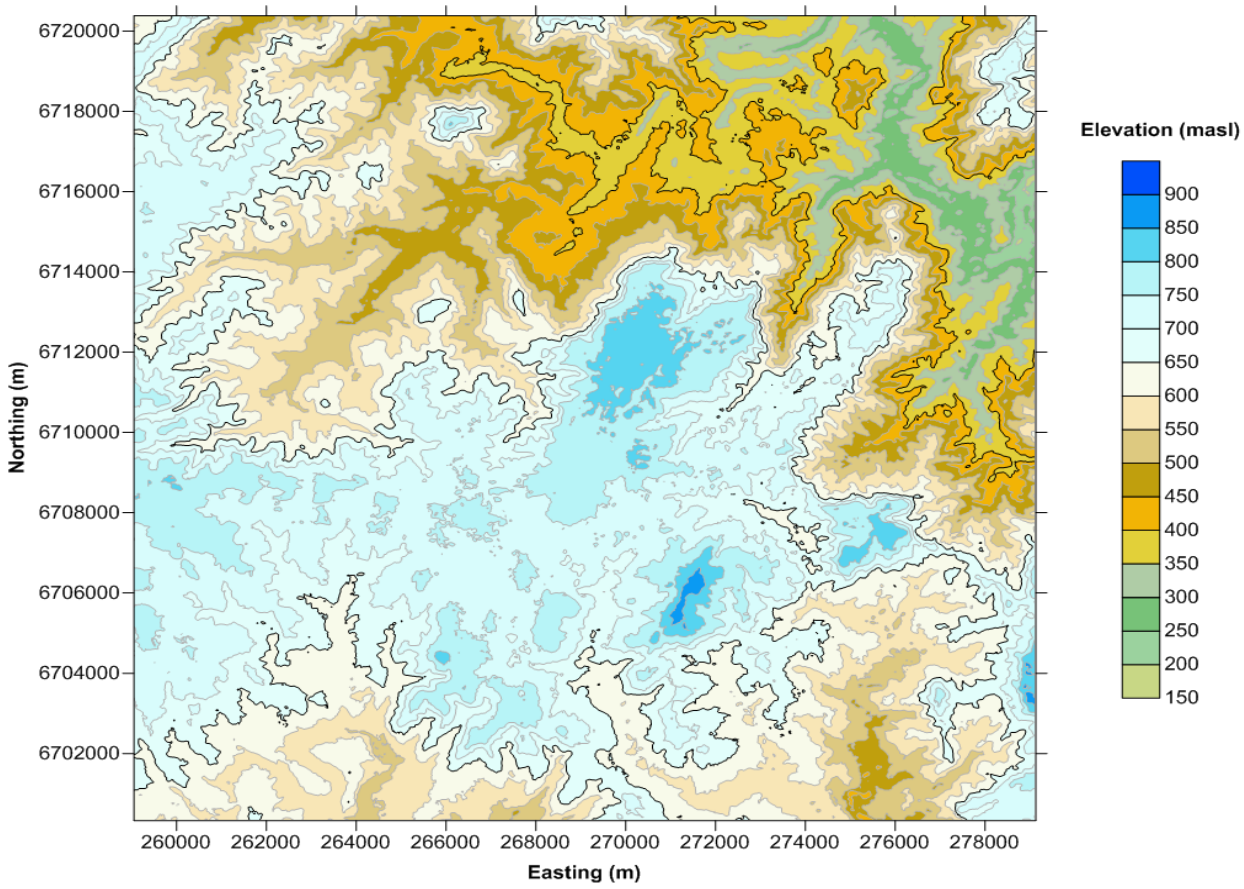


Figure 1.6: Topography (relief contours in meters) of the area surrounding the Enterprise (20km x 20km)

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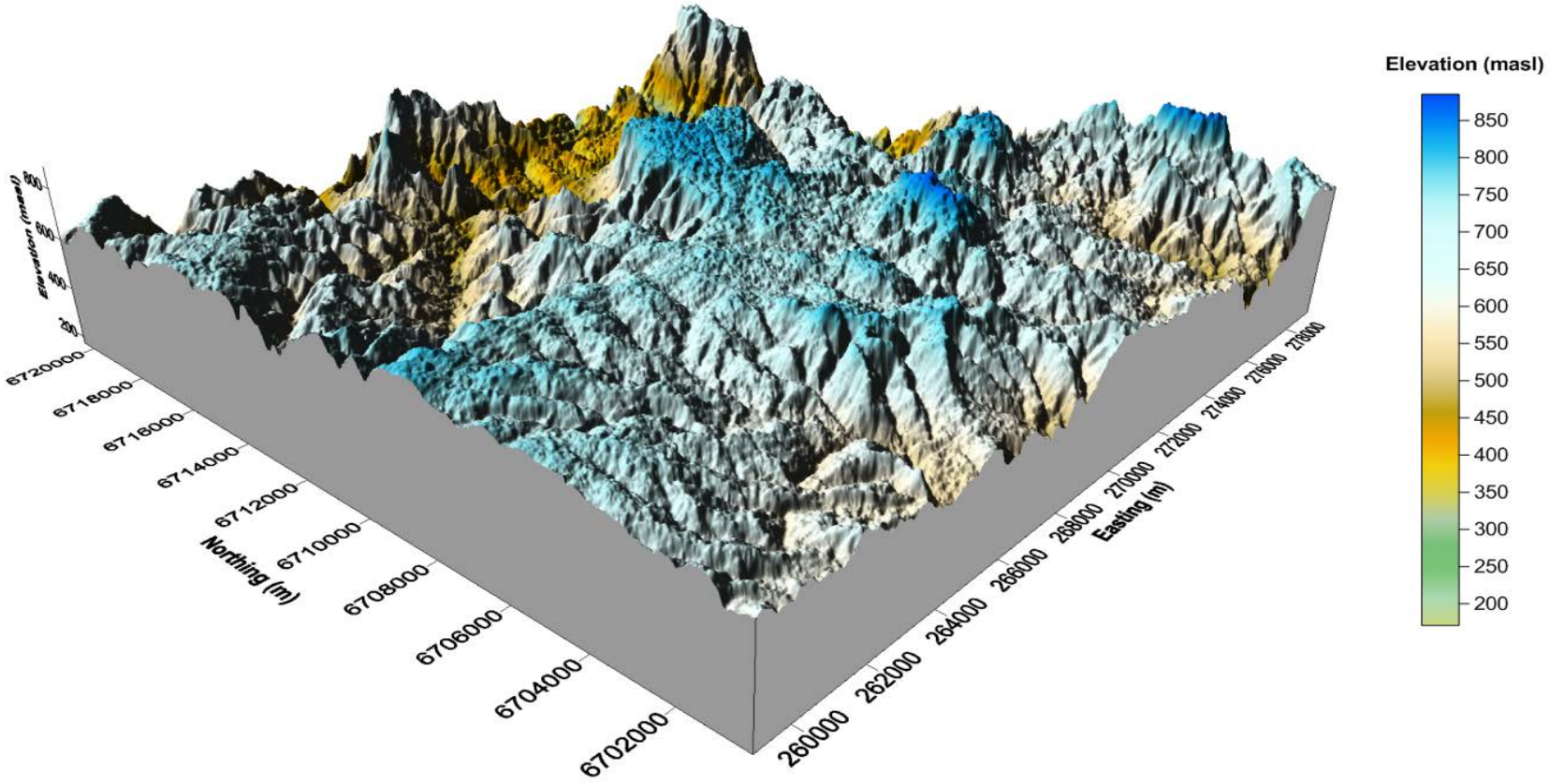


Figure 1.7: Topography (surface profile) of the area surrounding the Enterprise (20km x 20km)

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1.3 Authorisations: Atmospheric Emission License and Other

1.3.1 Atmospheric Emission License & Emission Control Officer

In light of specific products produced, raw materials consumed and or specific process, with respect to ferromanganese, ACRW is currently licenced to operate the following Listed Activities in terms of Section 21 of NEM:AQA:

1. Storage and handling of ore and coal (Subcategory 5.1);
2. Agglomeration operations (Subcategory 4.11);
3. Production of alloys of iron with chromium, manganese, silicon or vanadium, the separation of titanium slag from iron-containing minerals using heat (Subcategory 4.9);
4. Sinter Plant (Subcategory 4.5);

Table 1.1: Emission Control Officer Details

i)	Contact Person:	Mr. Wessel Oosthuizen
	Contact details	
	Telephone Number:	+27 (0) 31 782 5000
	Cell Phone Number:	+27 (0) 82 453 6361
	Fax Number:	+27 (0) 86 632 5077
	E-mail Address:	wesselo@feralloys.co.za
	After Hours Contact Details:	+27 (0) 82 453 6361
ii)	Responsible Person:	Mr. Ashwin Santhilal
	Contact details	
	Telephone Number:	+27 (0) 31 782 5000
	Fax Number:	+27 (0) 86 632 5077
	E-mail Address:	ashwnis@feralloys.co.za
	After Hours Contact Details:	+27 (0) 82 453 6361

1.3.2 Other Authorisations

ACRW also has other authorisations in terms of water use and waste management, etc.

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2. NATURE OF PROCESS

2.1 Process description

In accordance with the approved Plan of Study for this assessment, the contribution of other industrial point sources from Listed Activities in terms of Section 21 of NEM:AQA within the 10km x 7km domain, were included in the study based on available information obtained from the eThekwini Municipality Licensing Authority. The other sources/operations included are AVI Products (bio filter), Cato Ridge Crematorium, Shu Powders and Safal Steel. Vehicle emissions emanating from traffic on the N3 which passes Cato Ridge was included in the assessment based on available traffic data obtained from Mikros Traffic Monitoring (Pty) Ltd. Emission data available for the period of 2017-2019 (pre COVID-19 2020 and 2021 National Lockdown) was utilized together with ambient air and meteorological monitoring data for this assessment. It is noted that there are other sources of emissions within the investigation domain which were not included in this assessment. In view of the study conducted on behalf of Assmang, the ACRW operation is referenced in this report as the relevant Enterprise in terms of the required format of an Atmospheric Impact Report.

Assmang Limited established the Cato Ridge Works (formerly Feralloys Limited) in 1956 when construction was started on a ferromanganese smelter. The ferromanganese smelter was commissioned in 1959 and originally consisted of two 9MVA submerged electric arc furnaces. The operations at the site was expanded and upgraded over the years and currently operations are six submerged electric arc furnaces, a refinery operation known as Cato Ridge Alloys (CRA) and a Metal Recovery Plant. The site is also equipped with a Briquetting Plant which produces briquettes from recovered dust, ore and other materials, including binding agents. The High Carbon and the Refined (Low Carbon) Crushing & Screening Plants provide the final product for despatch by road and or rail to customers. Processed slag is deposited on the slag dump. Environmental authorisation was obtained in 2021 for a Sinter Plant at ACRW. The different processing units have gas cleaning equipment for the abatement of particulate matter emissions.

In light of specific products produced, raw materials consumed and or specific process, with respect to ferromanganese, ACRW is currently licenced to operate the following Listed Activities in terms of Section 21 of NEM:AQA:

5. Storage and handling of ore and coal (Subcategory 5.1);
6. Agglomeration operations (Subcategory 4.11);
7. Production of alloys of iron with chromium, manganese, silicon or vanadium, the separation of titanium slag from iron-containing minerals using heat (Subcategory 4.9);
1. Sinter Plant (Subcategory 4.5);

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2.2 Scenario 1: Baseline Conditions

The other industrial sources from Listed Activities in terms of Section 21 of NEM:AQA included are AVI Products (bio filter), Cato Ridge Crematorium, Shu Powders and Safal Steel. The details of the processes and emissions associated with those sources are not specified nor referenced in this report and should be requested from the eThekwini Municipality Licensing Authority for further reference. Traffic volume data (light and heavy vehicle classes) was obtained from Mikros Traffic Monitoring (Pty) Ltd. for the period of 2019 (pre COVID-19) for the N3 passing Cato Ridge (both north and south bound). EnviroNgaka estimated the emissions which could potentially emanate from that traffic on the N3 which is included in the domain of the study. Those estimated emissions were included in the impact assessment. It is noted that there are other sources of emissions within the investigation domain which were not included in this assessment. Figure 2-0 below provides the locations of the sources/operations (ACRW, AVI Products, Cato Ridge Crematorium, Shu Powders, Safal Steel and the N3 freeway) included in the investigation relative to the Study Areas.

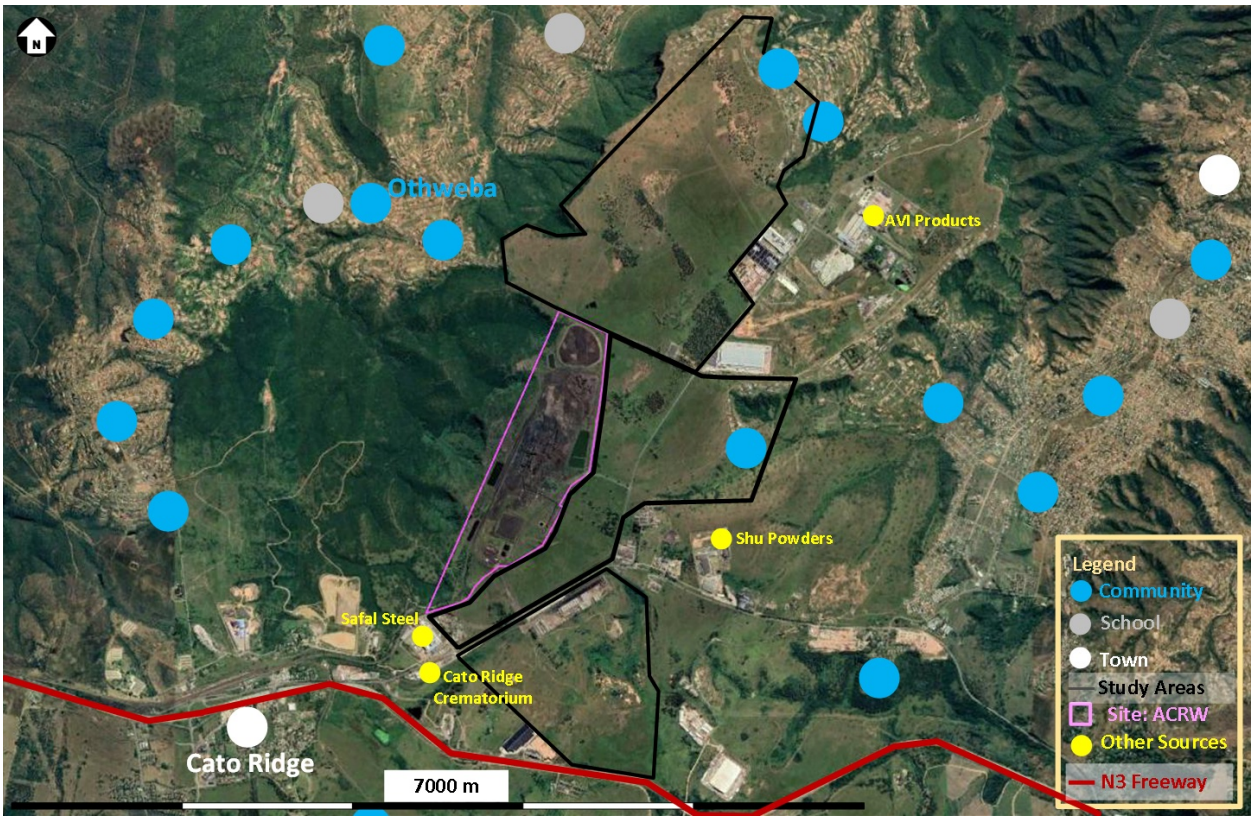


Figure 2.0: Scenario 1 – Emission Sources/Operations Included in the Investigation

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With respect to ACRW, the impact assessment is done per the emissions of all relevant pollutants at expected concentrations against full production capacity (achievable emissions and does not imply AEL emission limits); and includes an additional planned Sinter Plant (Subcategory 4.5 of the Listed Activities in terms of Section 21 of NEM:AQA) to produce pellets from raw material as feed to the furnaces, with no modifications or improvements made to the current process / additional abatement of secondary fugitive emissions from the furnaces. The production of the aforementioned products is achieved by means of the following unit processes:

Tippler 1 and Tippler 2

The majority of the raw materials enter the site by train. The rail cars are tipped into a sump at the Tipplers. From there it is conveyed and stockpiled for later use.

Batching South Plant (Furnace 1, 2, 3 and 4)

Raw material is loaded into 24-hour bunkers via an ore bridge. From there the raw material is transported via vibrators and conveyors to be weighed then dispatched to the furnace 8-hour bins.

Batching North Plant (Furnace 5 and 6)

Raw material is loaded into 24-hour bunkers by means of an overhead “spacer car”. It is then conveyed to a weigh flask and fed to the furnace feed bins.

Furnace 8-hr bins

These are positioned above each furnace, and act as a surge capacity for feed to the furnace.

Briquetting plant

Dry dust from the furnaces and converter baghouses is stockpiled along with dried sludge and metal recovery plant middlings. It is then combined and mixed with a binding agent through a wet process in order to be formed into briquettes. The briquettes are stockpiled for reprocessing in the furnaces. The briquetting plant is equipped with a stack (point source).

Furnaces

The company has six furnaces in total. Three furnaces are semi-closed electric arc furnaces (Furnace 1, 2 and 5) and the other three are closed electric arc furnaces (Furnaces 3, 4 and 6). These furnaces are continually filled with raw material in order to keep the electrodes submerged. An arc is continually struck between the electrodes and the furnace hearth in order to provide the heat required to melt the raw materials. The carbon in the raw materials, in combination with the heat, allows the furnace to produce a molten high carbon ferro-manganese (HC FeMn). The by-product from the electric furnaces is slag. Other discharges are fumes and gas that are processed through the gas plant. . Furnaces 3 and 4 have been excluded from this study since it is not foreseen for them to be operational in future. HC metal (high carbon) is cast into moulds consisting of metal fines. This molten metal solidifies, and it is then removed via a crane and loaded onto a tractor and transported to a concrete pad at the HC crushing and screening plant (HC C&S plant).

HC C&S plant

The metal cools further on the concrete pad, and when it is sufficiently cooled, it is crushed and screened in order to be separated into various size fractions. The different fractions are collected with a tractor and taken to their respective stockpiles. From the stockpiles, the product is weighed and trucked or railed out to the clients.

Converter operation (CRA plant)

This section allows the company to produce a medium and low carbon FeMn (MC & LC FeMn) product from the HC FeMn produced in the furnaces. The MC & LC FeMn metal is cast into moulds consisting of metal fines. The Molten metal solidifies, and is removed via a crane from where it is transported to a 10-tonne bay floor to be crushed.

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Refined (Low Carbon) C&S plant

The MC & LC FeMn metal further cools on the concrete pad, and when it is sufficiently cooled, it is crushed and screened in order to be separated into various size fractions. The different fractions are collected with a tractor and taken to their respective stockpiles. From the stockpiles, the product is weighed and trucked or railed out to the clients.

Slag Movement

Slag is currently removed from plant via a locomotive and tipped into "slag ponds". It is recovered from the ponds with an excavator and then stored at the slag storage facility.

Metal Recovery Plant (MRP)

The slag from the slag storage facility is taken to the metal recovery plant (MRP). Here the slag is crushed in order to mechanically separate the remaining metal from the slag. The MRP is a wet process without the application of heat to recover metal. The metal is brought back into the plant where it is stockpiled to await export. The remainder of the processed slag is sold.

Gas Plants

The type of gas plant varies with each furnace type. The semi-closed furnaces (Furnaces 1, 2 and 5) each have a baghouse. A Baghouse has compartments that are filled with bags with a fine weave. The dust and fumes from the furnace enter the baghouse, are sucked though the bags. This results in cleaned gas leaving the baghouse while the dust remains in the bags. Two of the three baghouse are closed (Furnace 1 and 2), with the cleaned gas being emitted through individual stacks. The Furnace 5 baghouse is an open baghouse with no stack. Dust from the baghouse are removed via a tractor and taken to an onsite blocking plant. The Closed furnaces (Furnaces 3, 4 and 6) each have a gas scrubbing plant. Water, in a closed circuit, is used to wash the dust out of the off-gas. The clean gas exits each of the gas plants via a stack where it is flared. The effluent (sludge) from the scrubbing plants is pumped to the effluent treatment plant. The converter (ACP plant) also has a closed baghouse and a stack.

Effluent treatment plant

The effluent (sludge) from the closed furnace gas plants enter a thickener where the sludge is thickened. The clear water overflow of the thickener is returned to the gas plants. The thickened sludge is pumped to slimes dams where sludge settles and the clear water overflow is returned to filter plant. The sludge in the dams dries out and is later used in the blocking plant.

Dust and fume extraction systems

In accordance with the authorisation received from the Department of Agriculture, Environmental Affairs and Rural Development of KwaZulu-Natal, dated 12 September 2008 for these systems, dust and fume capturing and treatment systems are installed for the following sections:

- Installed: At the Furnace tapping fumes, and
- At the High Carbon (HC) & Low Carbon (LC) Crushing and Screening (C&S) Plants

Furnace tapping fume treatment system

A dust and fume extraction system was installed at the tap holes, launder and ladle for Furnaces No. 1 – 6. The system assists with reducing the emissions inside the furnace buildings. It also assists with limiting exposure of personnel to manganese containing dust and fumes. The extraction systems contain dust and fume canopy hoods for the tap holes, launders and ladle for all six furnaces. Furnaces No. 1 - 4 have a common ducting that joins with the common ducting for Furnaces No. 5 - 6 prior to entering a baghouse. Cleaned air from the baghouse is emitted through a stack next to the baghouse.

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Dust extraction and suppression systems at the Crushing and Screening Plants

Dust alleviation systems are located at the following sections:

- the High Carbon Ferromanganese Crushing and Screening Plant (HC C&S); and
- the Low Carbon Ferromanganese Crushing and Screening Plant (LC C&S) located at the CRA Plant

High Carbon Ferromanganese Crushing and Screening Plant (HC C&S)

The dust extraction system for the HC C&S Plant is as follows:

- At the static grizzly / feed bin area:
  - Access for the front-end loader to load cooled ingots onto the static grizzly is limited to the southern side only;
  - Water sprays are installed at the eastern and western walls of the static grizzly building; and
  - The tunnel underneath the static grizzly housing with the feed conveyor is enclosed with an industrial strip curtain.
- At the following areas all the components are enclosed and dust extraction systems installed:
  - At the primary crusher area: the vibrating grizzly and primary crusher
  - The primary screening and secondary crusher area:
  - The secondary and tertiary screening area:
  - The final product bin
- The load-out points from the vibrating feeders at the final product section are equipped with dust suppression.

Low Carbon Ferromanganese Crushing and Screening Plant

The dust extraction system for the LC C&S Plant is as follows:

- The load in and load out stations will be equipped with dust suppression;
- At the following areas all the components are enclosed and dust extraction systems installed:
  - At the primary crusher area: the vibrating grizzly feeding into the primary crusher, it's outlet chute and the primary crusher inlet and discharge;
  - The primary screen and the conveyor feeding it;
  - At the secondary crusher area: the conveyors feeding over-size material back to the secondary crusher, the secondary crusher itself, and its discharge;
  - At the product screening and bin area: the conveyor feeding into the secondary screen, and the secondary and tertiary screens.

Each section is serviced by a baghouse which emits the cleaned air to the atmosphere via a stack.

Export ore stockpile

Assmang Manganese Cato Ridge Works is used as an intermediate storage location for export ore from other Assmang mining operations. The ore are delivered to the Site of Works by train, and dispatched to the Durban Harbour by road, or alternatively by rail. The new infrastructure installed at the Site of Works is as follows:

- Export ore are received via rail transport at Tippler 1 (which will be upgraded to facilitate a higher throughput) and from there they are conveyed and stockpiled;
- The conveyor system to the Export ore stockpile includes a Road Receiving section which ties in with the conveyor system to the storage area;
- The export ore received by road or rail, are conveyed to a Screening section where fines are recovered before it is conveyed to the storage area. The fines recovered from the export ore are stored in bins for use as raw material in the furnaces at the Site of Works;

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- The export ore are stored on two conical shaped stockpiles with a capacity of 40 000 tonnes each;
- The export ore are reclaimed from the stockpiles by frontend loaders which deposit the ore into one of three frontend loader reclaim hoppers located next to the stockpile area and are conveyed to one of two dispatching areas;
- The export ore are conveyed to storage bins at either a Road load-out section or a Rail load-out section, depending on the transport method;

Dust suppression is assisted as follows:

- Road receiving - Reverse and Side tipping trucks dump ore on an enclosed grizzly;
- Conveyor transfer towers – are enclosed chute transfer systems, but are 100% dust tight;
- Conical stockpile – Screened ore are deposited by an open spiral chute;
- Frontend loader reclaim hopper – Material is dumped at the machine's dump height into the reclaim hoppers;
- Road Load-out – A shuttle conveyor fills the trucks with ore from the storage bins;
- Rail load-out – A shuttle conveyor fills the rail trucks with ore from the storage bins;

Planned additional Sinter Plant

It is intended to install a Traxys Brix (Pty) Ltd. Sinter Plant based on a proprietary Vessel-Sinter Technology at ACRW. The proposed additional sinter plant will produce 120000 tonne/annum of sintered raw material to serve as raw material for the furnaces. The plant does not require binders and will include a Proportioning System to mix raw materials according to pre-determined mixing recipes, which will be conveyed to, and stored in a mixture silo. The material is then conveyed to and passed through a pelletising disc into a buffer silo. The material is then sintered. Charcoal will be used as energy source for the sintering process. Hot sintered material is cooled in a cooling building which is also connected to air pollution control equipment in order to abate fumes emanated during the cooling process. Cooled material is then crushed and screened to specification. Sized Sinter are conveyed to the sinter silo from where it is transferred as feed for the furnaces. Emissions generated from the sintering process are captured and directed to air pollution control equipment. Emissions generated at the proportioning system, sintering process (including the off-gas from the charcoal utilised as energy source), the cooling building and the crushing and screening captured and directed to air pollution control equipment, which includes baghouses and a wet scrubber.

Figure 2.1 on the following page provides a process flow diagram for the ACRW operation.

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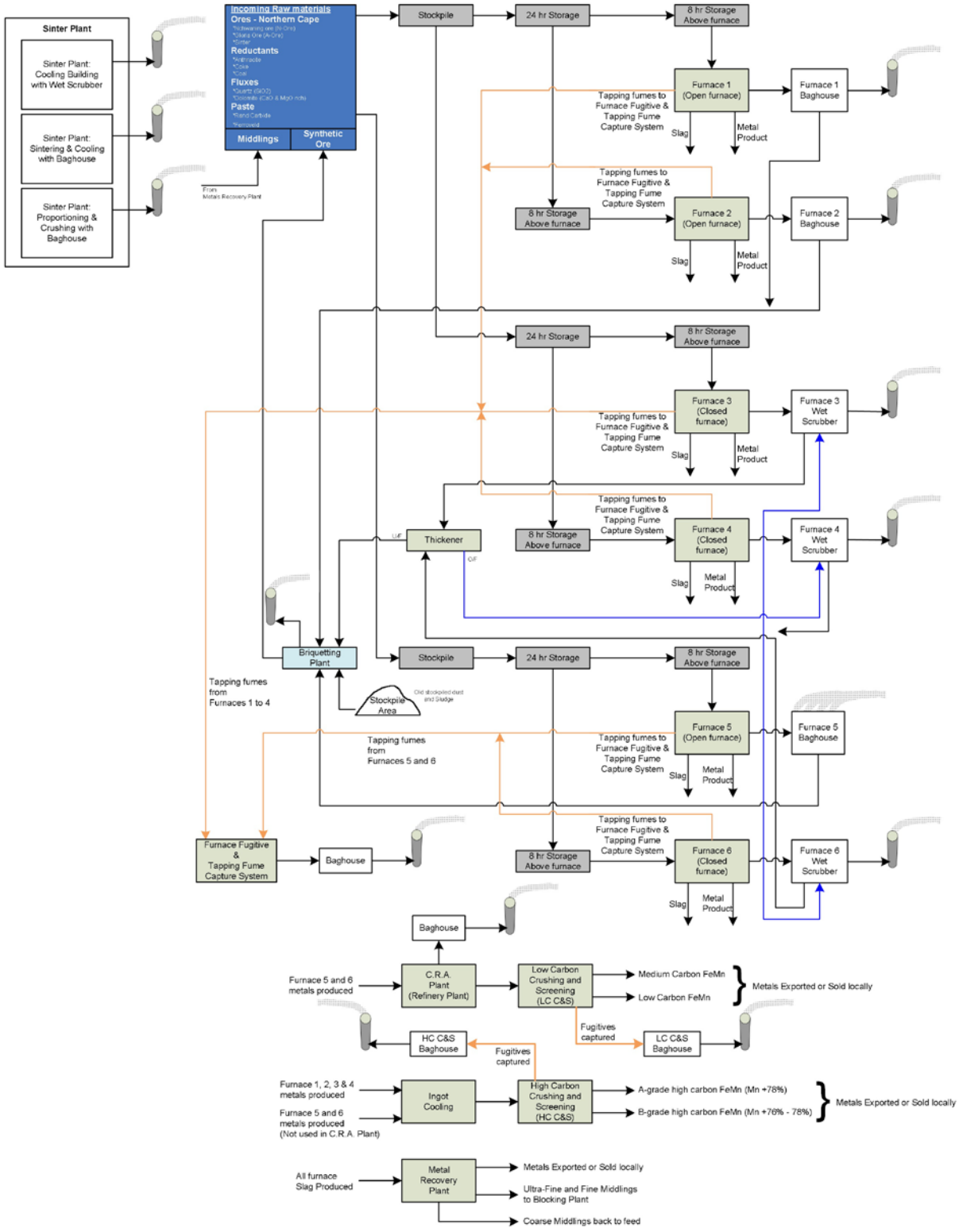


Figure 2.1: Scenario 1 – ACRW Process Flow Diagram

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Table 2.1: Unit processes: Scenario 1 – ACRW Baseline Conditions

Unit processes				
Unit Process	**Unit Process Function**	**Batch or Continuous Process**	**Operating Hours**	**Number of Days Operated per Year**
Furnace 1	Ferromanganese Production (HC)	Continuous	00h00 – 24h00	365
Furnace 2	Ferromanganese Production (HC)	Continuous	00h00 – 24h00	365
Furnace 3[1]	Ferromanganese Production (HC)	Continuous	00h00 – 24h00	365
Furnace 4[2]	Ferromanganese Production (HC)	Continuous	00h00 – 24h00	365
Furnace 5	Ferromanganese Production (HC)	Continuous	00h00 – 24h00	365
Furnace 6	Ferromanganese Production (HC)	Continuous	00h00 – 24h00	365
CRA Plant	Ferromanganese Production (Refined: MC and or LC)	Continuous	00h00 – 24h00	365
Furnace Fugitive & Tapping Fume Capture System	Furnace Fugitive & Tapping Fume Capture System	Continuous	00h00 – 24h00	365
HC Crushing & Screening plant Fugitive Capture System	HC Crushing & Screening plant Fugitive Capture System	Continuous	00h00 – 24h00	365
LC Crushing & Screening plant Fugitive Capture System	LC Crushing & Screening plant Fugitive Capture System	Continuous	00h00 – 24h00	365
Briquetting plant	Production of Briquettes	Continuous	00h00 – 24h00	365
Metal Recovery Plant	Metal Recovery Plant	Continuous	00h00 – 24h00	365
Secondary Sources	Secondary Emission Sources: Storage areas, Wind Generated, Material Transfer, Loading&Unloading, Vehicle Movement	Continuous	00h00 – 24h00	365
Sinter Plant	Agglomeration of fine ore and sintering	Continuous	00h00 – 24h00	365

[1]. Furnaces 3 and 4 have been included in this study although it is not foreseen for them to be operational in future

[2]. Furnaces 3 and 4 have been included in this study although it is not foreseen for them to be operational in future.

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3. TECHNICAL INFORMATION

In light of specific products produced, raw materials consumed and or specific process, with respect to ferromanganese, ACRW is currently licenced to operate the following Listed Activities in terms of Section 21 of NEM:AQA:

1. Storage and handling of ore and coal (Subcategory 5.1);
2. Agglomeration operations (Subcategory 4.11);
3. Production of alloys of iron with chromium, manganese, silicon or vanadium, the separation of titanium slag from iron-containing minerals using heat (Subcategory 4.9);
4. Sinter Plant (Subcategory 4.5);

Emission sources at the site are primary point sources from the processes and Listed Activities referred to, with secondary sources from material processing, storage areas, handling and roads.

3.1 Material Flows: ACRW Raw Material(s) Used & Production

Per the information provided in Section 2, Table 3.1.1 provides an indication of the flow of material for the processing operations for Scenario 1.

Table 3.1.1: Material Flow[3]: Scenario 1 ACRW

MATERIAL DESCRIPTION	Scenario 1 Full Production Condition (Volume)	Units (quantity / period)
Product: Sinter Pellets	12629	tonne/month
Product: Briquettes	5977	tonne/month
Product: HC FeMn	27684	tonne/month
Product: MC/LC FeMn	6500	tonne/month
By-product (waste): Slag	20011	tonne/month
Ore (includes Briquettes, Pellets, Concentrate, Chips, Lumpy, Mn and scrap)	51516	tonne/month
Reductants	12502	tonne/month
Fluxes	2686	tonne/month
Paste	491	tonne/month
CRA: Coolant - Fines	896	tonne/month
CRA: Metal	7691	tonne/month
CRA: Argon	58	tonne/month
CRA: Nitrogen	14	tonne/month
CRA: Oxygen	681	tonne/month
CRA: Skulls	65	tonne/month
LP gas	30	tonne/month
Briquetting: Feed Material (Metal, Ore, Dust & Sludge)	6296	tonne/month
Briquetting: Binder and Water	441	tonne/month
Charcoal (Sinter Plant)	105 expected-TBD	tonne/month
Diesel	59104	litres/month

[3] The volumes/quantities referred includes Furnaces 3 and 4 although it is not foreseen for them to be operational in future

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3.2 Appliances & Abatement Equipment

Table 3.2 below refers to appliances and measures envisaged to prevent air pollution for the different scenarios considered, referencing the applicable scenarios in the top row of the table.

Table 3.2: ACRW Appliances and measures to abate air pollution

Emission source:	P1	P2	P3	P4	P5	P6	P8	P7	P9	P10	P11	P12	P13	P30	P31	P32
Appliance / Process Equipment Number	Furnace 1	Furnace 2	Furnace 3 OGP	Furnace 4 OGP	Furnace 3&4 Shared VAI	Furnace 5	Furnace 6 OGP	Furnace 6 VAI	Converter Section (CRA)	Furnace Building & Tapping Fumes	High Carbon Crushing & Screening	Medium / Low Carbon Crushing & Screening	Briquetting Plant	Sinter Plant: Proportioning & Crushing	Sinter Plant: Sintering & Cooling	Sinter Plant: Cooling Building
Appliance Type / Description	Negative Pressure Baghouse	Negative Pressure Baghouse	Wet Scrubber	Wet Scrubber	Wet Scrubber	Positive Pressure Baghouse	Wet Scrubber	Wet Scrubber	Negative Pressure Baghouse	Negative Pressure Baghouse	Negative Pressure Baghouse	Negative Pressure Baghouse		Negative Pressure Baghouse	Negative Pressure Baghouse	Wet Scrubber
Appliance Serial Number	GCP-BH-F1	GCP-BH-F2	GCP-BH-F3	GCP-BH-F4	GCP-VAI-F3&4	GCP-BH-F5	GCP-VAI-F6	GCP-CG-F6	GCP-BH-CRA	GCP-BH-FTF	GCP-BH-HC	GCP-BH-LC	GCP-BP	Planned TBD	Planned TBD	Planned TBD
Abatement Equipment Technology Type	Negative Pressure Baghouse	Negative Pressure Baghouse	Wet Scrubber	Wet Scrubber	Wet Scrubber	Positive Pressure Baghouse	Wet Scrubber	Wet Scrubber	Negative Pressure Baghouse	Negative Pressure Baghouse	Negative Pressure Baghouse	Negative Pressure Baghouse		Negative Pressure Baghouse	Negative Pressure Baghouse	Wet Scrubber
Product name	Albany Beier	Pyromet	Elektrokemisk	Elektrokemisk	VAI	Brandt	VAI	Wet Scrubber	Howden	Baghouse	Baghouse	Baghouse	n/ap	TBD	TBD	TBD
Product model	Refer above	Refer above	Refer above	Refer above	Refer above	Refer above	Refer above	Refer above	Refer above	Refer above	Refer above	Refer above	Refer above	Refer above	Refer above	Refer above
Abatement Equipment Manufacture Date	2006	1996	1963	1963	1963	1975	1989	2002	1997	2010	2012	2012	2020	Planned	Planned	Planned
Commission Date	16/06/2006	08/08/1996	21/11/1963	21/11/1963	21/11/1963	1975	1989	18/04/2003	1997	2010	2012	2013	2020	Planned	Planned	Planned
a) Design[4]	6.64 tonne/h	6.64 tonne/h	4.11 tonne/h	4.11 tonne/h	8.22 tonne/h	8.22 tonne/h	8.22 tonne/h	8.22 tonne/h	8.9 tonne/h	37.92 tonne/h	37.92 tonne/h	8.9 tonne/h	8.2 tonne/h	17.3 tonne/h	17.3 tonne/h	17.3 tonne/h
b) Minimum Control Efficiency (%) – Particulate Matter	97.3	97.3	98.3	98.3	98.3	97.0	98.5	98.5	99	85	98	98	n/ap	TBD	TBD	TBD

[4] Design capacity is expressed in terms of the production design capacity which the equipment is designed against

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Emission source:	P1	P2	P3	P4	P5	P6	P8	P7	P9	P10	P11	P12	P13	P30	P31	P32
c) Minimum Utilisation (%)	98	98	98	98	98	98	98	98	99	98	98	98	99	100	100	100
Significant modifications and/or upgrades																
Upgrade 1 Date	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap
Upgrade 1 Reason	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap
Upgrade 2 Date	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap
Upgrade 2 Reason	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap
Planned modifications within next 5 years																
Nature of the modification	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/ap	n/ap	n/ap
Potential impact on Atmospheric Emissions	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/ap	n/ap	n/ap
Timetable																
Installation	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/ap	n/ap	n/ap
Commission	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/ap	n/ap	n/ap

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4. ATMOSPHERIC EMISSIONS

In light of specific products produced, raw materials consumed and or specific process, with respect to ferromanganese, ACRW is currently licenced to operate the following Listed Activities in terms of Section 21 of NEM:AQA:

1. Storage and handling of ore and coal (Subcategory 5.1);
2. Agglomeration operations (Subcategory 4.11);
3. Production of alloys of iron with chromium, manganese, silicon or vanadium, the separation of titanium slag from iron-containing minerals using heat (Subcategory 4.9);
4. Sinter Plant (Subcategory 4.5);

The details of the other sources included in the assessment (AVI Products, Cato Ridge Crematorium, Shu Powders and Safal Steel), i.e. processes and emissions associated with those sources, are not specified or referenced in this report and should be requested from the eThekwini Municipality Licensing Authority for further reference. Emission sources at the site are primary point and potential fugitive sources from the processes operated with secondary sources from material processing, storage areas, handling and roads. The primary pollutants from the emission sources at the Enterprise and from other sources included, which were considered to be relevant for this study are tabled in Table 4.1 below[5].

Table 4.1: Primary Pollutants

Pollutants considered[6]		Notes	Applicability	Considered	Modelled
PM	Classical air pollutant	Total Particulate Matter	Yes	Yes	PM_{10} & $PM_{2.5}$
PM_{10}	Classical air pollutant	PM with an aerodynamic diameter of equal to or less than 10µm	Yes	Yes	Yes
$PM_{2.5}$	Classical air pollutant	PM with an aerodynamic diameter of equal to or less than 2.5µm	Yes	Yes	Yes
SO_2	Classical air pollutant		Yes	Yes	Yes
NO_x (as NO_2)	Classical air pollutant		Yes	Yes	Yes
CO	Organic air pollutant	Not a classical pollutant	Yes	Yes	Yes
VOC - Benzene	Organic air pollutant	Not a classical pollutant	Yes	Yes	Yes
NH_3	Inorganic air pollutant	Not a classical pollutant	Yes	Yes	Yes
Mn	Inorganic air pollutant	Not a classical pollutant	Yes	Yes	Yes

As referenced under Sections 2 and 3 of this report, this study will assess the expected impact of the sources included, emanating from atmospheric emissions, on the surrounding ambient air quality per defined scenario.

4.1 Emission Sources

The emission sources with stacks/vents in the study area are the point sources from the different unit processes as indicated in the tables which will follow for the defined scenario[7]. Figure 4.1.1 indicates the locations of the point

[5] NO_x is expressed as NO_2 for all sources

[6] Pollutants listed as applicable and modelled are the pollutants which are the primary pollutants associated with this operation. Unless specified differently, all emission mg/Nm^3 concentrations referenced in Sections 4.2 and 4.3 are expressed as Normalised conditions where "Nm^3" refers to the Normalised volume under reference conditions of Pressure at 101.325kPa and Temperature at 0°C (273.15K) against actual oxygen content

[7] Abnormal emissions during abnormal circumstances of failure of APCE: relevance to the sources listed is as specified in section 4.3 of this report

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sources (fugitive tapping sources are not indicated but modelled as fugitives from the buildings) for Scenario 1 at the Enterprise, with Figure 4.1.2 providing an indication of the location of the other sources included in the study (information relating to occurrences of abnormal emissions and fugitive emissions from those sources or processes was not referenced/provided and were therefore understood to be negligible).

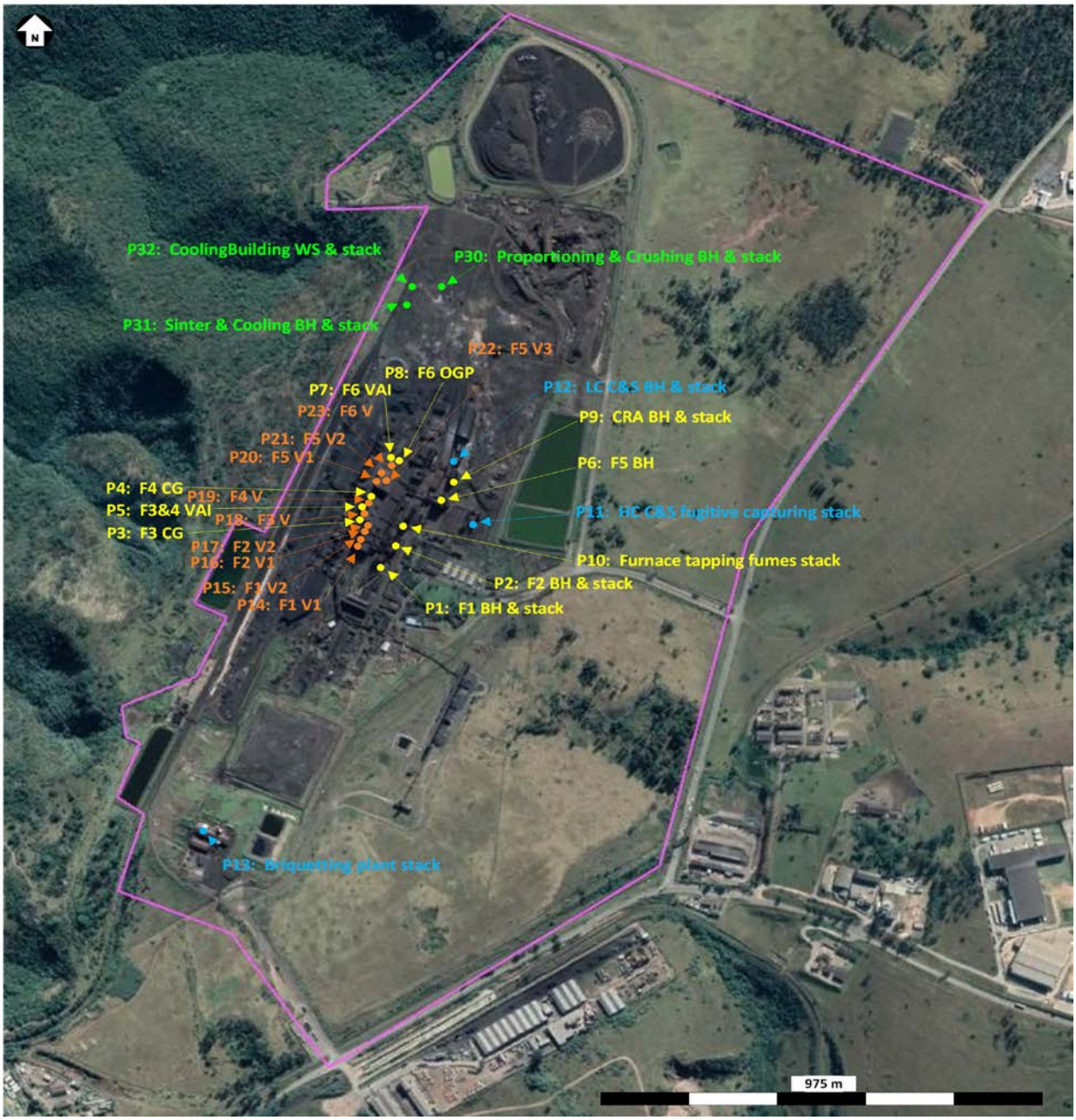


Figure 4.1.1: Locations of the stack point sources – ACRW

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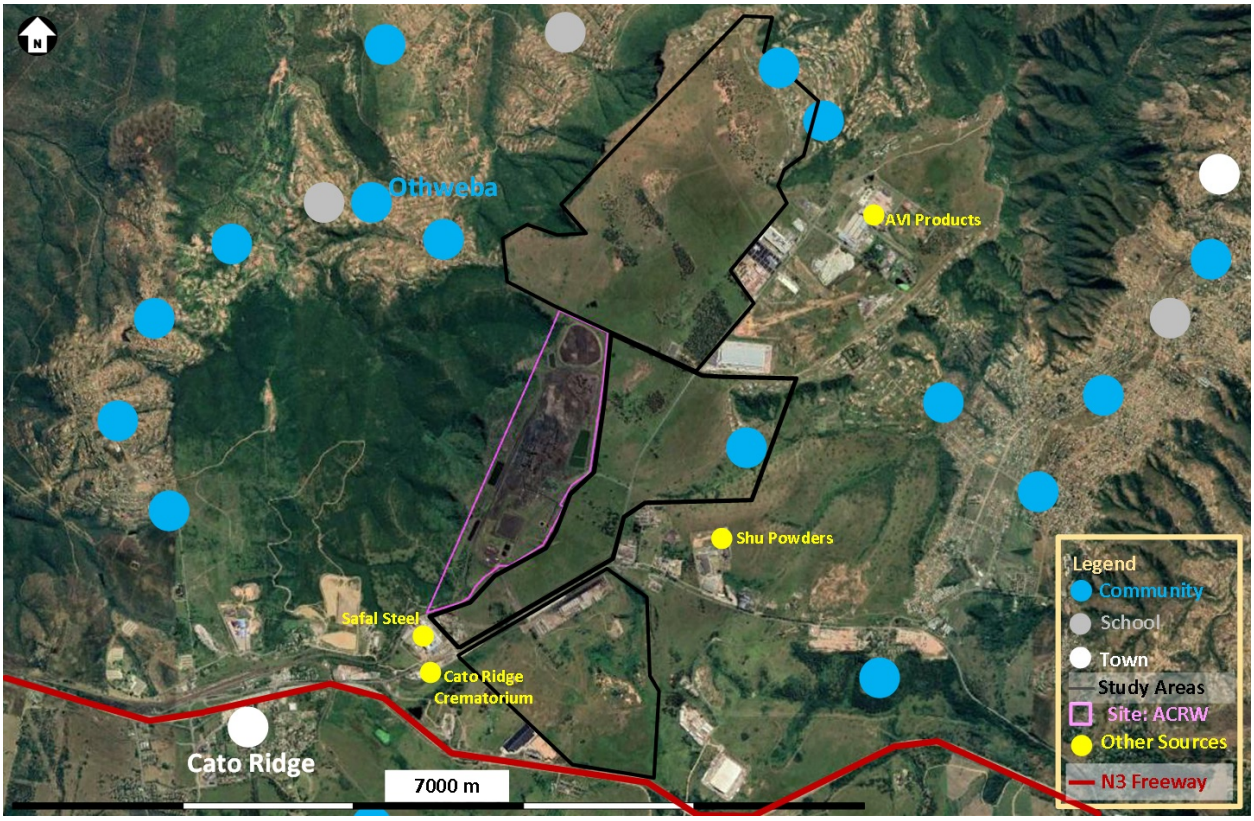


Figure 4.1.2: Locations of other sources/operations included

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4.1.1 Baseline Conditions Point Source Parameters

Table 4.1-1: Point Source Parameter – ACRW

Point Source Number	Point Source Name	Point Source Coordinates		Height of Release Above Ground	Height Above Nearby Building	Diameter at Stack Tip/Vent Exit	Actual Gas Exit Temperature	Actual Gas Volumetric Flow	Actual Gas Exit Velocity	Type of Emission (Continuous / Batch)
		UTM	UTM	(m)	(m)	(m)	(K)	(m3/h)	(m/s)	
		Easting	Northing							
P1	F1 BH Stack	269074.0	6710253.0	36.6	14.6	2.200	378.15	271185	19.8	Continuous
P2	F2 BH Stack	269118.0	6710318.0	36.6	14.6	2.700	378.15	271185	13.2	Continuous
P3	F3 OGP Stack	269054.0	6710392.0	39.0	7.0	0.430	318.15	8900	17.0	Continuous
P4	F4 OGP Stack	269047.0	6710388.0	39.0	7.0	0.430	318.15	8900	17.0	Continuous
P5	F3&4 Shared VAI Stack	269056.0	6710403.0	39.0	7.0	0.500	318.15	17801	25.2	Continuous
P6	F5 BH equivalent 1 point (to model as 20)	269193.0	6710393.1	22.0	0.0	11.193	333.15	1041642	2.9	Continuous
P8	F6 OGP Stack	269110.0	6710500.0	45.4	5.4	0.470	318.15	17801	28.5	Continuous
P7	F6 VAI Stack	269101.0	6710504.0	45.4	5.4	0.500	318.15	17801	25.2	Continuous
P9	CRA Stack	269230.0	6710454.0	28.2	6.2	2.838	353.15	352560	15.5	Continuous
P10	Furnace Building Fugitive Fume Stack	269133.0	6710352.0	56.5	24.5	3.500	298.15	519541	15.0	Continuous
P11	HC C&S Stack	269279.0	6710365.0	20.0	0.0	1.300	303.15	75268	15.8	Continuous
P12	LC C&S Stack	269224.0	6710512.5	20.0	0.0	1.300	303.15	67690	14.2	Continuous
P13	Briquetting Plant	268694.0	6709634.0	6.4	0.0	0.300	303.15	1813	7.1	Continuous
P30	Sinter-Proportioning & Crushing	269191.5	6710910.1	15.0	9.0	0.890	303.15	28000	12.5	Continuous
P31	Sinter-Sintering & Cooling	269128.7	6710905.3	10.0	1.0	0.700	303.15	28000	20.2	Continuous
P32	Sinter-Cooling Building	269137.0	6710922.0	25.0	19.0	1.610	303.15	110000	15.0	Continuous
P14	F1 Uncontrolled RG Vent 01	269041.0	6710302.0	36.6	6.6	1.700	523.15	44770	5.5	Intermittent Abnormal
P15	F1 Uncontrolled RG Vent 02	269046.0	6710314.0	36.6	6.6	1.700	523.15	44770	5.5	Intermittent Abnormal
P16	F2 Uncontrolled RG Vent 01	269049.0	6710321.0	36.6	6.6	1.700	523.15	44770	5.5	Intermittent Abnormal
P17	F2 Uncontrolled RG Vent 02	269054.0	6710334.0	36.6	6.6	1.700	523.15	44770	5.5	Intermittent Abnormal
P18	F3 Rawgas Stack	269052.0	6710381.0	34.5	3.4	0.780	523.15	14635	8.5	Intermittent Abnormal
P19	F4 Rawgas Stack	269063.0	6710401.0	34.5	3.4	0.780	523.15	14635	8.5	Intermittent Abnormal
P20	F5 Uncontrolled RG Vent 01	269083.0	6710432.0	47.0	7.0	2.650	523.15	24656	1.2	Intermittent Abnormal
P21	F5 Uncontrolled RG Vent 02	269090.0	6710448.0	47.0	7.0	2.650	523.15	24656	1.2	Intermittent Abnormal
P22	F5 Uncontrolled RG Vent 03	269100.0	6710436.0	47.0	7.0	2.650	523.15	24656	1.2	Intermittent Abnormal
P23	F6 Rawgas Stack	269107.0	6710481.0	44.3	7.0	0.900	523.15	29270	12.8	Intermittent Abnormal
FCR	CRA-Uncontrolled 01/10	269148.2	6710485.9	10.0	0.0	3.000	523.15	76341	3.0	Intermittent Abnormal
FF1	F1-Uncontrolled Tap equivalent 1 point (to model as 10)	269033.0	6710304.4	20.0	0.0	45.135	343.15	2880000	0.5	Intermittent Abnormal
FF2	F2-Uncontrolled Tap equivalent 1 point (to model as 10)	269043.9	6710329.4	20.0	0.0	45.135	343.15	2880000	0.5	Intermittent Abnormal
FF3	F3-Uncontrolled Tap equivalent 1 point (to model as 10)	269054.9	6710354.4	20.0	0.0	45.135	343.15	2880000	0.5	Intermittent Abnormal
FF4	F4-Uncontrolled Tap equivalent 1 point (to model as 10)	269065.9	6710379.4	20.0	0.0	45.135	343.15	2880000	0.5	Intermittent Abnormal
FF5	F5-Uncontrolled Tap equivalent 1 point (to model as 10)	269070.9	6710423.2	20.0	0.0	45.135	343.15	2880000	0.5	Intermittent Abnormal
FF6	F6-Uncontrolled Tap equivalent 1 point (to model as 10)	269090.6	6710469.2	20.0	0.0	45.135	343.15	2880000	0.5	Intermittent Abnormal

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The details of the processes and emissions associated with those sources are not specified or referenced in this report and should be requested from the eThekwini Municipality Licensing Authority for further reference.

4.2 Point Source Emissions (Normal Operating Conditions)

4.2.1 Emissions – ACRW (Normal)

The emission rates from the point sources under normal operating conditions for ACRW, are per achieved emissions rates/concentrations based on historical emission data, AEL limits, design parameters and or estimations for pollutants and or sources which are not measured and or referenced in the AEL. Please refer to Appendix D for additional emission inventory related information. For ACRW the information provided in Table 4.2.1-1 applies.

Table 4.2.1-1: Normal Operating Conditions Point Source Emissions – ACRW

Point Source Number	Point Source Name	Average Emission Concentration								Averaging Period	Duration of Emissions
		PM_{10}	$PM_{2.5}$	SO_2	NO_x	CO	NH_3	C_6H_6	Mn		
		(mg/Nm^3)	(mg/Nm^3)	(mg/Nm^3)	(mg/Nm^3)	(mg/Nm^3)	(mg/Nm^3)	(mg/Nm^3)	($\mu g/Nm^3$)		
P1	F1 BH Stack	10	10	20	50	250	n/ap	0.00	3743	24h	Continuous
P2	F2 BH Stack	15	14	20	50	250	n/ap	0.00	5614	24h	Continuous
P3	F3 OGP Stack	35	25	500	400	184649	n/ap	0.00	9330	24h	Continuous
P4	F4 OGP Stack	35	25	500	400	184649	n/ap	0.00	9330	24h	Continuous
P5	F3&4 Shared VAI Stack	35	25	500	400	184649	n/ap	0.00	9330	24h	Continuous
P6	F5 BH equivalent 1 point (to model as 20)	10	10	10	50	71	n/ap	0.00	3743	24h	Continuous
P8	F6 OGP Stack	35	25	500	400	184649	n/ap	0.00	9330	24h	Continuous
P7	F6 VAI Stack	35	25	500	400	184649	n/ap	0.00	9330	24h	Continuous
P9	CRA Stack	30	29	39	18	167	n/ap	0.98	17015	24h	Continuous
P10	Furnace Building Fugitive Fume Stack	2	2	76	11	46	n/ap	n/av	77	24h	Continuous
P11	HC C&S Stack	20	19	12	10	5	n/ap	n/av	3000	24h	Continuous
P12	LC C&S Stack	30	29	3	10	5	n/ap	n/av	6000	24h	Continuous
P13	Briquetting Plant	30	30	0	1	0	30.00	n/ap	4500	24h	Continuous
P30	Sinter-Proportioning & Crushing	50	48	15	30	150	n/ap	n/ap	5000	24h	Continuous
P31	Sinter-Sintering & Cooling	50	48	100	100	150	n/ap	n/ap	10000	24h	Continuous
P32	Sinter-Cooling Building	50	38	100	100	10000	n/ap	n/ap	5000	24h	Continuous

4.2.2 Emissions – Other Sources Included Emissions (Normal)

The details of the processes and emissions associated with those sources are not specified or referenced in this report and should be requested from the eThekwini Municipality Licensing Authority for further reference.

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4.3 Point Source Maximum Emission Rates (Abnormal: Start-up, Shut-down & Maintenance Conditions)

4.3.1 Abnormal Conditions – ACRW

Tapping occurs for approximately 10min during every 2hour operational cycle of a furnace. Based on site data it was assumed that approximately 95% of the tapping emissions are captured at 96% abatement efficiency, resulting in the balance of 5% of the fugitives remaining as fugitives; with furnace raw gas abnormal emissions occur 0.025% of production time, which equates to approximately 7.2min per month per furnace, and 0.14% for the CRA (60min per month), hence reference to an averaging period of 10minutes referenced in the following tables. Abnormal emissions for start-up, shut-down, maintenance and other abnormal emission conditions for these sources are in terms of APCE availability of the relevant processes. The estimated emission concentrations from these point sources under Start-up, Shut-down, Maintenance and other abnormal emission conditions are therefore provided for Scenario 1 below. Please also refer Appendix D for additional emission inventory related information. The estimated concentrations emitted from each point source under abnormal situations, are provided in Table 4.3.1-1.

Table 4.3.1-1: Abnormal Operating Conditions Point Source Emissions – ACRW

Point Source Number	Point Source Name	Average Emission Concentration									Duration of Emissions
		PM_{10}	$PM_{2.5}$	SO_2	NO_X	CO	NH_3	C_6H_6	Mn	Averaging Period	
		(mg/Nm^3)	(mg/Nm^3)	(mg/Nm^3)	(mg/Nm^3)	(mg/Nm^3)	(mg/Nm^3)	(mg/Nm^3)	($\mu g/Nm^3$)		
P14	F1 Uncontrolled RG Vent 01	2328	1862	84	209	1047	0.00	0.00	871251	10min	Intermittent
P15	F1 Uncontrolled RG Vent 02	2328	1862	84	209	1047	0.00	0.00	871251	10min	Intermittent
P16	F2 Uncontrolled RG Vent 01	2328	1862	84	209	1047	0.00	0.00	871251	10min	Intermittent
P17	F2 Uncontrolled RG Vent 02	2328	1862	84	209	1047	0.00	0.00	871251	10min	Intermittent
P18	F3 Rawgas Stack	5882	1765	500	400	184649	0.00	0.00	1568079	10min	Intermittent
P19	F4 Rawgas Stack	5882	1765	500	400	184649	0.00	0.00	1568079	10min	Intermittent
P20	F5 Uncontrolled RG Vent 01	3492	2793	222	1109	1571	0.00	0.00	1306877	10min	Intermittent
P21	F5 Uncontrolled RG Vent 02	3492	2793	222	1109	1571	0.00	0.00	1306877	10min	Intermittent
P22	F5 Uncontrolled RG Vent 03	3492	2793	222	1109	1571	0.00	0.00	1306877	10min	Intermittent
P23	F6 Rawgas Stack	5882	1765	500	400	184649	0.00	0.00	1568079	10min	Intermittent
FCR	CRA-Uncontrolled 01/10	15882	13438	269	122	1141	0.00	6.72	9007627	10min	Intermittent
FF1	F1-Uncontrolled Tap equivalent 1 point (to model as 10)	2	2	1	0	13	n/ap	n/av	94	10min	Intermittent
FF2	F2-Uncontrolled Tap equivalent 1 point (to model as 10)	2	2	1	0	13	n/ap	n/av	94	10min	Intermittent
FF3	F3-Uncontrolled Tap equivalent 1 point (to model as 10)	2	2	1	0	13	n/ap	n/av	94	10min	Intermittent
FF4	F4-Uncontrolled Tap equivalent 1 point (to model as 10)	2	2	1	0	13	n/ap	n/av	94	10min	Intermittent
FF5	F5-Uncontrolled Tap equivalent 1 point (to model as 10)	2	2	1	0	13	n/ap	n/av	94	10min	Intermittent
FF6	F6-Uncontrolled Tap equivalent 1 point (to model as 10)	2	2	1	0	13	n/ap	n/av	94	10min	Intermittent

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4.3.2 Abnormal Conditions – Other Sources Included

Abnormal emissions for start-up, shut-down, maintenance and other abnormal emission conditions for these sources are in terms of APCE availability of the relevant processes. As a result of limited available information, potential abnormal emissions from the other sources could not be included in the investigation. The details of the processes and emissions associated with those sources are not specified or referenced in this report and should be requested from the eThekwini Municipality Licensing Authority for further reference.

4.4 Fugitive / Secondary Emissions (Area and or Line Sources)

Secondary emission sources such as stockpiles, the handling (loading/unloading) of material, crushing and screening operations and gravel roads which give rise to secondary particulate matter emissions are present at the operation and therefore included in this study.
The fugitive / secondary emissions at the Enterprise emanate from the following sources/operations:

- Raw Materials / Waste Storage facilities (loading / unloading);
- Final product processing and stockpiles (crushing / screening);
- Vehicles and roads.

The main sources of secondary emissions from the processes / plants are the roads, waste disposal / slag storage, as well as the material storage areas. When relevant/applicable secondary emissions from secondary area and or line sources such as stockpiles and gravel roads, are assessed in accordance with the information and methodology provided in Appendix D of this document in terms of the expected quantities of material consumed or processed and moved for different scenarios considered. Please refer to respectively to Figure 4.2 and 4.3, for process/plant secondary sources; material processing, storage/material handling area sources and roads applicable for all scenarios. It is also noted that the following prefixes are used in the tables which follow for the sources under the "Source Code" column:
"A__A": Area Source applicable to ACRW (no secondary sources were referenced for the other Cato Ridge Sources);
"A__L": Line Source applicable to ACRW (no secondary sources were referenced for the other Cato Ridge Sources);
"2__A": Area Source applicable ACRW (no secondary sources were referenced for the other Cato Ridge Sources);
"2__L": Line Source applicable to ACRW (no secondary sources were referenced for the other Cato Ridge Sources);

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Figure 4.2: Secondary Process/Plant Emission Sources – ACRW Area Sources



Figure 4.3: Secondary Process/Plant Emission Sources – ACRW Line Sources

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4.4.1 ACRW Fugitive / Secondary Emissions

For all of the emission scenarios, the estimated fugitive / secondary emissions from the relevant fugitive / secondary sources are provided in Table 4.4.1-1, which includes wind generated, wheel generated, loading/unloading and vehicle emissions.

Table 4.4.1-1: Fugitive / Secondary Emissions – ACRW

Source Code	Source Description	Average Emission Rates								Averaging Period	Duration of Emissions
		PM_{10} (tonne /annum)	$PM_{2.5}$ (tonne /annum)	SO_2 (tonne /annum)	NO_X (tonne /annum)	CO (tonne /annum)	NH_3 (tonne /annum)	Mn (tonne /annum)	$VOC(C_6H_6)$ (tonne /annum)		
A__A09HC	Area_HighCarbonC&S	0.913	0.274	0.001	0.045	0.016	0.000	0.639	0.000	Annual	Intermittent
A__A10LC	Area_LowCarbonC&S	0.292	0.088	0.001	0.030	0.011	0.000	0.228	0.000	Annual	Intermittent
A__A14BP	Area_BriquettingPlant	0.051	0.015	0.000	0.000	0.000	0.000	0.015	0.000	Annual	Intermittent
A__A03RS	Area_RawMaterialStorage	2.849	0.855	0.037	1.349	0.488	0.000	0.865	0.003	Annual	Intermittent
A__A15BS	Area_BriquettingPlantStockpiles	0.182	0.054	0.004	0.136	0.049	0.000	0.055	0.000	Annual	Intermittent
A__A12ES	Area_ExportStockpile_South	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.000	Annual	Intermittent
A__A12EN	Area_ExportStockpile_North	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.000	Annual	Intermittent
A__A11SN	Area_SlagDisposal_New	0.665	0.199	0.000	0.000	0.000	0.000	0.003	0.000	Annual	Intermittent
A__A01SO	Area_SlagDisposal_Old	2.698	0.809	0.000	0.000	0.000	0.000	0.012	0.000	Annual	Intermittent
A__A02CT	Area_SlagPondCoolingTrenches	0.477	0.143	0.009	0.321	0.116	0.000	0.085	0.001	Annual	Intermittent
A__A13IO	Area_Product&RM_InOutLoading_NEW	0.476	0.143	0.009	0.322	0.117	0.000	0.345	0.001	Annual	Intermittent
A__A05BN	Area_BaghouseDustStorage_NEW	0.106	0.032	0.000	0.000	0.000	0.000	0.035	0.000	Annual	Intermittent
A__A06PS	Area_ProductStorage	0.120	0.036	0.000	0.000	0.000	0.000	0.087	0.000	Annual	Intermittent
A__A07ST	Area_SlimesDamsTailings	0.241	0.072	0.000	0.000	0.000	0.000	0.049	0.000	Annual	Intermittent
A__A08MR	Area_MRP	2.206	0.662	0.037	1.347	0.487	0.000	0.395	0.003	Annual	Intermittent
2__A16SP	Area_SinterPlant_MatH	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Annual	Intermittent
A__L0901	Road_Unpaved_Hostel_L09_01	0.004	0.001	0.000	0.000	0.000	0.000	0.000	0.000	Annual	Intermittent
A__L0902	Road_Unpaved_Hostel_L09_02	0.018	0.006	0.000	0.000	0.000	0.000	0.000	0.000	Annual	Intermittent
A__L0903	Road_Unpaved_Hostel_L09_03	0.010	0.003	0.000	0.000	0.000	0.000	0.000	0.000	Annual	Intermittent
A__L0904	Road_Unpaved_Hostel_L09_04	0.009	0.003	0.000	0.000	0.000	0.000	0.000	0.000	Annual	Intermittent
A__L0905	Road_Unpaved_Hostel_L09_05	0.003	0.001	0.000	0.000	0.000	0.000	0.000	0.000	Annual	Intermittent
A__L0906	Road_Unpaved_Hostel_L09_06	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Annual	Intermittent
A__L0907	Road_Unpaved_Hostel_L09_07	0.003	0.001	0.000	0.000	0.000	0.000	0.000	0.000	Annual	Intermittent
A__L0908	Road_Unpaved_Hostel_L09_08	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Annual	Intermittent
A__L1001	Road_Unpaved_MRP-Storage_L10_01	0.545	0.164	0.009	0.338	0.122	0.000	0.098	0.001	Annual	Intermittent
A__L1002	Road_Unpaved_MRP-Storage_L10_02	0.131	0.039	0.002	0.081	0.029	0.000	0.024	0.000	Annual	Intermittent
A__L1003	Road_Unpaved_MRP-Storage_L10_03	0.117	0.035	0.002	0.073	0.026	0.000	0.021	0.000	Annual	Intermittent
A__L1004	Road_Unpaved_MRP-Storage_L10_04	0.142	0.042	0.002	0.088	0.032	0.000	0.025	0.000	Annual	Intermittent
A__L1005	Road_Unpaved_MRP-Storage_L10_05	0.259	0.078	0.004	0.161	0.058	0.000	0.046	0.000	Annual	Intermittent
A__L1006	Road_Unpaved_MRP-Storage_L10_06	0.194	0.058	0.003	0.120	0.043	0.000	0.035	0.000	Annual	Intermittent
A__L1007	Road_Unpaved_MRP-Storage_L10_07	0.209	0.063	0.004	0.129	0.047	0.000	0.037	0.000	Annual	Intermittent
A__L1008	Road_Unpaved_MRP-Storage_L10_08	0.044	0.013	0.001	0.027	0.010	0.000	0.008	0.000	Annual	Intermittent
A__L1009	Road_Unpaved_MRP-Storage_L10_09	0.151	0.045	0.003	0.093	0.034	0.000	0.027	0.000	Annual	Intermittent
A__L1010	Road_Unpaved_MRP-Storage_L10_10	0.116	0.035	0.002	0.072	0.026	0.000	0.021	0.000	Annual	Intermittent
A__L1011	Road_Unpaved_MRP-Storage_L10_11	0.678	0.203	0.012	0.420	0.152	0.000	0.121	0.001	Annual	Intermittent
A__L0101	Road_Unpaved_SlagDisposal_Old_L01_01	0.869	0.261	0.008	0.294	0.106	0.000	0.004	0.001	Annual	Intermittent
A__L0102	Road_Unpaved_SlagDisposal_Old_L01_02	1.441	0.432	0.013	0.487	0.176	0.000	0.006	0.001	Annual	Intermittent
A__L0103	Road_Unpaved_SlagDisposal_Old_L01_03	0.776	0.233	0.007	0.262	0.095	0.000	0.003	0.001	Annual	Intermittent
A__L0201	Road_Unpaved_SlagPondCoolingTrenches_L02_01	0.625	0.188	0.006	0.211	0.076	0.000	0.112	0.000	Annual	Intermittent
A__L0202	Road_Unpaved_SlagPondCoolingTrenches_L02_02	0.216	0.065	0.002	0.073	0.026	0.000	0.039	0.000	Annual	Intermittent
A__L0203	Road_Unpaved_SlagPondCoolingTrenches_L02_03	0.283	0.085	0.003	0.096	0.035	0.000	0.051	0.000	Annual	Intermittent
A__L0204	Road_Unpaved_SlagPondCoolingTrenches_L02_04	0.157	0.047	0.001	0.053	0.019	0.000	0.028	0.000	Annual	Intermittent
A__L0301	Road_Paved_RawMaterial_L03_01	0.777	0.233	0.013	0.460	0.166	0.000	0.236	0.001	Annual	Intermittent
A__L0302	Road_Paved_RawMaterial_L03_02	0.625	0.187	0.010	0.370	0.134	0.000	0.190	0.001	Annual	Intermittent
A__L0303	Road_Paved_RawMaterial_L03_03	0.047	0.014	0.001	0.028	0.010	0.000	0.014	0.000	Annual	Intermittent
A__L0304	Road_Paved_RawMaterial_L03_04	0.037	0.011	0.001	0.022	0.008	0.000	0.011	0.000	Annual	Intermittent
A__L0305	Road_Paved_RawMaterial_L03_05	0.673	0.202	0.011	0.398	0.144	0.000	0.204	0.001	Annual	Intermittent
A__L0306	Road_Paved_RawMaterial_L03_06	0.119	0.036	0.002	0.070	0.025	0.000	0.036	0.000	Annual	Intermittent

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Source Code	Source Description	Average Emission Rates								Averaging Period	Duration of Emissions
		PM_{10} (tonne /annum)	$PM_{2.5}$ (tonne /annum)	SO_2 (tonne /annum)	NO_X (tonne /annum)	CO (tonne /annum)	NH_3 (tonne /annum)	Mn (tonne /annum)	$VOC(C_6H_6)$ (tonne /annum)		
A__L0401	Road_Unpaved_BHDustStorage_Old_L04_01	0.115	0.035	0.001	0.021	0.008	0.000	0.000	0.000	Annual	Intermittent
A__L0501	Road_Unpaved_BHDustStorage_New_L05_01	0.475	0.142	0.002	0.086	0.031	0.000	0.157	0.000	Annual	Intermittent
A__L0601	Road_Paved_ProductStorage_L06_01	0.075	0.022	0.002	0.061	0.022	0.000	0.027	0.000	Annual	Intermittent
A__L0602	Road_Paved_ProductStorage_L06_02	0.070	0.021	0.002	0.056	0.020	0.000	0.025	0.000	Annual	Intermittent
A__L0603	Road_Paved_ProductStorage_L06_03	0.043	0.013	0.001	0.035	0.013	0.000	0.016	0.000	Annual	Intermittent
A__L0604	Road_Paved_ProductStorage_L06_04	0.073	0.022	0.002	0.060	0.022	0.000	0.027	0.000	Annual	Intermittent
A__L0605	Road_Paved_ProductStorage_L06_05	0.070	0.021	0.002	0.057	0.021	0.000	0.025	0.000	Annual	Intermittent
A__L0701	Road_Unpaved_SlimesDams(Tailings)_L07_01	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Annual	Intermittent
A__L0801	Road_Paved_Main_L08_01	0.115	0.034	0.003	0.109	0.039	0.000	0.006	0.000	Annual	Intermittent
A__L0802	Road_Paved_Main_L08_02	0.230	0.069	0.006	0.219	0.079	0.000	0.012	0.000	Annual	Intermittent
A__L0803	Road_Paved_Main_L08_03	0.458	0.137	0.012	0.435	0.157	0.000	0.024	0.001	Annual	Intermittent
A__L0804	Road_Paved_Main_L08_04	0.572	0.172	0.015	0.544	0.197	0.000	0.029	0.001	Annual	Intermittent
A__L0805	Road_Paved_Main_L08_05	0.326	0.098	0.009	0.310	0.112	0.000	0.017	0.001	Annual	Intermittent
A__L0806	Road_Paved_Main_L08_06	0.581	0.174	0.015	0.552	0.200	0.000	0.030	0.001	Annual	Intermittent
A__L0807	Road_Paved_Main_L08_07	0.350	0.105	0.009	0.332	0.120	0.000	0.018	0.001	Annual	Intermittent
A__L0808	Road_Paved_Main_L08_08	0.155	0.047	0.004	0.148	0.053	0.000	0.008	0.000	Annual	Intermittent
A__L0809	Road_Paved_Main_L08_09	0.594	0.178	0.016	0.565	0.204	0.000	0.031	0.001	Annual	Intermittent
A__L0810	Road_Paved_Main_L08_10	0.232	0.070	0.006	0.221	0.080	0.000	0.012	0.000	Annual	Intermittent
A__L0811	Road_Paved_Main_L08_11	0.087	0.026	0.002	0.083	0.030	0.000	0.004	0.000	Annual	Intermittent
A__L0812	Road_Paved_Main_L08_12	0.193	0.058	0.005	0.183	0.066	0.000	0.010	0.000	Annual	Intermittent
A__L0813	Road_Paved_Main_L08_13	0.240	0.072	0.006	0.228	0.082	0.000	0.012	0.000	Annual	Intermittent
A__L0814	Road_Paved_Main_L08_14	0.098	0.029	0.003	0.093	0.034	0.000	0.005	0.000	Annual	Intermittent
A__L0815	Road_Paved_Main_L08_15	0.073	0.022	0.002	0.069	0.025	0.000	0.004	0.000	Annual	Intermittent
A__L0816	Road_Paved_Main_L08_16	0.310	0.093	0.008	0.295	0.107	0.000	0.016	0.001	Annual	Intermittent
A__L0817	Road_Paved_Main_L08_17	0.338	0.102	0.009	0.322	0.116	0.000	0.017	0.001	Annual	Intermittent
A__L1101	Road_Unpaved_SlagDisposal_New_L11_01	0.540	0.162	0.005	0.183	0.066	0.000	0.002	0.000	Annual	Intermittent
A__L1102	Road_Unpaved_SlagDisposal_New_L11_02	1.407	0.422	0.013	0.476	0.172	0.000	0.006	0.001	Annual	Intermittent
A__L1103	Road_Unpaved_SlagDisposal_New_L11_03	0.408	0.123	0.004	0.138	0.050	0.000	0.002	0.000	Annual	Intermittent
A__L1104	Road_Unpaved_SlagDisposal_New_L11_04	0.523	0.157	0.005	0.177	0.064	0.000	0.002	0.000	Annual	Intermittent
A__L1105	Road_Unpaved_SlagDisposal_New_L11_05	1.245	0.374	0.012	0.421	0.152	0.000	0.006	0.001	Annual	Intermittent
A__L1106	Road_Unpaved_SlagDisposal_New_L11_06	0.778	0.233	0.007	0.263	0.095	0.000	0.003	0.001	Annual	Intermittent

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4.5 Emergency incidents

Table 4.5-1 below provides a summary of the emergency incidents during the last 5 years which resulted in atmospheric emissions for ACRW (no information was available for the other Cato Ridge sources included).

Table 4.5-1: Emergency incidents

Emergency Incidents			
Description	**Nature & Cause**	**Actions undertaken Immediately to Minimise Impact**	**Actions undertaken Subsequently to Reduce Likelihood of Reoccurrence**
Failure of APCE	a) Problems with fume extraction; b) Problems with scrubbers; c) Problems with baghouses;	1) Corrective action taken during operation; 2) If problem persists unit process is stopped; 3) Problem is investigated and rectified;	Reasons for incidents vary and actions are undertaken to reduce likelihood of re-occurrence following investigations

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5. IMPACT OF ENTERPRISE ON THE RECEIVING ENVIRONMENT

5.1 Analysis of Emissions' Impact on Human Health

In accordance with the requirements of the Regulations Prescribing the Format of the Atmospheric Impact Report as published in Government Gazette No. 36904 on the 11th of October 2013 and the Regulations Regarding Air Dispersion Modelling as published in Government Gazette No. 37804 on the 11th of July 2014, the impact of the Enterprise was assessed by means of air dispersion modelling in accordance with the Code of Practice for Air Dispersion Modelling in Air Quality Management in South Africa. The South African National Ambient Air Quality Standards, in terms of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004), was published in Government Gazette No. 32816 on the 24th of December 2009. The document contains the National standards for ambient air quality, and specifically assigns the tolerated "Frequency of Exceedance" of the "Limit value" for each pollutant. Where relevant, the tolerated "Frequency of Exceedance" is the same for all the pollutants and can be seen in Table 5.1.

Table 5.1: Tolerated frequency of exceedances of ambient air guidelines

Tolerated frequency of exceedances of ambient air guidelines	
Averaging period	**Tolerated Frequency of Exceedance of Limit value**
1 hour	88 exceedances of 1 hour limit per annum
8 hour	11 exceedances of 8 hour limit per annum
24 hour	4 exceedances of 24 hour limit per annum
1 year (Annual)	0 exceedances of annual limit per annum

The "Frequency of exceedance" is a frequency (number/time) related to a limit value representing the tolerated exceedance of that limit value, i.e. if the exceedances of the limit value are within the tolerances there is still compliance with the standard. With the exception of the annual average limit, the values reported in Table 5.1 indicate a tolerable exceedance of 1% of values for each averaging period, i.e. for the 1 hour averaging period, 88 of the 8760 hourly measured concentrations (1%) over a calendar year can exceed the Limit value and compliance with the standard can still be met. This therefore implies that if the 99th percentile of measured data is below the ambient air guidelines for a relevant pollutant, there will be compliance with the standard.

Table 5.2.1 provides the South African ambient air quality standard for pollutants, which includes the pollutants included in this investigation.

Table 5.2.1: South African Ambient Air Quality Standards for the applicable gasses and particulate matter

South African Ambient Air Quality Standard[8]					
	Averaging Period	**1 Hour**	**8 Hour**	**24 Hour**	**Annual**
		µg/m³	µg/m³	µg/m³	µg/m³
PM_{10} Particulate matter	PM_{10}			75	40
$PM_{2.5}$Particulate matter	$PM_{2.5}$			40	20
Sulphur Dioxide	SO_2	350		125	50
Oxides of Nitrogen	NO_x (as NO_2)	200			40
Carbon Monoxide	CO	30 000	10 000		
Ozone	O_3		120		
Benzene	C_6H_6				5
Lead	Pb				0.5

Table 5.2.2 provides guidelines and reference concentrations for pollutants for which South African ambient air quality standards do not exist.

[8] Interim ambient air quality standards also apply which are referenced in Tables 5.3 and 5.4

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Table 5.2.2: Other Ambient Air Quality Guidelines for Pollutants

Other Ambient Air Quality Guidelines						
Averaging Period		**1 Hour**	**8 Hour**	**24 Hour**	**Annual**	**Unit Risk**
		µg/m³	µg/m³	µg/m³	µg/m³	(µg/m³)⁻¹
US EPA Reference Concentration (RfC)						
Hydrogen Chloride	HCl			20		
Ammonia	NH_3			100		
n-Hexane	C_6H_{14}			200		
Isopropanol[9]	$CH_3CHOHCH_3$			4945	3296	
Chlorine[10]	Cl_2	15				
California Air Resources Board Air Quality Standard & Maine County Air Quality Guideline						
Hydrogen Sulphide	H_2S	45			2	
WHO Ambient Air Quality Guidelines						
Hydrogen Sulphide	H_2S	7				
Hydrogen Fluoride	HF	600		1		
Carbon Disulphide	CS_2	20				
Polycyclic Aromatic Hydrocarbons	PAH					0.0875
Acrylonitrile	CH_2CHCN					0.000002
Trichloroethylene	C_2HCl_3					0.00000043
Tetrachloroethylene	C_2Cl_4			250		
1,2-Dichloroethane	$C_2H_4Cl_2$			700		
Dichloromethane	CH_2Cl_2			3000		
Formaldehyde	CH_2O	100[11]				
Styrene	C_8H_8	70[12]				
Toluene	C_7H_8	1000[13]				
Mercury	Hg				1.00	
Arsenic	As					0.0015
Cadmium	Cd				0.01	
Hexavalent Chrome	Cr(VI)					0.04
Manganese	Mn				0.15	
Nickel	Ni					0.0004
Lead	Pb				0.50	
Vanadium	V			1.00		

The Ontario Ministry of Environment have set a 30-day ambient air standard for gaseous HF during the growing season at 0.34 µg/m³ which is used as reference for monthly and annual average HF concentrations.

Included with the National Ambient Air Quality Standards published are interim levels for $PM_{2.5}$, as is referred in Table 5.3. The South African National Ambient Air Quality Standards for $PM_{2.5}$ (Particulate matter with an aerodynamic diameter less than 2.5µm), in terms of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004), was published in Government Gazette No. 35463 on the 29th of June 2012.

[9] Alberta Environment, 2004
[10] Alberta Environment, 2017
[11] 30-min average
[12] 30-min average
[13] 30-min average

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Table 5.3: Interim ambient air quality standards for $PM_{2.5}$

Interim ambient air quality standards				
Particulate matter ($PM_{2.5}$)				
Period	**Type of standard**	**Concentration**	**Frequency of Exceedance**	**Compliance date**
24 hours	Interim level	40 µg/m³	4	1 January 2016 to 31 December 2029
1 year (Annual)	Interim level	20 µg/m³	0	1 January 2016 to 31 December 2029
24 hours	National ambient air quality standard	25 µg/m³	4	From 1 January 2030
1 year (Annual)	National ambient air quality standard	15 µg/m³	0	From 1 January 2030

It is noted that this investigation is limited to the dispersion modelling done and assessment of the results against the South African Ambient Air Quality Standards and or other guidelines in ambient air and does not constitute a full health impact assessment / toxicology study and the information provided in Tables 5.4, 5.5 and 5.6 are informative in order to relate to the potential risks associated with various pollutants.

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Table 5.4: Pollutants emitted to the atmosphere

Pollutants, their effect on humans and technologies for disposal of them							
	Exposure Routes	**Symptoms**	**Target Organs**		**Hazardous Waste Disposal**		
					Preferred Technology	**Allowed Technology**	**Unacceptable Technology**
Classical pollutants							
SO_2	Inh, Con	Irrit eyes, nose, throat; rhin; choking, cough; reflex bronchoconstriction; liquid: frostbite	Eyes, skin, resp sys				
NO_x as NO_2	Inh, Ing, Con	Irrit eyes, nose, throat; cough, mucoid frothy sputum, decr pulm func, chronic bron, dysp; chest pain; pulm edema, cyan, tachypnea, tacar	Eyes, resp sys, CVS, Pulmonary function affected-airway responsiveness				
HF	Inh, Abs (liquid), Ing (solution), Con	Irrit eyes, skin, nose, throat; pulm edema; eye, skin burns; rhinitis; bron; bone changes	Eyes, skin, resp sys, bones				
NH_3	Inh, Ing (solution), Con (solution/liquid)	Irrit eyes, nose, throat; dysp, wheez, chest pain; pulm edema; pink frothy sputum; skin burns, vesic; liquid: frostbite	Eyes, skin, resp sys				
HCl	Inh, Ing (solution), Con	Irrit nose, throat, larynx; cough, choking; derm; solution: eye, skin burns; liquid: frostbite; in animals: lar spasm; pulm edema	Eyes, skin, resp sys				
TSP (Total Suspended Particles)	Inh, Con	Irrit eyes, skin, throat, upper resp sys	Eyes, skin, resp sys, card				
PM_{10}	Inh, Con	Irrit eyes, skin, throat, upper resp sys	Eyes, skin, resp sys, card				
$PM_{2.5}$	Inh, Con	Irrit eyes, skin, throat, upper resp sys	Eyes, skin, resp sys, card				
Organic pollutants							
CO	Inh, Abs, Ing, Con	Dizz, head, poor sleep, lass, anxi, anor, low-wgt; psychosis; polyneur; Parkinson-like syndrome; ocular changes; coronary heart disease; gastritis; kidney, liver inj; eye, skin burns; derm; repro effects	CNS, PNS, CVS, eyes, kidneys, liver, skin, repro sys, tissue hypoxia				
CO_2	Inh, Con (liquid/solid)	Head, dizz, restless, pares; dysp; sweat, mal; incr heart rate, card output, BP; coma; asphy; convuls; frostbite (liq, dry ice)	Resp sys, CVS				
Heavy metal content of TSP's							
As	Inh, Ing, Con	In animals: irrit skin, possible derm; resp distress; diarr; kidney damage; musc tremor, convuls; possible GI tract, repro effects; possible liver damage	Skin, resp sys, kidneys, CNS, liver, GI tract, repro sys		RCY, IML	ENC, LFC	
Cd	Inh, Ing	Pulm edema, dysp, cough, chest tight, subs pain; head; chills, musc aches; nau, vomit, diarr; anos, emphy, prot, mild anemia; [carc]	Resp sys, kidneys, prostate, blood [prostatic & lung cancer]		RCY, IML	PRN	LWT
Pb	Inh, Ing, Con	Lass, insom; facial pallor; anor, low-wgt, malnut; constip, abdom pain, colic; anemia; gingival lead line; tremor; para wrist, ankles; encephalopathy; kidney disease; irrit eyes; hypotension	Eyes, GI tract, CNS, kidneys, blood, gingival tissue		RCY	ENC, IML	LWT
Mn	Inh, Ing	Parkinson's; asthenia, insom, mental conf; metal fume fever: dry throat, cough, chest	Resp sys, CNS, blood, kidneys		RCY, IML	ENC, PRN	LWT

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Pollutants, their effect on humans and technologies for disposal of them							
	Exposure Routes	**Symptoms**	**Target Organs**		**Hazardous Waste Disposal**		
					Preferred Technology	**Allowed Technology**	**Unacceptable Technology**
		tight, dysp, rales, flu-like fever; low-back pain; vomit; mal; lass; kidney damage					
Hg	Inh, Abs, Ing, Con	Irrit eyes, skin; cough, chest pain, dysp, bron, pneu; tremor, insom, irrity, indecision, head, lass; stomatitis, salv; GI dist, anor, low-wgt; prot	Eyes, skin, resp sys, CNS, kidneys		RCY, IML	ENC, OCR	LWT
Ni	Inh, Ing, Con	Sens derm, allergic asthma, pneu; [carc]	Nasal cavities, lungs, skin [lung and nasal cancer]		RCY, IML	ENC, PRN	LWT
Tl	Inh, Abs, Ing, Con	Nau, diarr, abdom pain, vomit; ptosis, strabismus; peri neuritis, tremor; retster tight, chest pain, pulm edema; convuls, chorea, psychosis; liver, kidney damage; alopecia; pares legs	Eyes, resp sys, CNS, liver, kidneys, GI tract, body hair				
V (as V_2O_5)	Inh, Ing, Con	Irrit eyes, skin, throat; green tongue, metallic taste, eczema; cough; fine rales, wheez, bron, dysp	Eyes, skin, resp sys		RCY, IML	PRN	LWT
Zn (as ZnO)	Inh	Metal fume fever: chills, musc ache, nau, fever, dry throat, cough; lass; metallic taste; head; blurred vision; low back pain; vomit; mal; chest tight; dysp, rales, decr pulm func	Resp sys				

Table 5.5: Abbreviations for "Exposure Routes, Symptoms and Target Organs"

Abbreviations for the table showing "Exposure Routes, Symptoms, and Target Organs"				
abdom	Abdominal		irreg	Irregular/Irregularities
abnor	Abnormal/Abnormalities		irrit	Irritation
abs	Skin absorption		irrity	Irritability
album	Albuminuria (presence of albumin (a water-soluble protein) in the urine)		jaun	Jaundice
anes	Anesthesia		kera	Keratitis (inflammation of the cornea)
anor	Anorexia		lac	Lacrimation (discharge of tears)
anos	Anosmia (loss of the sense of smell)		lar	Laryngeal
anxi	Anxiety		lass	Lassitude (weakness, exhaustion)
arrhy	Arrhythmias (an abnormality in the heart's rhythm)		leucyt	Leukocytosis (increased blood leukocytes)
aspir	Aspiration		leupen	Leukopenia (reduced blood leukocytes)
asphy	Asphyxia		liq	Liquid
BP	Blood pressure		local	Localized
breath	Breath/breathing		low-wgt	Weight loss
bron	Bronchitis		mal	Malaise (vague feeling of discomfort)
BUN	Blood urea nitrogen		malig	Malignant - clinical course that progresses rapidly to death
[carc]	Potential occupational carcinogen		malnut	Malnutrition
card	Cardiac		mesot	Mesothelioma - cancer from previous exposure to asbestos

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Abbreviations for the table showing "Exposure Routes, Symptoms, and Target Organs"				
chol	Cholinesterase		methemo	Methemoglobinemia
cirr	Cirrhosis		muc	memb Mucous membrane
CNS	Central nervous system		musc	Muscle
conc	Concentration		narco	Narcosis
con	Skin and/or eye contact		nau	Nausea
conf	Confusion		nec	Necrosis
conj	Conjunctivitis		neph	Nephritis
constip	Constipation		numb	Numb/numbness
convuls	Convulsions		opac	Opacity
corn	Corneal		palp	Palpitations
CVS	Cardiovascular system		para	Paralysis
cyan	Cyanosis (resulting from inadequate oxygenation of the blood)		pares	Paresthesia
decr	Decreased		perf	Perforation
depres	Depressed/Depression		peri neur	Peripheral neuropathy
derm	Dermatitis (inflammation of the skin)		periorb	Periorbital (situated around the eye)
diarr	Diarrhea		phar	Pharyngeal
dist	Disturbance		photo	Photophobia (abnormal visual intolerance to light)
dizz	Dizziness		pneu	Pneumonitis
drow	Drowsiness		polyneur	Polyneuropathy
dysp	Dyspnea (breathing difficulty)		prot	Proteinuria
emphy	Emphysema		pulm	Pulmonary
eosin	Eosinophilia		RBC	Red blood cell
epilep	Epileptiform		repro	Reproductive
epis	Epistaxis (nosebleed)		resp	Respiratory/respiration
equi	Equilibrium		restless	Restlessness
eryt	Erythema (skin redness)		retster	Retrosternal (occurring behind the sternum)
euph	Euphoria		rhin	Rhinorrhea (discharge of thin nasal mucus)
fail	Failure		salv	Salivation
fasc	Fasciculation		sens	Sensitization
FEV	Forced expiratory volume		short	Shortness
fib	Fibrosis		sneez	Sneezing
ftg	Fatigue		sol	Solid
func	Function		soln	Solution
Gen	Genotoxicity (Mutation, tumors)		subs	Substernal (occurring beneath the sternum)
GI	Gastrointestinal		sweat	Sweating
halu	Hallucinations		swell	Swelling
head	Headache		sys	System
hema	Hematuria (blood in the urine)		tacar	Tachycardia
hemato	Hematopoietic		tend	Tenderness
hemorr	Hemorrhage		terato	Teratogenic

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Abbreviations for the table showing "Exposure Routes, Symptoms, and Target Organs"				
hyperpig	Hyperpigmentation		throb	Throbbing
hypox	Hypoxemia (reduced O2 in the blood)		tight	Tightness
inco	Incoordination		twitch	Twitching
incr	Increased		uncon	Unconsciousness
inebri	Inebriation		vap	Vapor
inflamm	Inflammation		vesic	Vesiculation
ing	Ingestion		vis	Visual
inh	Inhalation		vomit	Vomiting
inj	Injury		weak	Weak/weakness
insom	Insomnia		wheez	Wheezing

Table 5.6: Hazardous waste disposal technologies

Description of Abbreviations for Technology terms		
Abbreviation	**Technology**	**Description**
CTR	Chemical Treatment then landfill co-dispose residues	A chemical treatment procedure (unspecified), that can meet the requirements must be used prior to co-disposal to landfill.
DBI	Detonation, Burning or Incineration	Destruction by detonation, by burning or by controlled incineration as approved by the Chief Inspector of Explosives or the Government Mining Engineer.
ENC	Encapsulation	The containment of waste in drums or other approved containers in a reinforced concrete cell within a permitted hazardous waste landfill. Encapsulation of organic materials is permitted only in the absence of an appropriate and cost effective incineration facility.
HNR	Hydrolyse & Neutralise then landfill codispose residues	Hydrolysis of a compound, organic or inorganic, using acid or base followed by neutralisation prior to codisposal to landfill.
IML	Immobilisation then landfill	This term includes all immobilisation techniques such as microencapsulation, vitrification and solidification but not macroencapsulation.
INC	Incineration	The controlled thermal destruction of the waste in a facility permitted for that type of waste. For chemical waste, appropriate pollution control equipment, e.g. for the scrubbing of acid gases, may be required.
LFL	Landfilling not allowed	Disposal of this waste to a landfill is not allowed.
LFC	Landfill codispose	Mixing or blending of a Hazardous Waste with General Waste within a permitted landfill with a recommended minimum ratio of 1 to 9 v/v.
LWT	Landfilling without treatment	Landfilling of the waste is not allowed without appropriate pretreatment.
LFB	Landfill-ash blend	Mixing or blending of a flammable waste with sufficient fly ash, bottom ash or other material approved by the Department, so that the flash point is >61°C. Ash blending is considered a treatment process and therefore the resulting product must be landfill-codisposed with municipal or commercial waste.
NCR	Neutralise then landfill codispose residues	Addition acid or alkali to bring the pH in the region of 7. Lime is normally used to neutralise acid wastes prior to codisposal to landfill.
OCR	Oxidation then landfill codispose residues	Oxidise, e.g. by using chlorine or another oxidising agent, prior to codisposal to landfill.
PRN	Precipitation then landfill codispose residues	Addition of lime, sodium sulphide or other reagent that results in the formation of insoluble compounds that come out of solution. Usually the solids are separated from the liquids prior to codisposal to landfill.

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Description of Abbreviations for Technology terms		
Abbreviation	**Technology**	**Description**
RCY	Recovery	This term includes all recycling, reuse and utilisation techniques.
RCR	Reduction then landfill codispose residues	Reduce by using, e.g., ferrous sulphate, sodium sulphite or another reducing agent prior to codisposal to landfill.
RTA	Release to Atmosphere	Small amounts of gas may be released to the atmosphere with appropriate health and safety precautions. The Department of Health should, however, be consulted about the requirements of the Atmospheric Pollution Act.
WTL	Weather then landfill codispose residues	Exposure of the waste to the elements, e.g. the sun, in order to decompose the hazardous substance prior to codisposal to landfill.

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5.1.1 Baseline/Current Ambient Air Quality

Emission Monitoring & Calculation Monitoring is done by ACRW in order to inform the operations with respect to emission inventory compilation, atmospheric impact assessments and to assess compliance against the limits contained in the AEL and or relevant local by-laws. Ambient air monitoring, as dust fallout monitoring, is conducted by the Enterprise. In addition thereto continuous ambient air quality monitoring and passive ambient air quality monitoring is conducted.

5.1.1.1 Monitoring Localities

Emission Monitoring

Emission monitoring is performed at the site by means of isokinetic stack sampling on an annual basis in accordance with the AEL requirements on an ongoing basis.

The monitoring points are defined as the primary point sources which need to be sampled in order to assess their emissions. There are 13 point sources listed in the current AEL. These point sources as referenced in Section 4 of this report, are listed in Table 5.8-1 below. Refer to Figure 4.1 for the locations of these points.

Table 5.8-1: Emission Monitoring Point Source Description

Point Source Code	Point Source Code (AEL)	UTM Easting (mE)	UTM Northing (mN)	Description
P1	P1	269074.0	6710253.0	F1 BH Stack
P2	P2	269118.0	6710318.0	F2 BH Stack
P3	P3	269054.0	6710392.0	F3 OGP Stack
P4	P4	269047.0	6710388.0	F4 OGP Stack
P5	P5	269056.0	6710403.0	F3&4 Shared VAI Stack
P6	P6	269193.0	6710393.1	F5 BH equivalent 1 point (to model as 20)
P8	P8	269110.0	6710500.0	F6 OGP Stack
P7	P7	269101.0	6710504.0	F6 VAI Stack
P9	P9	269230.0	6710454.0	CRA Stack
P10	P10	269133.0	6710352.0	Furnace Building Fugitive Fume Stack
P11	P11	269279.0	6710365.0	HC C&S Stack
P12	P12	269224.0	6710512.5	LC C&S Stack
P13	P13	268694.0	6709634.0	Briquetting Plant

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Ambient Monitoring

Ambient Air Monitoring was implemented by ACRW at locations to monitor the ambient air quality in the area surrounding the Enterprise, which could also be utilised to assess potential impact / contribution of ACRW on the surrounding ambient air quality. Two continuous ambient air monitoring stations are utilised for this purpose, one stations is located at Radnor (Site ''R'') and at the Cato Ridge Country Club (Site ''C''), as indicated in Figure 5.1-1. Passive sampling of benzene is also conducted near the Candy Plant, refer Figure 5.1-1. In accordance with requirements, Dust Fallout measurements should be conducted by the Enterprise. The Enterprise conducts Dust Fallout monitoring by means of an established dust fallout monitoring network.

In view of this study being associated with the quality of the ambient air surrounding the Enterprise / operations, referenced monitoring locations are those which are considered “off-site” relative to the Enterprise / operations.

Table 5.8-2: Ambient Monitoring Locations & Description

Location Reference Number	Classification	UTM Easting (mE)	UTM Northing (mN)	Assessment Done Against
Old Hostel Security Gate	Non-residential	269094.9	6711100.3	NDCR (GN827, 01Nov2013)
Small Slag Dump	Non-residential	269393.1	6710514.1	NDCR (GN827, 01Nov2013)
Northern Fence (Airfield Fence)	Non-residential	269363.8	6711128.8	NDCR (GN827, 01Nov2013)
Inchanga Park	Residential	271962.0	6708862.0	NDCR (GN827, 01Nov2013)
Othweba School	Residential	267983.4	6712430.0	NDCR (GN827, 01Nov2013)
Thornridge Nursery	Residential	267118.1	6708899.9	NDCR (GN827, 01Nov2013)
Cato Ridge Spar	Residential	267529.5	6708533.1	NDCR (GN827, 01Nov2013)
George Cato School	Residential	266687.6	6707939.5	NDCR (GN827, 01Nov2013)
Metallica	Non-residential	269989.6	6709863.3	NDCR (GN827, 01Nov2013)
Abattoir	Non-residential	271810.1	6712357.9	NDCR (GN827, 01Nov2013)
South Fence (near H:H Slimes dams)	Non-residential	268826.3	6709445.5	NDCR (GN827, 01Nov2013)
SW Fence (Candy filter plant direction)	Non-residential	268594.3	6709860.5	NDCR (GN827, 01Nov2013)
West Fence	Non-residential	268834.1	6710381.4	NDCR (GN827, 01Nov2013)
Bass Beams	Non-residential	272028.4	6711688.2	NDCR (GN827, 01Nov2013)
Eskom	Non-residential	268513.2	6708902.4	NDCR (GN827, 01Nov2013)
Briquetting Plant	Non-residential	268539.0	6709398.0	NDCR (GN827, 01Nov2013)
Radnor DFO	Non-residential	270114.0	6709705.0	NDCR (GN827, 01Nov2013)
CAAQMS: Radnor	Off-site	270106.0	6709698.9	SA National Ambient Air Quality Standards
CAAQMS: Cato Ridge Country Club	Off-site	267129.0	6707835.0	SA National Ambient Air Quality Standards
Passive Sampling(Benzene): Candy Plant	Off-site	268606.5	6709967.2	SA National Ambient Air Quality Standards

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Meteorological data (wind speed, wind direction and rainfall) obtained from a meteorological station located approximately 323m southeast of the centre of the site, is used for the monthly reporting of DFO results for the Enterprise in order to assess potential high wind speed incidents which could potentially contribute to high DFO results. It is noted that the simulated meteorological data used for this dispersion modelling study (refer Appendix A) might differ from the meteorological data referred to in the last mentioned DFO reports as a result of the difference in location.

The Enterprise's ambient monitoring network is indicated in Figure 5.1-1.

Appendix B contains a summary of the results of ambient air monitoring conducted.

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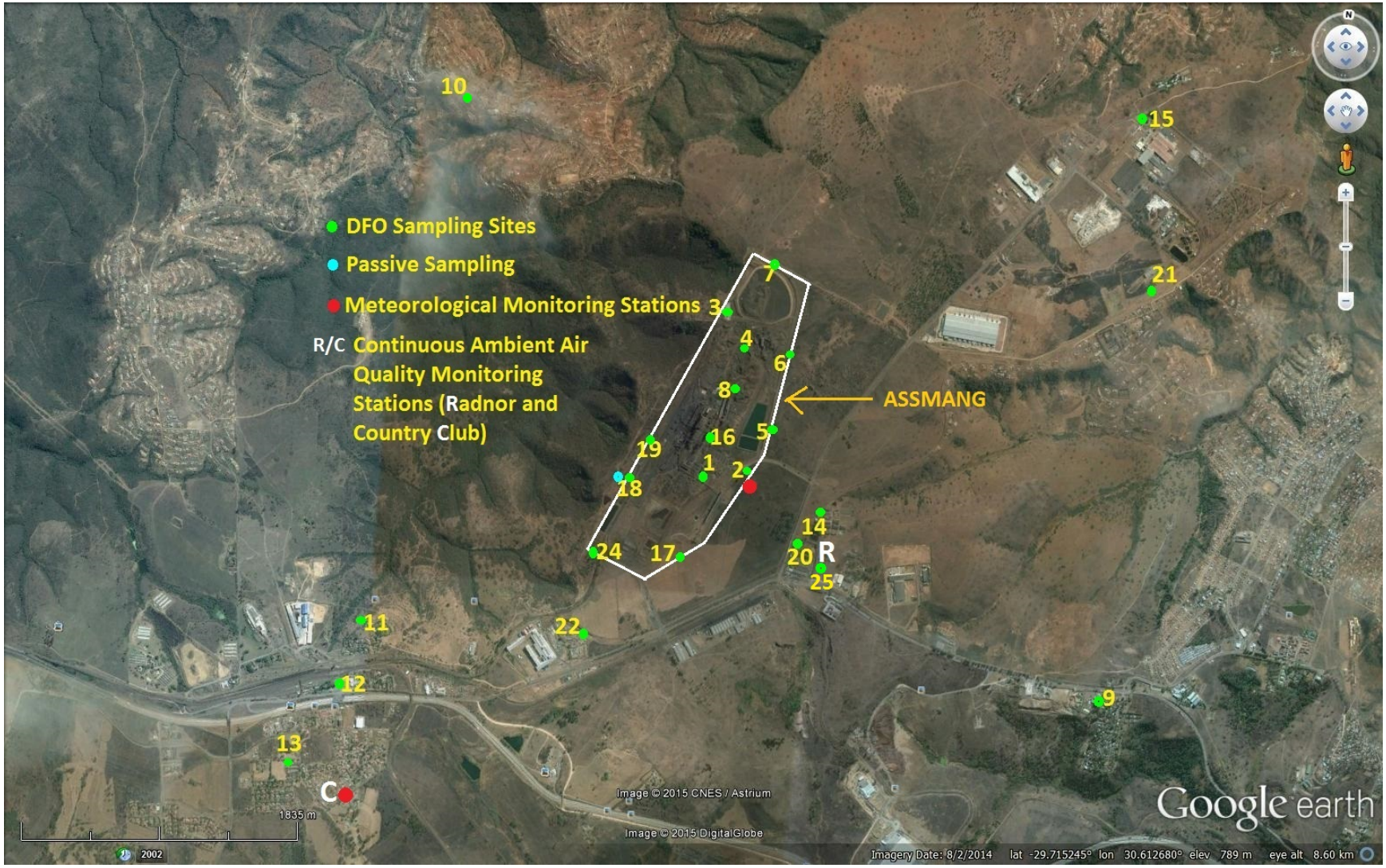


Figure 5.1-1: Ambient monitoring locations

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5.1.2 Dispersion Modelling Impact Assessment

Figure 5.2.1 below provides an overview of the modelling domain for this study, which provides an indication of surrounding communities and schools.

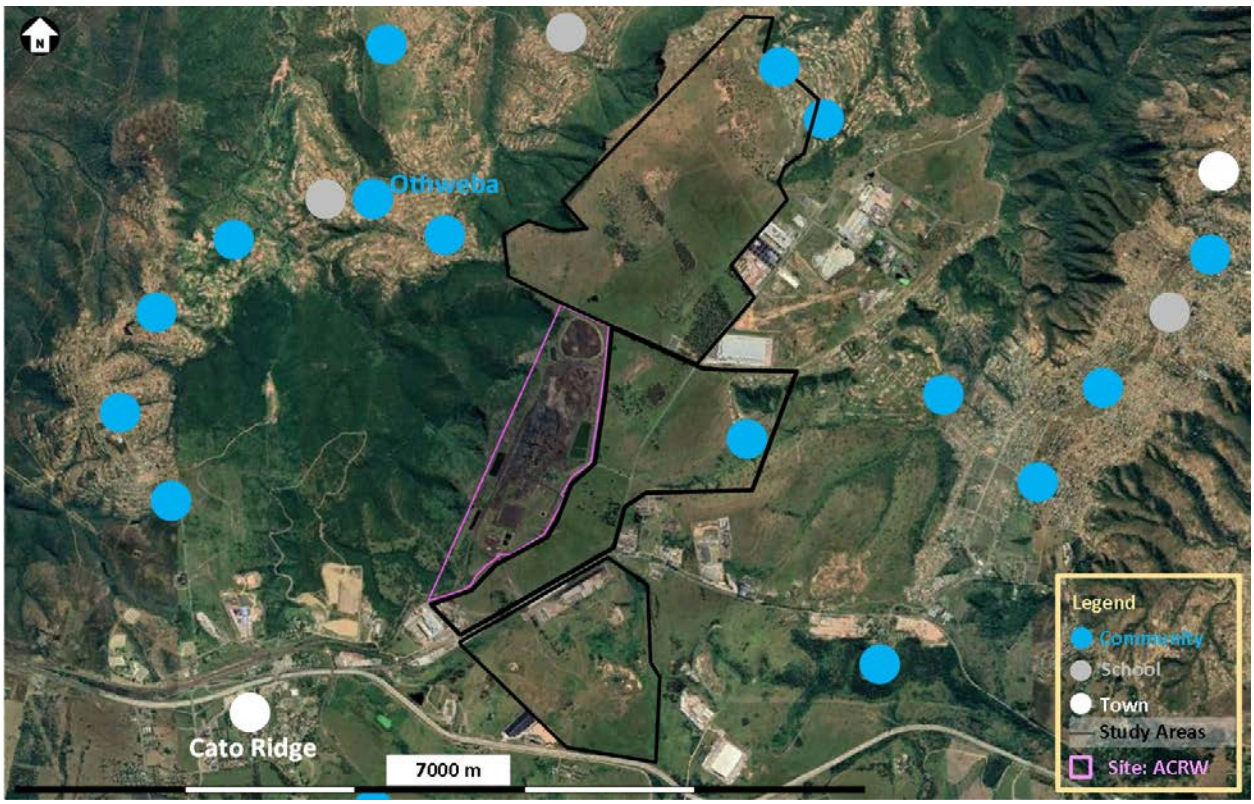


Figure 5.2.1: AQIA Modelling Domain indicating Surrounding Communities, Schools and Towns

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The emission sources with stacks/vents in the study area were provided in Figures 4.1. Figure 5.2.2 below provides an overview of the modelling domain with the receptors with the Enterprise in the centre as modelled for Scenarios 1 to 4, whilst Figure 5.2.3 indicates the sensitive discrete receptors.

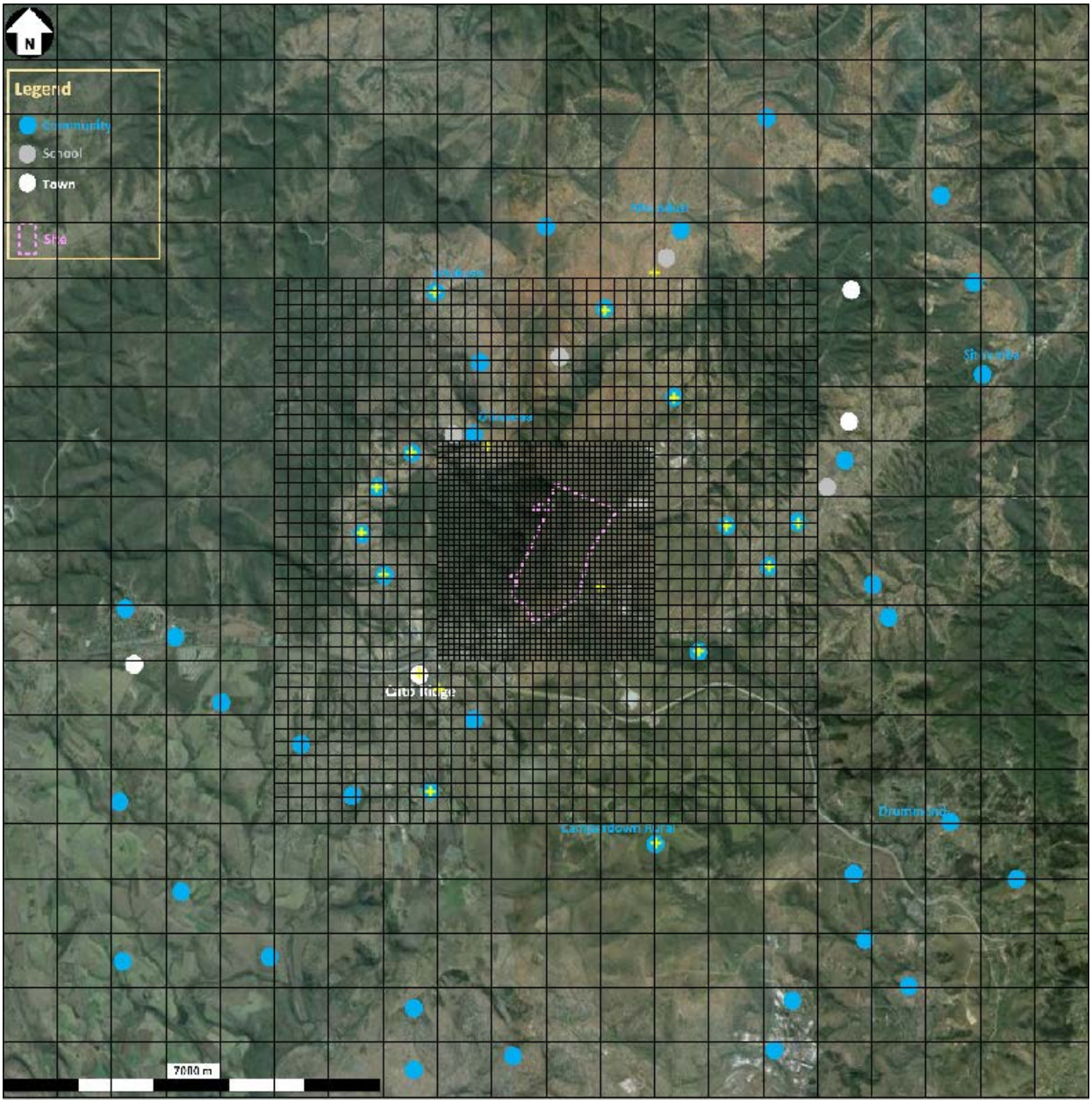


Figure 5.2.2: Modelling Receptor Grid and Enterprise

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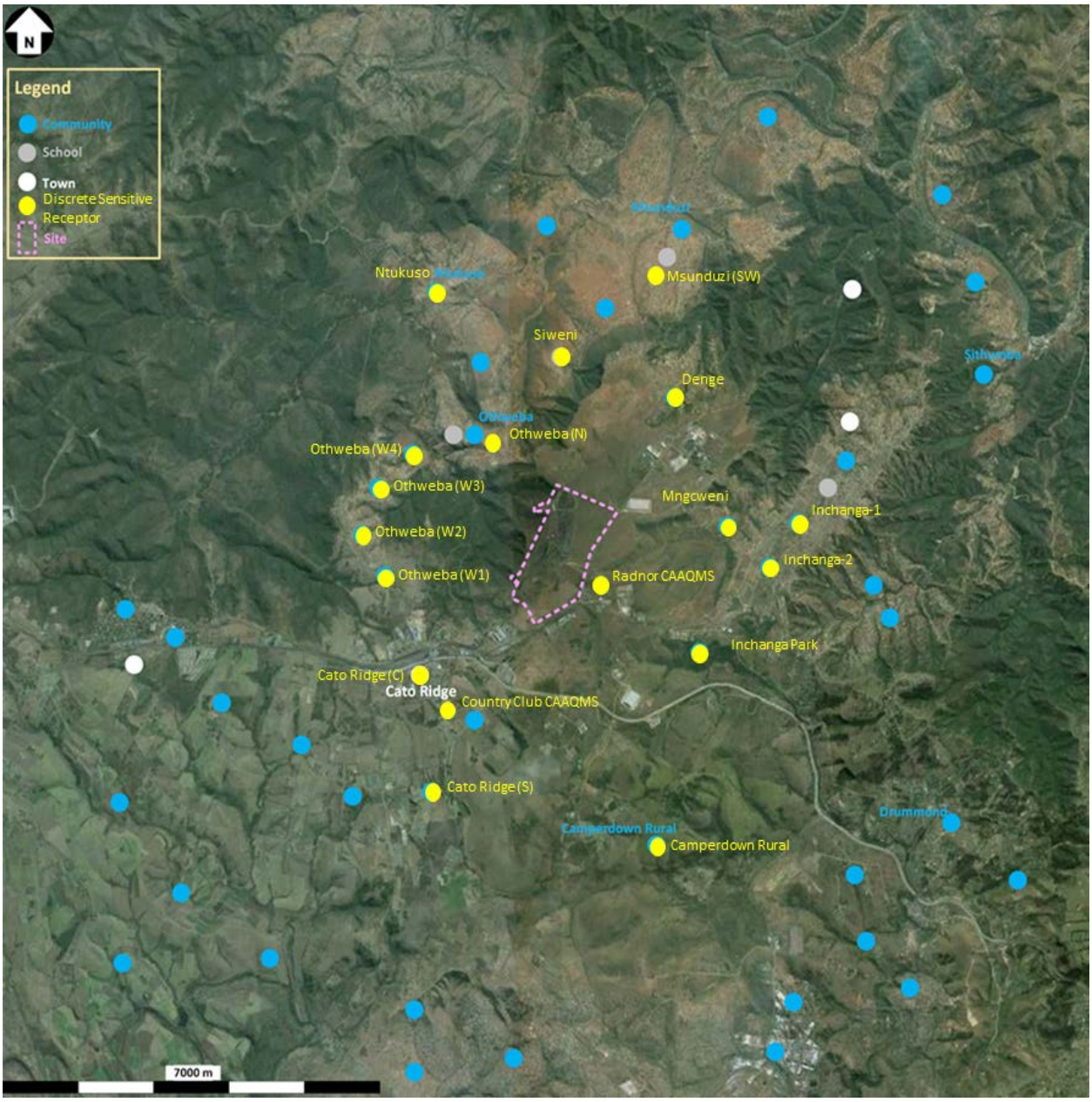


Figure 5.2.3: Discrete Sensitive Receptors surrounding the Enterprise

More detailed information regarding the emissions and modelling actions are provided in Appendices D and C respectively.

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5.1.3 Expected Contribution to Ambient Air Quality Standards – Dispersion Modelling Scenarios' Results

The results of the impact assessment conducted by means of air dispersion modelling are discussed in this section by means of isopleths as assessed against the South African National Ambient Air Quality Standards as referenced earlier in Section 5.1 of this report or ambient air guidelines for pollutants which do not have South African Ambient Air Quality Standards.

It is important to note that isopleths are provided in a range of different coloured contours in the figures which will follow. In the figures, the site is in the centre of the map, and the location of the highest concentration modelled in each case is indicated by a white cross, with the concentration written next to it on the figure with a white background.

As indicated earlier, there are also blue, grey and white markers (filled circles) on each map to indicate the locations of communities, schools and towns respectively. Please do not misinterpret them as isopleths/contours. The isopleths/contours are clearly distinguishable from these place markers.

Results for the sensitive discrete receptors are tabulated at the end for each section or pollutant.

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5.1.3.PM10-1 Particulate Matter (PM_{10}) – 24 hour, 99th percentile (Ambient Air Quality Standard: 75µg/m³)

Figure 5.3.PM10-1.1 below provides an indication of the expected impact of PM_{10} emissions for Scenario 1.

For Study Area 1, it is foreseen to be "likely" that the ambient air quality falls within the relevant NAAQS.

For Study Area 2, it is foreseen to be "likely" that the ambient air quality over portions of study area 2 bordering ACRW (approximately 0-100m east of ACRW) will exceed the relevant NAAQS.

For Study Area 3, it is foreseen to be "very likely" that the ambient air quality over portions of study area 3 bordering ACRW (approximately 0-400m north of ACRW) will exceed the relevant NAAQS.

All Sources (per Scenario 1):

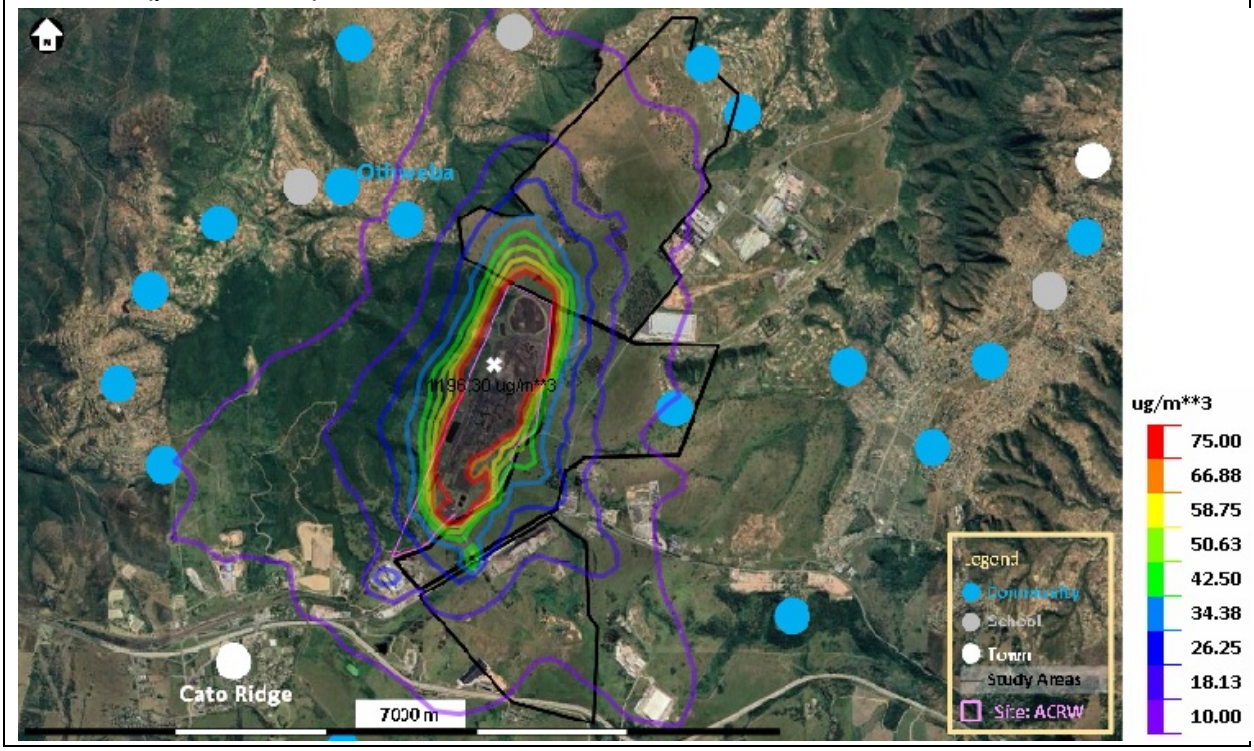


Figure 5.3.PM10-1.1: Scenario 1– Particulate Matter (PM_{10}) – 24hour, 99th percentile

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Table 5.PM10-1 summarises the maximum simulated 24-hr PM_{10} concentrations at the sensitive receptors in the region. The NAAQS for a 24-hr averaging period is 75µg/m^3.

Table 5.PM10-1: Sensitive receptors: Maximum 24-hr PM_{10} concentrations (µg/m^3)

Sensitive Receptor	Scenario 1
Msunduzi (SW)	9.557
Denge	22.597
Mngcweni	8.459
Inchanga-1	4.959
Inchanga-2	5.944
Inchanga Park	5.272
Camperdown Rural	10.425
Country Club CAAQMS	14.595
Cato Ridge (S)	9.336
Cato Ridge (C)	11.990
Othweba (W1)	16.324
Othweba (W2)	8.780
Othweba (W3)	7.999
Othweba (W4)	13.742
Othweba (N)	15.392
Ntukuso	7.359
Siweni	17.809
Radnor CAAQMS	23.921

Per the tabled information for the sensitive receptors, red text illustrates for which sensitive receptors, the highest concentration modelled over the 3 year period will be in excess of the standard's concentration. It was found that the highest concentration modelled over the period at each sensitive receptor was less than the standard's concentration. An assessment of the time-series data was therefore not required.

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5.1.3.PM10-2 Particulate Matter (PM_{10}) – Annual Average (Ambient Air Quality Standard: 40µg/m³)

Figure 5.3.PM10-2.1 below provides an indication of the expected impact of PM_{10} emissions for Scenario 1.

For Study Area 1, it is foreseen to be "likely" that the ambient air quality falls within the relevant NAAQS.

For Study Area 2, it is foreseen to be "likely" that the ambient air quality falls within the relevant NAAQS.

For Study Area 3, it is foreseen to be "likely" that the ambient air quality falls within the relevant NAAQS.

All Sources (per Scenario 1):

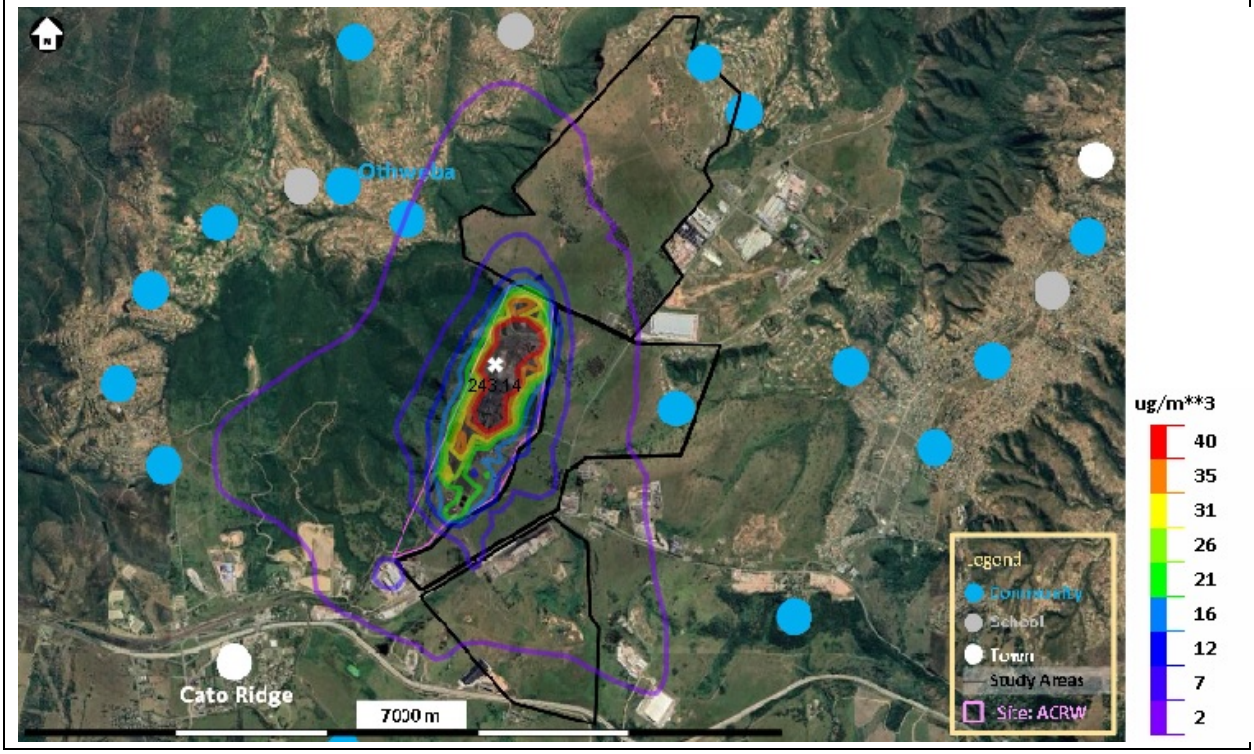


Figure 5.3.PM10-2.1: Scenario 1– Particulate Matter (PM_{10}) – Annual Average

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Table 5.PM10-2 summarises the annual simulated PM_{10} concentrations at the sensitive receptors in the region. The NAAQS for an annual averaging period is 40µg/m^3.

Table 5.PM10-2: Sensitive receptors: Annual PM_{10} concentrations (µg/m^3)

Sensitive Receptor	Scenario 1
Msunduzi (SW)	0.536
Denge	0.697
Mngcweni	0.508
Inchanga-1	0.327
Inchanga-2	0.383
Inchanga Park	0.558
Camperdown Rural	0.884
Country Club CAAQMS	0.987
Cato Ridge (S)	0.543
Cato Ridge (C)	1.085
Othweba (W1)	1.678
Othweba (W2)	1.167
Othweba (W3)	0.718
Othweba (W4)	0.634
Othweba (N)	1.510
Ntukuso	0.596
Siweni	0.932
Radnor CAAQMS	3.243

Per the tabled information for the sensitive receptors, red text illustrates for which sensitive receptors, the highest concentration modelled over the 3 year period will be in excess of the standard's concentration. It was found that the highest concentration modelled over the period at each sensitive receptor was less than the standard's concentration. An assessment of the time-series data was therefore not required.

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5.1.3.PM2.5-1 Particulate Matter ($PM_{2.5}$) – 24 hour, 99th percentile (Ambient Air Quality Standard: 40µg/m³)

Figure 5.3.PM2.5-1.1 below provides an indication of the expected impact of $PM_{2.5}$ emissions for Scenario 1.

For Study Area 1, it is foreseen to be "likely" that the ambient air quality falls within the relevant NAAQS.

For Study Area 2, it is foreseen to be "likely" that the ambient air quality over portions of study area 2 bordering ACRW (approximately 0-100m east of ACRW) will exceed the relevant NAAQS.

For Study Area 3, it is foreseen to be "very likely" that the ambient air quality over portions of study area 3 bordering ACRW (approximately 0-400m north of ACRW) will exceed the relevant NAAQS.

All Sources (per Scenario 1):

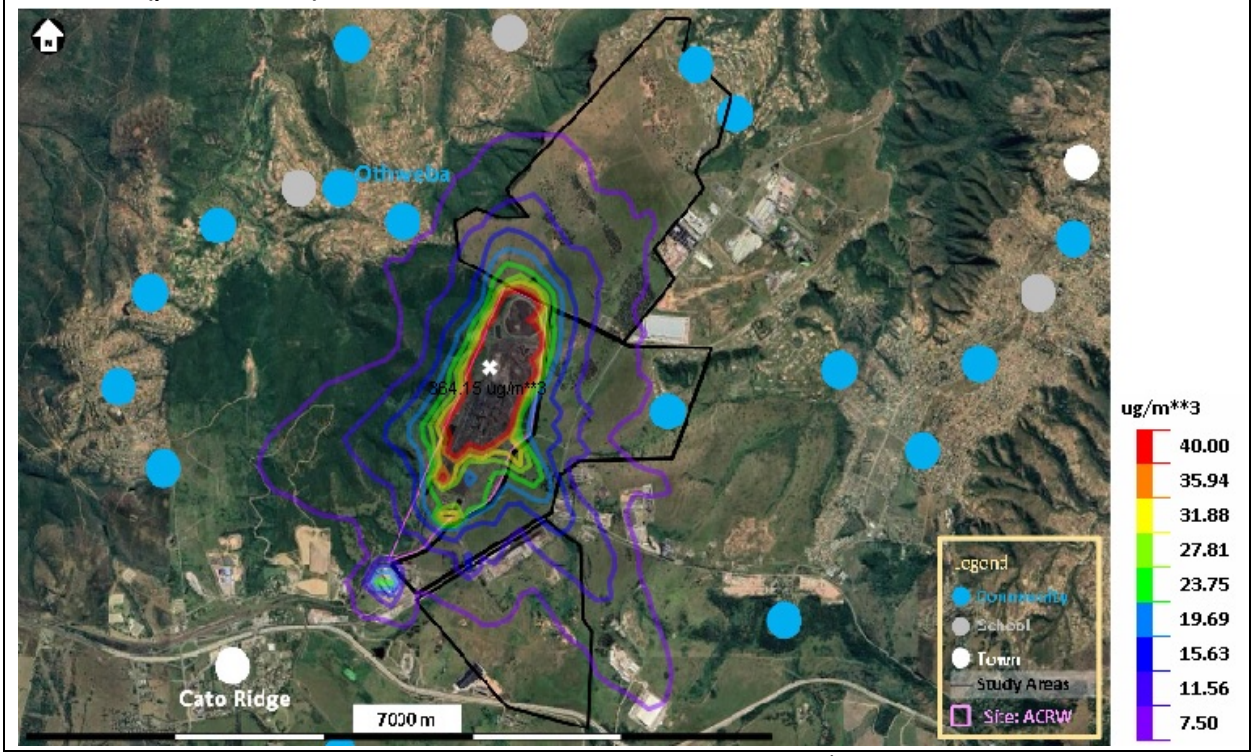


Figure 5.3.PM2.5-1.1: Scenario 1– Particulate Matter ($PM_{2.5}$) – 24 hour, 99th percentile

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Table 5.PM2.5-1 summarises the maximum simulated 24-hr $PM_{2.5}$ concentrations at the sensitive receptors in the region. The NAAQS for a 24-hr averaging period is 40µg/m^3.

Table 5.PM2.5-1: Sensitive receptors: Maximum 24-hr $PM_{2.5}$ concentrations (µg/m^3)

Sensitive Receptor	Scenario 1
Msunduzi (SW)	4.666
Denge	9.372
Mngcweni	5.817
Inchanga-1	3.645
Inchanga-2	3.851
Inchanga Park	4.199
Camperdown Rural	7.106
Country Club CAAQMS	5.479
Cato Ridge (S)	4.579
Cato Ridge (C)	5.692
Othweba (W1)	9.648
Othweba (W2)	4.583
Othweba (W3)	4.852
Othweba (W4)	5.197
Othweba (N)	7.978
Ntukuso	4.930
Siweni	7.633
Radnor CAAQMS	13.949

Per the tabled information for the sensitive receptors, red text illustrates for which sensitive receptors, the highest concentration modelled over the 3 year period will be in excess of the standard's concentration. It was found that the highest concentration modelled over the period at each sensitive receptor was less than the standard's concentration. An assessment of the time-series data was therefore not required.

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5.1.3.PM2.5-2 Particulate Matter ($PM_{2.5}$) – Annual Average (Ambient Air Quality Standard: 20µg/m³)

Figure 5.3.PM2.5-2.1 below provides an indication of the expected impact of $PM_{2.5}$ emissions for Scenario 1.
For Study Area 1, it is foreseen to be "likely" that the ambient air quality falls within the relevant NAAQS.
For Study Area 2, it is foreseen to be "likely" that the ambient air quality falls within the relevant NAAQS.
For Study Area 3, it is foreseen to be "likely" that the ambient air quality falls within the relevant NAAQS.

All Sources (per Scenario 1):

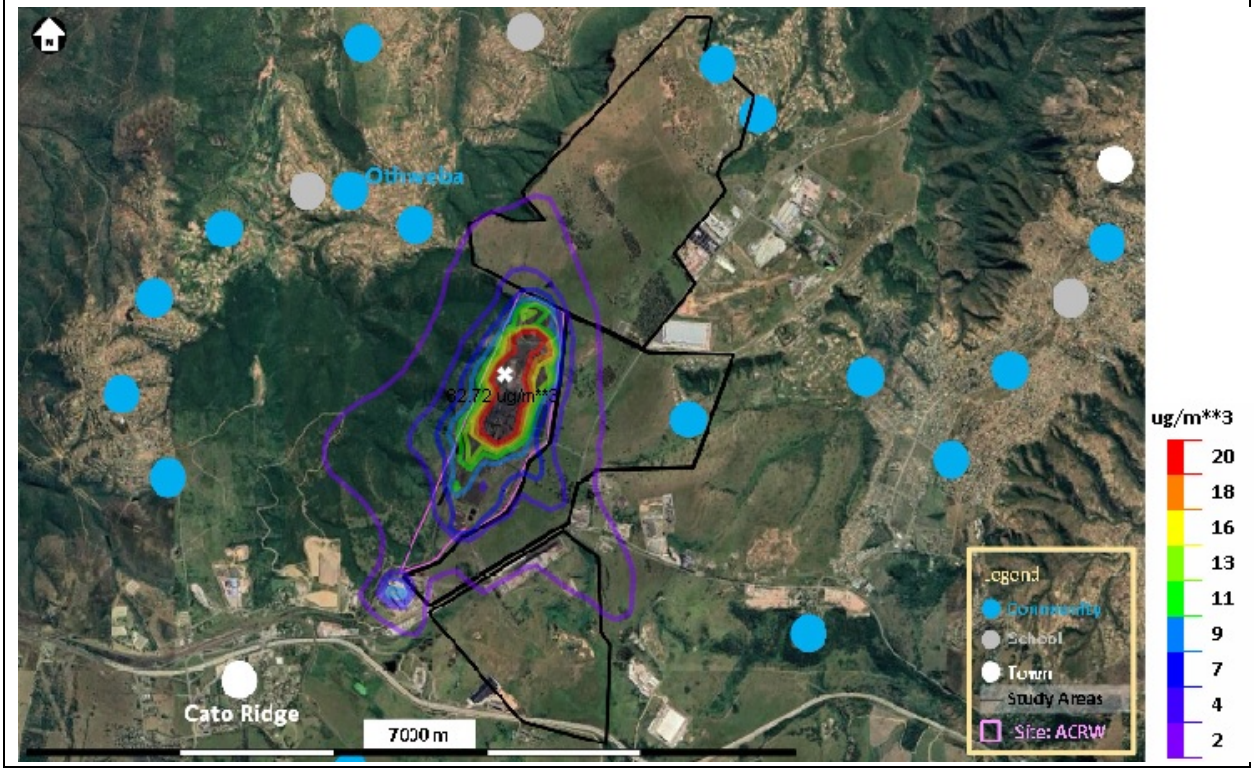


Figure 5.3.PM2.5-2.1: Scenario 1– Particulate Matter ($PM_{2.5}$) – Annual Average

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Table 5.PM2.5-2 summarises the annual simulated $PM_{2.5}$ concentrations at the sensitive receptors in the region. The NAAQS for an annual averaging period is 20µg/m^3.

Table 5.PM2.5-2: Sensitive receptors: Annual $PM_{2.5}$ concentrations (µg/m^3)

Sensitive Receptor	Scenario 1
Msunduzi (SW)	0.343
Denge	0.399
Mngcweni	0.332
Inchanga-1	0.220
Inchanga-2	0.260
Inchanga Park	0.351
Camperdown Rural	0.652
Country Club CAAQMS	0.559
Cato Ridge (S)	0.343
Cato Ridge (C)	0.637
Othweba (W1)	1.075
Othweba (W2)	0.774
Othweba (W3)	0.452
Othweba (W4)	0.381
Othweba (N)	0.888
Ntukuso	0.402
Siweni	0.549
Radnor CAAQMS	1.607

Per the tabled information for the sensitive receptors, red text illustrates for which sensitive receptors, the highest concentration modelled over the 3 year period will be in excess of the standard's concentration. It was found that the highest concentration modelled over the period at each sensitive receptor was less than the standard's concentration. An assessment of the time-series data was therefore not required.

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5.1.3.SO2-1 Sulphur Dioxide (SO_2) – 1 hour, 99th percentile (Ambient Air Quality Standard: 350µg/m³)

Figure 5.3.SO2-1.1 below provides an indication of the expected impact of SO_2 emissions for Scenario 1.

For Study Area 1, it is foreseen to be "very likely" that the ambient air quality falls within the relevant NAAQS.

For Study Area 2, it is foreseen to be "very likely" that the ambient air quality falls within the relevant NAAQS.

For Study Area 3, it is foreseen to be "very likely" that the ambient air quality falls within the relevant NAAQS.

All Sources (per Scenario 1):

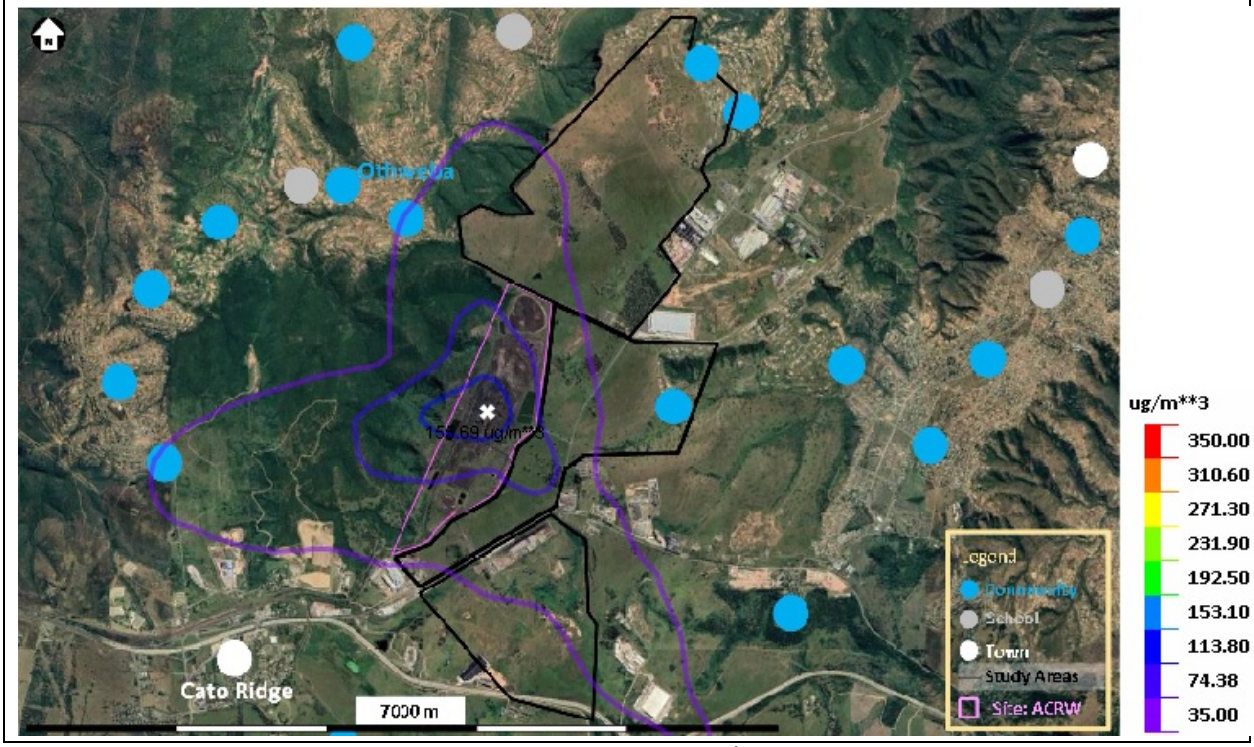


Figure 5.3.SO2-1.1: Scenario 1– Sulphur Dioxide (SO_2) – 1hour, 99th percentile

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Table 5.SO2-1 summarises the maximum simulated 1-hr SO_2 concentrations at the sensitive receptors in the region. The NAAQS for a 1-hr averaging period is 350µg/m^3.

Table 5.SO2-1: Sensitive receptors: Maximum 1-hr SO_2 concentrations (µg/m^3)

Sensitive Receptor	Scenario 1
Msunduzi (SW)	26.714
Denge	30.016
Mngcweni	68.728
Inchanga-1	46.641
Inchanga-2	53.129
Inchanga Park	64.675
Camperdown Rural	49.275
Country Club CAAQMS	40.841
Cato Ridge (S)	36.093
Cato Ridge (C)	45.417
Othweba (W1)	78.163
Othweba (W2)	68.372
Othweba (W3)	39.645
Othweba (W4)	57.380
Othweba (N)	100.208
Ntukuso	40.519
Siweni	40.055
Radnor CAAQMS	158.088

Per the tabled information for the sensitive receptors, red text illustrates for which sensitive receptors, the highest concentration modelled over the 3 year period will be in excess of the standard's concentration. It was found that the highest concentration modelled over the period at each sensitive receptor was less than the standard's concentration. An assessment of the time-series data was therefore not required.

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5.1.3.SO2-2 Sulphur Dioxide (SO_2) – 24 hour, 99th percentile (Ambient Air Quality Standard: 125µg/m³)

Figure 5.3.SO2-2.1 below provides an indication of the expected impact of SO_2 emissions for Scenario 1.

For Study Area 1, it is foreseen to be "very likely" that the ambient air quality falls within the relevant NAAQS.

For Study Area 2, it is foreseen to be "very likely" that the ambient air quality falls within the relevant NAAQS.

For Study Area 3, it is foreseen to be "very likely" that the ambient air quality falls within the relevant NAAQS.

All Sources (per Scenario 1):

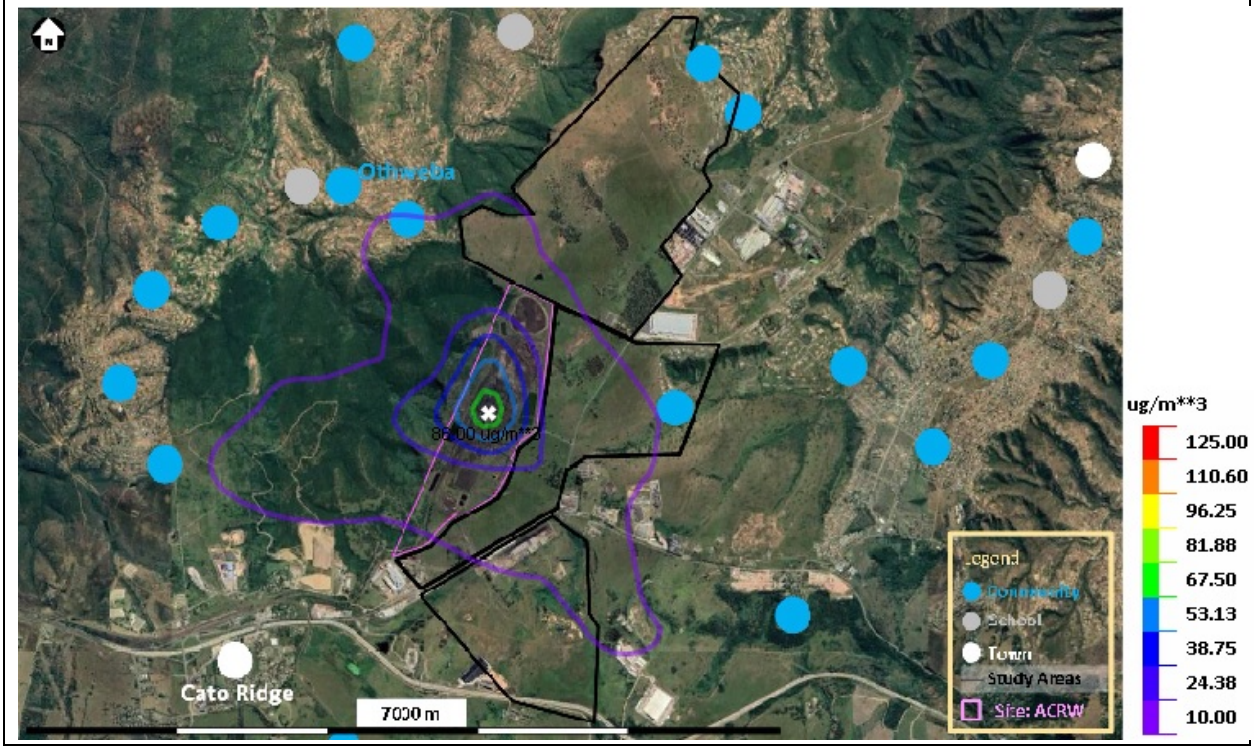


Figure 5.3.SO2-2.1: Scenario 1– Sulphur Dioxide (SO_2) – 24hour, 99th percentile

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Table 5.SO2-2 summarises the maximum simulated 24-hr SO_2 concentrations at the sensitive receptors in the region. The NAAQS for a 24-hr averaging period is 125µg/m^3.

Table 5.SO2-2: Sensitive receptors: Maximum 24-hr SO_2 concentrations (µg/m^3)

Sensitive Receptor	Scenario 1
Msunduzi (SW)	4.568
Denge	5.837
Mngcweni	8.755
Inchanga-1	5.273
Inchanga-2	5.142
Inchanga Park	6.639
Camperdown Rural	9.715
Country Club CAAQMS	6.215
Cato Ridge (S)	5.303
Cato Ridge (C)	5.810
Othweba (W1)	15.636
Othweba (W2)	8.796
Othweba (W3)	6.790
Othweba (W4)	5.420
Othweba (N)	13.117
Ntukuso	6.125
Siweni	8.083
Radnor CAAQMS	17.417

Per the tabled information for the sensitive receptors, red text illustrates for which sensitive receptors, the highest concentration modelled over the 3 year period will be in excess of the standard's concentration. It was found that the highest concentration modelled over the period at each sensitive receptor was less than the standard's concentration. An assessment of the time-series data was therefore not required.

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5.1.3.SO2-3 Sulphur Dioxide (SO_2) – Annual Average (Ambient Air Quality Standard: 50µg/m^3)

Figure 5.3.SO2-3.1 below provides an indication of the expected impact of SO_2 emissions for Scenario 1.

For Study Area 1, it is foreseen to be "very likely" that the ambient air quality falls within the relevant NAAQS.

For Study Area 2, it is foreseen to be "very likely" that the ambient air quality falls within the relevant NAAQS.

For Study Area 3, it is foreseen to be "very likely" that the ambient air quality falls within the relevant NAAQS.

All Sources (per Scenario 1):

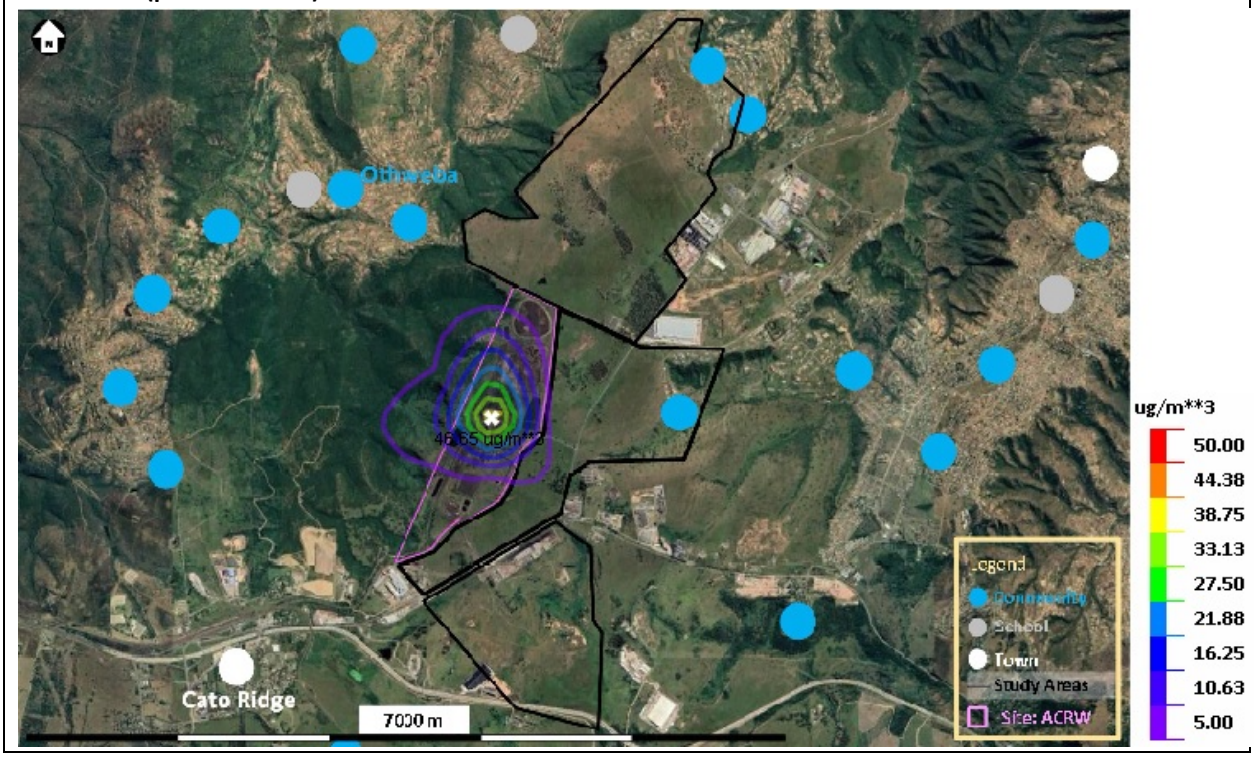


Figure 5.3.SO2-3.1: Scenario 1– Sulphur Dioxide (SO_2) – Annual Average

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Table 5.SO2-3 summarises the annual simulated SO_2 concentrations at the sensitive receptors in the region. The NAAQS for an annual averaging period is 50µg/m^3.

Table 5.SO2-3: Sensitive receptors: Annual SO_2 concentrations (µg/m^3)

Sensitive Receptor	Scenario 1
Msunduzi (SW)	0.420
Denge	0.462
Mngcweni	0.507
Inchanga-1	0.330
Inchanga-2	0.391
Inchanga Park	0.497
Camperdown Rural	0.843
Country Club CAAQMS	0.694
Cato Ridge (S)	0.437
Cato Ridge (C)	0.723
Othweba (W1)	1.874
Othweba (W2)	1.356
Othweba (W3)	0.730
Othweba (W4)	0.638
Othweba (N)	1.474
Ntukuso	0.579
Siweni	0.724
Radnor CAAQMS	1.836

Per the tabled information for the sensitive receptors, red text illustrates for which sensitive receptors, the highest concentration modelled over the 3 year period will be in excess of the standard's concentration. It was found that the highest concentration modelled over the period at each sensitive receptor was less than the standard's concentration. An assessment of the time-series data was therefore not required.

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5.1.3.NO2-1 Nitrogen Dioxide (NO_2) – 1 hour, 99th percentile (Ambient Air Quality Standard: 200µg/m³)

Figure 5.3.NO2-1.1 below provides an indication of the expected impact of NO_2 emissions for Scenario 1.

It is noted that the NO_X (as NO_2) emissions from ACRW and its impact on the surrounding ambient could conservatively have been overstated and that the following points are subject to that.

For Study Area 1, it is foreseen to be "likely" that the ambient air quality over portions of study area 1 (approximately 0-100m south-east of Study Area 2) could exceed the relevant NAAQS.

For Study Area 2, it is foreseen to be "likely" that the ambient air quality over portions of study area 2 bordering ACRW (approximately 0-800m south-east of ACRW and approximately 0-100m east of ACRW) could exceed the relevant NAAQS.

For Study Area 3, it is foreseen to be "likely" that the ambient air quality over study area 3 should fall within the relevant NAAQS.

All Sources (per Scenario 1):

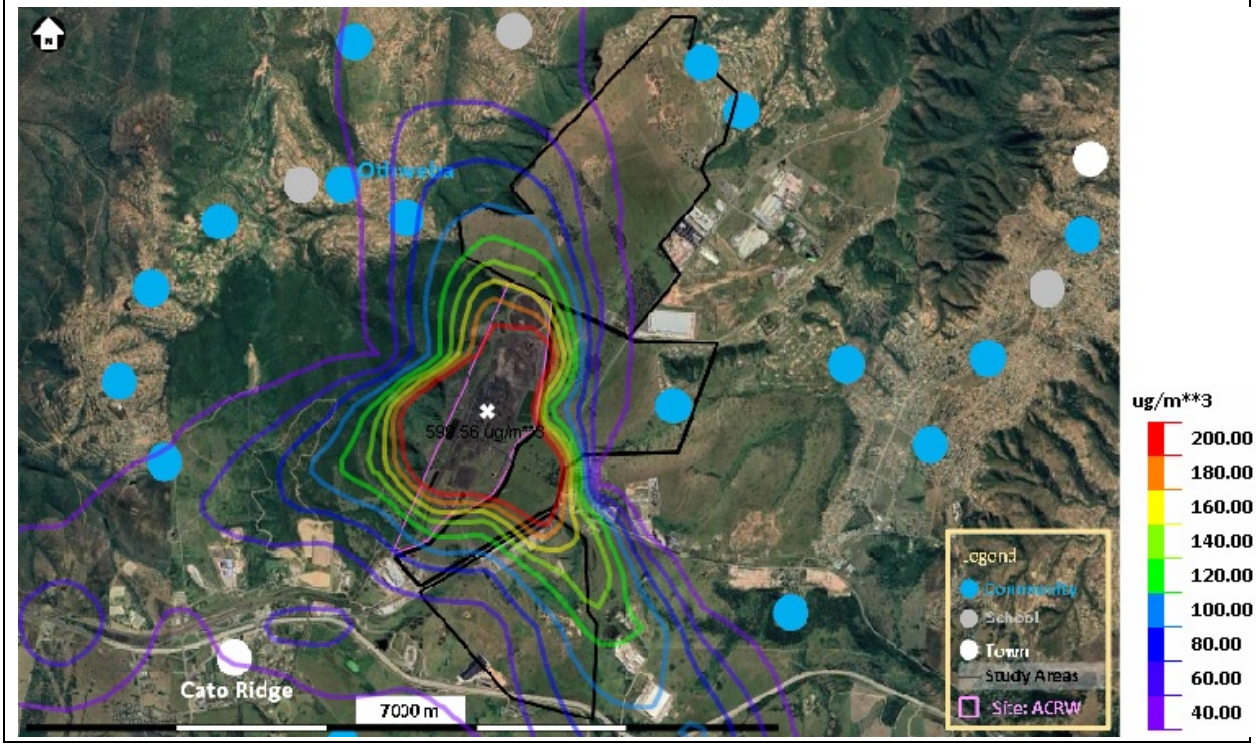


Figure 5.3.NO2-1.1: Scenario 1– Nitrogen Dioxide (NO_2) – 1hour, 99th percentile

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Table 5.NO2-1 summarises the maximum simulated 1-hr NO_2 concentrations at the sensitive receptors in the region. The NAAQS for a 1-hr averaging period is 200µg/m^3.

Table 5.NO2-1: Sensitive receptors: Maximum 1-hr NO_2 concentrations (µg/m^3)

Sensitive Receptor	Scenario 1
Msunduzi (SW)	65.274
Denge	104.375
Mngcweni	146.580
Inchanga-1	101.730
Inchanga-2	110.606
Inchanga Park	114.142
Camperdown Rural	112.849
Country Club CAAQMS	125.137
Cato Ridge (S)	79.325
Cato Ridge (C)	109.058
Othweba (W1)	123.453
Othweba (W2)	116.507
Othweba (W3)	58.582
Othweba (W4)	68.259
Othweba (N)	139.241
Ntukuso	81.214
Siweni	85.057
Radnor CAAQMS	360.357

Per the tabled information for the sensitive receptors, red text illustrates for which sensitive receptors, the highest concentration modelled over the 3 year period will be in excess of the standard's concentration. It was found that the highest concentration modelled over the period at the "Radnor CAAQMS" receptor could be more than the standard's concentration. An assessment of the time-series data is illustrated in the following figure for that sensitive receptor.

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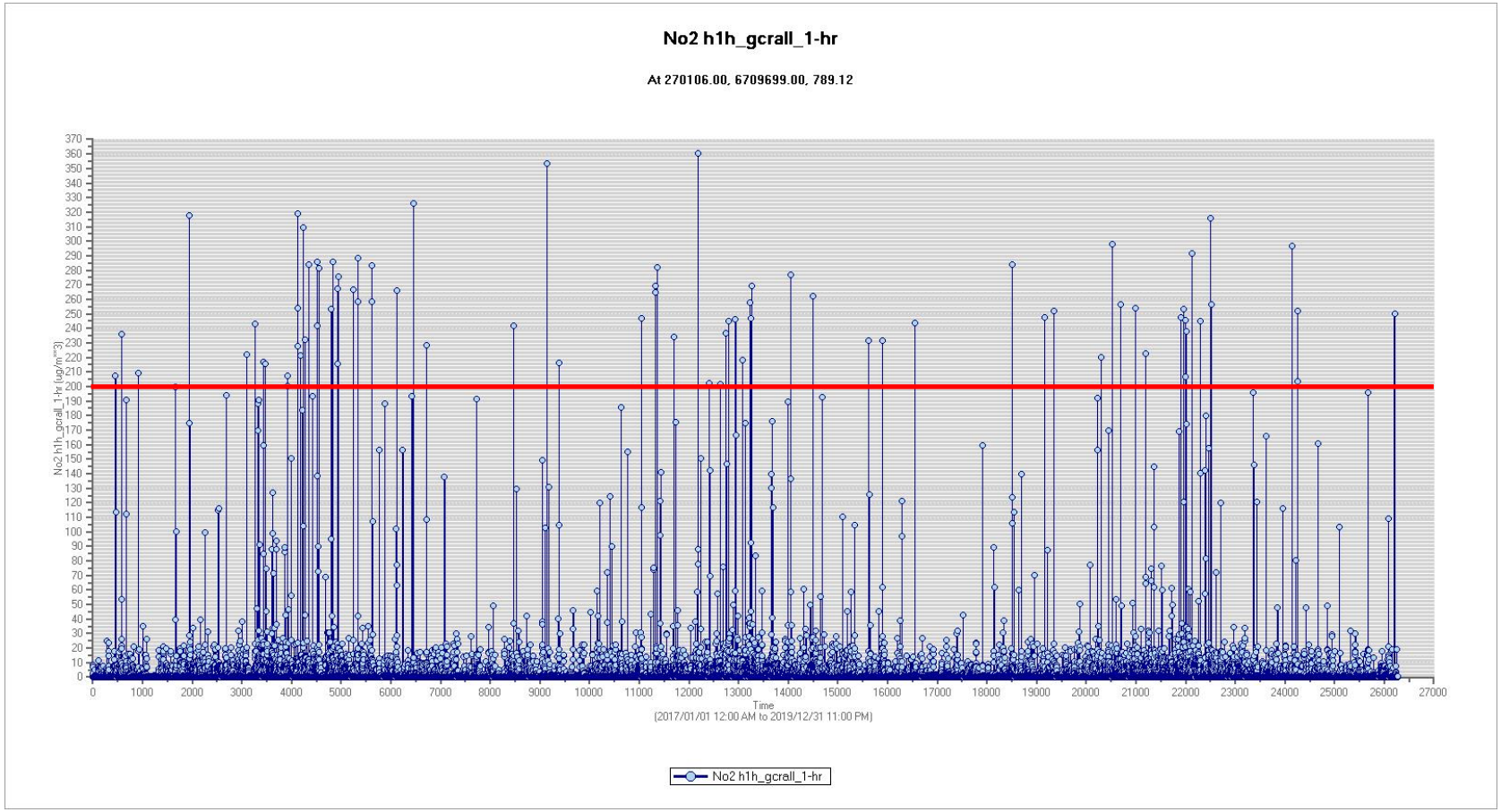


Figure 5.3.NO2-1.TSR1S1: Scenario 1 – Nitrogen Dioxide (NO_2), 1hour Time-Series Plot: D18 – Radnor CAAQMS

Assessed over the 3 year modelling period, the number of exceedances during the modelling period fall within the relevant standard, which implies that the contribution from the site to the specific location, is likely to comply with the relevant National Ambient Air Quality Standard.

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5.1.3.NO2-2 Nitrogen Dioxide (NO_2) – Annual Average (Ambient Air Quality Standard: 40µg/m^3)

Figure 5.3.NO2-2.1 below provides an indication of the expected impact of NO_2 emissions for Scenario 1.

For Study Area 1, it is foreseen to be "very likely" that the ambient air quality falls within the relevant NAAQS.

For Study Area 2, it is foreseen to be "very likely" that the ambient air quality falls within the relevant NAAQS.

For Study Area 3, it is foreseen to be "very likely" that the ambient air quality falls within the relevant NAAQS.

All Sources (per Scenario 1):

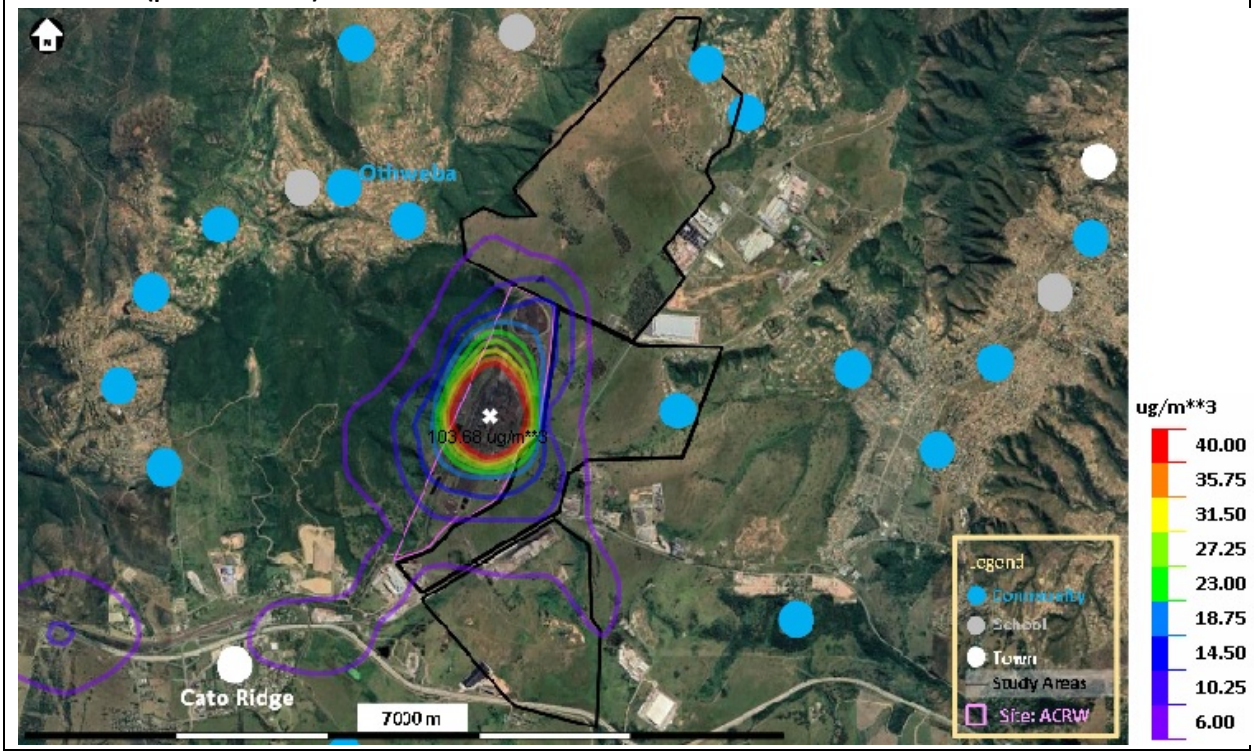


Figure 5.3.NO2-2.1: Scenario 1– Nitrogen Dioxide (NO_2) – Annual Average

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Table 5.NO2-2 summarises the maximum simulated annual NO_2 concentrations at the sensitive receptors in the region. The NAAQS for an annual period is 40µg/m^3. No exceedance of the NAAQS was simulated at the sensitive receptors under all scenarios.

Table 5.NO2-2: Sensitive receptors: Annual NO_2 concentrations (µg/m^3)

Sensitive Receptor	Scenario 1
Msunduzi (SW)	0.949
Denge	1.067
Mngcweni	1.257
Inchanga-1	0.799
Inchanga-2	1.068
Inchanga Park	1.824
Camperdown Rural	1.947
Country Club CAAQMS	3.266
Cato Ridge (S)	1.435
Cato Ridge (C)	4.323
Othweba (W1)	3.081
Othweba (W2)	2.168
Othweba (W3)	1.307
Othweba (W4)	1.131
Othweba (N)	2.482
Ntukuso	1.152
Siweni	1.428
Radnor CAAQMS	3.661

Per the tabled information for the sensitive receptors, red text illustrates for which sensitive receptors, the highest concentration modelled over the 3 year period will be in excess of the standard's concentration. It was found that the highest concentration modelled over the period at each sensitive receptor was less than the standard's concentration. An assessment of the time-series data was therefore not required.

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5.1.3.CO-1 Carbon Monoxide (CO) – 1 hour, 99th percentile (Ambient Air Quality Standard: 30 000µg/m³)

Figure 5.3.CO-1.1 below provides an indication of the expected impact of CO emissions for Scenario 1.

For Study Area 1, it is foreseen to be "very likely" that the ambient air quality falls within the relevant NAAQS.

For Study Area 2, it is foreseen to be "very likely" that the ambient air quality falls within the relevant NAAQS.

For Study Area 3, it is foreseen to be "very likely" that the ambient air quality falls within the relevant NAAQS.

All Sources (per Scenario 1):

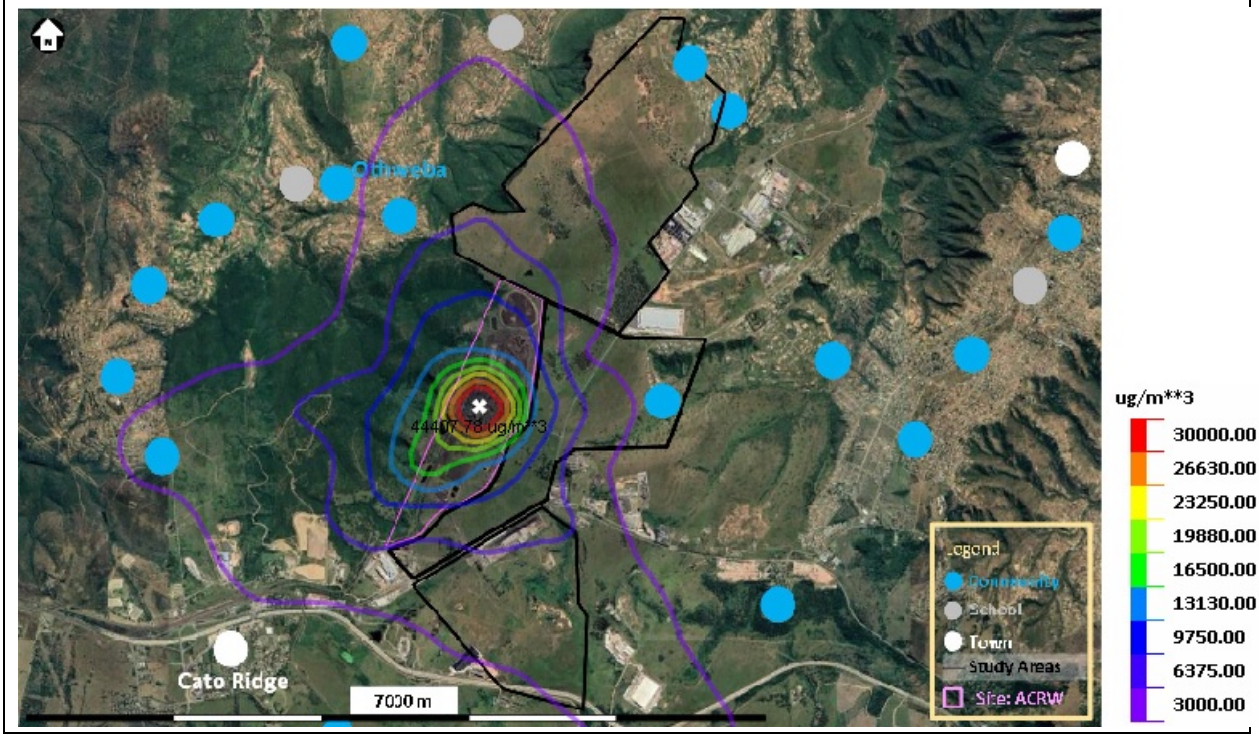


Figure 5.3.CO-1.1: Scenario 1– Carbon Monoxide (CO) – 1hour, 99th percentile

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Table 5.CO-1 summarises the maximum simulated 1-hr CO concentrations at the sensitive receptors in the region. The NAAQS for a 1-hr averaging period is 30000µg/m^3.

Table 5.CO-1: Sensitive receptors: Maximum 1-hr CO concentrations (µg/m^3)

Sensitive Receptor	Scenario 1
Msunduzi (SW)	4106.902
Denge	5935.436
Mngcweni	11755.322
Inchanga-1	6161.222
Inchanga-2	7264.432
Inchanga Park	11302.390
Camperdown Rural	4591.750
Country Club CAAQMS	11890.034
Cato Ridge (S)	5228.267
Cato Ridge (C)	11787.857
Othweba (W1)	13194.820
Othweba (W2)	11579.998
Othweba (W3)	11965.443
Othweba (W4)	13827.415
Othweba (N)	18121.677
Ntukuso	4195.334
Siweni	4703.968
Radnor CAAQMS	33355.927

Per the tabled information for the sensitive receptors, red text illustrates for which sensitive receptors, the highest concentration modelled over the 3 year period will be in excess of the standard's concentration. It was found that the highest concentration modelled over the period at the "Radnor CAAQMS" receptor could be more than the standard's concentration. An assessment of the time-series data is illustrated in the following figure for that sensitive receptor.

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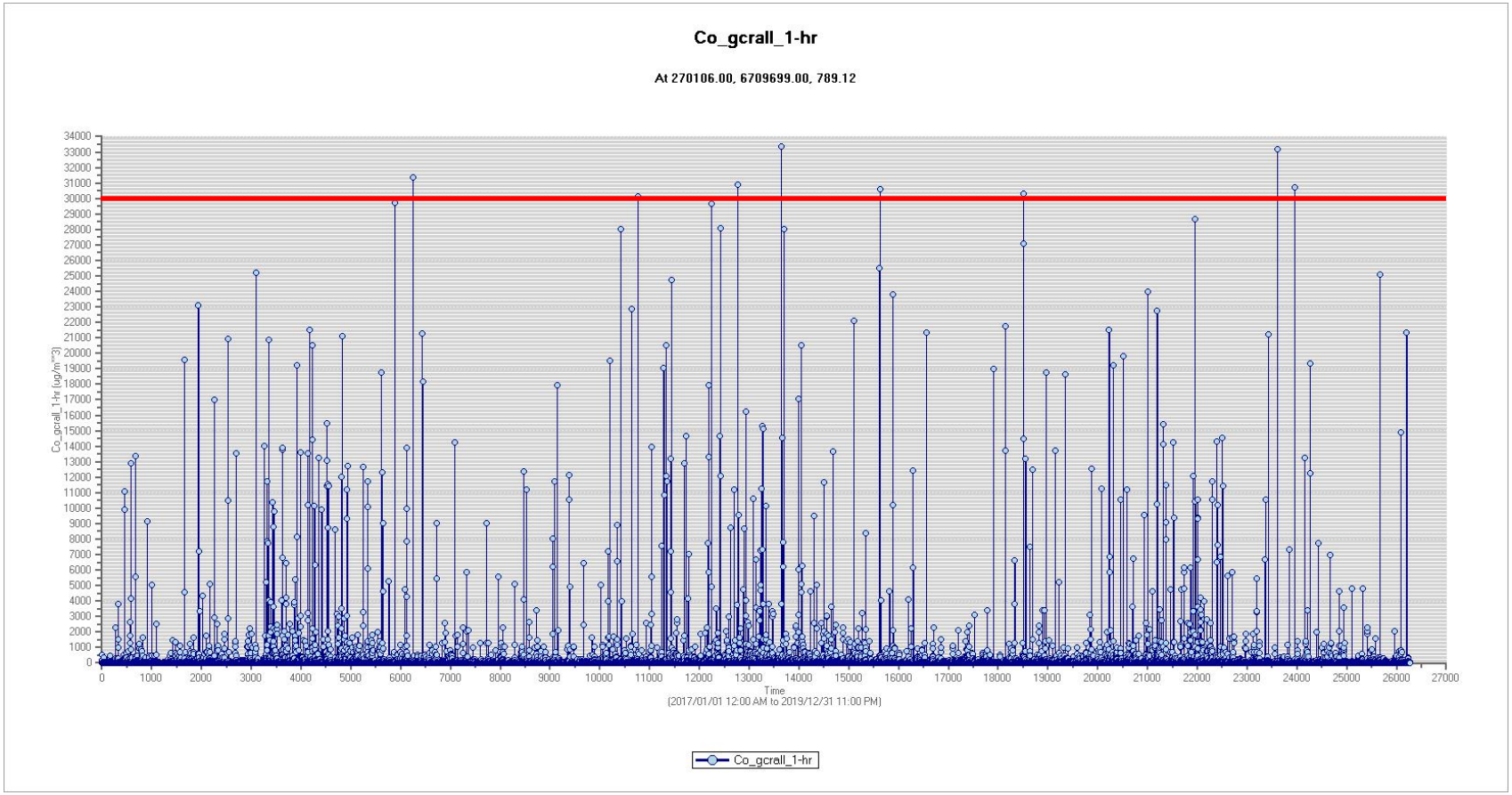


Figure 5.3.CO-1.TSR1S1: Scenario 1 – Carbon Monoxide (CO), 1hour Time-Series Plot: D18 – Radnor CAAQMS

Assessed over the 3 year modelling period, the number of exceedances during the modelling period fall within the relevant standard, which implies that the contribution from the site to the specific location, is likely to comply with the relevant National Ambient Air Quality Standard.

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5.1.3.CO-2 Carbon Monoxide (CO) – 8 hour, 99th percentile (Ambient Air Quality Standard: 10 000µg/m³)

Figure 5.3.CO-2.1 below provides an indication of the expected impact of CO emissions for Scenario 1.

For Study Area 1, it is foreseen to be "very likely" that the ambient air quality falls within the relevant NAAQS.

For Study Area 2, it is foreseen to be "very likely" that the ambient air quality falls within the relevant NAAQS.

For Study Area 3, it is foreseen to be "very likely" that the ambient air quality falls within the relevant NAAQS.

All Sources (per Scenario 1):

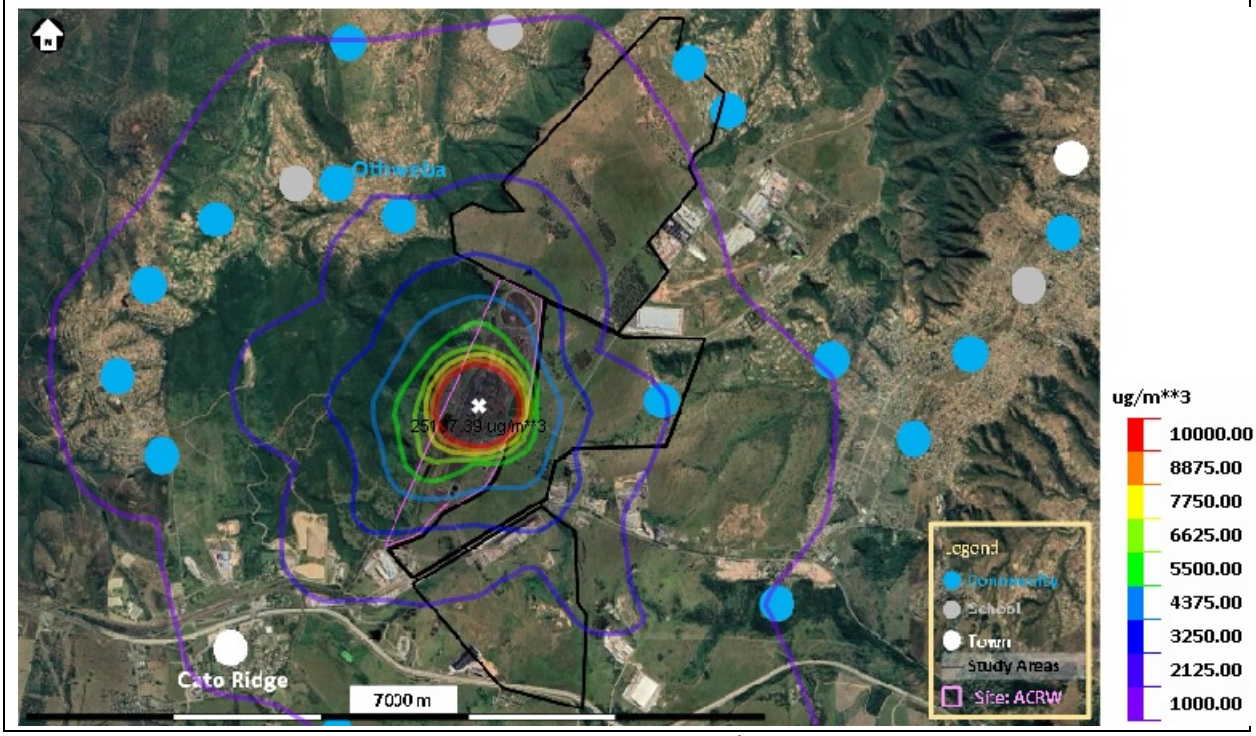


Figure 5.3.CO-2.1: Scenario 1– Carbon Monoxide (CO) – 8hour, 99th percentile

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Table 5.CO-2 summarises the maximum simulated 8-hr CO concentrations at the sensitive receptors in the region. The NAAQS for a 1-hr averaging period is 10000µg/m^3.

Table 5.CO-2: Sensitive receptors: Maximum 8-hr CO concentrations (µg/m^3)

Sensitive Receptor	Scenario 1
Msunduzi (SW)	1130.763
Denge	1688.692
Mngcweni	3145.880
Inchanga-1	1562.840
Inchanga-2	1642.981
Inchanga Park	2287.356
Camperdown Rural	1673.506
Country Club CAAQMS	2359.732
Cato Ridge (S)	1168.308
Cato Ridge (C)	2338.188
Othweba (W1)	3644.018
Othweba (W2)	2427.898
Othweba (W3)	3241.221
Othweba (W4)	4042.720
Othweba (N)	4800.960
Ntukuso	1413.532
Siweni	1885.982
Radnor CAAQMS	9099.790

Per the tabled information for the sensitive receptors, red text illustrates for which sensitive receptors, the highest concentration modelled over the 3 year period will be in excess of the standard's concentration. It was found that the highest concentration modelled over the period at each sensitive receptor was less than the standard's concentration. An assessment of the time-series data was therefore not required.

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5.1.3.Mn-1 Manganese (Mn) – Annual Average (WHO Ambient Air Quality Guideline: 0.15 µg/m³)

Figure 5.3.Mn-1.1 below provides an indication of the expected impact of Mn emissions for Scenario 1.

In the absence of a national air quality standard, the WHO ambient air quality guideline of 0.15µg.m^{-3} is used as a reference.

For Study Areas 1, 2 and 3, it is foreseen to be "very likely" that the ambient air quality will be in excess of the relevant guideline

All Sources (per Scenario 1):

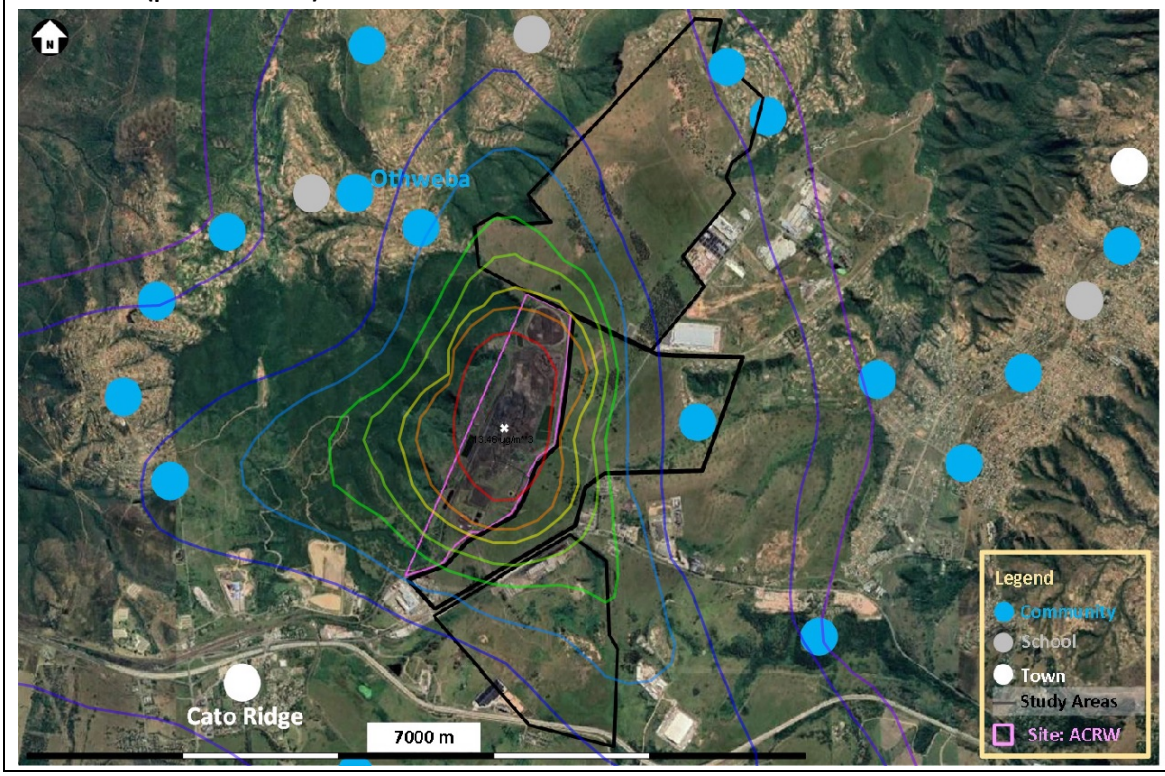


Figure 5.3.Mn-1.1: Scenario 1– Manganese (Mn) – Annual Average

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Table 5.Mn-1 summarises the maximum simulated annual Mn concentrations from FeMn production at the sensitive receptors in the region. In the absence of a national air quality standard, the WHO ambient air quality guideline of 0.15μg.m^{-3} is used as a reference.

Table 5.Mn-1: Sensitive receptors: Annual Mn concentrations (μg/m^3)

Sensitive Receptor	Scenario 1
Msunduzi (SW)	0.110
Denge	0.137
Mngcweni	0.114
Inchanga-1	0.072
Inchanga-2	0.085
Inchanga Park	0.117
Camperdown Rural	0.203
Country Club CAAQMS	0.182
Cato Ridge (S)	0.110
Cato Ridge (C)	0.196
Othweba (W1)	0.405
Othweba (W2)	0.268
Othweba (W3)	0.144
Othweba (W4)	0.126
Othweba (N)	0.335
Ntukuso	0.132
Siweni	0.184
Radnor CAAQMS	0.606

Per the tabled information for the sensitive receptors, red text illustrates for which sensitive receptors, the highest concentration modelled over the 3 year period will be in excess of the WHO guideline's concentration. It is likely that the Mn ambient concentration will exceed the WHO guideline concentration over a distance of approximately 5km and 6.5km surrounding ACRW for Scenario 1.

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5.1.3.NH3-1 Ammonia (NH_3) – 24 hour, 99th percentile (US EPA Reference Concentration: 100 µg/m³)

Figure 5.3.NH3-1.1 below provides an indication of the expected impact of NH_3 emissions for Scenario 1.

In the absence of a NAAQS, the 24-hour average US EPA Reference Concentration of 100µg.m^{-3} is used as a reference.

For Study Area 1, it is foreseen to be "very likely" that the ambient air quality falls within the relevant NAAQS.

For Study Area 2, it is foreseen to be "very likely" that the ambient air quality falls within the relevant NAAQS.

For Study Area 3, it is foreseen to be "very likely" that the ambient air quality falls within the relevant NAAQS.

All Sources (per Scenario 1):

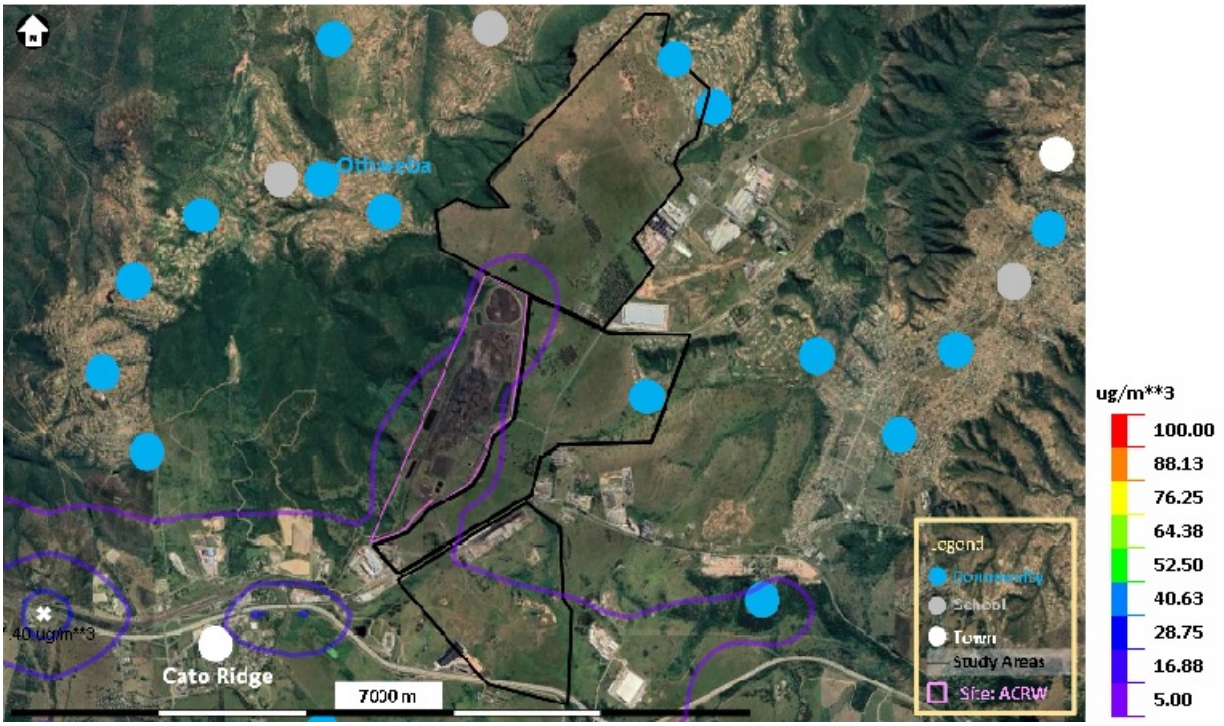


Figure 5.3.NH3-1.1: Scenario 1– Ammonia (NH_3) – 24hour, 99th percentile

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Table 5.NH3-1 summarises the maximum simulated 24-hr NH_3 concentrations at the sensitive receptors in the region. In the absence of a national air quality standard, the 24-hour average US EPA Reference Concentration of 100μg.m^{-3} is used as a reference.

Table 5.NH3-1: Sensitive receptors: Maximum 24-hr NH_3 concentrations (μg/m^3)

Sensitive Receptor	Scenario 1
Msunduzi (SW)	1.523
Denge	2.381
Mngcweni	2.724
Inchanga-1	2.311
Inchanga-2	3.465
Inchanga Park	7.947
Camperdown Rural	0.923
Country Club CAAQMS	11.874
Cato Ridge (S)	3.888
Cato Ridge (C)	16.183
Othweba (W1)	5.152
Othweba (W2)	3.216
Othweba (W3)	2.303
Othweba (W4)	2.028
Othweba (N)	2.612
Ntukuso	1.211
Siweni	1.927
Radnor CAAQMS	2.213

Per the tabled information for the sensitive receptors, red text illustrates for which sensitive receptors, the highest concentration modelled over the 3 year period will be in excess of the reference concentration. It was found that the highest concentration modelled over the period at each sensitive receptor was less than the reference concentration. An assessment of the time-series data was therefore not required.

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5.1.3.VOC-1 Volatile Organic Compounds (VOC's) – Annual Average (Guideline Concentration: 5 µg/m³)

Figure 5.3.VOC-1.1 below provides an indication of the expected impact of VOC emissions for Scenario 1. In the absence of a national ambient air quality standard for VOC species, 5 µg/m³ for benzene (NAAQS) was utilised, since benzene is present in the VOC emission.

For Study Area 1, it is foreseen to be "very likely" that the ambient air quality falls within the relevant NAAQS.

For Study Area 2, it is foreseen to be "very likely" that the ambient air quality falls within the relevant NAAQS.

For Study Area 3, it is foreseen to be "very likely" that the ambient air quality falls within the relevant NAAQS.

All Sources (per Scenario 1):

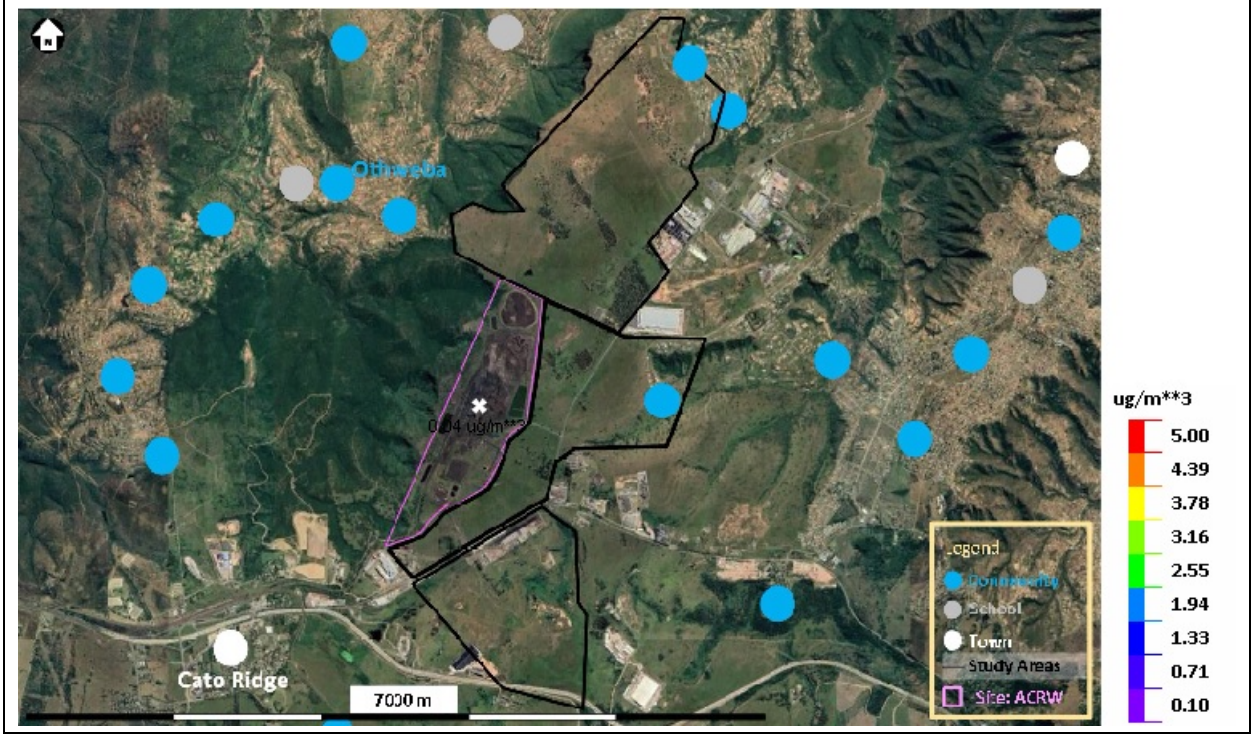


Figure 5.3.VOC-1.1: Scenario 1 – Volatile Organic Compounds (VOC's) – Annual Average

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Table 5.VOC-1 summarises the maximum simulated annual VOC concentrations at the sensitive receptors in the region, assessed against the NAAQS for benzene at an annual averaging period is 5µg/m^3.

Table 5.VOC-1: Sensitive receptors: Maximum Annual VOC concentrations (µg/m^3)

Sensitive Receptor	Scenario 1
Msunduzi (SW)	0.006
Denge	0.011
Mngcweni	0.008
Inchanga-1	0.004
Inchanga-2	0.007
Inchanga Park	0.007
Camperdown Rural	0.004
Country Club CAAQMS	0.009
Cato Ridge (S)	0.006
Cato Ridge (C)	0.012
Othweba (W1)	0.011
Othweba (W2)	0.008
Othweba (W3)	0.006
Othweba (W4)	0.006
Othweba (N)	0.013
Ntukuso	0.005
Siweni	0.006
Radnor CAAQMS	0.012

Per the tabled information for the sensitive receptors, red text illustrates for which sensitive receptors, the highest concentration modelled over the 3 year period will be in excess of the standard's concentration. It was found that the highest concentration modelled over the period at each sensitive receptor was less than the standard's concentration. An assessment of the time-series data was therefore not required.

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5.1.4 Modelled 1st Highest Concentrations

The highest/maximum concentrations modelled for the relevant pollutants under Scenario 1 are provided in Table 5.30-1, together with their coordinates.

Table 5.30-1: Modelled 1st Highest / Maximum Concentrations for Scenario 1

Pollutant	Averaging period	Scenario 1: Baseline			
		Concentration	Coordinates		
		µg/m³	X	Y	date
PM_{10}	24h	1716.80	269140.5	6710846.5	10-Oct-18
	Ann	243.14	269140.5	6710846.5	n/ap
$PM_{2.5}$	24h	521.35	269140.5	6710846.5	10-Oct-18
	Ann	82.70	269140.5	6710846.5	n/ap
SO_2	1h	306.21	269079.4	6710381.4	07-Apr-19
	24h	102.33	269079.4	6710381.4	15-Dec-17
	Ann	46.65	269079.4	6710381.4	n/ap
NO_2	1h	729.77	269079.4	6710381.4	07-Mar-17
	Ann	103.68	269079.4	6710381.4	n/ap
NH_3	24h	41.66	265079.4	6708381.4	24-Jul-18
CO	1h	106317.73	269079.4	6710381.4	07-Apr-19
	8h	33710.06	269079.4	6710381.4	26-Apr-18
Mn	Ann	13.46	269079.4	6710381.4	n/ap
VOC (Benzene)	Ann	0.04	269079.4	6710381.4	n/ap

It is noted that all locations referred above are within the boundary of ACRW.

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5.2 Analysis of Emissions' Impact on the Environment

In accordance with the requirements of the Regulations Prescribing the Format of the Atmospheric Impact Report as published in Government Gazette No. 36904 on the 11th of October 2013 and the Regulations Regarding Air Dispersion Modelling as published in Government Gazette No. 37804 on the 11th of July 2014, the impact of the Enterprise was assessed by means of air dispersion modelling in accordance with the Code of Practice for Air Dispersion Modelling in Air Quality Management in South Africa.

This project did not assess the additional impact with respect to soil and water bodies. Bird and Scholes, 2012 proposed that land type and water-use, was more influential on water quality than atmospheric sulphur and nitrogen deposition at five river research sites in the Vaal Dam Catchment between 1995 and 2008. That investigation had assessed the impact of atmospheric sulphur and nitrogen deposition on water quality, and no statistically significant increases in nitrogen and sulphur concentrations were found.

The impact of pollutants on human receptors were assessed against the South African NAAQS (see Section 5.1). In the absence of stricter standards/guidelines for non-human receptors (environment) and where relevant, the South African NAAQS will be used as a screening limit for these pollutants. The analysis of emissions' impact on the environment was limited to the pollutant(s) included in this study.

5.2.1 Impact of Particulate Matter

5.2.1.1 Animals

Consistent evidence from both epidemiological and experimental studies have demonstrated that short- and long-term exposure to particulate matter, especially to the finest particles, is associated with cardiopulmonary injury and systemic diffusion. Experimental studies conducted on laboratory animals have shown that the pulmonary inflammatory response following inhalation of airborne dust is characterised by a local increase in macrophages and neutrophils as well as by activation of alveolar macrophages. Activation of monocytes determines the free radicals (ROS) production as well as the release of cytokines playing an important role in the development of fibrotic lesions. The fibrotic process is important for tissue repair, but if the tissue proliferation exceed, it can alter and compromise the structure and physiological functions of lung. Pollutant particles reaching the lung parenchyma via the airway may remain for years, and generally determine pneumopathies and sclerosing pneumoconiosis (Losacco & Perillo, 2018).

Experimental studies using animals have not provided convincing evidence of particle toxicity at ambient levels (CEPA, 1998). Acute exposures (4-6 hour single exposures) of laboratory animals to a variety of types of particles, almost always at concentrations well above those occurring in the environment have been shown to cause decreases in lung function, changes in airway defence mechanisms and increased mortality rates (CEPA, 1998):

- decreases in ventilatory lung function;
- changes in mucociliary clearance of particles from the lower respiratory tract (front line of defense in the conducting airways);

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- increased number of alveolar macrophages and polymorphonuclear leukocytes in the alveoli (primary line of defense of the alveolar region against inhaled particles);
- alterations in immunologic responses (particle composition a factor, since particles with known cytotoxic properties, such as metals, affect the immune system to a significantly greater degree);
- changes in airway defense mechanisms against microbial infections (appears to be related to particle composition and not strictly a particle effect);
- increase or decrease in the ability of macrophages to phagocytize particles (also related to particle composition);
- a range of histologic, cellular and biochemical disturbances, including the production of proinflammatory cytokines and other mediators by the lungs alveolar macrophages (may be related to particle size, with greater effects occurring with ultrafine particles);
- increased electrocardiographic abnormalities (an indication of cardiovascular disturbance);
- increased mortality.

The epidemiological finding of an association between 24-hour ambient particle levels below 100 µg/m^3 and mortality has not been substantiated by animal studies as far as PM_{10} and $PM_{2.5}$ are concerned. With the exception of ultrafine particles (0.1 µm), none of the other particle types and sizes used in animal inhalation studies cause such acute dramatic effects, including high mortality at ambient concentrations. The lowest concentration of $PM_{2.5}$ reported that caused acute death in rats with acute pulmonary inflammation or chronic bronchitis was 250 g/m^3 (3 days, 6 hr/day), using continuous exposure to concentrated ambient particles as presented by the Canadian Environmental Protection Agency (CEPA, 1998).

Most of the current studies concurred that the main implication of dusty environments are causing animal stress which is detrimental to their health. However, no threshold levels exist to indicate at what levels these are having a negative effect. In this light it was decided to use the same screening criteria applied to human health, i.e. the South African National Ambient Air Quality Standards. An individual's response depends on characteristics of the inhaled components (such as composition, particle size and antigenicity) and of the individual's susceptibility, which is tempered by extant respiratory conditions.

Based on the simulated ambient concentrations (sections 5.1.3.PM10 and 5.1.3.PM2.5):

1. For Study Area 1: It is foreseen to be "likely" that the ambient air quality falls within the relevant standards for 24-hour and annual averages;
2. For Study Area 2: It is foreseen to be "likely" that the ambient air quality over portions of study area 2 bordering ACRW (approximately 0-100m east of ACRW) will exceed the relevant National Ambient Air Quality Standards (NAAQS) for 24-hour and annual averages. It is noted that at present no Residential areas/Communities are located within this area of potential NAAQS exceedance;
3. For Study Area 3: It is foreseen to be "very likely" that the ambient air quality over portions of study area 3 bordering ACRW (approximately 0-400m north of ACRW) will exceed the relevant NAAQS for 24-hour and annual averages.

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5.2.1.2 Vegetation

Ambient air pollutants have a potential adverse impact on biochemical parameters, which further leads to a reduction in the overall growth and development of plants. The impact of various atmospheric pollutants on plants both in terms of physiology and biochemistry has been under investigation for many years (Agrawal and Agrawal, 1989; Rai, 2011 a, b; Rai and Panda, 2014; Rai and Singh, 2015; Rai, 2016 a, b). Plant adaptation to changing environmental factors involves both short-term physiological responses and long-term physiological, structural and morphological modifications. These changes help plants minimize stress and maximize use of internal and external resources (Dineva, 2004).

Since plants are constantly exposed to air, they are the primary receptors for both gaseous and particulate pollutants of the atmosphere. In terrestrial plant species, the enormous foliar surface area acts as a natural sink for pollutants especially the particulate ones. Vegetation is an effective indicator of the overall impact of air pollution particularly in context of particulate matter (PM).

According to Rai 2016a and Rai 2016b, there are two main types of direct injury that PM pollution can cause on plants: acute and chronic injury. Acute injury results from exposure to a high concentration of gas for a relatively short period and is manifested by clear visible symptoms on the foliage, often in the form of necrotic lesions. While this type of injury is very easy to detect (although not necessarily to diagnose), chronic injury is much more subtle: it results from prolonged exposure to lower gas concentrations and takes the form of growth and/ or yield reductions, often with no clear visible symptoms. Plants that are constantly exposed to environmental pollutants absorb, accumulate and integrate these pollutants into their systems. It reported that depending on their sensitivity level, plants show visible changes which would include alteration in the biochemical processes or accumulation of certain metabolites (Agbaire and Esiefarienrhe, 2009).

Pollutants can cause leaf injury, stomatal damage, premature senescence, decrease photosynthetic activity, disturb membrane permeability and reduce growth and yield in sensitive plant species (Tiwari et al., 2006). The long-term, low concentration exposures of air pollution produces harmful impacts on plant leaves without visible injury (Joshi et al., 2009). Several studies have been conducted to assess the effects of pollution on different aspects of plant life such as overall growth and development, foliar morphology, anatomy, and biochemical changes (Rai 2016).

Morphological impact of PM on plants showed reduction in plant growth (Bender et al., 2002) through its effect on leaf gas exchange (Ernst, 1982), flowering and reproduction of plants (Saunders and Godzik, 1986), number of leaves and leaf area variables in growth analyses (Lambers et al., 1998). Reduction in leaf area and leaf number maybe due to decreased leaf production rate and enhanced senescence (Seyyednejad et al., 2011). Dust deposition also affect the stomata causing occlude stomata (Hirano et al., 1995) as the particles enter the leaf through stomatal opening and their toxicity disturb the physiological activity of plants (Farmer, 1993) such as the inhibition of plant growth, rate of photosynthesis (Armbrust, 1986), late flower and the hormonal imbalance (Farooqui et al.,1995). The inhibition of net photosynthesis would inhibit the assimilate translocation and eventually leaf area would decrease. Literature revealed that stomatal closure can help to protect plants against pollution damage (Mansfield and Majernik, 1970).

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Physiological and biochemical effect on plants or plant leaves includes leaf-extract pH, relative water content, pigment content, photosynthesis and stomata changes (Rai, 2016).

In general, according to the Canadian Environmental Protection Agency (CEPA), air pollution adversely affects plants in one of two ways; either the quantity of output or yield is reduced, or the quality of the product is lowered. The former (invisible) injury results from pollutant impacts on plant physiological or biochemical processes and can lead to significant loss of growth or yield in nutritional quality (e.g. protein content). The latter (visible) may take the form of discolouration of the leaf surface caused by internal cellular damage. Such injury can reduce the market value of agricultural crops for which visual appearance is important (e.g. lettuce and spinach). Visible injury tends to be associated with acute exposures at high pollutant concentrations whilst invisible injury is generally a consequence of chronic exposures to moderately elevated pollutant concentrations. However, given the limited information available, specifically the lack of quantitative dose-effect information, it is not possible to define a Reference Level for vegetation and particulate matter (CEPA, 1998).

While there is little direct evidence of what the impact of dust fall on vegetation is under an African context, a review of European studies has shown the potential for reduced growth and photosynthetic activity in Sunflower and Cotton plants exposed to dust fall rates greater than 400 mg/m²/day (Farmer, 1993).

No threshold levels exist to indicate at what levels PM are having an adverse negative effect. In this light it was decided to use the same screening criteria applied to human health, i.e. the South African National Ambient Air Quality Standards. Based on the simulated ambient concentrations (sections 5.1.3.PM10 to 5.1.3.PM2.5):

1. For Study Area 1: It is foreseen to be “likely” that the ambient air quality falls within the relevant standards for 24-hour and annual averages;
2. For Study Area 2: It is foreseen to be “likely” that the ambient air quality over portions of study area 2 bordering ACRW (approximately 0-100m east of ACRW) will exceed the relevant National Ambient Air Quality Standards (NAAQS) for 24-hour and annual averages. It is noted that at present no Residential areas/Communities are located within this area of potential NAAQS exceedance;
3. For Study Area 3: It is foreseen to be “very likely” that the ambient air quality over portions of study area 3 bordering ACRW (approximately 0-400m north of ACRW) will exceed the relevant NAAQS for 24-hour and annual averages.

5.2.2 Impact of Sulphur Dioxide

5.2.2.1 Animals

Experimental studies on animals have shown the acute inhalation of SO_2 produces bronchoconstriction, increases respiratory flow resistance, increases mucus production and has been shown to reduce abilities to resist bacterial infection in mice (Costa and Amdur, 1996). Short exposures to low concentrations of SO_2 (~2.6 mg/m³) have been shown to have immediate physiological response without resulting in significant or permanent damage. In rabbits, acute exposures (16 mg/m³ for 4 hours) to SO_2 gas was irritating to the eyes and resulted in conjunctivitis, infection and lacrimation (Von Burg, 1995). Short exposures (<30 min) to concentrations of 26 mg/m³ produced more significant respiratory changes in cats but were usually completely reversible once exposure had ceased (Corn et al., 1972).

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Sulphur dioxide can produce mild bronchial constriction, changes in metabolism and irritation of the respiratory tract and eyes in cattle (Coppock and Mostrum, 1997). An increase in airway resistance was reported in sensitized sheep after four hours of exposure to 13 mg/m³. Studies report chronic exposure can affect mucus secretions and result in respiratory damage similar to chronic bronchitis. These effects were reported at concentrations above typical ambient concentrations (26-1053 mg/m³) (Amdur, 1978).

Exposure to air pollutants is expected to result in similar adverse effects in wildlife as in laboratory and domestic animals (Newman, 1984).

Most of the current studies concluded that immediate physiological response and/or significant or permanent damage occurs in the low to upper mg/m^3 concentration ranges. In this light it was decided to use the same screening criteria applied to human health, i.e. the South African National Ambient Air Quality Standards. Based on the simulated ambient concentrations (sections 5.1.3.SO2-1 to 5.1.SO2-3) it is "likely" that the ambient concentrations falls within the NAAQS for all three Study Areas.

5.2.2.2 Plants

Sulphur dioxide penetrates into leaves primarily in gaseous form through the stomata, although there is evidence for a limited pathway via the cuticle. The aperture of the stomata is controlled largely by the prevailing environmental conditions, such as humidity, temperature and light intensity. These external factors thus influence the rate of uptake of sulphur dioxide and hence the degree of injury. When the stomata are closed, as occurs under dark or drought conditions, then resistance to gas uptake is very high and the plant has a very low degree of susceptibility to injury. However, unlike higher plants, mosses and lichens do not have a protective cuticle exposed to sulphur dioxide which is the major reason for their extreme sensitivity to SO_2.

SO_2 directly affects vegetation by uptake through parts of the plants that are above the ground; the direct effects on leaves are mainly determined by air concentrations. Depending on the amount of SO_2 taken up per unit of time, various kind of biochemical and physiological effects take place in the plant tissue; these include the degradation of chlorophyll, reduced photosynthesis, raised respiration rates, and changes in protein metabolism. The lower plants such as lichens and mosses, due to their structure have a particular sensitivity to SO_2. The decisive factors in the action of SO_2 on plants are existing stresses on the plant, the concentration of SO_2, the duration of exposure, and the frequency and sequence of impact; within certain ranges of concentration and for a given dose (concentration times exposure duration), the extend of foliar injury increases with increasing concentration. The significance of very low concentrations of SO_2 on growth and yield, and on changing plant sensitivity to other environmental stresses is now also recognized some plants can also recover in pollution-free periods if the duration of exposure to injuring concentrations is not too long and if the pollution-free period is sufficiently long (EC, 1997).

Individual species and varieties, and individuals within a population, react with different degrees of sensitivity to stress resulting from air pollution. Sulphur is also an essential plant nutrient. In certain areas, where soils are deficient in sulphur (mainly calcareous-based on chalk and limestone), atmospheric sulphur may be taken up by leaves of some species and help contributing to the plant vitality but uptake is low and therefore not relevant to the setting of limit values. Due to falling emissions of SO_2 in many areas in Europe and to the recognition of O_3 and nitrogen compounds as being of much greater significance with regard to plant injury, the relative importance of

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SO_2 as a phytotoxic pollutant has diminished to a certain extent. Nevertheless SO_2 can locally play a role in vegetation damage, especially in combination with other pollutants (EC, 1997).

The results of field observations and fumigation experiments have been used to determine quantitative dose-response relationship between SO_2 concentrations and the effects on both annual and perennial plants and to derive guidelines accordingly. These guidelines are generally defined as annual and/or winter means and are tabulated in Table 5.31.

Table 5.31: WHO guideline values for impact on plant species (EC, 1997)

Annual and winter mean value (µg/m³)	Target Affected
30	Crops
20	Forests / Natural Vegetation
15	Sensitive Forests / Natural Vegetation
10	Lichens

Based on the simulated ambient concentrations (section 5.1.3.SO2-3) it is "likely" that the ambient concentrations falls within the WHO annual guidelines in Table 5.31 for all three Study Areas.

5.2.2.3 Materials and cultural heritage

Deterioration of materials and objects of cultural heritage is a process which occurs at a rate which is determined by meteorological parameters such as relative humidity, temperature and precipitation, and by air pollutants. Since the time of wetness and temperature exhibit only small variations in the temperate climatic zone, the concentration of atmospheric pollutants is often the dominant variable affecting the rate of corrosion. Among the anthropogenic air pollutants, SO_2 can be considered as the most important in deterioration of several materials. Many materials are affected; among them, e.g. stones used in historic and cultural monuments, which have resisted atmospheric attacks for hundreds or even thousands of years. But during recent decades, an accelerated degradation of their surface has been observed in many parts of Europe (EC, 1997).

There are several ways how SO_2 emissions can contribute to corrosion of materials: it deposits readily on surfaces and is then subsequently converted to sulphates; in ambient air, SO_2 is also partly converted to sulphate particulates which may be deposited on surfaces and can also cause corrosion. Both SO_2 and sulphate particulates may also dissolve in rain droplets and increase the acidity of precipitations thus enhancing the phenomena of corrosion (EC, 1997).

The decisive effect of SO_2 on corrosion of several materials like metals, calcareous stones, or stained medieval glass windows has been shown in several laboratory and field exposures. In the last years, however, a synergistic corrosive effect of SO_2 and NO_2 and later of SO_2 and O_3 has been discovered first in laboratory exposure; this has been confirmed later on by field exposure studies. They enhance the corrosive effect of SO_2 by promoting its oxidation to sulphate. This underlines the necessity to treat the deterioration of materials taking into account the interrelated role of SO_2, NO_2 and O_3 in a multi-pollutant situation. During the last decades, several field exposure programs have greatly contributed to enhancement of the present state of knowledge on the effects of acidifying air pollutants on

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materials. Field studies have shown that the dry deposition has, in most cases, the dominating effect and that SO_2 exerts the strongest corrosive effect both in unsheltered end sheltered exposure. The effect of wet deposition is demonstrated only for unsheltered exposure. In practical and economic terms, the corrosion due to SO_2 is closely tied to densely populated areas. Here, three conditions coincide: a high content of atmospheric pollutants, a high population density and a large use of materials. The corrosion rate decreases in general rapidly with increasing distance from the source of emission. In many regions, atmospheric corrosion is therefore a local effect. Based on the findings of various studies, experts are recommending the following guidelines (Table 5.32):

Table 5.32: WHO guideline values for impact on materials (EC, 1997)

Annual mean value (µg/m^3)	Target Affected
15	Zinc, weathering steel
10	Bronze, limestone and sandstone

Based on the simulated ambient concentrations (section 5.1.3.SO2-3) it is "likely" that the ambient concentrations falls within the WHO annual guidelines in Table 5.32 for all three Study Areas.

5.2.3 Impact of Nitrogen Dioxide

5.2.3.1 Animals

Although there are exceptions, the vast majority of lung biochemical studies show effects only after acute or sub-chronic exposure to levels of nitrogen dioxide exceeding 3160 µg/m^3 (2 ppm) (US EPA, 1993 and Berglund, M. et. al., 1993).

Nitrogen dioxide is toxic to various animals as well as to humans. Its toxicity relates to its ability to form nitric acid with water in the eye, lung, mucus membrane and skin. Studies of the health impacts of NO_2 include experimental studies on animals, controlled laboratory studies on humans and observational studies. In animals, long-term exposure to nitrogen oxides increases susceptibility to respiratory infections lowering their resistance to such diseases as pneumonia and influenza. Laboratory studies show susceptible humans, such as asthmatics, exposed to high concentrations of NO_2 can suffer lung irritation and potentially, lung damage.

Epidemiological studies have also shown associations between NO_2 concentrations and daily mortality from respiratory and cardiovascular causes and with hospital admissions for respiratory conditions. While results from these types of studies are not consistent, some suggest adverse effects may be associated with NO_2 exposure at levels below existing guideline values. For example, Burnett et. al., (1998) found a 4.3% increase in all-cause mortality for an increase in 24-hour average NO_2 levels of 47 µg/m^3. Daily NO_2 levels during the study ranged from 29 to 56 µg/m^3.

An evaluation of the health impacts of NO_2 concentrations carried out by the Ministry for the Environment (New Zealand) in support of the derivation of ambient air quality guideline values concluded that the health impacts associated with low level exposure to NO_2 were equivocal, and that the contribution of NO_2 as one of a mixture of pollutants in the ambient environment was yet to be clearly defined (Dennison et al, 2002).

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In this light it was decided to use the same screening criteria applied to human health, i.e. the South African National Ambient Air Quality Standards. Based on the simulated ambient concentrations (sections 5.1.3.NO2-1 & 5.1.3.NO2-2):

1. For Study Area 1: It is foreseen to be "likely" that the ambient air quality over portions of study area 1 (approximately 0-100m south of Study Area 2) could exceed the relevant NAAQS for a 1-hour average and falls within the NAAQS for the annual average period. It is noted that at present no Residential areas/Communities are located within this area of potential NAAQS exceedance;
2. For Study Area 2: It is foreseen to be "likely" that the ambient air quality over portions of study area 2 bordering ACRW (approximately 0-800m south-east of ACRW and approximately 0-100m east of ACRW) could exceed the relevant NAAQS for a 1-hour average and falls within the NAAQS for the annual average period. It is noted that at present no Residential areas/Communities are located within this area of potential NAAQS exceedance;
3. For Study Area 3: It is foreseen to be "likely" that the ambient air quality over study area 3 should fall within the relevant NAAQS, both 1-hour and annual averages.

5.2.3.2 Plants and ecosystems

Nitrogen oxides are absorbed by vegetation in the same way as CO_2 through stomata. Nitrogen oxides are dissolved in the stomata cavity water and form nitrite and nitrate, which in turn are reduced to NH_3 and eventually incorporated into organic compounds (Wellburn, A.R., Wilson, J. and Aldrige, P.H. 1980). If too much NO_2 is absorbed over time, acute damage may occur in form of necrosis. Biological membranes and chloroplasts are assumed to be damaged (Mudd et al. 1984). Acute effects occur at very high concentrations, which are seldom observed in ambient air, except near very large point sources. There is a range of long term exposure effects. Up to a certain level, no effects are observed. Above this, NO_2 may stimulate growth. However, higher doses will decrease growth in relation to controls. There is at present a dispute over which nitrogen oxides are the most toxic. Further knowledge is necessary to assess the situation (EC, 1997).
The effect nitrogen oxides on vegetation depends on the action of NO and NO_2. The ratio of NO_2 to NO is very important for the deposition rate, since NO_2 is deposited much faster than NO. Indirectly, NO may also have a positive effect on vegetation by consuming O_3. The NO_2 has a lower phyto-toxic effect than O_3.

Any change in nitrogen deposited to an ecosystem will cause a change in the nutrient status of the system. It will cause biological consequences such as favouring nitrogen favouring species, eutrophication and in the most severe case, acidification. The acidification is, in turn, linked to leakage of nitrates to ground and surface waters, as the system cannot consume all the nitrogen deposited. Indirectly, O_3 formed via NO_x emissions may also damage vegetation, crops, natural vegetation and forests. Limit values for NO_2 and NO_x will however have implications for acidification and O_3.

Critical levels for oxides of nitrogen in the atmosphere and critical loads for nitrogen deposition have been developed to protect ecosystems (Caporn, 1992). Guidelines to protect ecosystems have also been adopted by WHO, based on the UN work. Table 5.33 is a summary of guidelines for nitrogen deposition to natural and semi natural freshwater and terrestrial ecosystems (WHO, 2000).

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Table 5.33: Guidelines for nitrogen deposition to natural and semi natural freshwater and terrestrial ecosystems (WHO, 2000)

Ecosystem	Critical load (kg N/ha per year)	Indication of exceedance
Wetlands: Softwater lakes	5 – 10	Decline in isoetid aquatic plant species
Wetlands: Ombrotrophic (raised) bogs	5 – 10	Decrease in typical mosses; increase in tall graminoids; nitrogen accumulation
Wetlands: Mesotrophic fens	20 – 35	Increase in tall graminoids; decline in diversity
Grasslands: Calcareous grasslands	15 – 35	Increase in tall grasses; decline in diversity
Grasslands: Neutral–acid grasslands	20 – 30	Increase in tall grasses; decline in diversity
Grasslands: Montane–subalpine grassland	10 – 15	Increase in tall graminoids; decline in diversity
Heathlands: Lowland dry heathland	15 – 20	Transition from heather to grass
Heathlands: Lowland wet heathland	17 – 22	Transition from heather to grass
Heathlands: Species rich heaths/acid grassland	10 – 15	Decline in sensitive species
Heathlands: Upland *Calluna* heaths	10 – 20	Decline in heather, mosses and lichens
Heathlands: Arctic and alpine heaths	5 – 15	Decline in lichens, mosses and evergreen dwarf shrubs; increase in grasses
Trees and forest ecosystems: Coniferous trees (acidic; low nitrification rate)	10 – 15	Nutrient imbalance
Trees and forest ecosystems: Coniferous trees (acidic; medium to high nitrification rate)	20 – 30	Nutrient imbalance
Trees and forest ecosystems: Deciduous trees	15 – 20	Nutrient imbalance; increased shoot/root ratio
Trees and forest ecosystems: Acidic coniferous forests	7 – 20	Changes in ground flora and mycorrhizas; increased leaching
Trees and forest ecosystems: Acidic deciduous forests	10 – 20	Changes in ground flora
Trees and forest ecosystems: Calcareous forests	15 – 20	Changes in ground flora
Trees and forest ecosystems: Acidic forests (unmanaged)	7 – 15	Changes in ground flora and leaching
Trees and forest ecosystems: Forests in humid climates	5 - 10	Decline in lichens; increase in free-living algae

At this moment, the critical loads are set in values of total nitrogen inputs, which is a sum of the NH_Y (consisting of ammonia and ammonium ions), and NO_X (consisting of nitrogen dioxide and nitric oxide). The critical loads can be calculated as a function of the total deposition (wet- and dry deposition). Dry deposition velocities for NH_Y and NO_X species are available, but wet deposition is a function of concentration as well as the washout coefficients (cloud type, cloud height, precipitation intensity, size of droplets, etc.) of the pollutants during the precipitation event. Unfortunately, these washout coefficients are not available. Table 5.34 summarises the dry deposition velocities (V_d) as taken from Brodzinsky et. al. (1984).

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Table 5.34: Deposition velocities for selected species V_d (Brodzinsky et. al., 1984)

Compound	V_d (cm.s^{-1})	
	Day	Night
NO_2, NO	0.2	0.07
HNO3	1.0	0.07
PAN	0.25	0.07
NO_3^- (aerosol)	0.6	0.6

If we make the assumption that the annual NO_2 concentration is 10 µg/m^3 measured/modelled at 1.5 m above the ground, and the concentration is homogeneously mixed to the ground level, utilising Table 5.34 will give rise to a dry deposition load of 4.26 kg/ha.annum. A V_d of 0.135 cm/s was used as an average of the day and night dry deposition values. Following the same calculations will give dry deposition loads as tabulated in Table 5.35.

Table 5.35: Annual dry deposition loads for selected annual ambient air concentrations

Annual ambient NO_2 concentration (µg/m^3)	Dry deposition load (kg NO_2/ha per year)
1	0.43
2	0.85
5	2.13
10	4.26
20	8.51
50	21.29
100	42.57

The annual 4 µg/m^3, 8.5 µg/m^3 and 35.5 µg/m^3 NO_2 concentration isopleths are distinguishable in section 5.1.3.NO2-2. These concentrations will give rise to dry deposition loads of 2.6 kg NO_2/ha, 4.6 kg NO_2/ha and 15.1 kg NO_2/ha per year, respectively.

Excluding wet deposition and deposition of other "N" containing species, comparing the deposition loads of 2.6 kg NO_2/ha, 4.6 kg NO_2/ha and 15.1 NO_2/ha per year to Table 5.33 in terms of kg N/ha per year, it is "likely" that the ambient NO_2 concentrations beyond a distance of approximately 500m to the east and west of ACRW, will not have a significant adverse effect on vegetation and ecosystems. It is "likely" that the ambient NO_2 concentrations north and south of ACRW, will not have a significant adverse effect on vegetation and ecosystems.

5.2.3.3 Effect on materials

The effect on materials of an individual air pollutant is difficult to separate from the effect of others. Many of the effect on materials have been ascribed to the multipollutant situation in the urban atmosphere than to the action of separate pollutants. Nitrogen oxides may contribute to damage in several ways, but their role is not yet clarified (EC, 1997).

However, the role of nitrogen oxides is secondary compared to that of ozone for dyes, fabrics, plastics and elastomers, to that of oxygen, sulphur dioxide and wetting by rain, condensation, mist etc. on metals and to that of

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rain, carbon dioxide and sulphur dioxide for calcareous stonework. There is also a possibility that nitrate deposited on outdoor surfaces, can enhance the microbial activity and thus increase bio-degradation. Increased growth of algae due to deposition of nitrogen compounds on surface is considered as a soiling and undesirable effect. At present there is not sufficient data to enable a recommendation to be made for an air quality limit value for NO_2 in order to protect material from air pollution damage (EC, 1997).

In view of the above, light it was decided to use the same screening criteria applied to human health, i.e. the South African National Ambient Air Quality Standards. Based on the simulated ambient concentrations (sections 5.1.3.NO2-1 & 5.1.3.NO2-2) it is "likely":

1. For Study Area 1: It is foreseen to be "likely" that the ambient air quality over portions of study area 1 (approximately 0-100m south of Study Area 2) could exceed the relevant NAAQS for a 1-hour average and falls within the NAAQS for the annual average period. It is noted that at present no Residential areas/Communities are located within this area of potential NAAQS exceedance;
2. For Study Area 2: It is foreseen to be "likely" that the ambient air quality over portions of study area 2 bordering ACRW (approximately 0-800m south-east of ACRW and approximately 0-100m east of ACRW) could exceed the relevant NAAQS for a 1-hour average and falls within the NAAQS for the annual average period. It is noted that at present no Residential areas/Communities are located within this area of potential NAAQS exceedance;
3. For Study Area 3: It is foreseen to be "likely" that the ambient air quality over study area 3 should fall within the relevant NAAQS, both 1-hour and annual averages.

5.2.4 Impact of Carbon Monoxide

5.2.4.1 Animals

The binding of carbon monoxide with haemoglobin to form carboxyhaemoglobin (COHb) reduces the oxygen-carrying capacity of the blood and impairs the release of oxygen from haemoglobin to extravascular tissues, as well as transportation of oxygen around the body. This can impact on the brain, nervous tissues, heart muscle and other specialised tissues that require large amounts of oxygen to function. As a result of oxygen deprivation, these organs and tissues may suffer temporary or permanent damage (EC, 1999).

CO reacts readily with haemoglobin in the blood to form COHb. The affinity of haemoglobin for CO is 200-250 times that for oxygen, and as a result this binding reduces the oxygen-carrying capacity of the blood and impairs the release of oxygen to extravascular tissues. The most important variables determining the COHb level are CO in inhaled air, duration of exposure and lung ventilation. During an exposure to a fixed concentration of CO, the COHb concentration increases rapidly at the onset of exposure, starts to level off after 3 hours, and reaches a steady-state after 6-8 hours of exposure. Physical exercise accelerates the CO uptake process. The formation of COHb is a reversible process, but because of the tight binding of CO to haemoglobin, the elimination half-life while breathing room air is 2-6.5 hours depending on the initial COHb level (EC, 1999).

The toxic effects of CO become evident in organs and tissues with high oxygen consumption such as the brain, the heart, the exercising skeletal muscle. The effects of CO exposure at very high concentrations (well above ambient levels) are lethal. High concentrations may cause both reversible, short-lasting neurological deficits and severe, often delayed neurological damage. At COHb levels as low as 5.1-8.2% impaired coordination, vigilance and cognitive

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performance have been observed. In healthy subjects the endogenous production of CO results in COHb levels of 0.4-0.7% (EC, 1999).

Those most susceptible to the health effects of ambient air exposure to CO include those with ischaemic heart disease, other forms of cardiac disease including cyanotic heart disease, hypoxaemic lung disease, cerebrovascular disease, peripheral vascular disease, those with anaemia and haemoglobin abnormalities, children, and developing foeti.

The CO guidelines (Table 5.36) are based on the Coburn-Foster-Kane exponential equation, which takes into account all the known physiological variables affecting carbon monoxide uptake. The following guideline values (ppm values rounded) and periods of time-weighted average exposures have been determined in such a way that the COHb level of 2.5% is not exceeded, even when a normal subject engages in light or moderate exercise (WHO, 2000).

Table 5.36: Guidelines for carbon monoxide (CO) (WHO, 2000)

CO concentration		Time average
mg/m³	µg/m³	
100	100 000	15 minutes
60	60 000	30 minutes
30	30 000	1 hour
10	10 000	8 hours

Table 5.36 correlate with the South African NAAQS, thus the screening criteria applied to human health, i.e. the South African National Ambient Air Quality Standards will be used. Based on the simulated ambient concentrations (sections 5.1.3.CO-1 & 5.1.3.CO-2) it is “likely” that the ambient concentrations falls within the NAAQS for all three Study Areas.

5.2.4.2 Plants and ecosystems

Adverse direct impacts on vegetation by CO at ambient concentrations have not been reported. As a precursor of carbon dioxide and ozone, CO indirectly contributes to global warming and to direct effects by ozone to vegetation and materials.

In view of the above, light it was decided to use the same screening criteria applied to human health, i.e. the South African National Ambient Air Quality Standards. Based on the simulated ambient concentrations (sections 5.1.3.CO-1 & 5.1.3.CO-2) it is “likely” that the ambient concentrations falls within the NAAQS for all three Study Areas.

5.2.5 Impact of Ammonia

Ammonia released into air has an unpleasant odour, which is detectable even at low concentrations.

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5.2.5.1 Animals & Humans

Exposure to ammonia at environmental concentrations is unlikely to have adverse effects on health. However, exposure to high concentrations following an accidental release or in occupational settings could cause irritation of the eyes, nose and throat as well as burning the skin where there is direct contact.

Short-term inhalation exposure to high levels of ammonia in humans can cause irritation and serious burns in the mouth, lungs, and eyes. Chronic exposure to airborne ammonia can increase the risk of respiratory irritation, cough, wheezing, tightness in the chest, and impaired lung function in humans. Studies in experimental animals similarly indicate that breathing ammonia at sufficiently high concentrations can result in effects on the respiratory system. Animal studies also suggest that exposure to high levels of ammonia in air may adversely affect other organs, such as the liver, kidney, and spleen (ATSDR, 2004).

A sub chronic p-RfC (provisional inhalation Reference Concentration) of 0.1mg/m^3 was derived by applying a composite uncertainty factor of 30 to the human NOAEL (no-observed-adverse-effect-level) of 2.3 mg/m3 (Holness et al., 1989). The animal LOAEL (lowest-observed-adverse-effect-level) of 1.62 mg/m3 is in close proximity to the human NOAEL and gives a sixteen-fold ceiling to the RfC of 0.1 mg/m^3 (100µg/m^3).

Based on the simulated ambient concentrations (section 5.1.3.NH3-1) it is “likely” that the ambient concentrations falls within the abovementioned RfC for all three Study Areas.

5.2.5.2 Vegetation

Ammonia is a plant nutrient and the low concentrations are not foreseen to impact negatively on the surrounding vegetation. At particularly high concentrations it can also harm vegetation. The harm caused by ammonia in water bodies is more serious, because it is very toxic to aquatic organisms. Low concentrations of ammonia in soil are natural and actually essential for plant nutrition. Over-fertilisation can however lead to excessive concentrations which result in leaching to water bodies. On a wider scale, ammonia plays a role in the transportation and enhanced deposition of acidic pollutants - resulting in acidification of ground and water bodies, which can harm plant and animal life (ATSDR, 2004).

Biochemical and growth aspects in vegetation were reported for long term (8-months) exposure to NH_3 at 50µg/m^3 (Dueck & Elderson, 1992; Dueck, 1990), whilst short term (2-6 hours) exposure at 2000µg/m^3 (Van der Eerden, 1982; Benedict & Breen, 1955; Garber, 1935).

Based on the simulated ambient concentrations (section 5.1.3.NH3-1) it is “likely” that the ambient concentrations falls within the abovementioned RfC for all three Study Areas.

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6. COMPLAINTS

Table 6.1 below provides a summary of the complaints received during the past 5 years.

Table 6.1: Complaints

Complaints		
Nature & Source	**Frequency**	**Measures Taken in Response to Complaint**
Ad-hoc complaints/enquiries had been received relating to visible emissions / air pollution	Ad-hoc	• Operations are assessed; • Operational parameters are investigated and corrective operating protocol implemented and or projects initiated in order to implement corrective measures which require capital expenditure over the medium/long term.

7. CURRENT OR PLANNED AIR QUALITY MANAGEMENT INTERVENTIONS

The information referenced in this section pertains to approved and implemented air quality management improvement interventions for the Enterprise.

As referenced in Table 3.2 of Section 3.2.

8. COMPLIANCE AND ENFORCEMENT HISTORY

Table 8.1 below provides a summary of the air quality compliance and enforcement actions undertaken against the Enterprise in the last 5 years, such as directives, compliance notices, interdicts, prosecution, and fines.

Table 8.1: Compliance and Enforcement History

Compliance and Enforcement History		
Action	**Date**	**Description**
Not provided with this report – please refer to Site Management for relevant records/correspondence		

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9. ADDITIONAL INFORMATION – CONCLUDING COMMENTS & RECOMMENDATIONS

Subject to the information available for this study and the assumptions provided in this report in terms of the purpose/scope of the study, the following additional information is provided for the attention of the relevant Air Quality Officer/Manager/Authority/Environmental Assessment Practitioner:

1. The following concluding comments and recommendations are limited to the Proposed Development Areas, referred to as "Study Areas 1, 2 and 3", based on the defined purpose / scope of the study, the information available for the assessment, inclusive of all the emission sources/operations considered in this investigation;
2. It is understood from pre-feasibility studies for the proposed land development project had indicated that *light industry*, *general industry*, *warehousing* and *logistics land* uses proved to be viable land use options from a market perspective and in terms of eThekwini Town Planning Regulations, use zones are described as follows[14]:
   2.1) the light Industry, include light industrial and service industrial. Light Industry also comprises of the following special consent: Institution, Offices, Parking Garage, Petrol Service Station, Shop in terms of clause 6(31), Restaurant, Totalisator Depot, Special Building or use, any other use authorised in terms of clause 6;
   2.2) the General Industry, industrial purposes other than Extractive or Noxious are permitted. General Industry special consent are Institution, Offices, Parking Garage, Petrol Service Station, Shop in terms of clause 6(31), Restaurant, Totalisator Depot, Special Building or use, any other use authorised in terms of clause 6;
3. The available information was utilised to assess the potential impact to air quality over the defined study areas by means of dispersion modelling, limited to the data available and noting that other sources, not included in the study, will contribute to / impact on the quality of the ambient air over the study areas. It should also be noted that this is a theoretical / modelling assessment and it should always be considered that there are several factors which influence the resulting uncertainty of such a study, as flagged/indicated by means of the comments made throughout the content of this report. In terms of the dispersion modelling uncertainties provided in Appendix U, the assumptions made and the information contained in the report, the findings are made against a confidence rating of medium to high. Whilst all attempts are made to ensure objectivity and impartiality, the "assessment remains an act of judgement and can never escape the subjectivity inherent in attempting to define significance." The key findings are dealt with under the following points;
4. Subject to the aforementioned descriptions of potential land uses and the following key findings, it is considered/noted that:
   4.1) In light of the recent and unfortunate UPL South Africa (Pty) Ltd. warehouse fire in Cornubia, Umhlanga, that this investigation did not make provision for such an incident, that the findings and recommendations are made under the premise that an impact assessment(s) will be conducted for the specific land use as proposed by each applicant/tenant/land owner and that all preventative measures will be taken to prevent a re-occurrence of such an incident;
   4.2) It is "unlikely" that *light industry*, *general industry*, *warehousing* and *logistics land* uses will impact negatively on the surrounding communities and that it is "likely" that the ambient air quality standards could still be met over those sensitive receptors;

[14] Zutari (Pty) Ltd. 2021. Project description_Cato Ridge Land Development_EIA_07102021_Draft4.docx

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4.3) It is recommended that the land should not be for residential use and that no persons/employees should reside on the land;

5. Key findings of the dispersion modelling results (Section 5.1) indicates the following matters, with reference to the National Ambient Air Quality Standards (NAAQS) being the South African National Ambient Air Quality Standards, in terms of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004), as published in Government Gazette No. 32816 on the 24th of December 2009 and the South African National Ambient Air Quality Standards for $PM_{2.5}$ (Particulate matter with an aerodynamic diameter less than 2.5µm), in terms of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004), as published in Government Gazette No. 35463 on the 29th of June 2012:

5.1) PM_{10} & $PM_{2.5}$:

5.1)1. Study Area 1: It is foreseen to be "likely" that the ambient air quality falls within the relevant standards for 24-hour and annual averages;

5.1)2. Study Area 2: It is foreseen to be "likely" that the ambient air quality over portions of study area 2 bordering ACRW (approximately 0-100m east of ACRW) will exceed the relevant National Ambient Air Quality Standards (NAAQS) for 24-hour and annual averages. It is noted that at present no Residential areas/Communities are located within this area of potential NAAQS exceedance;

5.1)3. Study Area 3: It is foreseen to be "very likely" that the ambient air quality over portions of study area 3 bordering ACRW (approximately 0-400m north of ACRW) will exceed the relevant NAAQS for 24-hour and annual averages;

5.1)4. It is further noted that data from the Radnor continuous ambient air monitoring station (located approximately 1 km to the east of ACRW) has suggested that source(s) east/south-east/south of the station is/are impacting on the ambient air quality at that location which in addition contribute to exceedances of standards, which implies that it is "as likely as not" for Study Areas 1, 2 and 3 to exceed the relevant 24-hour and annual average NAAQS;

5.1)5. Under the premise that these proposed development areas are to be zoned for light industry/general industry/warehousing/logistics and that the quality of the air over the areas need not meet with the NAAQS, it is recommended that development should be such that it limits further contribution to the airshed and not impact negatively on existing or potential neighbouring sensitive receptors (residential areas). It hence also implies that people/employees should not reside on the properties;

5.1)6. No threshold PM levels exist to indicate adverse negative effects on animals and plants. In this light it was decided to use the same screening criteria applied to human health, i.e. the NAAQS (refer to AQIA report, section 5.1). Based on the simulated ambient concentrations (sections 5.1.3.PM10 to 5.1.3.PM2.5) the same findings apply as referred to under 5.1)1-5.1)4;

5.1)7. On an ongoing basis ACRW investigates and/or implements additional options/measures to mitigate PM emissions;

5.2) SO_2:

5.2)1. Study Areas 1, 2 and 3: It is foreseen to be "very likely" that the ambient air quality falls within the relevant NAAQS for 1-hour, 24-hour and annual averages;

5.2)2. Most of the current studies focusing on the impact of SO_2 on animals concluded that immediate physiological response and/or significant or permanent damage occurs in the low to upper mg/m^3 concentration ranges. In this light it was decided to use the same screening criteria applied to

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human health, i.e. the NAAQS (refer to AQIA report, section 5.1). Based on the simulated ambient concentrations (sections 5.1.3.SO2) it is "likely" that the ambient concentrations fall within the NAAQS and the World Health Organisation (WHO) annual guidelines for some plant species;

5.3) NO_2:

5.3)1. Regardless of the other sources/operations included in this investigation, it is noted that the NO_X (as NO_2) emissions from ACRW and its impact on the surrounding ambient air quality could conservatively have been overstated (estimated secondary emissions), with investigations planned to assess and to consider options. The following points are subject to the potential overestimation;

5.3)2. Study Area 1: It is foreseen to be "likely" that the ambient air quality over portions of study area 1 (approximately 0-100m south of Study Area 2) could exceed the relevant NAAQS for a 1-hour average and falls within the NAAQS for the annual average period. It is noted that at present no Residential areas/Communities are located within this area of potential NAAQS exceedance;

5.3)3. Study Area 2: It is foreseen to be "likely" that the ambient air quality over portions of study area 2 bordering ACRW (approximately 0-800m south-east of ACRW and approximately 0-100m east of ACRW) could exceed the relevant NAAQS for a 1-hour average and falls within the NAAQS for the annual average period. It is noted that at present no Residential areas/Communities are located within this area of potential NAAQS exceedance;

5.3)4. Study Area 3: It is foreseen to be "likely" that the ambient air quality over study area 3 should fall within the relevant NAAQS, both 1-hour and annual averages;

5.3)5. It was decided to use the same screening criteria for the impact on animals as applied to human health, i.e. the NAAQS (refer to AQIA report, section 5.1). Based on the simulated ambient concentrations in the AQIA (sections 5.1.3.NO2) it is "likely" that the same findings apply as referred under 5.3)2-5.3)4;

5.3)6. Under the premise that these areas are to be zoned for light industry/general industry/warehousing/logistics and that the quality of the air over the study areas need not meet with the NAAQS, it is therefore recommended that development should be such that it limits further contribution to the airshed not impact negatively on existing or potential neighbouring sensitive receptors (residential areas). It hence also implies that people/employees should not reside on the properties;

5.3)7. The annual 4 $\mu g/m^3$, 8.5 $\mu g/m^3$ and 35.5 $\mu g/m^3$ NO_2 concentration isopleths are distinguishable in section 5.1.3.NO2-2. This concentration will give rise to approximate dry deposition loads of 2.6 kg NO_2/ha, 4.6 kg NO_2/ha and 15.1 kg NO_2/ha per year, respectively;

5.3)8. Excluding wet deposition and deposition of other "N" containing species, comparing the deposition loads of 2.6 kg NO_2/ha, 4.6 kg NO_2/ha and 15.1 NO_2/ha per year to Table 5.33 in terms of kg N/ha per year, it is "likely" that the ambient NO_2 concentrations beyond a distance of approximately 500m to the east and west of ACRW, will not have a significant adverse effect on vegetation and ecosystems. It is "likely" that the ambient NO_2 concentrations north and south of ACRW, will not have a significant adverse effect on vegetation and ecosystems.

5.4) CO:

5.4)1. Study Areas 1, 2 and 3: It is foreseen to be "likely" that the ambient air quality falls within the relevant NAAQS for 1-hour and 8-hour annual averages;

5.4)2. The impact of CO on animals Table 5.36 correlate with the South African NAAQS, thus the screening criteria applied to human health, i.e. the NAAQS will be used (section 5.1). Based on the simulated

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ambient concentrations in sections 5.1.3.CO it is "likely" that the ambient concentrations falls within the NAAQS as referred to under 5.4)1;

5.4)3. It was decided to use the same screening criteria on plants and ecosystems as applied to human health, i.e. the NAAQS (section 5.1). Based on the simulated ambient concentrations in sections 5.1.13.CO it is "likely" that the ambient concentrations falls within the NAAQS as referred to under 3.4)1.

5.5) NH_3:

5.5)1. In the absence of a national air quality standard, the 24-hour average US EPA Reference Concentration of 100$\mu g.m^{-3}$ was used as a reference;

5.5)2. Study Areas 1, 2 and 3: It is foreseen to be "likely" that the NH_3 ambient air quality falls well within the relevant reference;

5.5)3. Most of the current studies focusing on the impact of NH_3 reference the US EPA Reference Concentration. Based on the simulated ambient concentrations (section 5.1.3.NH3) exceedances didn't occur, therefore it is "likely" that the ambient concentrations falls within the reference and adverse effects on the health of animals are unlikely;

5.6) Benzene (C_6H_6) for VOC:

5.6)1. Study Areas 1, 2 and 3: It is foreseen to be "very likely" that the C_6H_6 ambient air quality falls within the relevant NAAQS for an annual average;

5.6)2. No threshold C_6H_6 levels exist to indicate adverse negative effect on animals and plants. In this light, it was decided to use the same screening criteria applied to human health, i.e. the NAAQS (refer to AQIA report, section 5.1). Based on the simulated ambient concentrations exceedances are "unlikely" to occur as referred to under 5.6)1.

5.7) Manganese (Mn):

5.7)1. In the absence of a national air quality standard, the annual average WHO ambient air quality guideline of 0.15$\mu g.m^{-3}$ for Mn was used as a reference;

5.7)2. Study Areas 1, 2 and 3: It is foreseen to be "very likely" that the Mn ambient air quality will be in excess of the relevant guideline;

5.7)3. Under the premise that these areas are to be zoned for light industry/general industry/warehousing/logistics and that the quality of the air over the study areas need not meet with the NAAQS, it is therefore recommended that development should be such that it limits further contribution of Mn to the airshed and not impact negatively on existing or potential neighbouring sensitive receptors (residential areas). It hence also implies that people/employees should not reside on the properties (a specialist health impact assessment would be required to determine specific potential health risks, where/when required);

5.8) Dust Fallout (DFO):

5.8)1. Based on the DFO monitoring data (since 2017) of ACRW, compliance of DFO levels with the National Dust Control Regulations (NDCR) (Government Notice 827, 01November 2013) is very good as indicated by the data. Fugitive and secondary emissions sources appear to be well controlled. It is also noted that other sources in the area are also contributing to DFO levels sampled by ACRW;

5.8)2. It is however also noted that the possibility of fugitive dust from secondary sources, such as roads and storage facilities, is foreseen to increase significantly during spring and some winter months;

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5.8)3. It is recommended that activities that could potentially be considered in any of the study areas should preferably not contribute further to levels of DFO in the airshed and that the NDCR should be complied with and that DFO monitoring be conducted for the proposed development areas;

5.9) Ambient Air Quality Monitoring:

5.9)1. Based on the analysis of the data obtained from two monitoring locations (the Radnor CAAQMS and the Cato Ridge Country Club CAAQMS), the quality of ambient air in the region is fairly good and there is good compliance of the gaseous compounds to the relevant ambient air quality standards;

5.9)2. The Radnor CAAQMS is located approximately 1 km east of ACRW. It is noted that there are occurrences of high 24-hour average PM_{10} and $PM_{2.5}$ concentrations, most of which are either related to source(s) east/south-east/south of the station which contribute to levels, a gravel road near the station and or to regional pre-frontal synoptic conditions;

5.9)3. It is also noted that the number of 24-hour average PM_{10} concentrations at the Cato Ridge Country Club CAAQMS which exceed the standard's concentration, have decreased in 2021;

5.10) Air Quality Management Actions/Plans:

5.10)1. With due consideration of the risk/impact assessment provided in Appendix E proposed air quality management actions/plans are provided in Appendix F, which includes the following items, whilst ensuring that legal requirements are met:

5.10)1.1. Maintaining measures to minimise the release of abnormal emissions (raw gas and tapping/casting fugitives) to an absolute minimum since the impact thereof is potentially significant;

5.10)1.2. Maintaining the application of efficient dust abatement and suppression techniques in order to minimise overall particulate emissions;

5.10)1.3. Limiting vehicle movement and associated diesel consumption as far as possible;

5.10)1.4. Limiting fugitive emissions;

5.10)1.5. Aforementioned points will individually and collectively minimise emissions and impact of manganese;

5.10)1.6. It is recommended that additional monitoring of DFO and noxious fumes be conducted to establish additional baseline ambient monitoring data prior to the commencement of construction of the proposed development and continue thereafter. In addition to current monitoring actions, Figure F.1 read with Table F.2 provides an indication of proposed additional ambient monitoring and locations.

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10. FORMAL DECLARATIONS

10.1 Declaration of Accuracy of Information by Applicants

Please refer Appendix Z.

10.2 Declaration of Independence by Practitioners preparing this Atmospheric Impact Report

Please refer Appendix X.

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Appendix A: Meteorological data

The study area falls within the Highveld Climatic Zone. The meteorological characteristics present at a specific site, impact on the rate of emissions from fugitive sources, govern the dispersion, chemical transformation and the eventual removal of pollutants from the atmosphere (Pasquill and Smith, 1983; Godish, 1990). The extent to which pollution will accumulate or disperse in the atmosphere is dependent on the degree of thermal and mechanical turbulence within the earth's boundary layer. Dispersion comprises vertical and horizontal components of motion. The vertical component is defined by the stability of the atmosphere and the depth of the surface mixing layer, whereas the horizontal dispersion of pollution in the boundary layer is primarily a function of the wind field.

The wind speed will determine both the distance of downwind transport and the rate of dilution as a result of plume 'stretching'. The generation of mechanical turbulence is similarly a function of the wind speed, in combination with the surface roughness. The wind direction and the variability in wind direction, will determine the general path pollutants follow, as well as the extent of crosswind spreading (Shaw and Munn, 1971; Pasquill and Smith, 1983; Oke, 1990). Pollution concentration levels vary with changes in atmospheric stability, concurrent variations in the mixing depth and the wind field.

Spatial variations, and diurnal and seasonal changes, in the wind field and stability regime are functions of atmospheric processes operating at various temporal and spatial scales (Goldreich and Tyson, 1988). Atmospheric dispersion potential of an area is influenced by atmospheric conditions and processed at macro- and meso-scales.

The analysis of hourly average meteorological data is necessary to understand of the dispersion potential and to provide the input requirements for the dispersion modelling simulations. A comprehensive data set for a duration of at least one year of detailed hourly average wind speed, wind direction and temperature data are needed for the dispersion modelling.

Site-specific meteorological data was simulated for a period from January 2017 to December 2019 based on observed/monitored data from a meteorological station located approximately 323m southeast of the centre of the ACRW site, and utilised for the impact assessment and data interpretation. The location for the simulated meteorological monitoring data is located in close proximity to the entrance security gate of ACRW (bordering Proposed Development Area 2), approximately 399m southeast (29°43.0'S, 30°37.0'E) of the defined centre of ACRW at an elevation of approximately 793 mamsl, with the wind monitored at a height of 10m and the other parameters at 2m above ground level. This specific data set was assessed and discussed below.

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A.1 Wind

Throughout 2017 to 2019, winds are predominantly from North, North-northeast and Northeast (predominantly from the Northeast), but strong south-westerly and westerly winds are also distinguishable as illustrated by Figures A.1 and A.2.

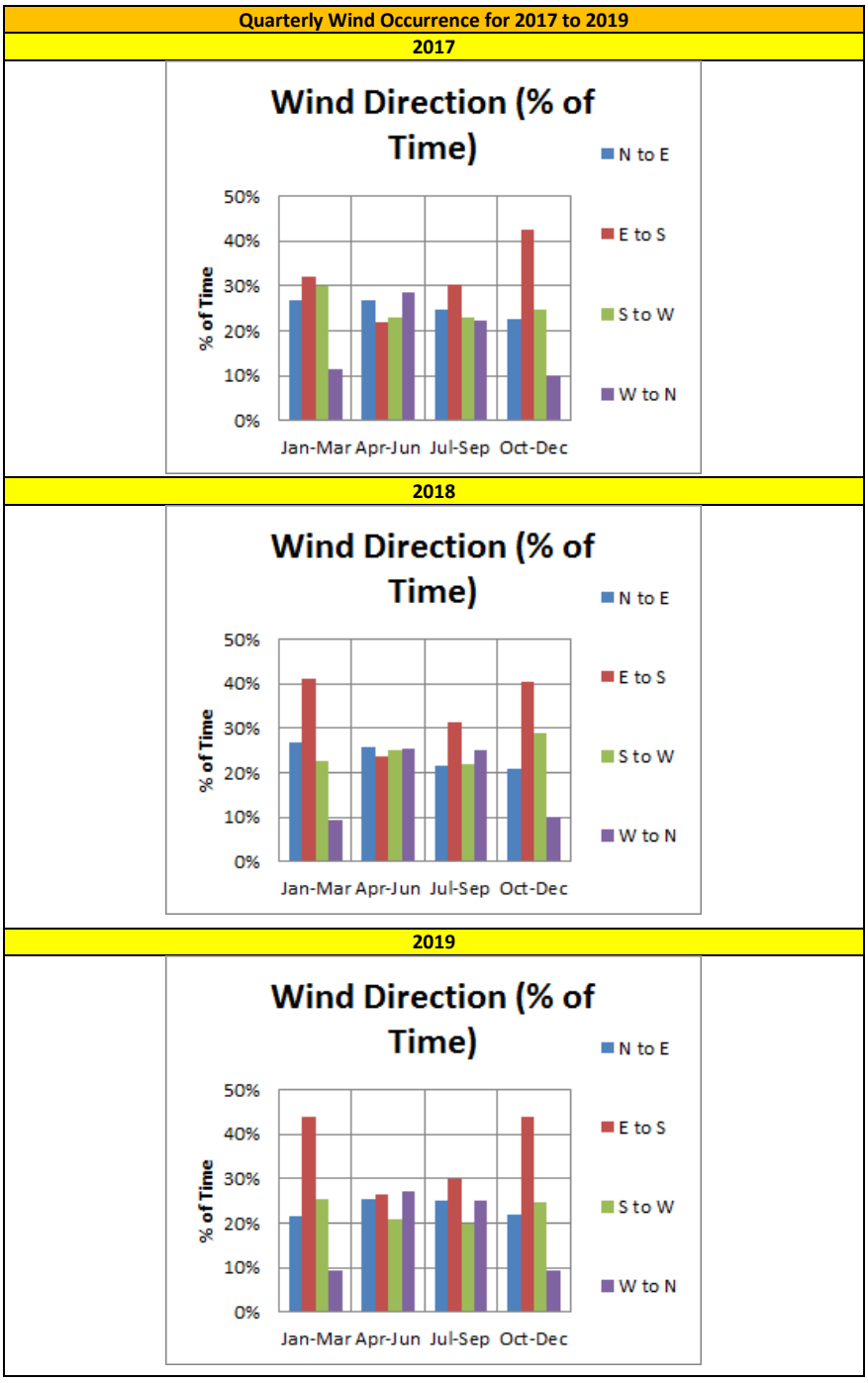


Figure A.1: Quarterly Wind Occurrence for 2017 to 2019

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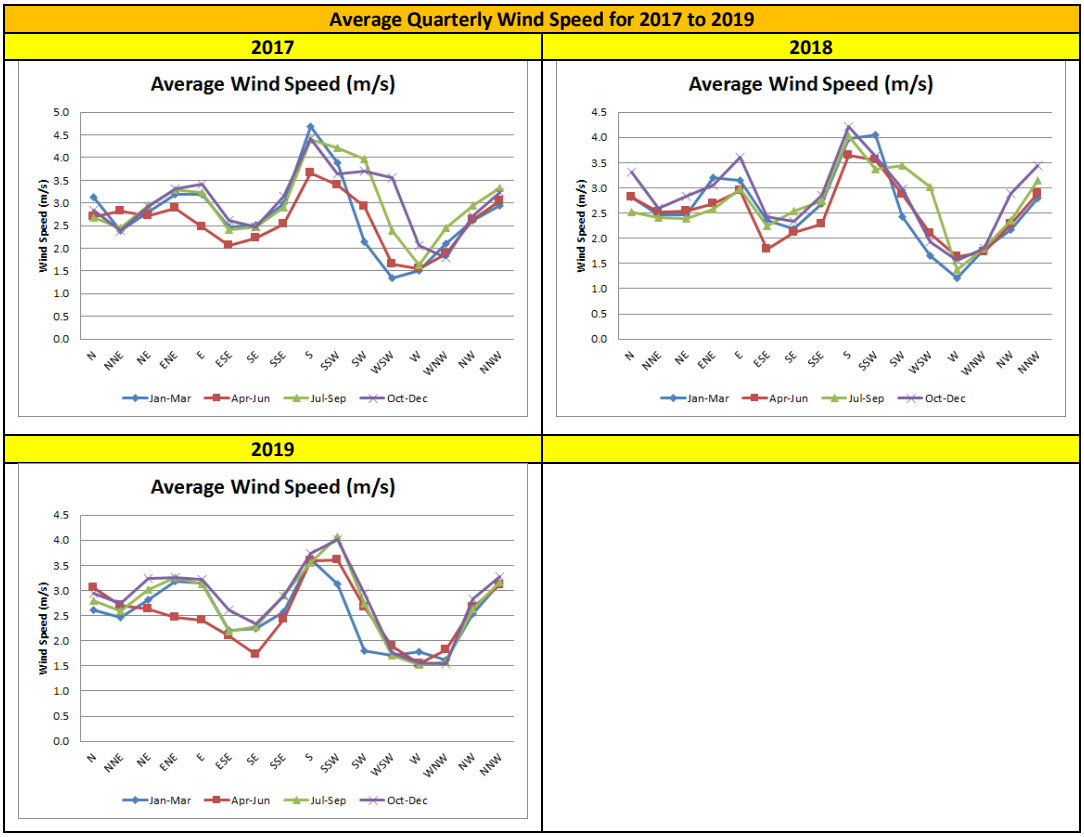


Figure A.2: Average quarterly wind speeds for 2017 to 2019

Figure A.2, also indicates that high wind speeds are predominantly from the eastern, southern and north-westerly directions. Higher wind speeds were also recorded during winter and spring months.

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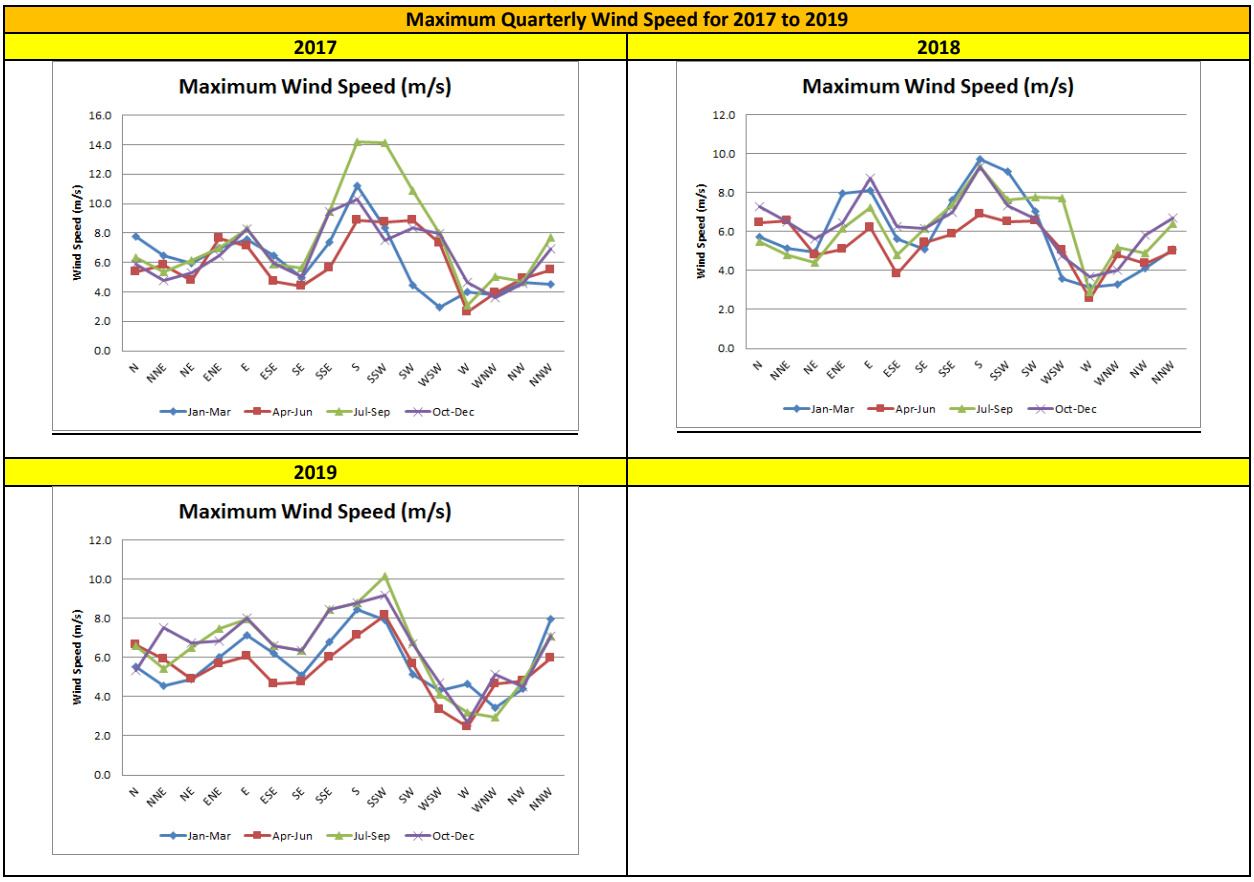


Figure A.3: Maximum quarterly wind speeds for 2017 to 2019

Figure A.3, indicates maximum wind speeds per season for the respective period.

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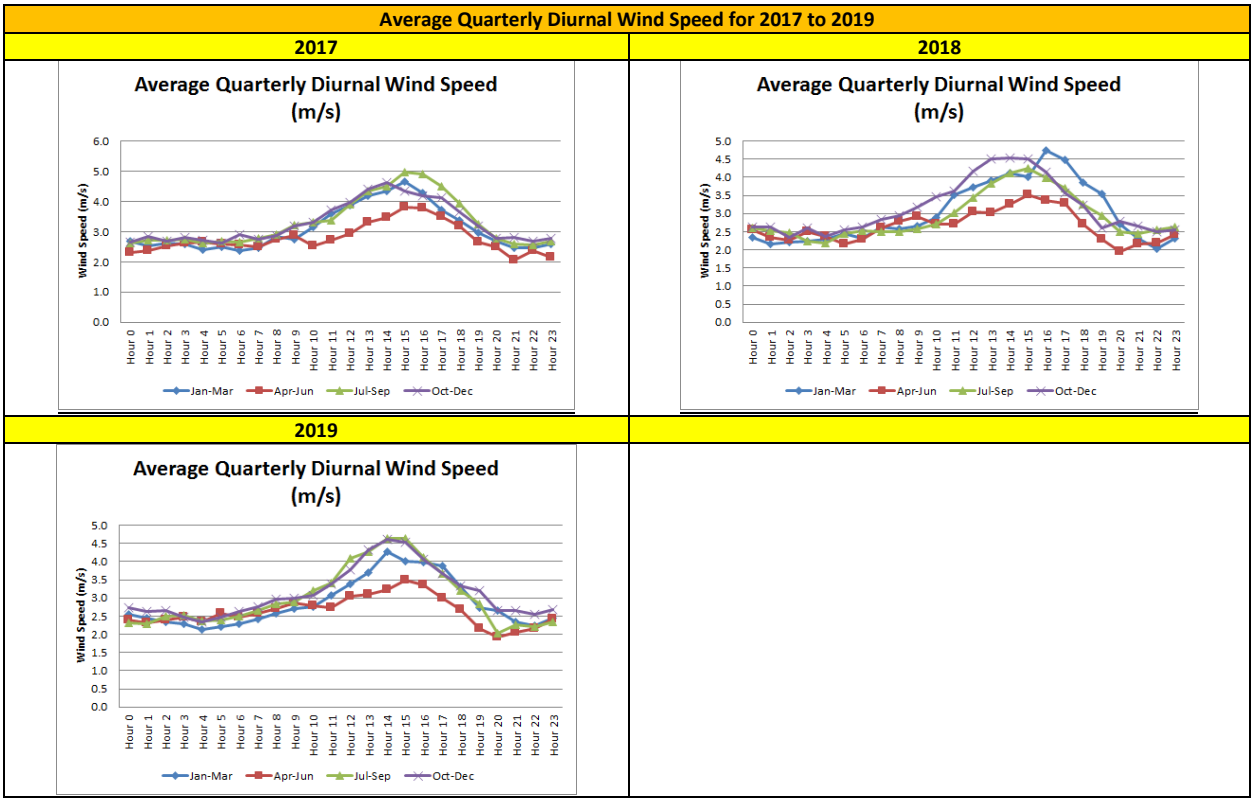


Figure A.4: Average Quarterly Diurnal Wind Speed for 2017 to 2019

From Figure A.4 it is evident that the wind speed increases after 08h00 and reduces from around 16h00, with maximums between around 13:00 and 15:00.

Figure A.5 illustrates the simulated site-specific annual wind-roses, as well as the annual day/night wind-roses. The wind is predominantly from east, south and northwest; strong southern and easterly winds are also distinguishable.

An increase in wind speed and ambient temperature improves the dispersion of air pollutants in the air. As a norm, unfortunately, wind speeds over 5.4m/s potentially has sufficient energy to pick up and transport loose and/or disturbed particulate matter, which gives rise to visible nuisance dust and clouds of dust at ground level. The extent to which this occurs / can occur depends on several parameters, such as the properties and characteristics of the particulate matter, moisture content, etc.

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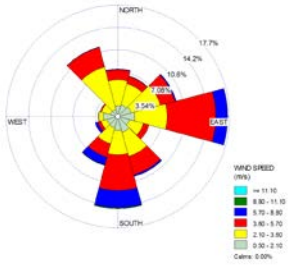
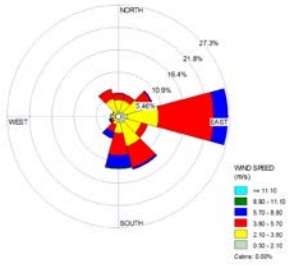
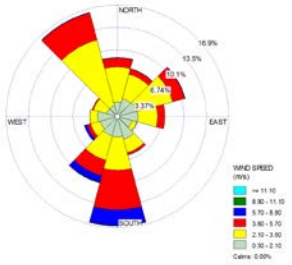
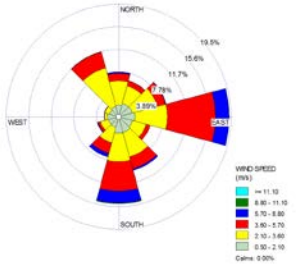
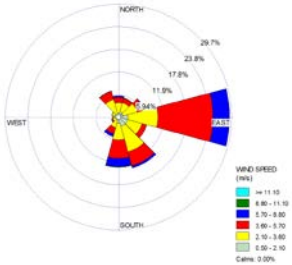
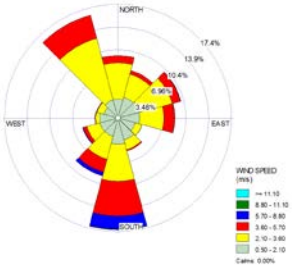
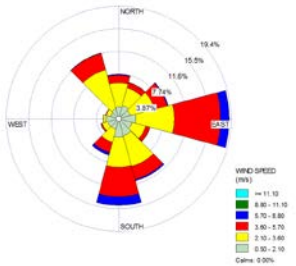
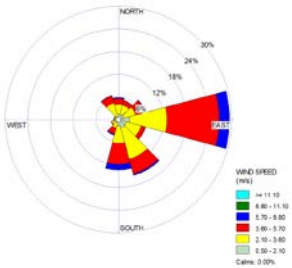
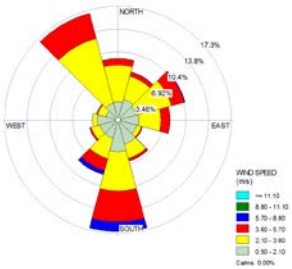
Wind roses for 2017 to 2019		
2017 Annual	**2017 Day-time**	**2017 Night-time**
		
2018 Annual	**2018 Day-time**	**2018 Night-time**
		
2019 Annual	**2019 Day-time**	**2019 Night-time**
		

Figure A.5: Site-specific wind roses for 2017 to 2019

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A.2 Ambient Temperature

Air temperature influences plume buoyancy (the larger the difference in temperature between the plume and the ambient air, the higher the plume could potentially rise), and the development of mixing and inversion layers in the atmosphere. Figures A.5 and A.6 provide the average monthly & average quarterly diurnal ambient temperature respectively for 2017 to 2019.

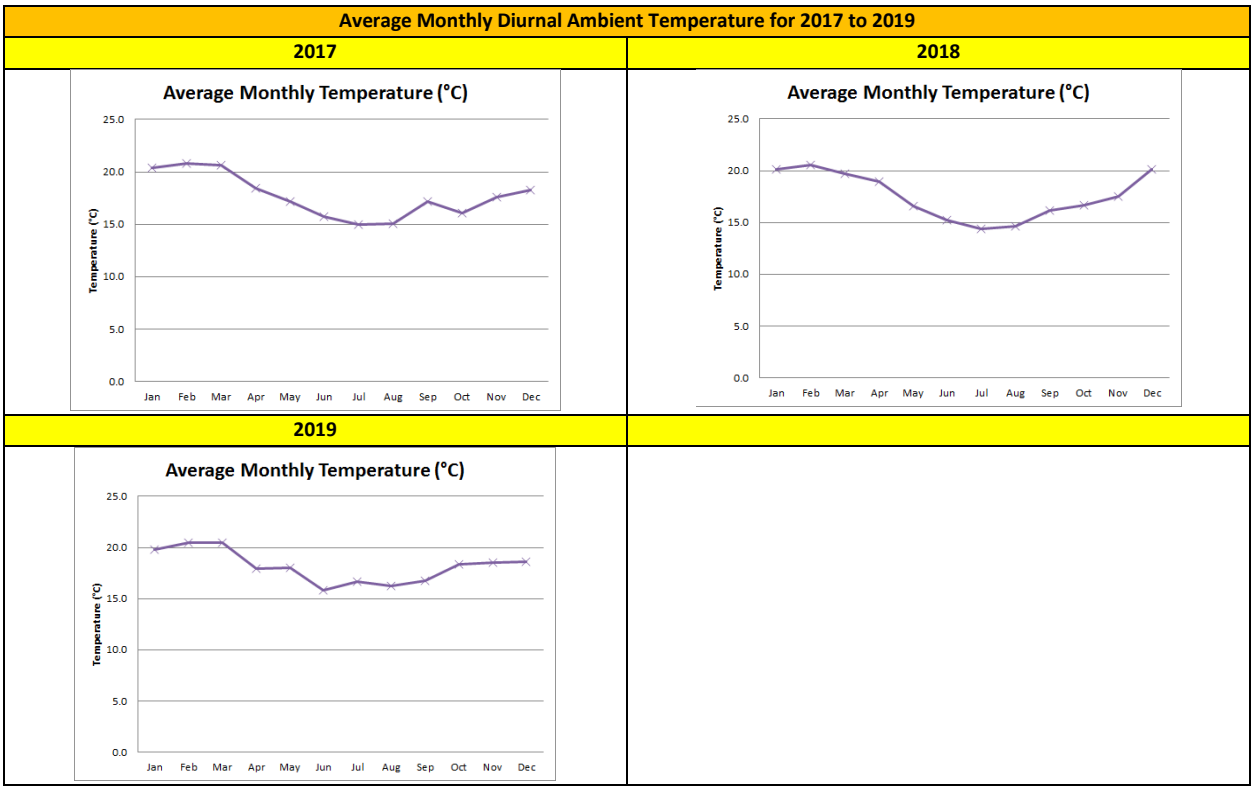


Figure A.5: Average Monthly Diurnal Ambient Temperature for 2017 to 2019

From the Figure A.5 it is evident that the average ambient air temperature decreases by approximately 5 to 7°C from March till July after which it increases again.

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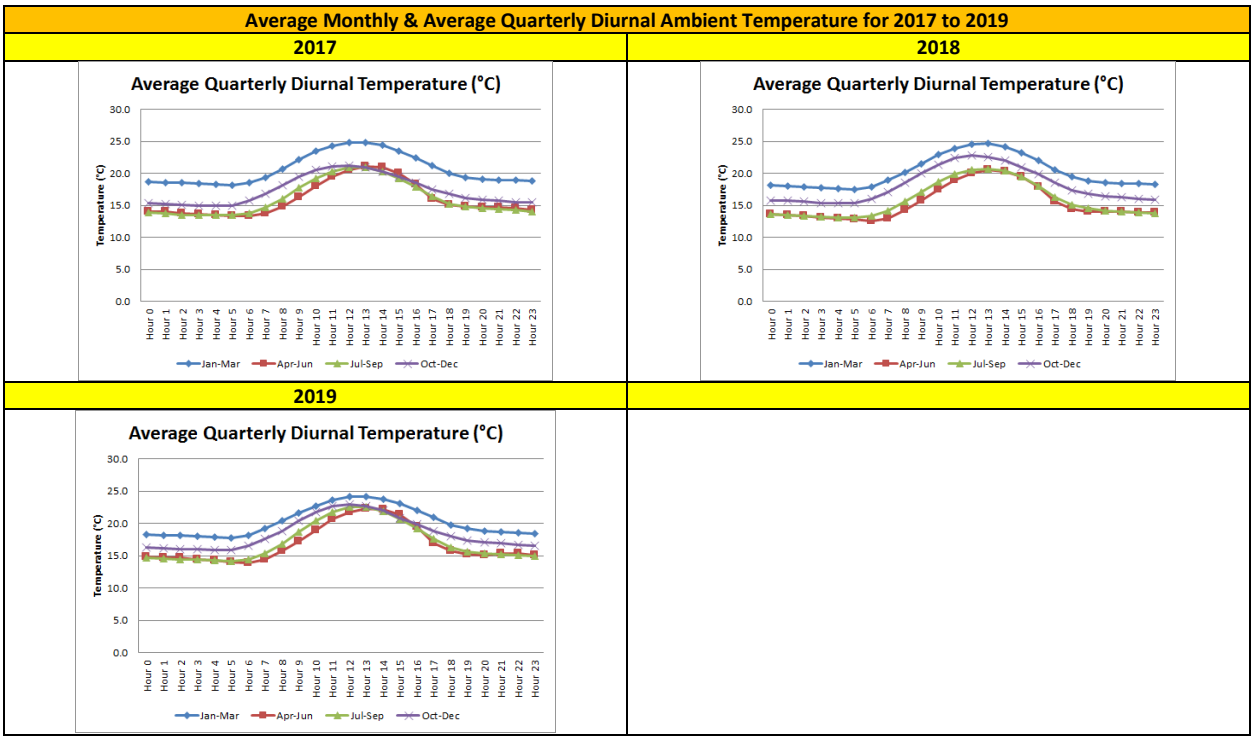


Figure A.6: Average Quarterly Diurnal Ambient Temperature for 2017 to 2019

From Figure A.6 it is evident that the diurnal ambient air temperature increases by approximately 7 to 10°C from around 08h00 till 15:00 after which it decreases. The highest quarterly temperatures are expected from January to March and October to December. An increase in wind speed and ambient temperature improves the dispersion of air pollutants in the air. As a norm, unfortunately wind speeds in excess of 5.4m/s potentially has sufficient energy to pick-up and transport loose and/or disturbed particulate matter, which gives rise to visible nuisance dust and clouds of dust at ground level. The extent, to which this occurs / can occur, depends on several parameters, such as the properties and characteristics of the particulate matter, moisture content, etc.

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A.3 Precipitation / Rainfall

Figure A.7 illustrates monthly rainfall (precipitation) for the selected years.

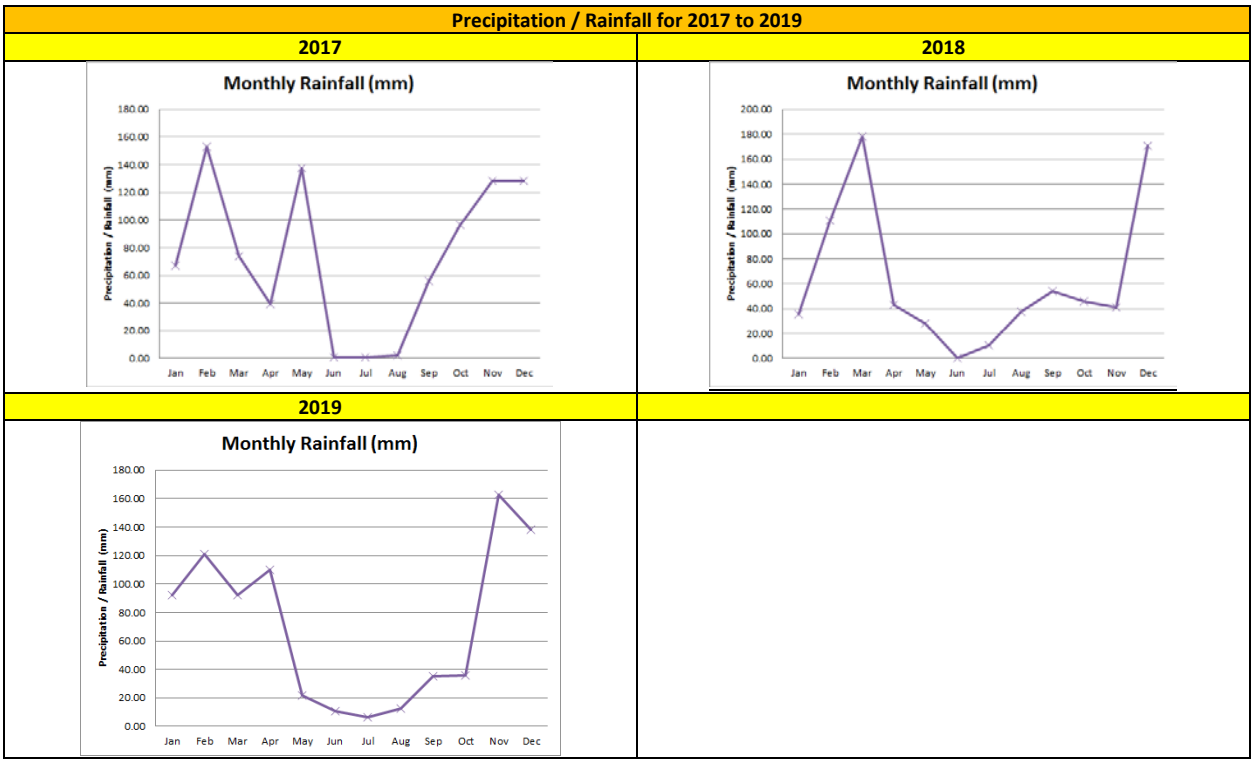


Figure A.7: Precipitation / Rainfall for 2017 to 2019

The total precipitation/rainfall measured at the site from 2017 to 2019:

2017: 883.6 mm;

2018: 755.3 mm;

2019: 839.6 mm.

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A.4 Stability indices and mixing heights

The atmospheric boundary layer (first few hundred metres of the atmosphere) is affected by the earth's surface as a result of retardation of flow due to the frictional drag of the earth's surface and or the heat and moisture exchanges which occur. To understand how natural and anthropogenic emissions affect the surrounding environment, it is necessary to investigate how plumes spread/dilute in the air. Figure A.8 illustrates the movement and concentration profile of a plume moving away from a point source (stack). The pollutant concentration profile (in Figure A.9) gets thinner away from the centre line and wider as the pollutant travels over a longer distance. This represents dispersion and dilution of the plume accounted by entrainment, or mixing, of the surrounding fluid at its edges. The Figures imply that a location farther away from the stack has a lower pollutant concentration and is less harmful.

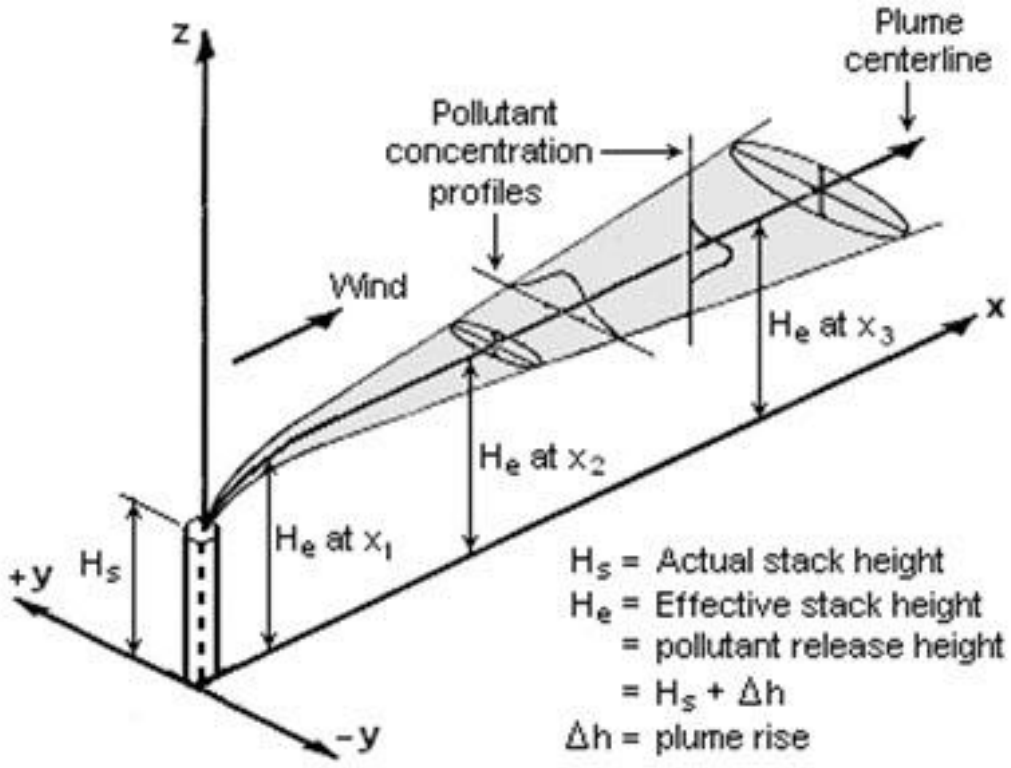


Figure A.8: 3D illustration of plume movement path and concentration profile

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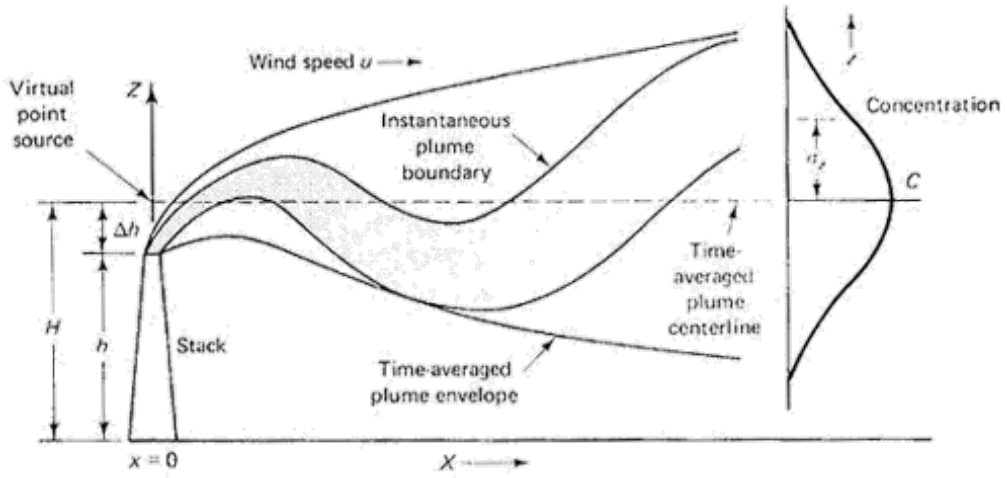


Figure A.9: 2D illustration of vertical plume movement

Buoyance (the force generated by the difference in density) pushes the hotter less dense air above colder heavier (denser) ambient air, resulting in the centre of the plume rising after it leaves the stack. The centre of a plume convectively rises by a distance above the stack (*Δh*) whilst the plume temperature and density differs from the ambient air. The effective stack height (*H*) is the sum of the actual stack height and *Δh*. Buoyancy determines vertical transport and dispersion of a plume in the atmosphere. Convection is rapid buoyant motion.

The atmosphere's resistance to vertical movement, Atmospheric stability, describes the buoyancy in the atmosphere at varying elevations. The upward and downward mixing of a plume in air can be described by the atmospheric stability.

The prevailing vertical temperature profile influences the vertical mixing. Unstable atmospheric conditions occur when a rapid decline in / large decrease of temperature with height are present and up and down air flow currents are promoted. Stable atmospheric conditions occur with a slight decline in temperature with height indicates, which inhibits vertical motion. Inversion occurs when the atmosphere temperature increases with height resulting in an extremely stable atmospheric condition. The atmospheric boundary layer is characterised by thermal turbulence during daytime as a result of the heating of the earth's surface with the mixing layer extended to the lowest elevated inversion. Ground-based inversions and the erosion of the mixing layer is usually the result of radiative flux during night time.

The stability of the atmosphere is influenced by the warming and cooling of the earth surface. Unstable atmospheric conditions with vertical dispersion result from the heating of the earth surface which increases the air temperature close to the surface. Stable conditions are set up with the cooling of the earth surface at sunset. The resulting stable conditions then hinder the upward transport of cold surface air containing a plume.

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Figure A.10 illustrates six general categories of plume movements, which vary with vertical temperature profile and wind profile. The caption below explains the atmospheric stability and the time of the day each plume is most likely to occur. Plume behaviour is a visible indicator of atmospheric stability:

Early morning: ideal conditions for fumigation and fanning plumes, the upward dispersion is hindered by inversion above the stack height. In winter when the solar heating is less than in summer, breaking of the inversion layer is difficult and dispersion is poor. "Ventilation" of urban areas tends to be suppressed at night and facilitated in the daytime.

Looping – Day time with strong instability;
Coning – Early morning with near-neutral/neutral stability and small scale mechanical turbulence;
Fanning – Night time clear conditions with surface inversion;
Fumigation – Early evening with aloft inversion;
Lofting – Early evening with inversion below stack height;
Tapping – inversion layers present below and above the stack height.

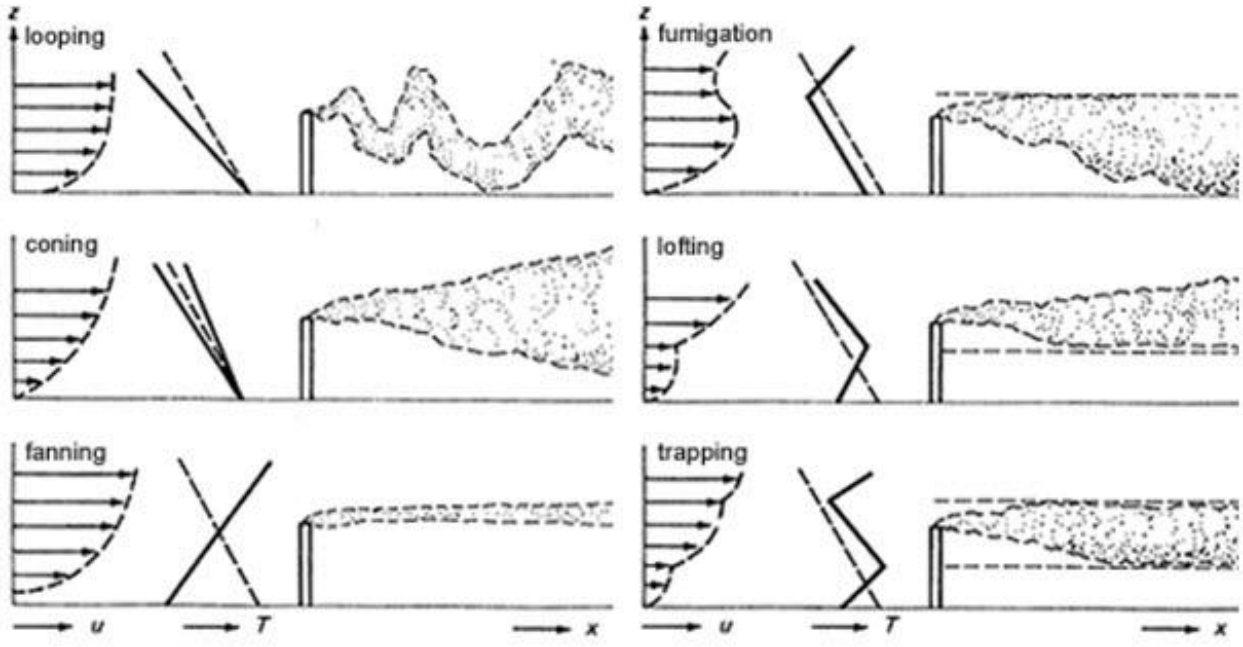


Figure A.10: Vertical wind profile (left), temperature profile (centre), and corresponding stack plume illustration

The mixing layer is estimated with prognostic models which derive thickness from routinely measured parameters such as solar radiation and temperature. The mixing layer is not easily measured. Atmospheric stability is frequently categorised into one of six Pasquill stability classes, which are briefly described in Table A.1. In the dispersion model used here, atmospheric stability is calculated by the meteorological pre-processor as a continuous function, rather than as a discrete variable.

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Table A.1: Pasquill Atmospheric Stability Classes.

Designation	Stability Class	Atmospheric Condition
A	Very Unstable	calm wind, clear skies, hot daytime conditions;
B	Moderately unstable	clear skies, daytime conditions;
C	Unstable	moderate wind, slightly overcast daytime conditions;
D	Neutral	high winds or cloudy days and nights;
E	Stable	moderate wind, slightly overcast night-time conditions;
F	Very stable	low winds, clear skies, cold night-time conditions.

Class A is Very Unstable: typically hot, calm days with the greatest amount of dispersion.
Class D is Neutral: typically windy days or the transition times of dawn and dusk (most frequently occurring stability class).
Class F is Very Stable: typically night time with low winds, with poor dispersion.

The atmospheric boundary layer is normally unstable during the day as a result of thermal turbulence due to the sun's heating effect on the earth's surface, as discussed previously. The depth of this mixing layer depends predominantly on the extent of solar radiation, increasing gradually from sunrise to reach a maximum at about 5-6 hours after sunrise. The extent of thermal turbulence is enhanced on clear warm days with light winds. During the night a stable layer, with limited vertical mixing, exists. During windy and/or cloudy conditions, the atmosphere is normally neutral. The significance of the diurnal shifts in the wind field will become clearer when discussing the stability classes. Night-time conditions are normally associated with stable atmospheres, whereas daytime conditions are more unstable. Limited vertical dispersion occurs under stable conditions and hence near ground level releases can result in relatively high concentrations during the night. Elevated releases will travel relatively far downwind before this "stable" plume reaches ground level and may therefore be sufficiently diluted not to cause high ground-level concentrations. Unstable conditions, particularly convective conditions normally occurring during low wind speeds, can result in high ground-level concentrations from elevated releases.

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The Pasquill-Turner Stability Index can therefore be summarized as follows (a numerical value, in brackets, will be assigned to each category):

A	(1)	Extremely Unstable (Greatest amount of dispersion)
B	(2)	Unstable
C	(3)	Slightly Unstable
D	(4)	Neutral Stability
E	(5)	Slightly Stable
F	(6)	Stable

The Pasquill Index is always neutral (Class D) for overcast conditions with a cloud ceiling that is less than 7000 feet (2134m). During "anticyclonic gloom", an inversion at a lower level could persist for days with a Class D Pasquill Index.

Tables A.2 to A.4 are summaries of the monthly stability indices for 2017 to 2019, using the numerical values assigned to each category as shown above. The table shows the hourly minimum, maximum and average stability indices. Each category is labelled with a colour, defined at the bottom of the table.

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Table A.2: Summary of the monthly Stability indices for 2017

Stability Index - Lowest index values																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Month																								
January	4	4	4	4	4	4	4	3	2	1	1	1	1	2	2	2	3	3	3	3	4	4	4	4
February	4	4	4	4	4	4	4	3	3	2	2	2	2	2	2	2	2	3	3	4	4	4	4	4
March	4	4	4	4	4	4	4	4	3	3	2	2	2	2	2	2	2	3	3	4	4	4	4	4
April	4	4	4	4	4	4	4	4	4	3	3	2	2	2	2	2	3	3	4	4	4	4	4	4
May	4	4	4	4	4	4	4	4	4	4	3	3	2	2	2	3	4	4	4	4	4	4	4	4
June	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4
July	4	4	4	4	4	4	4	4	4	3	3	3	3	2	2	3	3	4	4	4	4	4	4	4
August	4	4	4	4	4	4	4	4	3	3	3	2	2	2	2	2	3	3	4	4	4	4	4	4
September	4	4	4	4	4	4	4	4	3	3	2	2	2	2	2	2	3	3	4	4	4	4	4	4
October	4	4	4	4	4	4	4	3	3	3	2	1	2	2	2	2	2	3	3	4	4	4	4	4
November	4	4	4	4	4	4	4	3	3	2	2	2	2	2	2	2	2	3	3	4	4	4	4	4
December	4	4	4	4	4	4	4	3	3	2	2	2	2	1	1	2	2	3	3	4	4	4	4	4
Annual ave.	4	4	4	4	4	4	4	4	3	3	2	2	2	2	2	2	3	3	4	4	4	4	4	4

Stability Index - Highest index values																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Month																								
January	6	6	6	6	6	6	4	4	4	4	4	4	4	4	4	4	4	4	4	4	6	6	6	6
February	6	6	6	6	6	6	4	4	4	4	4	4	4	4	4	4	4	4	4	4	6	6	6	6
March	6	6	6	6	6	6	6	4	4	4	4	4	4	4	4	4	4	4	4	6	6	6	6	6
April	6	6	6	6	6	6	6	4	4	4	4	4	4	4	4	4	4	4	4	6	6	6	6	6
May	6	6	6	6	6	6	6	4	4	4	4	4	4	4	4	4	4	4	6	6	6	6	6	6
June	6	6	6	6	6	6	6	6	4	4	4	4	4	4	4	4	4	4	6	6	6	6	6	6
July	6	6	6	6	6	6	6	6	4	4	4	4	4	4	4	4	4	4	6	6	6	6	6	6
August	6	6	6	6	6	6	6	4	4	4	4	4	4	4	4	4	4	4	4	6	6	6	6	6
September	6	6	6	6	6	6	6	4	4	4	4	4	4	4	4	4	4	4	4	6	6	6	6	6
October	6	6	6	6	6	6	4	4	4	4	4	4	4	4	4	4	4	4	4	4	6	6	6	6
November	6	6	6	6	6	6	4	4	4	4	4	4	4	4	4	4	4	4	4	4	6	6	6	6
December	6	6	6	6	6	6	4	4	4	4	4	4	4	3	4	4	4	4	4	4	6	6	6	6
Annual ave.	6	6	6	6	6	6	5	4	4	4	4	4	4	4	4	4	4	4	5	5	6	6	6	6

Stability Index - Average (Average monthly index values)																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Month																								
January	5	5	5	5	5	5	4	4	3	3	3	3	3	3	3	3	3	3	4	4	5	5	4	5
February	5	5	5	5	5	5	4	4	4	3	3	3	3	3	3	3	3	4	4	4	4	4	5	5
March	5	5	5	5	5	5	5	4	4	4	3	3	3	3	3	3	3	4	4	5	5	5	5	5
April	5	5	5	5	5	5	5	4	4	4	3	3	3	3	3	3	4	4	4	5	5	5	5	5
May	5	5	5	5	5	5	5	4	4	4	4	4	3	3	4	4	4	4	4	5	5	5	5	5
June	6	6	6	6	5	5	5	5	4	4	4	4	4	4	4	4	4	4	6	6	5	5	5	5
July	5	5	5	5	5	5	5	4	4	4	4	4	3	3	4	4	4	4	5	5	5	5	5	5
August	5	5	5	5	5	5	5	4	4	4	4	3	3	3	3	4	4	4	4	5	5	5	5	5
September	5	5	5	5	5	5	5	4	4	4	3	3	3	3	3	4	4	4	4	5	5	5	5	5
October	5	4	4	4	5	5	4	4	4	3	3	3	3	3	3	3	3	4	4	4	5	4	4	5
November	5	5	5	5	5	5	4	4	4	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4
December	4	5	5	5	5	5	4	4	3	3	3	3	2	2	3	3	3	3	4	4	4	4	4	4
Annual ave.	5	5	5	5	5	5	5	4	4	4	3	3	3	3	3	3	4	4	4	5	5	5	5	5

Notes:		
	1 - 3	Good dispersion expected
	4	Average dispersion expected
	5 - 6	Poor dispersion expected

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Table A.3: Summary of the monthly Stability indices for 2018

Stability Index - Lowest index values																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Month																								
January	4	4	4	4	4	4	4	3	3	2	1	1	1	2	2	2	2	3	3	4	4	4	4	4
February	4	4	4	4	4	4	4	3	3	2	2	1	1	2	2	2	2	2	3	4	4	4	4	4
March	4	4	4	4	4	4	4	4	3	3	2	2	2	2	2	2	3	3	4	4	4	4	4	4
April	4	4	4	4	4	4	4	4	3	3	2	2	2	2	2	2	3	3	4	4	4	4	4	4
May	4	4	4	4	4	4	4	4	4	3	3	2	2	2	2	2	3	3	3	3	4	4	4	4
June	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	4	4	4	4	4	4	4
July	4	4	4	4	4	4	4	4	4	4	3	3	2	2	2	2	3	4	4	4	4	4	4	4
August	4	4	4	4	4	4	4	4	4	3	3	2	2	2	2	2	2	3	4	4	4	4	4	4
September	4	4	4	4	4	4	4	4	3	3	2	2	2	2	2	2	3	3	3	4	4	4	4	4
October	4	4	4	4	4	4	4	3	3	2	2	1	1	2	2	2	3	3	3	4	4	4	4	4
November	4	4	4	4	4	4	4	3	3	2	2	1	2	2	2	2	2	3	3	4	4	4	4	4
December	4	4	4	4	4	4	4	3	3	2	2	2	2	2	2	2	2	3	3	4	4	4	4	4
Annual ave.	4	4	4	4	4	4	4	4	3	3	2	2	2	2	2	2	3	3	3	4	4	4	4	4

Stability Index - Highest index values																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Month																								
January	6	6	6	6	6	6	4	4	4	4	4	4	4	4	4	4	4	4	4	4	6	6	6	6
February	6	6	6	6	6	6	4	4	4	4	4	4	4	4	4	4	4	4	4	4	6	6	6	6
March	6	6	6	6	6	6	6	4	4	4	4	4	3	4	4	4	4	4	4	6	6	6	6	6
April	6	6	6	6	6	6	6	4	4	4	4	4	4	4	4	4	4	4	4	6	6	6	6	6
May	6	6	6	6	6	6	6	4	4	4	4	4	4	4	4	4	4	4	6	6	6	6	6	6
June	6	6	6	6	6	6	6	6	4	4	4	4	4	4	4	4	4	4	6	6	6	6	6	6
July	6	6	6	6	6	6	6	6	4	4	4	4	4	4	4	4	4	4	6	6	6	6	6	6
August	6	6	6	6	6	6	6	4	4	4	4	4	4	4	4	4	4	4	4	6	6	6	6	6
September	6	6	6	6	6	6	6	4	4	4	4	4	4	4	4	4	4	4	4	6	6	6	6	6
October	6	6	6	6	6	6	4	4	4	4	4	4	4	4	4	4	4	4	4	4	6	6	6	6
November	6	6	6	6	6	6	4	4	4	4	4	4	4	4	4	4	4	4	4	4	6	6	6	6
December	6	6	6	6	6	6	4	4	4	4	4	4	4	4	4	4	4	4	4	4	6	6	6	6
Annual ave.	6	6	6	6	6	6	5	4	4	4	4	4	4	4	4	4	4	4	5	5	6	6	6	6

Stability Index - Average (Average monthly index values)																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Month																								
January	5	5	5	5	5	5	4	4	3	3	3	2	2	3	3	3	3	3	4	4	5	5	5	5
February	5	5	5	5	5	5	4	4	4	3	3	2	2	2	3	3	3	3	4	4	4	4	5	5
March	5	5	5	5	5	5	5	4	4	3	3	3	3	3	3	3	4	4	4	4	5	4	5	5
April	5	5	5	5	5	5	5	4	4	4	3	3	3	3	3	3	4	4	4	5	5	5	5	5
May	5	5	5	5	5	5	5	4	4	4	4	3	3	3	3	4	4	4	4	5	5	5	5	5
June	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	6	5	5	5	5	5
July	5	5	5	5	5	5	5	4	4	4	4	3	3	3	3	4	4	4	5	5	5	5	5	5
August	5	5	5	5	5	5	5	4	4	4	3	3	3	3	3	3	4	4	4	5	5	5	5	5
September	5	5	5	5	5	5	4	4	4	4	3	3	3	3	3	3	4	4	4	5	5	5	5	5
October	5	5	5	5	5	5	4	4	4	3	3	3	3	3	3	3	4	4	4	4	5	5	4	5
November	5	5	5	5	5	5	4	4	4	3	3	3	3	3	3	3	3	4	4	4	5	5	5	5
December	5	5	5	4	5	5	4	4	3	3	3	3	3	3	3	3	3	3	4	4	5	4	4	4
Annual ave.	5	5	5	5	5	5	5	4	4	3	3	3	3	3	3	3	4	4	4	5	5	5	5	5

Notes:		
	1 - 3	Good dispersion expected
	4	Average dispersion expected
	5 - 6	Poor dispersion expected

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Table A.4: Summary of the monthly Stability indices for 2019

Stability Index - Lowest index values																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Month																								
January	4	4	4	4	4	4	4	3	2	2	2	2	2	2	2	1	1	2	3	4	4	4	4	4
February	4	4	4	4	4	4	4	3	3	2	2	2	1	2	2	2	2	3	3	4	4	4	4	4
March	4	4	4	4	4	4	4	4	3	3	2	2	2	2	2	2	2	3	3	4	4	4	4	4
April	4	4	4	4	4	4	4	4	3	3	2	2	2	2	2	2	3	3	4	4	4	4	4	4
May	4	4	4	4	4	4	4	4	4	3	3	3	3	2	2	3	3	4	4	4	4	4	4	4
June	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4
July	4	4	4	4	4	4	4	4	4	4	3	2	2	2	2	2	3	3	4	4	4	4	4	4
August	4	4	4	4	4	4	4	4	4	3	3	2	2	2	2	2	3	3	4	4	4	4	4	4
September	4	4	4	4	4	4	4	4	3	3	2	2	2	2	2	2	2	3	4	4	4	4	4	4
October	4	4	4	4	4	4	4	3	3	2	2	1	2	2	2	3	2	3	4	4	4	4	4	4
November	4	4	4	4	4	4	4	3	3	2	2	2	2	1	2	2	2	2	3	3	3	4	4	4
December	4	4	4	4	4	4	4	3	2	2	2	1	1	1	2	2	2	2	3	4	4	4	4	4
Annual ave.	4	4	4	4	4	4	4	4	3	3	2	2	2	2	2	2	2	3	4	4	4	4	4	4

Stability Index - Highest index values																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Month																								
January	5	6	6	6	6	6	4	4	4	4	4	4	4	4	4	4	4	4	4	4	6	6	6	6
February	6	6	6	6	6	6	4	4	4	4	4	4	4	4	4	4	4	4	4	4	6	6	6	6
March	6	6	6	6	6	6	6	4	4	4	4	3	3	3	3	4	4	4	4	6	6	6	6	6
April	6	6	6	6	6	6	6	4	4	4	4	4	4	4	4	4	4	4	4	6	6	6	6	6
May	6	6	6	6	6	6	6	4	4	4	4	4	4	4	4	4	4	4	6	6	6	6	6	6
June	6	6	6	6	6	6	6	6	4	4	4	4	4	4	4	4	4	4	6	6	6	6	6	6
July	6	6	6	6	6	6	6	4	4	4	4	4	4	4	4	4	4	4	6	6	6	6	6	6
August	6	6	6	6	6	6	6	4	4	4	4	4	4	4	4	4	4	4	4	6	6	6	6	6
September	6	6	6	6	6	6	6	4	4	4	4	4	4	4	4	4	4	4	4	6	6	6	6	6
October	6	6	6	6	6	6	4	4	4	4	4	4	4	4	4	4	4	4	4	4	6	6	6	6
November	6	6	6	6	6	6	4	4	4	4	4	4	4	4	4	4	4	4	4	4	6	6	6	6
December	6	6	6	6	6	6	4	4	4	4	4	4	4	4	4	4	4	4	4	4	6	6	6	6
Annual ave.	6	6	6	6	6	6	5	4	4	4	4	4	4	4	4	4	4	4	5	5	6	6	6	6

Stability Index - Average (Average monthly index values)																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Month																								
January	4	4	4	5	5	5	4	4	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4
February	4	4	5	5	5	4	4	4	3	3	3	2	2	2	2	3	3	3	4	4	4	4	4	4
March	5	5	5	5	5	5	5	4	4	3	3	3	3	3	3	3	3	4	4	4	4	4	4	5
April	5	5	5	5	5	5	5	4	4	4	3	3	3	3	3	3	4	4	4	4	5	5	5	5
May	5	5	5	6	6	5	5	4	4	4	4	3	3	3	3	4	4	4	4	5	5	5	5	5
June	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	6	6	5	5	5	5
July	6	6	6	6	5	6	5	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5
August	5	5	5	5	5	5	5	4	4	4	4	3	3	3	3	4	4	4	4	5	5	5	5	5
September	5	5	5	5	5	5	5	4	4	4	3	3	3	3	3	4	4	4	4	5	5	5	5	5
October	5	5	5	5	5	5	4	4	4	3	3	3	3	3	3	3	4	4	4	4	5	5	5	5
November	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4
December	5	5	5	5	4	4	4	4	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4
Annual ave.	5	5	5	5	5	5	5	4	4	3	3	3	3	3	3	3	3	4	4	5	5	5	5	5

Notes:		
	1 - 3	Good dispersion expected
	4	Average dispersion expected
	5 - 6	Poor dispersion expected

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From Tables A.2 to A.4, for the monthly averages, the average expected dispersion possible (bottom of each table):

- *Worst expected dispersion:*
  From 19:00 to 07:00, the expected dispersion will be poor.
- *Best expected dispersion:*
  From 10:00 to 15:00, the Stability index shows that for this period the expected dispersion will be the best.
- *Average expected dispersion:*
  The transition times are the periods during the year for which the expected dispersion will range from good to poor, depending on the time of the year. These periods were identified as being from 07:00 to 9:00 and from 16:00 to 18:00.

Tables A.5 to A.7 indicates the overall stability class distribution from 2017 to 2019, whilst Figure A.11 illustrates these results graphically.

Table A.5: Stability class Group distribution for 2017

Monthly Stability Index (%)								
Stability Index	1	2	3	4	5	6	1-4	5-6
Month								
January	0.9	9.9	23.4	48.4	7.8	9.5	**82.7**	**17.3**
February	0.0	9.8	19.6	53.9	6.8	9.8	**83.3**	**16.7**
March	0.0	7.9	20.4	46.9	5.5	19.2	**75.3**	**24.7**
April	0.0	2.2	18.1	47.9	9.7	22.1	**68.2**	**31.8**
May	0.0	0.5	8.9	56.9	7.4	26.3	**66.3**	**33.7**
June	0.0	0.0	6.9	47.4	12.4	33.3	**54.3**	**45.7**
July	0.0	0.3	10.2	52.8	9.5	27.2	**63.3**	**36.7**
August	0.0	2.4	13.2	55.2	9.3	19.9	**70.8**	**29.2**
September	0.0	4.4	13.2	59.7	8.2	14.4	**77.4**	**22.6**
October	0.1	9.8	18.0	56.2	9.0	6.9	**84.1**	**15.9**
November	0.0	8.8	21.5	52.9	9.4	7.4	**83.2**	**16.8**
December	0.3	10.5	25.7	50.8	6.3	6.5	**87.2**	**12.8**
							74.7	**25.3**

Table A.6: Stability class Group distribution for 2018

Monthly Stability Index (%)								
Stability Index	1	2	3	4	5	6	1-4	5-6
Month								
January	0.5	12.1	21.8	45.5	10.1	10.0	**79.9**	**20.1**
February	0.3	12.6	22.0	48.1	6.5	10.4	**83.0**	**17.0**
March	0.0	7.4	20.8	52.3	5.4	14.1	**80.5**	**19.5**
April	0.0	3.8	20.3	48.1	10.4	17.5	**72.1**	**27.9**
May	0.0	1.3	16.5	48.3	10.3	23.5	**66.1**	**33.9**
June	0.0	0.0	6.4	52.5	8.9	32.2	**58.9**	**41.1**
July	0.0	1.5	12.1	49.6	10.6	26.2	**63.2**	**36.8**
August	0.0	4.4	14.4	51.5	13.0	16.7	**70.3**	**29.7**
September	0.0	5.6	16.8	52.6	8.2	16.8	**75.0**	**25.0**
October	0.4	5.6	21.2	51.5	9.3	12.0	**78.8**	**21.2**
November	0.1	7.8	21.1	51.4	9.2	10.4	**80.4**	**19.6**
December	0.0	11.4	23.8	51.1	7.4	6.3	**86.3**	**13.7**
							74.5	**25.5**

From Tables A.5 to A.7 it can be seen that the Groups A to D (1 to 4) stability classes (associated with good dispersion) occur approximately 75% of the time. Groups E and F (5 to 6) are the groups expected to contribute the most to poor dispersion of pollutants, and occur approximately 25% of the time.

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Table A.7: Stability class Group distribution for 2019

Monthly Stability Index (%)								
Stability Index	**1**	**2**	**3**	**4**	**5**	**6**	**1-4**	**5-6**
Month								
January	0.3	11.7	21.6	52.6	8.1	5.8	**86.2**	**13.8**
February	0.1	15.6	21.1	50.9	8.2	4.0	**87.8**	**12.2**
March	0.0	9.4	24.2	46.4	7.5	12.5	**80.0**	**20.0**
April	0.0	5.4	18.6	56.3	8.6	11.1	**80.3**	**19.7**
May	0.0	0.3	13.6	48.1	7.9	30.1	**62.0**	**38.0**
June	0.0	0.0	5.3	53.2	11.9	29.6	**58.5**	**41.5**
July	0.0	1.1	5.8	49.7	9.7	33.7	**56.6**	**43.4**
August	0.0	2.6	12.4	56.0	8.6	20.4	**71.0**	**29.0**
September	0.0	3.8	15.7	55.6	5.8	19.2	**75.0**	**25.0**
October	0.1	5.6	18.3	53.4	9.1	13.4	**77.4**	**22.6**
November	0.1	12.2	23.6	55.3	4.0	4.7	**91.3**	**8.8**
December	0.7	8.7	28.2	48.8	6.6	7.0	**86.4**	**13.6**
							76.0	**24.0**

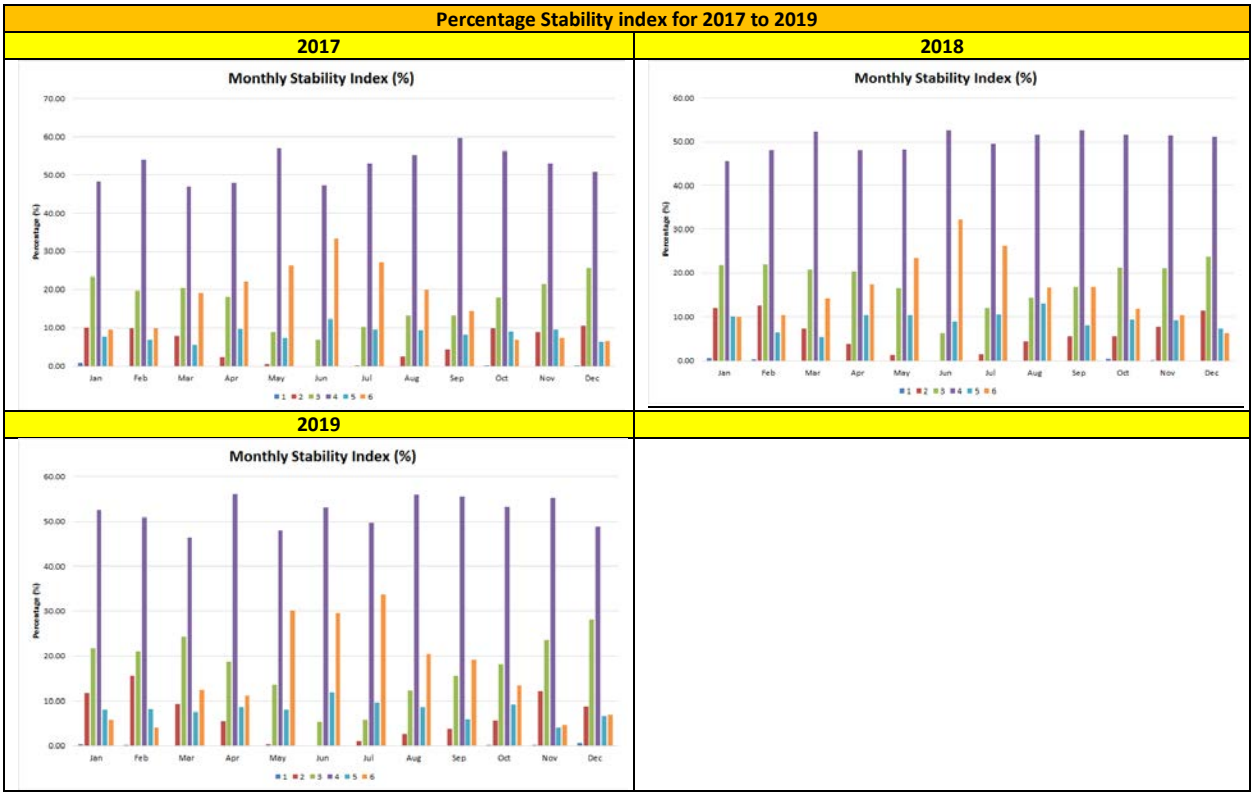


Figure A.11: Annual monthly distribution of stability classes for 2017 to 2019

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Tables A.8 to A.10 summarises the average hourly calculated mixing height for the specific months. The calculated mixing height varies between the low heights from 01:00 to 10:00 and 18:00 to 24:00, to maximum heights of ± 450 meters from 12:00 to 16:00.

Table A.8: Hourly average mixing height for 2017

Mixing Height - Monthly Average (meters)																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Month																								
January	171	160	145	150	153	147	147	153	188	272	379	472	536	563	542	490	406	326	278	241	199	190	178	168
February	176	164	142	141	137	126	125	133	156	226	331	427	501	532	516	486	372	289	215	158	182	179	164	180
March	146	134	131	197	117	115	122	129	160	205	318	428	498	524	513	459	357	255	186	134	168	163	154	154
April	185	155	153	134	140	147	145	145	125	120	211	346	452	512	519	502	388	286	196	165	171	190	193	186
May	152	142	147	126	121	134	127	130	128	103	113	183	256	289	298	275	204	147	137	141	151	149	147	175
June	145	135	145	145	156	134	144	148	136	127	146	172	244	292	312	307	224	146	136	137	141	142	136	139
July	124	131	123	131	122	125	121	129	121	117	134	191	244	284	300	299	252	182	139	172	221	145	112	125
August	137	143	145	159	173	169	165	152	118	121	195	281	339	389	399	387	301	212	143	152	156	153	153	143
September	180	157	157	157	161	161	152	144	161	201	263	332	371	390	403	394	335	251	204	201	198	188	189	179
October	175	179	183	174	170	174	169	168	175	233	315	404	469	492	486	455	375	317	276	218	208	204	200	180
November	210	214	180	157	157	151	153	155	205	258	344	407	444	463	457	461	408	343	296	245	235	263	249	305
December	193	191	185	191	204	187	169	157	190	263	348	426	467	486	467	450	387	323	262	231	215	168	175	180
Annual ave.	166	159	153	155	151	147	145	145	155	187	258	339	402	435	434	414	334	256	206	183	187	178	171	176

Table A.9: Hourly average mixing height for 2018

Mixing Height - Monthly Average (meters)																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Month																								
January	210	192	197	192	184	186	170	141	172	267	392	490	552	572	544	489	423	342	282	225	198	191	198	198
February	147	170	168	162	139	154	128	130	153	229	345	435	484	511	506	477	399	312	235	173	145	154	155	151
March	220	173	163	160	159	149	139	123	135	167	259	370	451	487	485	447	349	289	231	219	194	218	201	204
April	156	166	138	151	141	129	126	118	122	146	229	334	423	468	467	427	322	240	177	144	182	164	156	142
May	148	142	142	129	127	122	120	126	110	106	156	260	341	385	396	361	326	223	146	132	173	167	174	168
June	135	127	122	128	135	136	132	131	126	113	111	136	197	233	240	230	207	122	109	103	113	120	120	117
July	120	118	117	112	106	107	114	111	105	94	97	191	275	349	360	341	280	170	128	141	139	124	128	120
August	178	187	190	189	184	175	158	157	146	150	197	246	312	351	380	378	325	284	211	184	179	160	170	171
September	149	148	169	155	168	171	177	170	136	167	238	329	370	398	384	367	323	258	190	177	175	192	196	157
October	180	179	175	177	169	161	152	158	176	245	340	429	484	514	508	472	381	323	245	211	221	260	268	202
November	238	212	192	190	183	173	202	145	186	255	346	422	457	468	450	460	432	324	282	275	262	224	264	229
December	187	189	180	150	162	175	141	134	173	241	305	366	407	420	436	392	336	301	252	208	175	190	185	179
Annual ave.	172	167	163	158	155	153	146	137	145	182	251	334	396	430	430	403	342	266	207	183	180	180	185	170

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Table A.10: Hourly average mixing height for 2019

Mixing Height - Monthly Average (meters)																								
Hour	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
Month																								
January	205	189	166	149	134	135	138	143	200	265	367	455	505	518	507	475	431	375	279	212	181	177	206	199
February	149	136	144	196	174	126	124	128	167	242	336	422	483	512	507	483	402	315	233	159	128	144	145	127
March	161	160	167	155	145	144	138	134	133	192	299	402	457	478	472	422	340	260	207	146	148	149	156	153
April	169	170	160	158	214	146	152	134	122	158	225	333	415	460	462	432	358	272	215	184	198	185	188	165
May	107	116	117	132	123	123	120	118	109	90	108	189	273	321	322	312	221	172	123	121	129	130	120	106
June	132	137	148	127	124	118	109	110	110	90	87	111	188	252	247	230	219	144	121	124	140	189	145	134
July	137	148	137	142	143	212	154	181	178	156	137	151	196	284	311	326	269	185	126	141	144	140	131	137
August	139	131	141	128	145	151	120	113	114	128	178	235	300	368	383	352	293	209	159	155	149	158	144	141
September	159	143	140	152	138	133	127	127	131	141	224	308	359	375	370	351	304	241	202	200	225	223	198	212
October	205	209	184	172	167	152	139	132	164	235	296	372	425	438	428	411	373	304	242	204	197	192	196	191
November	159	162	160	148	147	155	147	156	201	246	292	359	410	430	416	408	355	323	246	225	198	196	193	174
December	207	201	208	210	207	195	184	179	209	267	351	423	464	467	445	414	381	331	290	264	240	221	199	210
Annual ave.	161	158	156	156	155	149	138	138	153	184	242	313	373	409	406	385	329	261	204	178	173	176	168	162

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Appendix B: Summary of the Ambient Air Quality

B.DFO Assessment of Monitored Dust Fallout against the South African National Dust Control Regulation

The Enterprise conducts Dust Fallout monitoring by means of an established dust fallout monitoring network. A list of dust fallout monitoring locations (considered as off-site locations) are provided in Table B.DFO.1 below, and the network is indicated on Figure B.DFO.1 (both on-site and off-site locations).

Table B.DFO.1: Dust Fallout Monitoring Locations

Location Reference Number	Classification	UTM Easting (mE)	UTM Northing (mN)	Assessment Done Against
Old Hostel Security Gate	Non-residential	269094.9	6711100.3	NDCR (GN827, 01Nov2013)
Small Slag Dump	Non-residential	269393.1	6710514.1	NDCR (GN827, 01Nov2013)
Northern Fence (Airfield Fence)	Non-residential	269363.8	6711128.8	NDCR (GN827, 01Nov2013)
Inchanga Park	Residential	271962.0	6708862.0	NDCR (GN827, 01Nov2013)
Othweba School	Residential	267983.4	6712430.0	NDCR (GN827, 01Nov2013)
Thornridge Nursery	Residential	267118.1	6708899.9	NDCR (GN827, 01Nov2013)
Cato Ridge Spar	Residential	267529.5	6708533.1	NDCR (GN827, 01Nov2013)
George Cato School	Residential	266687.6	6707939.5	NDCR (GN827, 01Nov2013)
Metallica	Non-residential	269989.6	6709863.3	NDCR (GN827, 01Nov2013)
Abattoir	Non-residential	271810.1	6712357.9	NDCR (GN827, 01Nov2013)
South Fence (near H:H Slimes dams)	Non-residential	268826.3	6709445.5	NDCR (GN827, 01Nov2013)
SW Fence (Candy filter plant direction)	Non-residential	268594.3	6709860.5	NDCR (GN827, 01Nov2013)
West Fence	Non-residential	268834.1	6710381.4	NDCR (GN827, 01Nov2013)
Bass Beams	Non-residential	272028.4	6711688.2	NDCR (GN827, 01Nov2013)
Eskom	Non-residential	268513.2	6708902.4	NDCR (GN827, 01Nov2013)
Briquetting Plant	Non-residential	268539.0	6709398.0	NDCR (GN827, 01Nov2013)
Radnor DFO	Non-residential	270114.0	6709705.0	NDCR (GN827, 01Nov2013)

Meteorological data (wind speed, wind direction and rainfall) obtained from a meteorological station located approximately 323m southeast of the centre of the site, is used for the monthly reporting of DFO results for the Enterprise in order to assess potential high wind speed incidents which could potentially contribute to high DFO results. It is noted that the simulated meteorological data used for this dispersion modelling study (refer Appendix A) might differ from the meteorological data referred to in the last mentioned DFO reports as a result of the difference in location.

Tables B.DFO.2 and B.DFO.3 provide a summary of the results for the off-site dust fallout (DFO) bucket locations.

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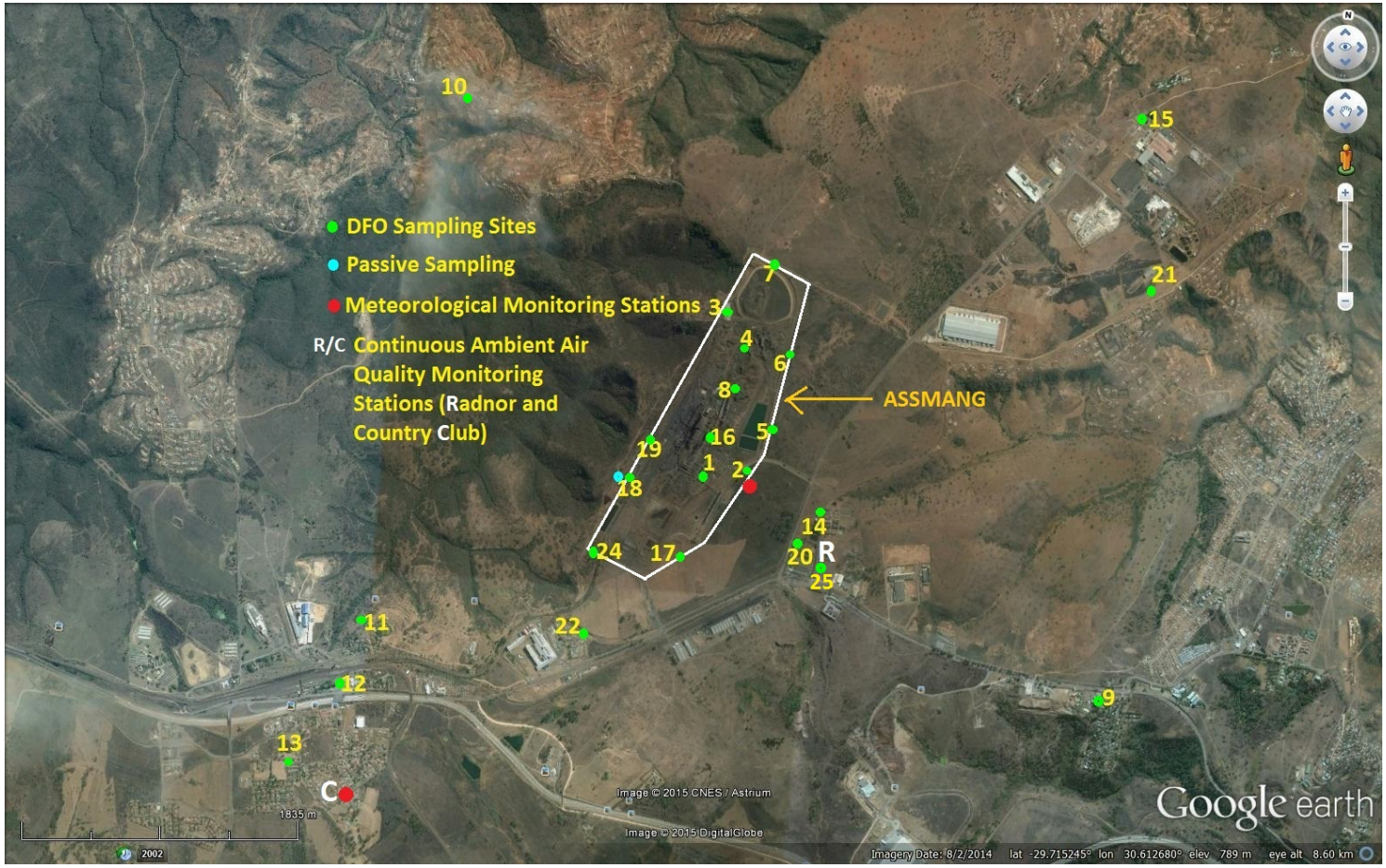


Figure B.DFO.1: Dust Fallout monitoring locations

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Table B.DFO.2: Monthly DFO Results: Off-Site Locations

Period / Location Ref	Month Specific DFO Rate Results (mg/m^2/day)																
	Old Hostel Security Gate	Small Slag Dump	Northern Fence (Airfield Fence)	Inchanga Park	Othweba School	Thornridge Nursery	Cato Ridge Spar	George Cato School	Metallica	Abattoir	South Fence (near H:H Slimes dams)	SW Fence (Candy filter plant direction)	West Fence	Bass Beams	Eskom	Briquetting Plant	Radnor DFO
Jul-17	456	405	319	171	361	127	216	620	312	126	255	281	601	306	147	136	NT
Aug-17	493	330	231	163	1097	222	567	567	298	215	258	424	722	290	296	212	183
Sep-17	588	445	511	224	2615	289	1001	817	398	393	327	491	1152	425	525	291	288
Oct-17	342	262	307	199	341	312	463	486	345	281	231	398	322	202	123	234	155
Nov-17	486	418	369	251	322	292	365	401	368	394	261	269	412	140	347	175	205
Dec-17	233	322	168	184	NT	194	376	NT	245	135	162	242	387	139	229	114	89
Jan-18	257	217	177	178	311	NT	125	473	177	228	267	235	444	166	202	130	139
Feb-18	561	455	260	166	405	174	390	366	151	138	164	426	961	130	221	112	52
Mar-18	300	260	178	160	259	134	166	237	177	153	177	263	357	174	172	117	148
Apr-18	147	242	145	104	141	139	186	191	186	101	104	167	278	96	95	69	58
May-18	188	133	186	115	168	122	141	336	131	127	158	229	257	158	68	94	141
Jun-18	199	240	162	184	175	68	223	410	264	102	154	203	493	135	46	102	269
Jul-18	212	277	184	204	227	153	212	471	235	184	229	271	497	225	290	136	288
Aug-18	196	161	146	137	314	127	209	299	162	108	166	139	400	169	165	126	178
Sep-18	77	199	120	49	275	88	183	281	137	151	125	426	233	125	82	50	110
Oct-18	134	131	60	124	125	78	103	170	120	111	141	151	275	106	106	69	105
Nov-18	348	252	161	135	204	260	234	210	191	173	141	230	405	154	195	231	213
Dec-18	231	142	84	87	307	48	145	193	95	66	72	95	416	188	63	163	126
Jan-19	207	88	84	83	307	146	199	193	274	165	78	96	643	188	105	56	183
Feb-19	90	93	54	55	102	54	138	130	52	72	117	103	198	59	64	25	68
Mar-19	73	71	30	29	99	47	146	126	60	64	100	122	190	53	47	65	27
Apr-19	113	87	41	36	99	98	78	126	119	123	106	189	303	67	47	27	67
May-19	122	146	101	108	101	96	118	248	175	179	138	99	253	148	78	86	151
Jun-19	142	146	162	115	251	96	224	410	126	169	112	132	248	86	179	129	209
Jul-19	227	194	193	245	295	187	338	410	312	249	240	237	297	308	236	193	312
Aug-19	173	107	92	109	223	94	200	304	127	79	104	114	171	135	127	78	164
Sep-19	216	141	123	165	538	121	180	342	105	110	91	194	437	91	149	63	68
Oct-19	460	174	230	229	538	285	711	342	232	135	172	258	685	287	295	307	282
Nov-19	227	117	137	114	377	104	175	178	134	105	151	242	368	171	272	111	150
Dec-19	227	150	62	138	106	126	172	93	166	120	160	294	239	153	122	111	45
Jan-20	131	48	49	146	106	68	38	93	74	39	109	70	285	70	29	71	27
Feb-20	166	78	51	40	180	62	103	188	156	67	80	174	207	31	121	34	25
Mar-20	139	87	107	177	NT	136	140	70	156	110	86	129	409	123	170	94	146
Apr-20	64	31	28	52	NT	62	113	70	28	106	30	24	58	54	55	12	37
May-20	64	42	46	56	NT	94	113	70	67	38	49	80	98	47	81	39	132
Jun-20	219	171	86	117	NT	121	177	70	NT	785	133	146	183	338	160	120	186

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Table B.DFO.3: Rolling Annual Average DFO Results: Off-Site Locations

Period / Location Ref	Rolling Annual Average DFO Rates (mg/m^2/day)																
	Old Hostel Security Gate	Small Slag Dump	Northern Fence (Airfield Fence)	Inchanga Park	Othweba School	Thornridge Nursery	Cato Ridge Spar	George Cato School	Metallica	Abattoir	South Fence (near H:H Slimes dams)	SW Fence (Candy filter plant direction)	West Fence	Bass Beams	Eskom	Briquetting Plant	Radnor DFO
Jun-18	354	311	251	175	563	189	351	446	254	199	210	302	532	197	206	149	157
Jul-18	334	300	240	178	551	191	351	432	248	204	207	302	524	190	218	149	168
Aug-18	309	286	233	175	480	182	321	408	237	195	200	278	497	180	207	142	168
Sep-18	266	265	200	161	267	164	253	359	215	175	183	272	420	155	170	122	153
Oct-18	249	255	180	155	247	143	223	331	196	161	176	252	416	147	168	108	149
Nov-18	238	241	162	145	237	140	212	313	181	143	166	249	416	148	156	113	149
Dec-18	237	226	155	137	243	126	193	303	169	137	158	236	418	152	142	117	152
Jan-19	233	215	148	129	242	128	199	280	177	132	142	225	435	154	134	110	156
Feb-19	194	185	130	120	217	118	178	260	169	126	138	198	371	148	121	103	157
Mar-19	175	169	118	109	204	111	176	251	159	119	132	186	357	138	110	99	147
Apr-19	172	156	109	103	200	107	167	245	153	121	132	188	359	136	106	95	148
May-19	167	157	102	102	195	105	165	238	157	125	131	177	359	135	107	95	149
Jun-19	162	149	102	97	201	107	166	238	145	130	127	171	338	131	118	97	144
Jul-19	163	143	103	100	207	110	176	233	152	136	128	168	322	138	114	102	146
Aug-19	161	138	99	98	199	107	175	233	149	133	123	166	303	135	111	98	145
Sep-19	173	133	99	108	221	110	175	239	146	130	120	147	320	132	116	99	141
Oct-19	200	137	113	116	255	127	226	253	156	132	123	156	354	147	132	119	156
Nov-19	190	125	111	115	270	115	221	250	151	126	123	157	351	148	138	109	151
Dec-19	190	126	109	119	253	121	223	242	157	131	131	173	336	145	143	104	144
Jan-20	183	123	106	124	236	115	210	234	140	120	133	171	306	136	137	106	131
Feb-20	190	122	106	123	243	115	207	238	149	120	130	177	307	133	142	106	127
Mar-20	195	123	112	135	256	123	206	234	157	124	129	178	325	139	152	109	137
Apr-20	191	118	111	136	272	120	209	229	149	123	123	164	305	138	153	107	135
May-20	186	110	107	132	290	120	209	214	140	111	115	162	292	130	153	103	133
Jun-20	193	112	100	132	295	122	205	186	141	162	117	164	286	151	151	103	131

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Table B.DFO.4 provides a summary of an assessment of the DFO results for the latest / a recent 12 month period (Jul2019 to Jun2020) against the National Dust Control Regulation and SANS1929 as a guideline, with 100% (17 out 17) of the locations in compliance.

Table B.DFO.4: Latest 12-Month NDCR Compliance Assessment: Off-Site Locations

Bucket Locations	Assessment of Dustfall Rates (D) against the National Dust Control Regulation and SANS1929 as a guideline		
	D > Acceptable rate; More than 2 times /year (NDCR)	D > Acceptable rate; No Sequential months (NDCR)	D > 2400; (Guideline per SANS1929)
Non-residential: Old Hostel Security Gate	Comply	Comply	Comply
Residential: Inchanga Park	Comply	Comply	Comply
Residential: Cato Ridge Spar	Comply	Comply	Comply
Residential: Thornridge Nursery	Comply	Comply	Comply
Residential: George Cato School	Comply	Comply	Comply
Residential: Othweba School	Comply	Comply	Comply
Non-residential: West Fence	Comply	Comply	Comply
Non-residential: Northern Fence (Airfield Fence)	Comply	Comply	Comply
Non-residential: Abattoir	Comply	Comply	Comply
Non-residential: Bass Beams	Comply	Comply	Comply
Non-residential: Small Slag Dump	Comply	Comply	Comply
Non-residential: Metallica	Comply	Comply	Comply
Non-residential: South Fence (near H:H Slimes	Comply	Comply	Comply
Non-residential: Eskom	Comply	Comply	Comply
Non-residential: SW Fence (Candy filter plant	Comply	Comply	Comply
Non-residential: Briquetting Plant	Comply	Comply	Comply
Non-residential: Radnor DFO	Comply	Comply	Comply

The following figures provide a graphical representation of the DFO results.

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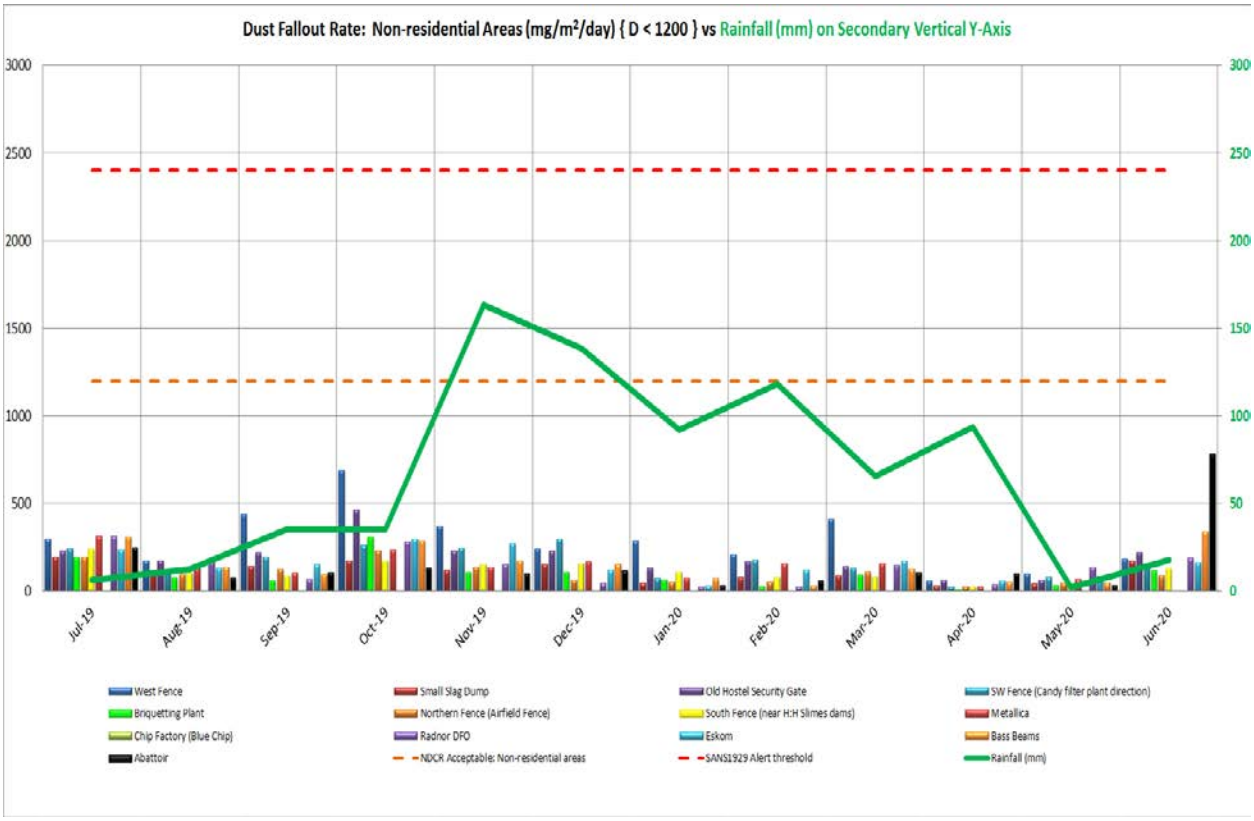


Figure B.DFO.2NR: Dust Fallout Rate: Latest 12 Months – Non-Residential Locations

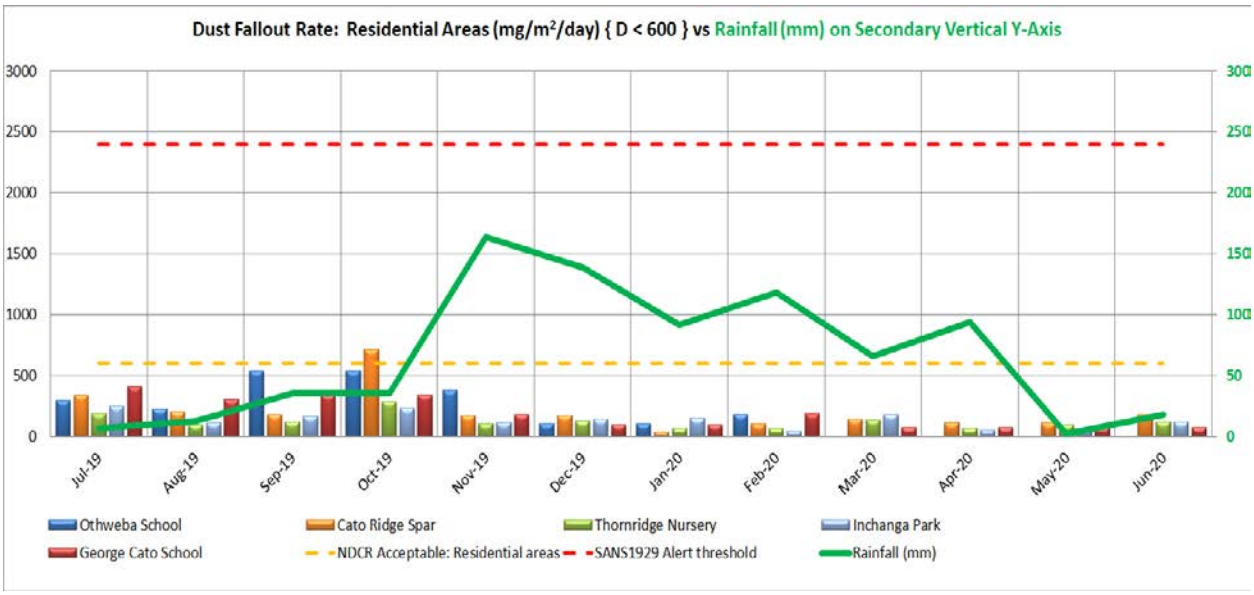


Figure B.DFO.2R: Dust Fallout Rate: Latest 12 Months – Residential Locations

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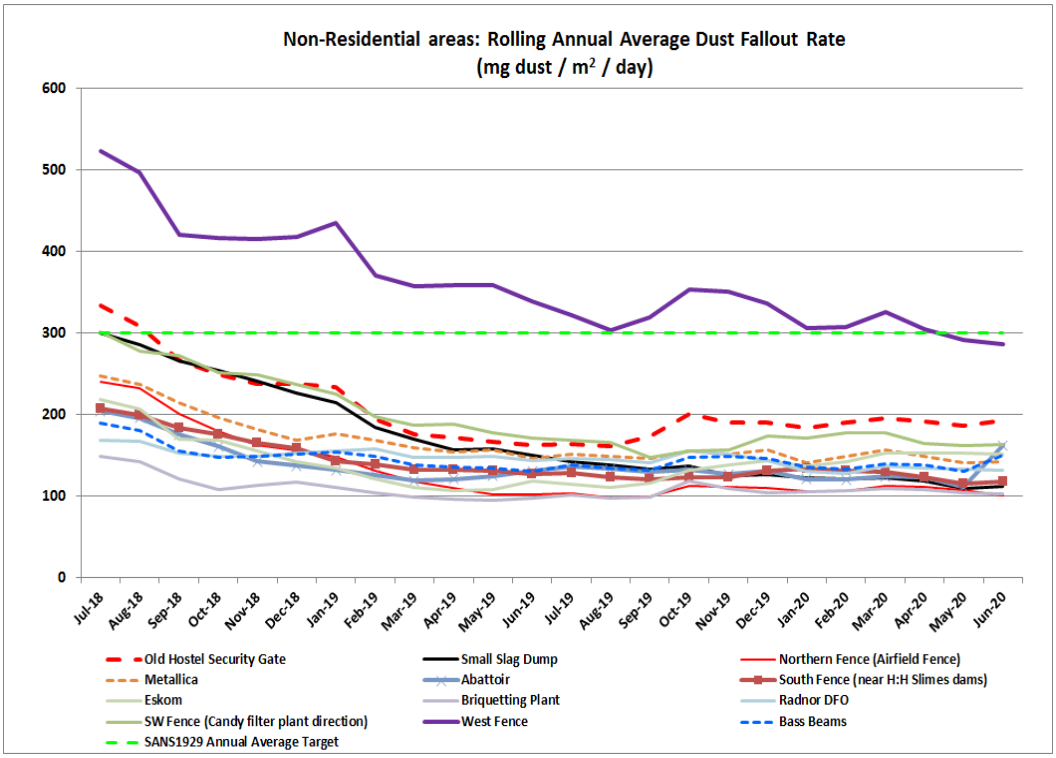


Figure B.DFO.3NR: Dust Fallout Rate: Rolling Annual Averages – Non-Residential Locations

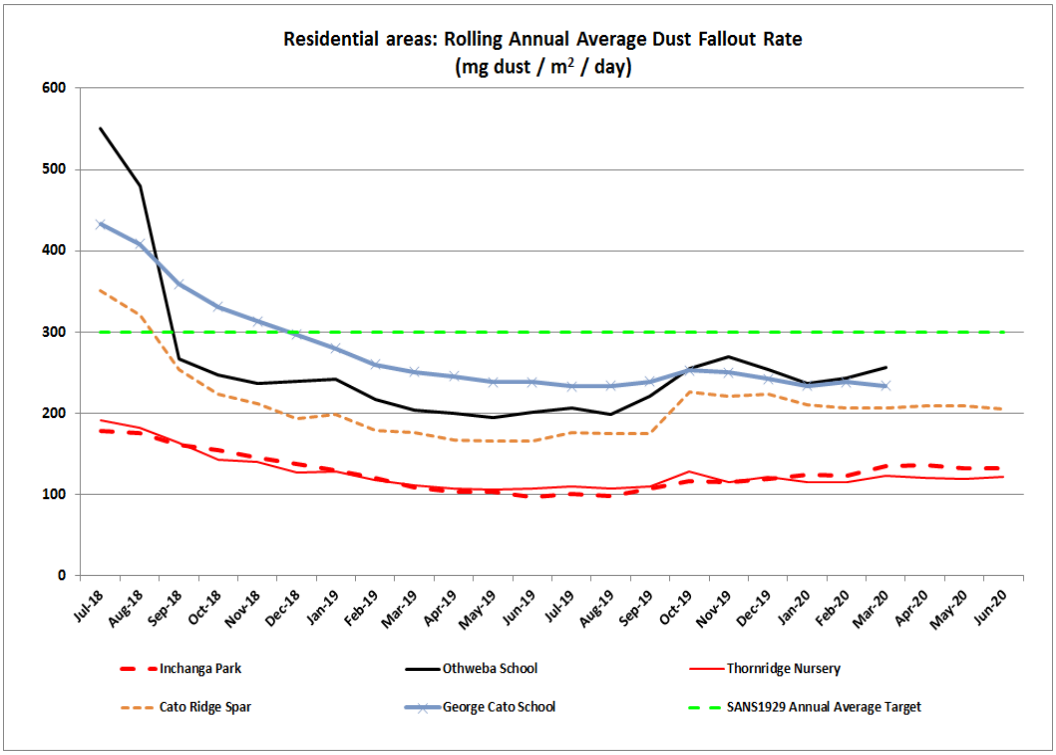


Figure B.DFO.3R: Dust Fallout Rate: Rolling Annual Averages – Residential Locations

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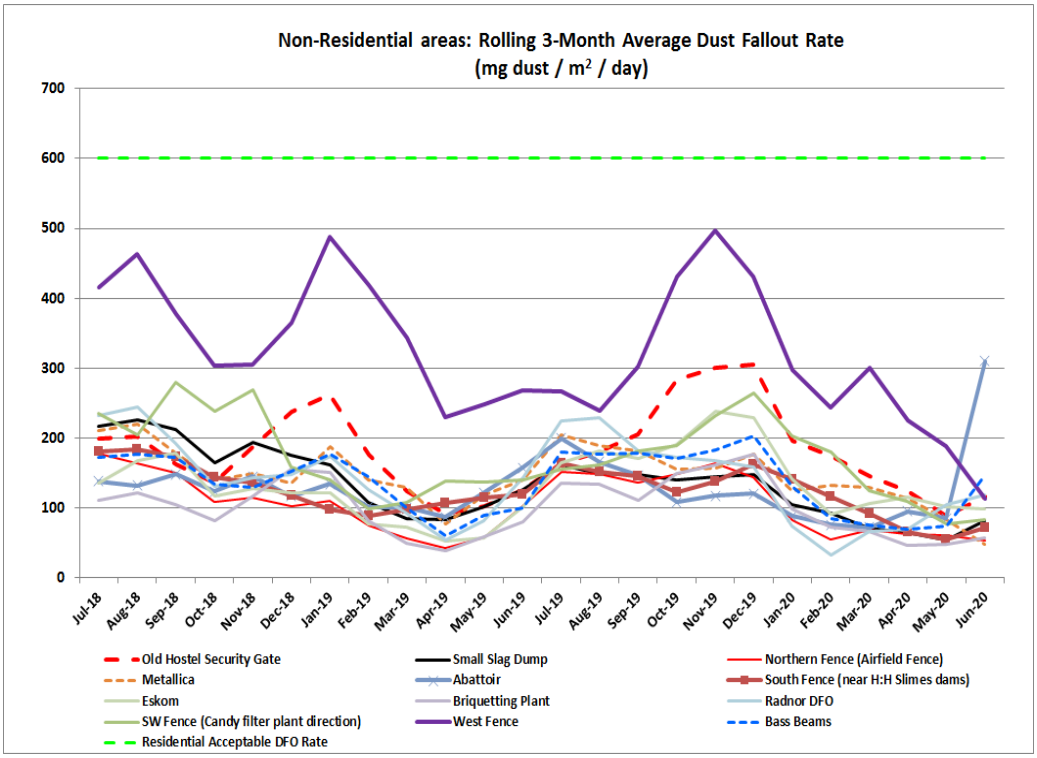


Figure B.DFO.4NR: Dust Fallout Rate: 3-Monthly Averages – Non-Residential Locations

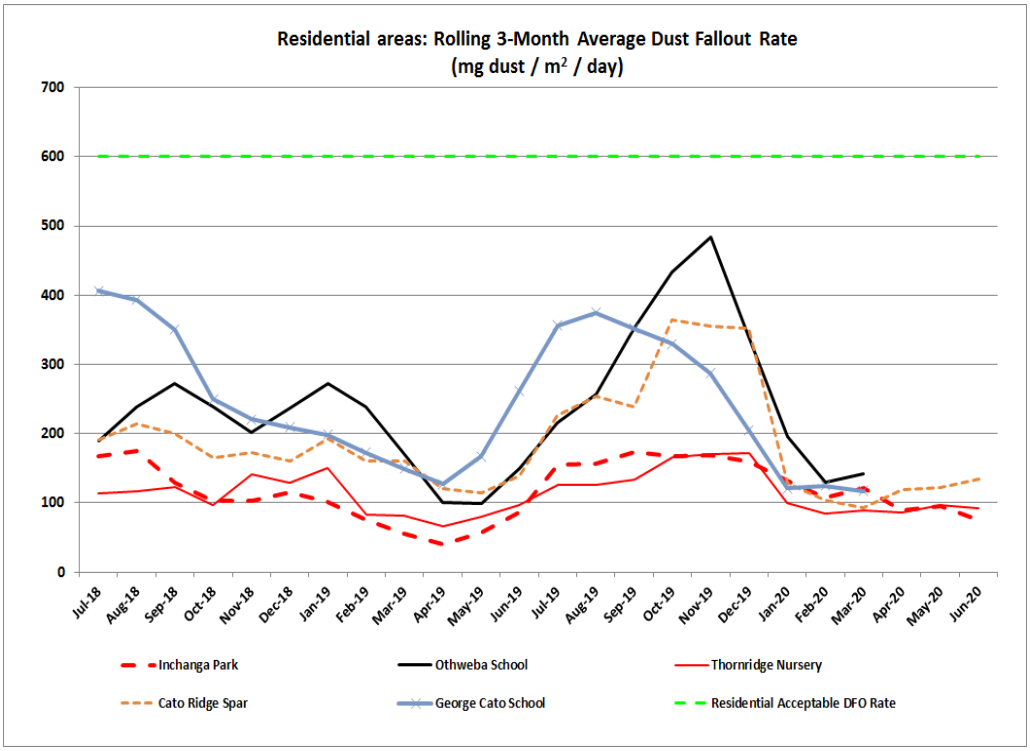


Figure B.DFO.4R: Dust Fallout Rate: 3-Monthly Averages – Residential Locations

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B.AAQ Assessment of air quality against South African Ambient Air Quality Standards

Ambient Air Monitoring was implemented by ACRW at locations to monitor the ambient air quality in the area surrounding the Enterprise, which could also be utilised to assess potential impact / contribution of ACRW on the surrounding ambient air quality. Two continuous ambient air monitoring stations are utilised for this purpose, one stations is located at Radnor (Site ''R'') and at the Cato Ridge Country Club (Site ''C''), as indicated in Figure 5.1-1. Passive sampling of benzene is also conducted near the Candy Plant, refer Figure 5.1-1. In accordance with requirements, Dust Fallout measurements should be conducted by the Enterprise. The Enterprise conducts Dust Fallout monitoring by means of an established dust fallout monitoring network.

In view of this study being associated with the quality of the ambient air surrounding the Enterprise / operations, referenced monitoring locations are those which are considered “off-site” relative to the Enterprise / operations.

Table B.AAQ.1: Ambient Monitoring Locations & Description

Location Reference Number	Classification	UTM Easting (mE)	UTM Northing (mN)	Assessment Done Against
CAAQMS: Radnor	Off-site	270106.0	6709698.9	SA National Ambient Air Quality Standards
CAAQMS: Cato Ridge Country Club	Off-site	267129.0	6707835.0	SA National Ambient Air Quality Standards
Passive Sampling(Benzene): Candy Plant	Off-site	268606.5	6709967.2	SA National Ambient Air Quality Standards

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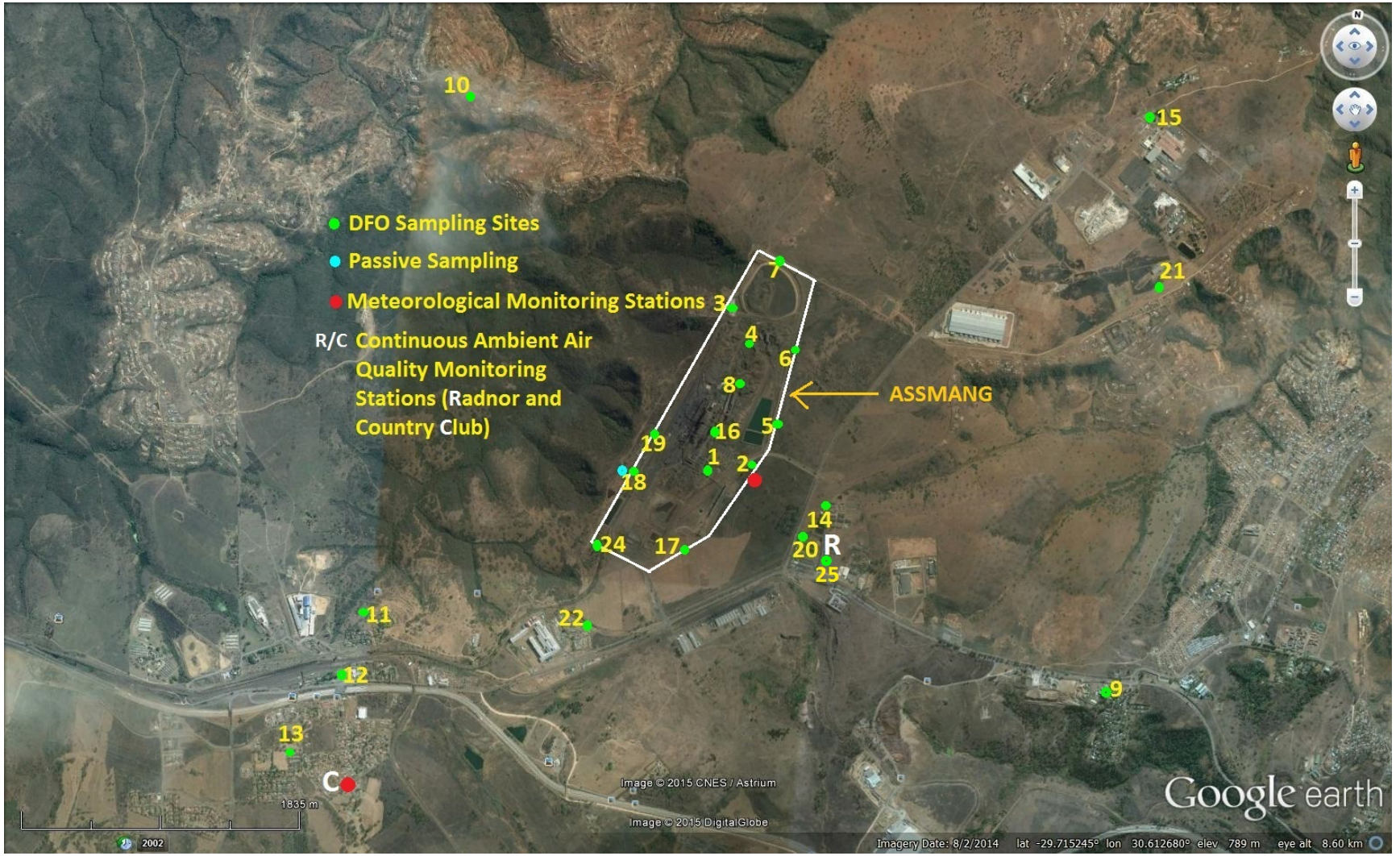


Figure B.AAQ.1: Ambient Air Quality Monitoring Locations

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B.AAQ.1 Data Capturing Statistics and Averages of Monitored Pollutants

The tables provided below, summarises the continuous ambient monitoring statistics, and the monitored monthly averages at the stations referred, for the July 2017 to Jun 2020 period.

Table B.AAQ.S1.S: Continuous Ambient Monitoring Statistics – Country Club AQMS – Jul2017 to Jun2018

% Data Recovery: "Cato Ridge Country Club" Continuous Ambient Air Quality Monitoring Station Data						
Period	PM_{10}	SO_2	NO_X	CO	O_3	Comments
July-17	96.8%	100.0%	100.0%	100.0%	59.4%	- Good data recovery except for a) ozone data invalidated from 17 Jul 2017 due to leaking sample line (repaired 8 Aug 2017), and b) real time PM_{10} data due to faulty real time component. Temp & RH data supplemented from Main Entrance gate met station until further notice. SANAS accredited gas analyser calibrations scheduled for end Aug '17.
August-17	100.0%	99.1%	99.2%	99.4%	75.9%	- Good data recovery except for a) ozone data invalidated from 17 Jul 2017 due to leaking sample line identified & repaired on 8 Aug 2017, and b) real time PM_{10} data due to faulty real time component, high repair cost anticipated. SANAS accredited gas analyser calibrations performed on 25 Aug 2017, next calibrations due end Nov 2017.
September-17	93.5%	92.7%	92.7%	92.8%	92.8%	- Good data recovery although lower than Aug '17 due to power supply interruption from 29 Sep '17 until 2 Oct '17. Some met data parameters (eg rain, temperature, humidity) supplemented from Main Entrance Gate met station as required.
October-17	100.0%	94.6%	94.5%	94.6%	94.6%	- Very good / improved data recovery for gas / PM_{10} analysers this month. Data lost on 1 & 2 Oct '17 due to PC logger failure to reboot after 29 Sep '17 power failure. Wind anemometer damaged by lightning strike on 4 Oct '17, repair approval awaited. Some met data parameters supplemented from Main Entrance Gate met station as required.
November-17	93.5%	96.5%	96.5%	96.4%	96.4%	- Good data recovery for gas analysers and 24h PM_{10}. Approval awaited for new ambient temp / %RH sensor & anemometer repair hence some met data supplemented from Main Entrance Gate met station. Quarterly SANAS accredited gas analyser calibrations performed on 27 & 28 Nov '17.
December-17	35.5%	81.6%	81.5%	81.0%	81.8%	- Faulty PM_{10} analyser (offline) since 13 Dec '17 hence very poor data recovery. Service agents to assess fault. Poor data recovery for gas analysers as datalogger software failed to auto-reboot following power outage on 30 Dec '17. Logger manually rebooted on 2 Jan '18. Approval awaited for new temp / RH sensor & anemometer repair hence some met data supplemented from Main Entrance Gate met station. Annual met station cals may be delayed until equipment repairs approved & completed.
January-18	71.0%	94.5%	75.9%	94.7%	95.0%	- Faulty PM_{10} analyser repaired onsite on 10 Jan '18 hence no PM_{10} data from 1 to 10 Jan '18. All station's data lost from 30 Dec '17 to 2 Jan '18 as analysers failed to auto-reboot after power failure until logger was manually rebooted on 2 Jan '18. NOx analyser fault rectified onsite on 10 Jan '18. Repaired wind anemometer installed on 16 Jan '18 & new RH/Temp sensor installed on 18 Jan '18 during annual SANAS met station cals. Missing met data supplemented from Main Entrance Gate Met Station (also SANAS calibrated on 18 Jan '18)
February-18	96.4%	99.8%	99.7%	99.9%	99.8%	- Excellent data recovery for all measurement parameters this month. Quarterly SANAS gas analyser calibrations and annual Opsis SM200 PM_{10} analyser verification audits performed as scheduled on 28 Feb '18. An increase in analyser and related equipment maintenance has been generally evident at both stations over past year as the analysers & equipment is now 8 years old.
March-18	100.0%	99.8%	99.8%	99.8%	99.8%	- Excellent data recovery for all measurement parameters this month. Next quarterly SANAS accredited gas analyser calibrations due at end May '18.
April-18	100.0%	99.9%	99.8%	97.5%	99.9%	- Excellent data recovery for all measurement parameters again this month. Next quarterly SANAS accredited gas analyser calibrations due at end of May '18.
May-18	100.0%	99.8%	81.4%	99.8%	99.8%	- Quarterly SANAS accredited multipoint gas analyser calibrations performed on 25 May 2018. Excellent data recovery except for NOx analyser (81%) as data was invalidated from 18 to 24 May 18 due to faulty ozone generator (repaired onsite).
June-18	96.8%	95.6%	95.6%	95.6%	95.9%	- Several hours data lost from 2 power failures on 15 & 26 June, otherwise an excellent data recovery rate from all analysers.

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Table B.AAQ.S1.S: Continuous Ambient Monitoring Statistics – Country Club AQMS – Jul2018 to Jun2019

% Data Recovery: "Cato Ridge Country Club" Continuous Ambient Air Quality Monitoring Station Data						
Period	PM_{10}	SO_2	NO_X	CO	O_3	Comments
July-18	100.0%	100.0%	100.0%	100.0%	66.1%	- Excellent data recovery except for Ozone analyser (66%) as data was invalidated from 3 to 4 July and 8 to 17 July '18 due to analyser pump (bearings) failure & subsequent repair. Quarterly SANAS accredited multipoint gas analyser calibrations scheduled for week beginning 20 Aug '18.
August-18	100.0%	99.7%	99.6%	99.7%	99.7%	- Excellent data recovery for all analysers this month. Quarterly SANAS accredited multipoint gas analyser calibrations were performed on 22 Aug '18.
September-18	100.0%	10.6%	100.0%	100.0%	100.0%	- Excellent data recovery for all analysers except for SO_2 analyser which was offline since 4 Sep '18 due to a faulty PMT and cooler assembly. Analyser sent to service agents, approval for replacement components is pending.
October-18	100.0%	46.9%	100.0%	100.0%	100.0%	- Excellent data recovery for all analysers except for SO_2 which was repaired (new PMT & cooler assembly) then re-installed on 17 October 2018, hence poor (but improved) data recovery of 47% for SO_2 this month. Quarterly SANAS accredited multipoint gas analyser calibrations are scheduled for next month.
November-18	96.7%	93.8%	93.8%	93.9%	93.8%	- SANAS accredited quarterly gas analyser calibrations were performed this month. Load shedding has impacted negatively upon analysers' data recovery rates this month. Some analysers take longer "to recover" from power outages than other analysers.
December-18	100.0%	95.3%	98.6%	98.9%	99.0%	- Good data recovery for all analysers, marginally lower for SO_2 as this analyser takes much longer to stabilise and recover from power outages.
January-19	91.9%	94.1%	94.8%	94.6%	94.7%	- Annual SANAS accredited met station calibration was performed on 23 Jan '19. Majority of invalid data arose from a SQL server fault during server maintenance on 30 Jan '19 which required manual onsite interventions to reboot the data logging program.
February-19	96.4%	85.9%	90.1%	91.5%	91.8%	- Low data recovery for all gas analysers due to several load shedding power failures this month. Additional data also lost after power restored due to long analyser stabilisation / recovery periods, particularly for the SO_2 analyser. SANAS multipoint gas analyser calibrations performed on 8 Feb 2019.
March-19	80.6%	71.3%	78.9%	84.3%	85.0%	- Very poor data recovery for all analysers due to a) several load shedding power failures; b) lengthly stabilisation time (additional data loss) required for some analysers after power restored. Annual verification audit performed on the Opsis SM200 PM_{10} analyser on 12 Mar 2019.
April-19	100.0%	100.0%	100.0%	100.0%	100.0%	- Excellent data recovery for all gas analysers and meteorological equipment this month. Next quarterly SANAS multipoint gas analyser calibrations due end May '19.
May-19	87.1%	88.2%	91.5%	91.9%	92.4%	- UPS failure resulted in loss of all station data between 15 & 17 May '19. PM_{10} analyser malfunctioned after UPS repaired hence another few days PM_{10} data was lost / invalidated. SANAS multipoint gas analyser calibrations were performed on 21 May '19. Data lost from faulty humidity / temp sensor was supplemented using data from nearby Main Entrance Gate station.
June-19	100.0%	99.7%	99.9%	99.7%	100.0%	- Excellent data recovery for all gas analysers and meteorological equipment this month. Relative humidity / temperature sensor was repaired and re-installed on 4 Jun '19. Next quarterly SANAS multipoint gas analyser calibrations due in Aug '19.

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Table B.AAQ.S1.S: Continuous Ambient Monitoring Statistics – Country Club AQMS – Jul2019 to Jun2020

% Data Recovery: "Cato Ridge Country Club" Continuous Ambient Air Quality Monitoring Station Data						
Period	PM_{10}	SO_2	NO_X	CO	O_3	Comments
July-19	83.9%	93.6%	93.1%	94.1%	94.3%	- Low data recovery primarily due to power failure between 7 and 9 Jul '19. SANAS accredited multi-point gas analyser calibrations are scheduled for mid-Aug '19.
August-19	96.8%	99.4%	91.5%	99.8%	99.7%	- Excellent data recovery rate for all analysers this month. Faulty NOx analyser removed on 29 Aug '19 for for offsite repair by service agents (requires a new converter). Quarterly SANAS accredited multipoint gas analyser calibrations performed on 13 Aug '19. Next calibrations due in mid Nov '19.
September-19	100.0%	99.5%	0.0%	99.8%	99.8%	- Zero data recovery for NOx analyser as this analyser is offsite (since 29 Aug '19) being repaired by service agents. One hour's data was lost due to a power failure on 20 Sep '19. Next multipoint gas analyser calibrations due in mid Nov '19
October-19	100.0%	96.2%	0.0%	99.5%	99.6%	- NOx analyser repairs awaiting approval. Good data recovery for other analysers despite a few power failures this month. Next multipoint gas analyser calibrations due next month.
November-19	100.0%	99.5%	11.9%	99.7%	99.6%	- Quarterly SANAS accredited multipoint gas analyser calibrations performed on 27 Nov '19. Poor data recovery for NOx as this analyser was offsite being repaired until re-installed on 27 Nov '19.
December-19	83.9%	76.4%	80.5%	80.6%	80.6%	- Next SANAS accredited annual met station calibration is due in Jan '20, and the next quarterly multipoint gas analyser calibrations are due in Feb '20. General poor data recovery for all parameters in Dec '19 which was due to load shedding during first half of the month. Lower data recovery for SO_2 as this analyser takes longer to recover from power failures than the other analysers. Monthly rainfall is under estimated due to poor data recovery (load shedding).
January-20	100.0%	67.2%	67.4%	67.4%	67.4%	- The annual SANAS accredited met station calibrations were performed on 22 Jan '20. The next quarterly multipoint gas analyser calibrations are scheduled for early Feb '20. General poor data recovery for all gas analysers due to load shedding and a faulty DAS which fails to restart automatically after load shedding. PM_{10} data retrieved manually hence 100% recovery rate.
February-20	100.0%	26.3%	31.0%	30.2%	31.3%	- Quarterly SANAS accredited multipoint gas analyser calibrations performed on 11 Feb '20, next calibrations due in May '20. Next PM SM200 audits due in Mar '20. Very poor data recovery for most parameters due to load shedding related Data Aquisition System faults. Lower data recovery for SO_2 as this analyser's internal pump failed (bearings replaced), and this analyser takes longer to recover from power failures than the other analysers. PM_{10} data downloaded manually so 100% data recovery.
March-20	54.8%	63.8%	70.3%	70.2%	70.9%	- Next quarterly SANAS accredited multipoint gas analyser calibrations are due in mid May '20. Next annual PM_{10} analyser verification audit was due in Mar '20, delayed due to Corona lockdown and faulty analyser which cant be accessed during lockdown. General poor data recovery for all analysers and meteorological parameters due to load shedding and faulty DAS. The uncharacteristic SO_2 trend and low concentrations indicates a potential fault with this analyser which may require attention.
April-20	0.0%	0.0%	96.8%	96.8%	96.8%	- Quarterly SANAS accredited multipoint gas analyser calibrations are scheduled for mid May '20. PM_{10} analyser faulty so no PM_{10} data this month. SO_2 data invalidated for entire month as the data indicated fault (flatlining) which is being assessed. The Covid-19 lockdown is delaying some external repairs and spares so is beginning to impact upon data recovery.
May-20	58.1%	0.0%	99.8%	99.7%	99.8%	- Quarterly SANAS accredited multipoint gas analyser calibrations were perfomed on 14 May '20. New PM_{10} analyser pump installed so was fully operational again from 14 May '20, so this resulted in the poor 58% data recovery. No data for SO_2 as analyser is being assessed / repaired by service agent. Excellent data recovery for NO_X, CO and O_3.
June-20	100.0%	0.0%	100.0%	100.0%	100.0%	- Excellent data recovery rate for all analysers was recorded this month except for the SO_2 analyser for which a replacement part (kicker) is still awaited. Quarterly SANAS accredited multipoint gas analyser calibrations are scheduled for mid May '20.

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Table B.AAQ.S1.MA: Monthly Average of Monitored Pollutants – Country Club AQMS – Jul2017 to Jun2018

"Cato Ridge Country Club"
Continuous Ambient Air Quality Monitoring Station Data (Month Average in µg/m³)

Period / Unit	PM_{10}	SO_2	NO_X	CO	O_3
	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³
July-17	37.1	3.1	23.7	430	60.4
August-17	27.1	3.4	16.8	355	65.9
September-17	24.0	2.7	16.9	378	72.1
October-17	16.3	2.1	15.9	372	65.3
November-17	16.6	2.4	16.6	399	61.7
December-17	9.9	2.1	12.3	310	48.4
January-18	17.5	2.7	8.2	303	46.9
February-18	13.4	2.8	10.7	271	45.7
March-18	13.7	2.9	11.2	265	43.1
April-18	16.7	3.7	14.4	271	48.0
May-18	23.2	4.2	23.0	240	41.8
June-18	37.3	5.8	35.3	266	46.3

Table B.AAQ.S1.MA: Monthly Average of Monitored Pollutants – Country Club AQMS – Jul2018 to Jun2019

"Cato Ridge Country Club"
Continuous Ambient Air Quality Monitoring Station Data (Month Average in µg/m³)

Period / Unit	PM_{10}	SO_2	NO_X	CO	O_3
	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³
July-18	38.1	8.6	30.3	462	56
August-18	25.7	5.8	19.8	391	58
September-18	21.1	7.1	17.5	448	63
October-18	23.9	4.2	18.4	402	66
November-18	19.1	2.3	12.9	340	60
December-18	14.0	2.1	13.3	310	51
January-19	13.7	1.9	11.8	290	42
February-19	13.0	2.6	17.7	311	49
March-19	13.0	2.8	16.3	257	45
April-19	16.9	2.9	20.3	251	43
May-19	29.1	4.0	32.2	244	49
June-19	44.7	5.8	33.4	315	51

Table B.AAQ.S1.MA: Monthly Average of Monitored Pollutants – Country Club AQMS – Jul2019 to Jun2020

"Cato Ridge Country Club"
Continuous Ambient Air Quality Monitoring Station Data (Month Average in µg/m³)

Period / Unit	PM_{10}	SO_2	NO_X	CO	O_3
	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³
July-19	73.3	8.8	40.6	387	58
August-19	33.3	7.2	20.4	344	58
September-19	27.9	8.0	NoData	311	56
October-19	26.1	7.3	NoData	290	61
November-19	16.4	5.6	15.0	280	55
December-19	19.0	2.3	12.6	268	45
January-20	15.2	4.7	12.5	275	45
February-20	18.8	1.8	15.1	279	46
March-20	25.0	5.5	17.8	230	47
April-20	NoData	NoData	10.5	167	47
May-20	24.0	NoData	28.2	264	47
June-20	26.4	NoData	37.5	406	55

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Table B.AAQ.S2.S: Continuous Ambient Monitoring Statistics – Radnor AQMS – Jul2017 to Jun2018

% Data Recovery: "Radnor Old Age Home" Continuous Ambient Air Quality Monitoring Station Data						
Period	PM_{10}	$PM_{2.5}$	NO_X	CO	SO_2	Comments
July-17	100.0%	0.0%	100.0%	100.0%	100.0%	- Poor data recovery for $PM_{2.5}$ as all 24 hour $PM_{2.5}$ data was invalidated this month. Real time $PM_{2.5}$ data was recorded but highly sporadic. Analyser to be sent for repair (with Club PM_{10} analyser) in Sep / Oct to coincide with expected low PM exceedance frequency. SANAS accredited gas analyser calibrations scheduled for end Aug 2017.
August-17	100.0%	0.0%	99.7%	99.9%	99.8%	- Faulty $PM_{2.5}$ analyser removed & sent for repair on 11 Aug 2017. Good data recovery for the other parameters. SANAS accredited multipoint gas analyser calibrations performed on 24 Aug 2017, next calibrations due end Nov 2017.
September-17	83.9%	0.0%	95.7%	95.8%	95.7%	- Good data recovery although lower than Aug '17 due to power failure/ data loss after extreme wind episode late on 16 Sep '17. PM_{10} analyser failed to reboot following this power failure hence poor data recovery for PM_{10}. $PM_{2.5}$ analyser offsite with agents for repair, spares required / awaited to enable troubleshooting to be completed.
October-17	96.8%	0.0%	100.0%	100.0%	100.0%	- Excellent data recovery this month except for $PM_{2.5}$, as analyser still offsite / with agents since 11 Aug '17, quote for repair awaited. Quarterly SANAS accredited gas analyser calibrations scheduled for end Nov '17.
November-17	80.6%	0.0%	96.5%	96.7%	96.6%	- Good data recovery this month for gas analysers but not PM analysers. $PM_{2.5}$ analyser still offsite / with agents since Aug 2017 assessing fault, quote for repair awaited. PM_{10} lost 5 days data from 22 to 26 Nov 2017 hence low 81% data recovery. Quarterly SANAS accredited gas analyser calibrations performed on 27 & 28 Nov '17. CO analyser response is recording a "high level of noise".
December-17	100.0%	0.0%	95.5%	95.5%	98.4%	- Good data recovery this month for PM_{10} and gas analysers. $PM_{2.5}$ analyser still being assessed by service agents so analyser offline / offsite since Aug 2017, quote for repair awaited. Power outages on 6, 8 and 30 Dec '17 resulted in data loss. Next quarterly SANAS accredited gas analyser calibrations to be scheduled for end Feb '17. CO analyser still recording a "high level of noise", and NOx analyser O-rings require replacement soon.
January-18	100.0%	41.9%	94.9%	0.0%	99.8%	- $PM_{2.5}$ analyser offline for repair by service agents from Aug '18 until 18 Jan '18. CO analyser's Jan '18 data invalidated as baseline noisy / faulty, removed for repair by service agents. Awaiting O rings for NOx analyser - preventative maintenance.
February-18	92.9%	89.3%	91.2%	0.0%	99.7%	- Good data recovery this month for PM_{10}, NO_X and SO_2 analysers. $PM_{2.5}$ analyser data recovery <90% as analyser was undergoing maintenance over last 3 days of February 2018. CO analyser still offline / with service agents awaiting spares from U.S. NOx analyser removed on 26 Feb '18 for assessment / repair by service agents. Quarterly SANAS gas analyser calibrations and annual PM analyser verification audits performed on schedule between 26 and 28 Feb '18. An increase in analyser and related equipment maintenance has been generally evident at both stations over past year as the analysers & equipment is now 8 years old.
March-18	96.8%	74.2%	0.0%	0.0%	99.7%	- Good data recovery for PM_{10}, and SO_2, poor (74%) data recovery for $PM_{2.5}$ as offline from 12 to 19 Mar '18 due to analyser fault. CO & NO_x analysers still offline / with service agents awaiting spares. Next quarterly SANAS accredited gas analyser calibrations due at end May '18.
April-18	96.7%	23.3%	41.1%	0.0%	99.8%	- Poor data recovery for $PM_{2.5}$, NOx and CO. Faulty $PM_{2.5}$ analyser (software / menu freezing) removed & sent for repair on 24 Apr '18. Repaired / calibrated NOx analyser installed on 18 Apr '18. CO analyser still with service agents awaiting spare part - currently unavailable from US suppliers. Next quarterly SANAS gas analyser calibrations due at end of May 2018.
May-18	100.0%	0.0%	99.8%	0.0%	99.8%	- Quarterly SANAS accredited multipoint gas analyser calibrations performed on 28 May 2018. Excellent data recovery except for CO and $PM_{2.5}$. Order placed for CO analyser repair (new source & detector kit), and faulty $PM_{2.5}$ analyser still offsite being assessed by service agents.
June-18	93.5%	0.0%	87.9%	32.2%	96.6%	- Power failure on 16 June resulted in temporary loss of data. $PM_{2.5}$ analyser offline again all month, service agents have still not identified fault. NOx analyser offline from 16th to 19th as it failed to log data after 16 June power failure until logger manually rebooted. Poor data recovery for CO analyser as installed on 19 June after costly replacement of source & detector system.

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Table B.AAQ.S2.S: Continuous Ambient Monitoring Statistics – Radnor AQMS – Jul2018 to Jun2019

% Data Recovery: "Radnor Old Age Home" Continuous Ambient Air Quality Monitoring Station Data						
Period	PM_{10}	$PM_{2.5}$	NO_X	CO	SO_2	Comments
July-18	100.0%	0.0%	100.0%	100.0%	100.0%	- Excellent data recovery for all analysers except for $PM_{2.5}$, as service agents have still not identified fault. Quarterly SANAS accredited multipoint gas analyser calibrations are scheduled for week beginning 20 Aug 2018.
August-18	90.3%	0.0%	99.9%	99.9%	99.8%	- Excellent data recovery for all analysers except for $PM_{2.5}$ which is now being repaired by service agents. Quarterly SANAS accredited multipoint gas analyser calibrations were performed on 23 Aug '18. PM_{10} data was invalidated for 3 days hence lower than normal PM_{10} data recovery this month.
September-18	100.0%	0.0%	100.0%	100.0%	100.0%	- Excellent data recovery for all analysers except for $PM_{2.5}$ as this analyser is still being repaired by the service agents. The next quarterly SANAS accredited multipoint gas analyser calibrations will be performed in Nov '18.
October-18	100.0%	48.4%	100.0%	99.8%	99.9%	- Excellent data recovery for all analysers except for $PM_{2.5}$ which was installed after repairs (new CPU & high voltage card) on 15 October 2018, hence poor (but improved) data recovery of 48% for $PM_{2.5}$ this month. Quarterly SANAS accredited multipoint gas analyser calibrations are scheduled for next month.
November-18	76.7%	93.3%	93.1%	93.3%	98.3%	- SANAS accredited quarterly gas analyser calibrations were performed this month. Load shedding has impacted negatively upon analysers' data recovery rates this month. Some analysers take longer "to recover" from power outages than other analysers.
December-18	58.1%	60.5%	60.9%	60.6%	54.1%	- Poor data recovery this month due to load shedding & sporadic tripping of UPS / analysers' circuit breaker. Faults related to power outage related faults only identified during routine 2 weekly station maintenance checks as remote data acquisition system (DAS) is faulty.
January-19	45.2%	100.0%	99.9%	99.9%	99.6%	- Data recovery rates improved significantly this month mainly due to no power outages. Poor PM_{10} data recovery rate is attributed to high frequency of invalidated data from erratic analyser outputs. Troubleshooting is currently in progress to identify fault which may be related to moisture entering PM_{10} inlet.
February-19	53.6%	57.1%	97.1%	96.9%	86.9%	- Low data recovery for all gas analysers due to several load shedding power failures this month. Additional data also lost after power restored due to long analyser stabilisation / recovery periods, particularly for the SO_2 analyser. SANAS multipoint gas analyser calibrations performed on 8 Feb 2019. PM_{10} analyser had intermittent fault and $PM_{2.5}$ analyser's filter exchange mechanism was faulty, both faults are being assessed & attended to.
March-19	0.0%	38.7%	56.1%	92.9%	69.9%	- Very poor data recovery for all analysers due to a) several load shedding power failures; b) lengthly stabilisation time (additional data loss) required for some analysers after power restored; c) faulty NOx analyser pump removed for repair on 19 Mar '19; d) faulty PM_{10} and $PM_{2.5}$ analysers removed on 12 Mar '19 for offsite repairs by service agents.
April-19	0.0%	0.0%	95.2%	100.0%	75.1%	- NOx offline since 19 Mar'19 for pump repair / rebuild, re-installed on 2 Apr '19. SO_2 offline 17 to 24 Apr '19 for new pump bearings. PM_{10} and $PM_{2.5}$ SM200 analysers both still offline / offsite for service agent repairs so no data for Apr '19. Annual Opsis SM200 (PM_{10} and $PM_{2.5}$) verification audits to be performed after repairs completed. Quarterly SANAS multipoint gas analyser calibrations due end May '19.
May-19	74.2%	0.0%	99.7%	99.8%	100.0%	- PM_{10} analyser repaired and re-installed on 7 May '19, no real time function. $PM_{2.5}$ analyser repairs completed on 22 May '19, PO & delivery awaited. Annual Opsis SM200 (PM_{10} and $PM_{2.5}$) verification audits were performed after repairs completed. Quarterly SANAS multipoint gas analyser calibrations were performed on 23 May '19.
June-19	96.7%	0.0%	100.0%	100.0%	100.0%	- Excellent data recovery rate for all analysers except for the $PM_{2.5}$ analyser which has been offline for repairs. Repairs now completed, analyser re-installed 4 Jul '19. Quarterly SANAS multipoint gas analyser calibrations due in Aug '19.

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Table B.AAQ.S2.S: Continuous Ambient Monitoring Statistics – Radnor AQMS – Jul2019 to Jun2020

% Data Recovery: "Radnor Old Age Home" Continuous Ambient Air Quality Monitoring Station Data						
Period	PM_{10}	$PM_{2.5}$	NO_X	CO	SO_2	Comments
July-19	87.1%	93.5%	100.0%	100.0%	100.0%	- PM_{10} analyser was faulty / offline for a few days between 4 & 8 Jul '19 until repaired remotely by service agents, hence low data recovery. Repaired $PM_{2.5}$ analyser was installed on 2 Jul '19 hence < 100% data recovery rate for $PM_{2.5}$. Quarterly SANAS multipoint gas analyser calibrations scheduled for mid-Aug '19.
August-19	93.5%	100.0%	99.9%	99.9%	99.7%	- Excellent data recovery rate for all analysers this month. Quarterly SANAS accredited multipoint gas analyser calibrations performed on 16 Aug '19. Next calibrations due in mid Nov '19.
September-19	43.3%	100.0%	100.0%	100.0%	100.0%	- PM_{10} analyser experienced an intermittent fault hence poor data recovery for 24h PM_{10}. $PM_{2.5}$ real time sensor faulty (may require a replacement RTPM sensor) hence limited (13%) real time data recorded in Sep '19. The remaining analysers recorded excellent data recovery rates. Next multipoint gas analyser calibrations due in mid Nov '19.
October-19	58.1%	77.4%	98.0%	97.9%	90.9%	- Only one PM analyser operational now so using this to measure PM_{10}, at the expense of $PM_{2.5}$. Analyser repairs required during low PM season when exceedances are rare and unlikely. Good data recovery for the 3 gas analysers despite several power failures this month. NOx analyser requires new O rings. Very sporadic and limited PM_{10} real time data was recorded this month. Next multipoint gas analyser calibrations due next month.
November-19	3.3%	0.0%	44.3%	44.7%	98.8%	- Quarterly SANAS accredited multipoint gas analyser calibrations performed on 28 Nov '19. Both PM (OPSIS SM200) analysers sent to service agents for repair (and a real time sensor replacement) hence poor data recovery for PM_{10} and $PM_{2.5}$. Poor data recovery for NOX & CO due to intermittent faulty connection between analysers and logger PC. Logger PC's rusted multiport may soon require replacement.
December-19	0.0%	0.0%	94.2%	86.6%	73.1%	- Next quarterly SANAS accredited multipoint gas analyser calibrations due in Feb '20. Both PM (OPSIS SM200) analysers are offline / offsite being assessed by service agents hence zero data recovery for PM_{10} and $PM_{2.5}$. General poor data recovery for all parameters due to load shedding during first half of Dec '19. Poor data recovery for CO and SO_2 as these analysers took longer to recover from power failures than the NOx analyser.
January-20	0.0%	0.0%	97.6%	97.8%	83.1%	- Quarterly SANAS accredited multipoint gas analyser calibrations scheduled for early Feb '20. Quotes received for repairs to both PM (OPSIS SM200) analysers which have been offline / offsite with service agents, approvals awaited. Poor data recovery for SO_2 which takes much longer to recover from power failures than the other analysers.
February-20	0.0%	0.0%	90.8%	90.8%	58.8%	- Quarterly SANAS accredited multipoint gas analyser calibrations done on 10 Feb '20. Next calibrations due in Mar '20. Both of the PM (PM_{10} and $PM_{2.5}$) analysers are offline / offsite with service agents awaiting repair approval, hence zero data recovery rates again for PM_{10} and $PM_{2.5}$. General poor data recovery for all parameters due to load shedding, particularly for SO_2 as this analyser takes longer to recover from power failures.
March-20	0.0%	0.0%	83.2%	83.3%	76.3%	- Next quarterly SANAS accredited multipoint gas analyser calibrations are due in mid May '20. PM_{10} and $PM_{2.5}$ analyser repairs approved and currently in progress. Corona lockdown related delays are inevitable. Poor data recovery for gases due to load shedding again, lower % for SO_2 which takes much longer to recover from power failures than the other analysers.
April-20	0.0%	0.0%	96.8%	96.8%	71.5%	- Quarterly SANAS accredited multipoint gas analyser calibrations are scheduled for mid May '20. Spares for faulty Radnor PM_{10} and $PM_{2.5}$ analysers delayed at customs. Poor data recovery for SO_2 as analyser was removed for repairs on 23 Apr '20 due to faulty PMT. The Covid-19 lockdown is delaying some external repairs and spares so is beginning to impact upon data recovery.
May-20	58.1%	0.0%	90.2%	90.1%	52.0%	- Quarterly SANAS accredited multipoint gas analyser calibrations performed on 15 May '20. PM_{10} analyser repairs completed, with a new real time PM_{10} sensor installed. Analyser re-installed on 12 May '20 so only 58% data recovery for May '20. $PM_{2.5}$ analyser still being repaired by service agents so 0% data recovery. Poor (52%) data recovery for SO_2 as analyser was offline being repaired until re-installed on 14 May '20. Good data recovery for NO_X and CO.
June-20	93.3%	0.0%	100.0%	100.0%	99.5%	- Excellent data recovery rate for all analysers was recorded this month except for the $PM_{2.5}$ analyser for which a replacement pump is still awaited. Quarterly SANAS accredited multipoint gas analyser calibrations are scheduled for mid May '20.

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Table B.AAQ.S2.MA: Monthly Average of Monitored Pollutants – Radnor AQMS – Jul2017 to Jun2018

"Radnor Old Age Home" Continuous Ambient Air Quality Monitoring Station Data (Month Average in µg/m³)					
Period / Unit	PM_{10}	$PM_{2.5}$	NO_X	CO	SO_2
	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³
July-17	43.2	NoData	17.3	740	4.9
August-17	33.2	NoData	15.5	429	8.5
September-17	29.0	NoData	13.4	394	5.7
October-17	20.6	NoData	11.7	544	4.6
November-17	20.2	NoData	10.0	273	3.7
December-17	12.1	NoData	8.7	308	2.4
January-18	17.0	8.6	5.8	NoData	3.1
February-18	16.3	6.9	8.8	NoData	3.3
March-18	13.2	7.4	NoData	NoData	2.0
April-18	18.8	9.1	13.0	NoData	3.5
May-18	27.9	NoData	17.0	NoData	4.6
June-18	44.5	NoData	19.0	289	6.7

Table B.AAQ.S2.MA: Monthly Average of Monitored Pollutants – Radnor AQMS – Jul2018 to Jun2019

"Radnor Old Age Home" Continuous Ambient Air Quality Monitoring Station Data (Month Average in µg/m³)					
Period / Unit	PM_{10}	$PM_{2.5}$	NO_X	CO	SO_2
	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³
July-18	42.5	NoData	20.1	325	9.0
August-18	28.2	NoData	15.3	350	6.3
September-18	24.9	NoData	14.0	413	6.6
October-18	25.0	8.9	10.6	365	7.1
November-18	23.1	12.7	7.6	343	2.6
December-18	15.5	10.5	11.5	285	2.3
January-19	13.7	7.1	6.9	328	2.2
February-19	15.7	9.7	5.8	336	1.6
March-19	NoData	6.8	5.8	335	2.3
April-19	NoData	NoData	12.2	265	3.1
May-19	40.8	NoData	12.6	266	3.1
June-19	40.8	NoData	16.4	359	7.9

Table B.AAQ.S2.MA: Monthly Average of Monitored Pollutants – Radnor AQMS – Jul2019 to Jun2020

"Radnor Old Age Home" Continuous Ambient Air Quality Monitoring Station Data (Month Average in µg/m³)					
Period / Unit	PM_{10}	$PM_{2.5}$	NO_X	CO	SO_2
	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³
July-19	65.6	27.3	18.3	429	12.2
August-19	29.0	15.5	15.0	410	7.6
September-19	31.8	8.7	12.9	330	6.0
October-19	25.2	9.8	12.9	312	5.1
November-19	23.0	NoData	18.0	290	5.0
December-19	NoData	NoData	11.3	318	2.7
January-20	NoData	NoData	9.7	313	3.2
February-20	NoData	NoData	11.8	326	3.2
March-20	NoData	NoData	13.6	249	6.3
April-20	NoData	NoData	6.9	254	2.5
May-20	33.7	NoData	16.2	324	5.0
June-20	39.7	NoData	17.7	511	5.6

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B.AAQ.2 Monitored Pollutant Concentrations in Ambient Air for the period July 2017 to June 2020

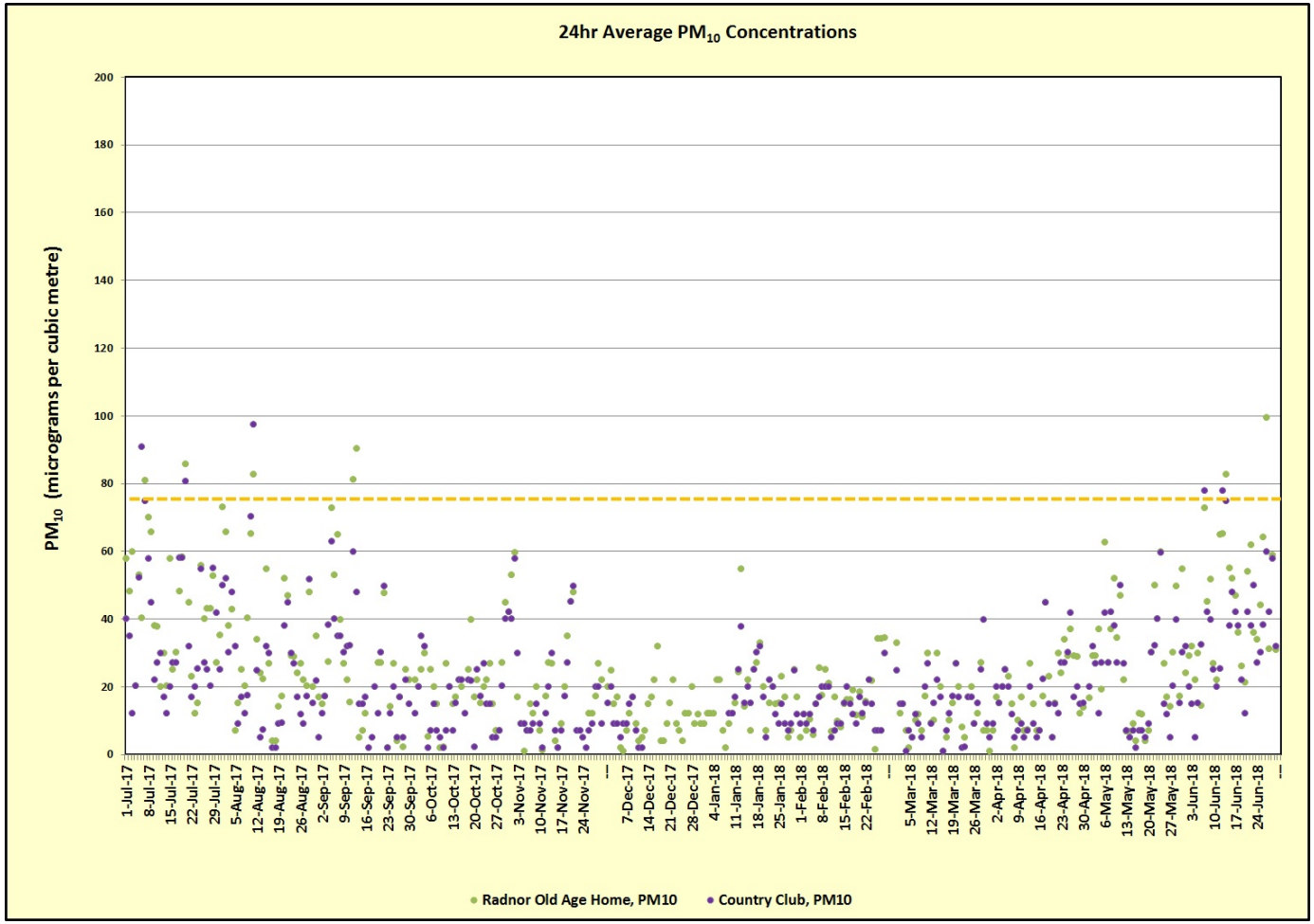


Figure B.AAQ.S.PM$_{10}$-24h: 24-hr Average PM$_{10}$ – Jul2017 to Jun2018

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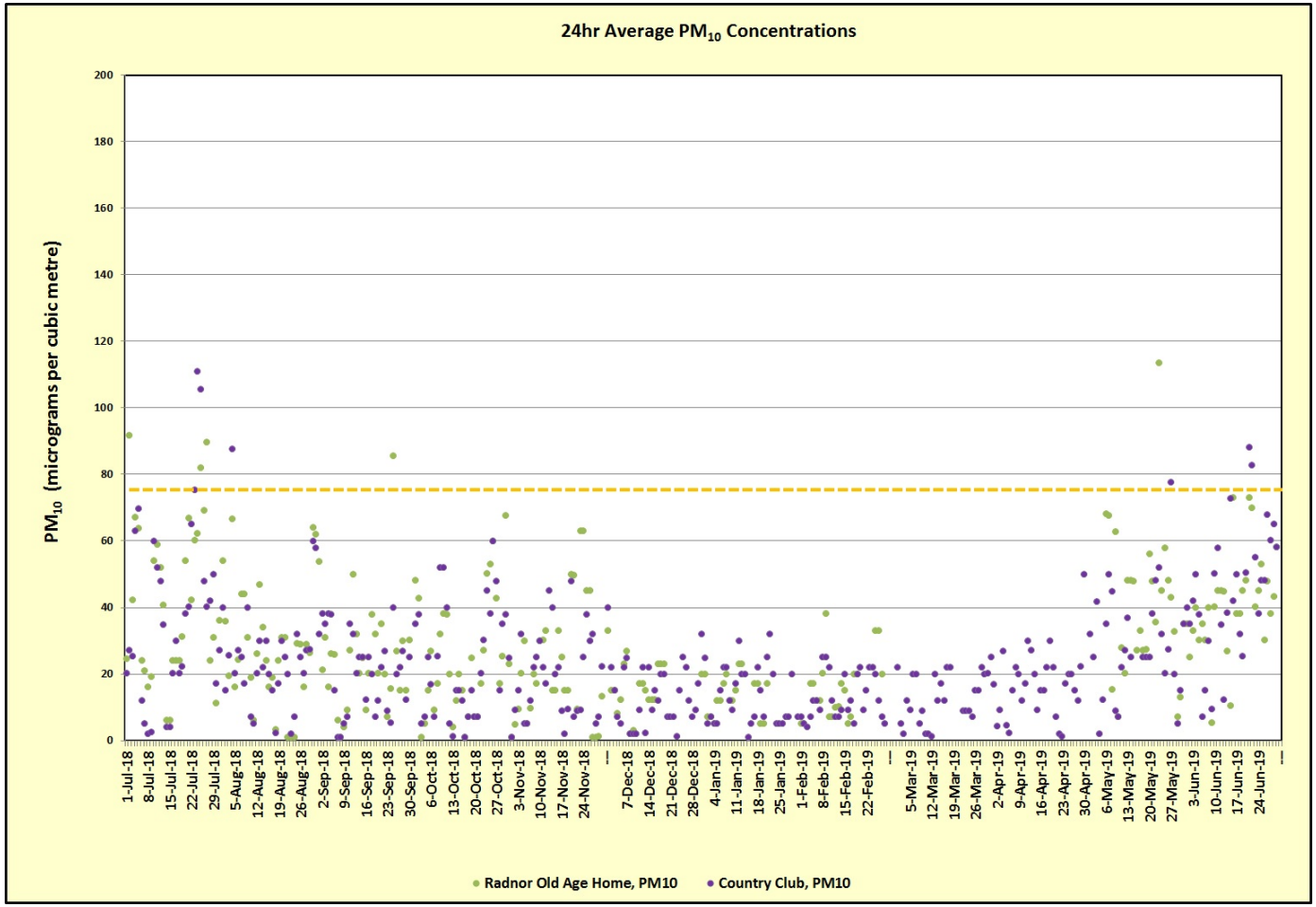


Figure B.AAQ.S.PM$_{10}$-24h: 24-hr Average PM$_{10}$ – Jul2018 to Jun2019

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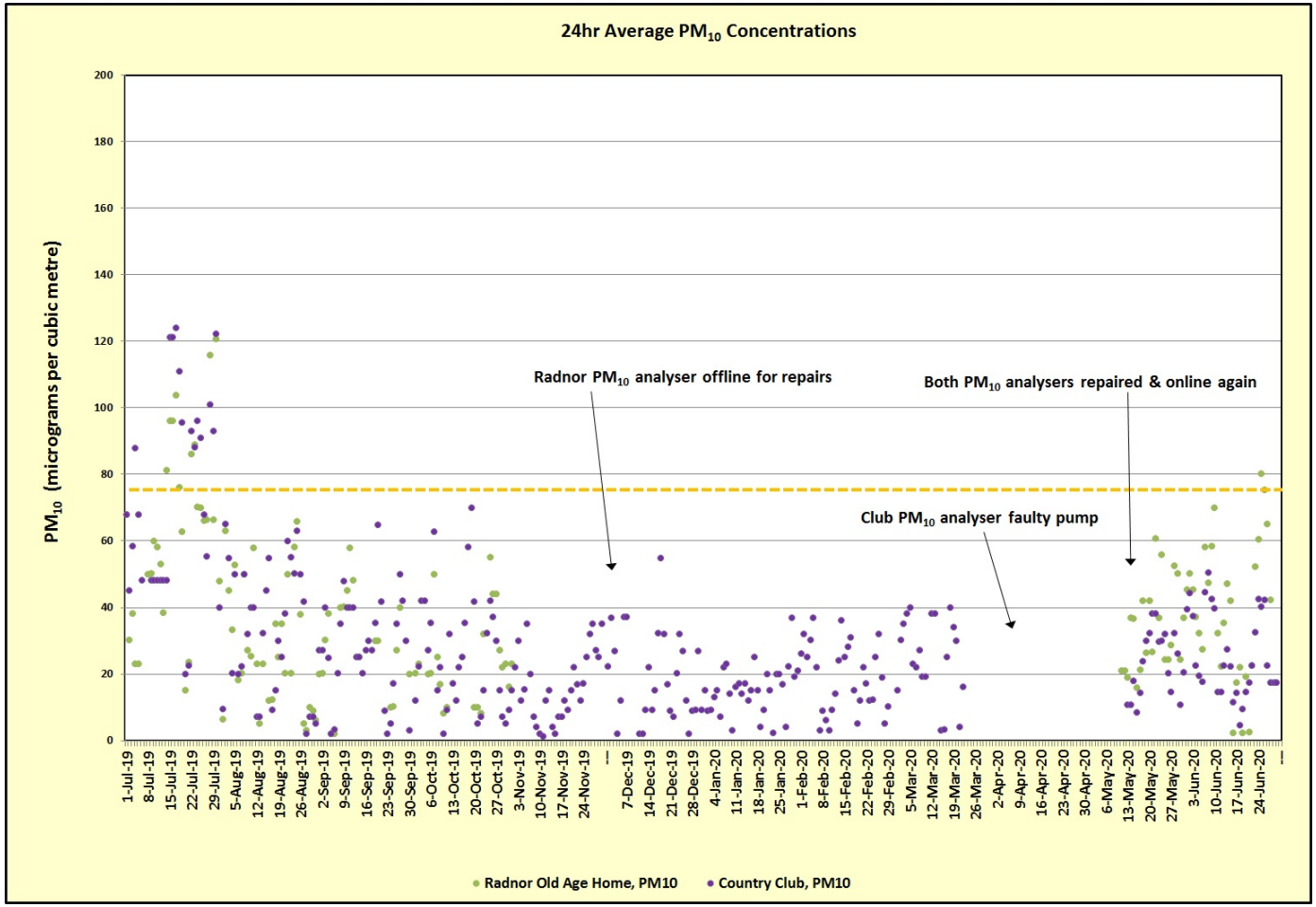


Figure B.AAQ.S.PM$_{10}$-24h: 24-hr Average PM$_{10}$ – Jul2019 to Jun2020

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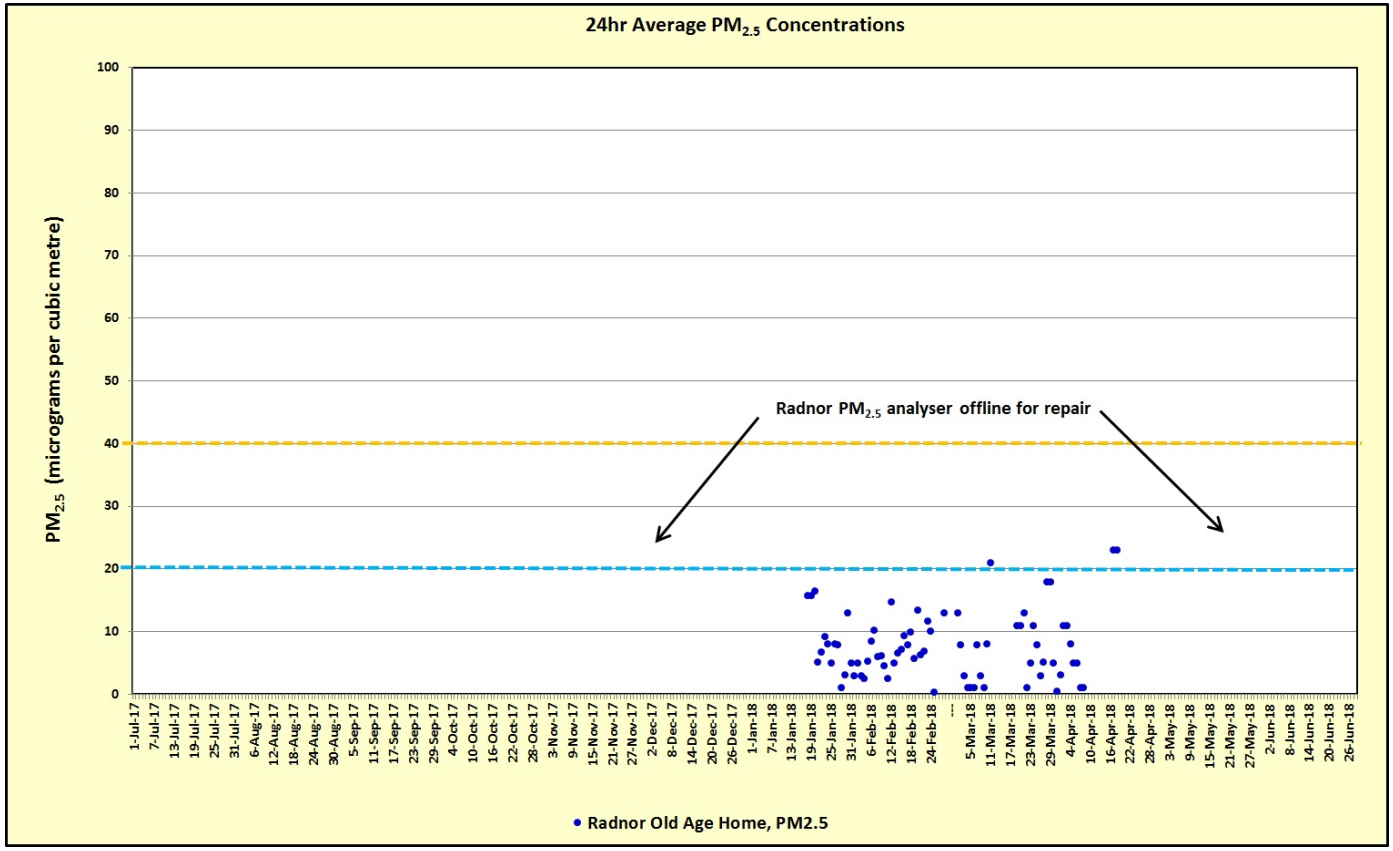


Figure B.AAQ.S.PM$_{2.5}$-24h: 24-hr Average PM$_{2.5}$ – Jul2017 to Jun2018

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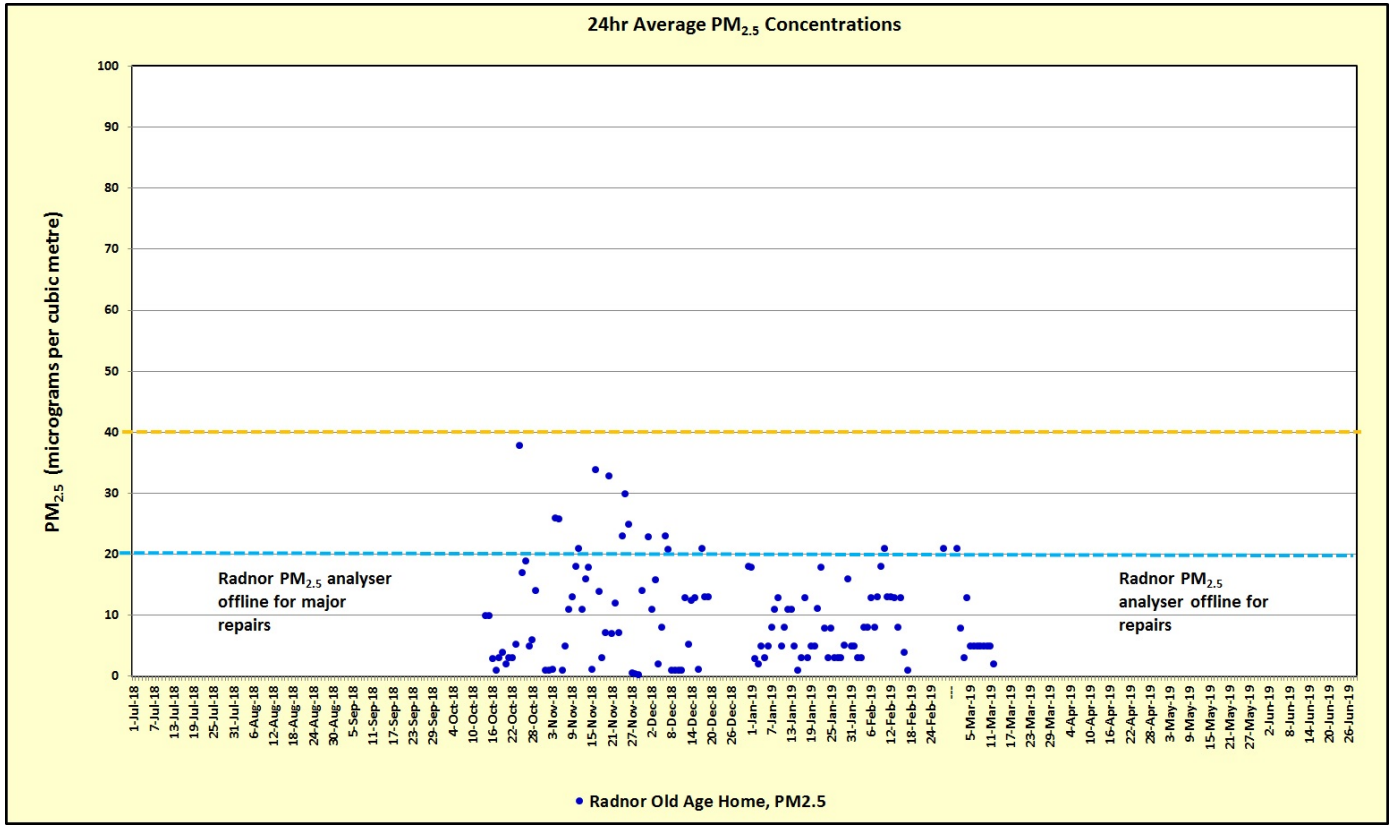


Figure B.AAQ.S.PM$_{2.5}$-24h: 24-hr Average PM$_{2.5}$ – Jul2018 to Jun2019

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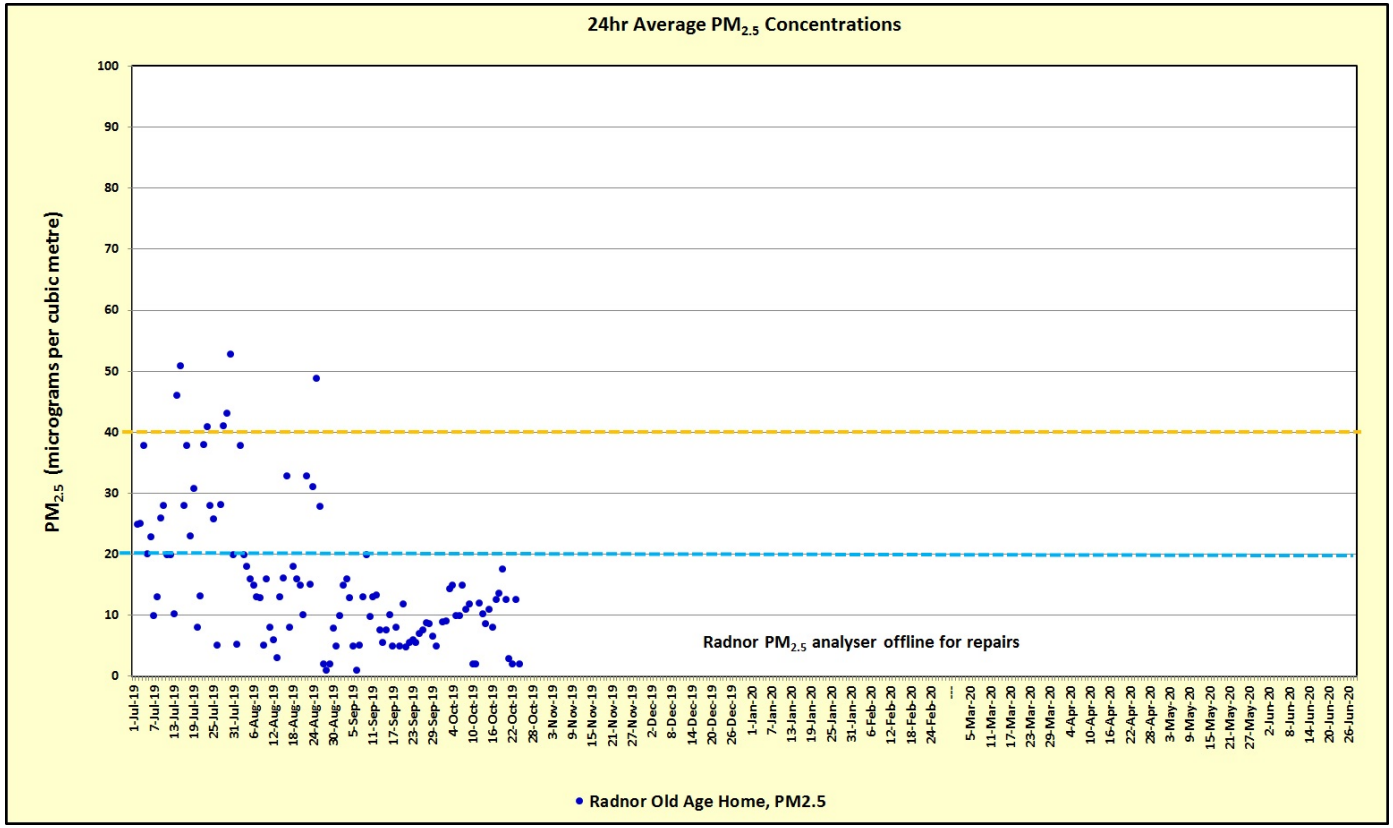


Figure B.AAQ.S.PM$_{2.5}$-24h: 24-hr Average PM$_{2.5}$ – Jul2019 to Jun2020

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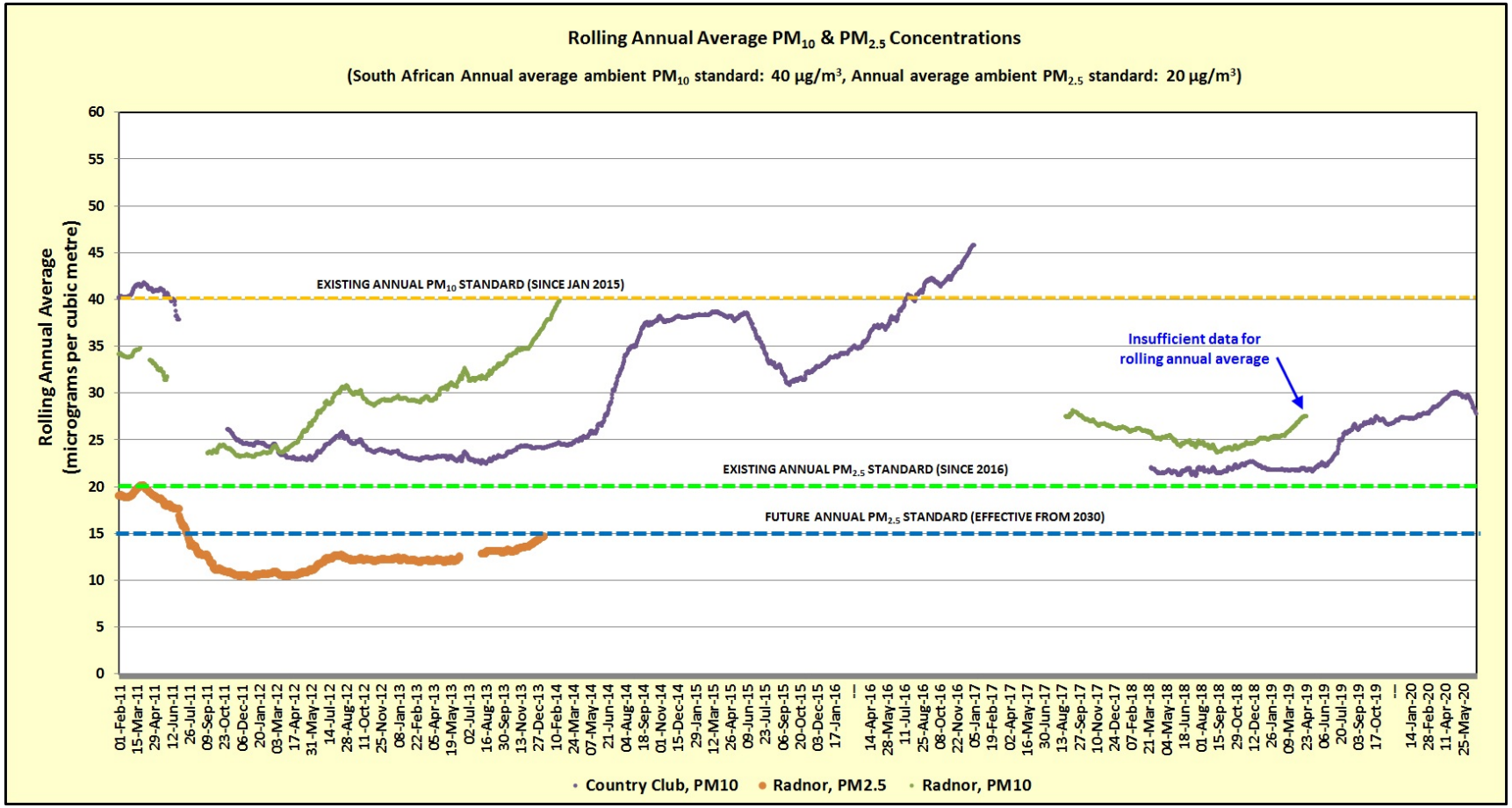


Figure B.AAQ.S.PM$_{10}$&PM$_{2.5}$-Ann: Rolling Annual Averages for PM$_{10}$ and PM$_{2.5}$ – till end Jun2020

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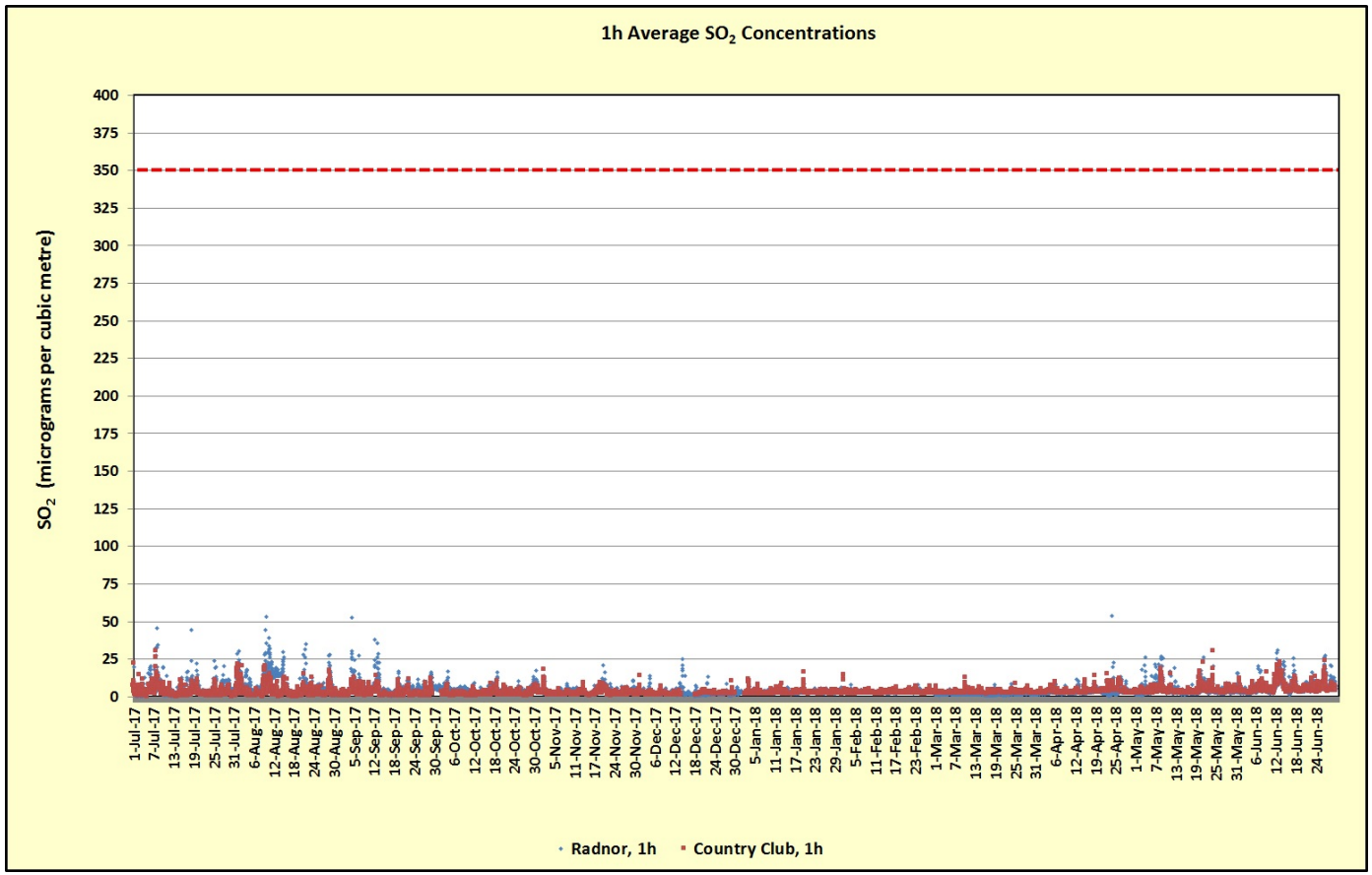


Figure B.AAQ.S.SO₂-1h: 1-hr Average SO_2 – Jul2017 to Jun2018

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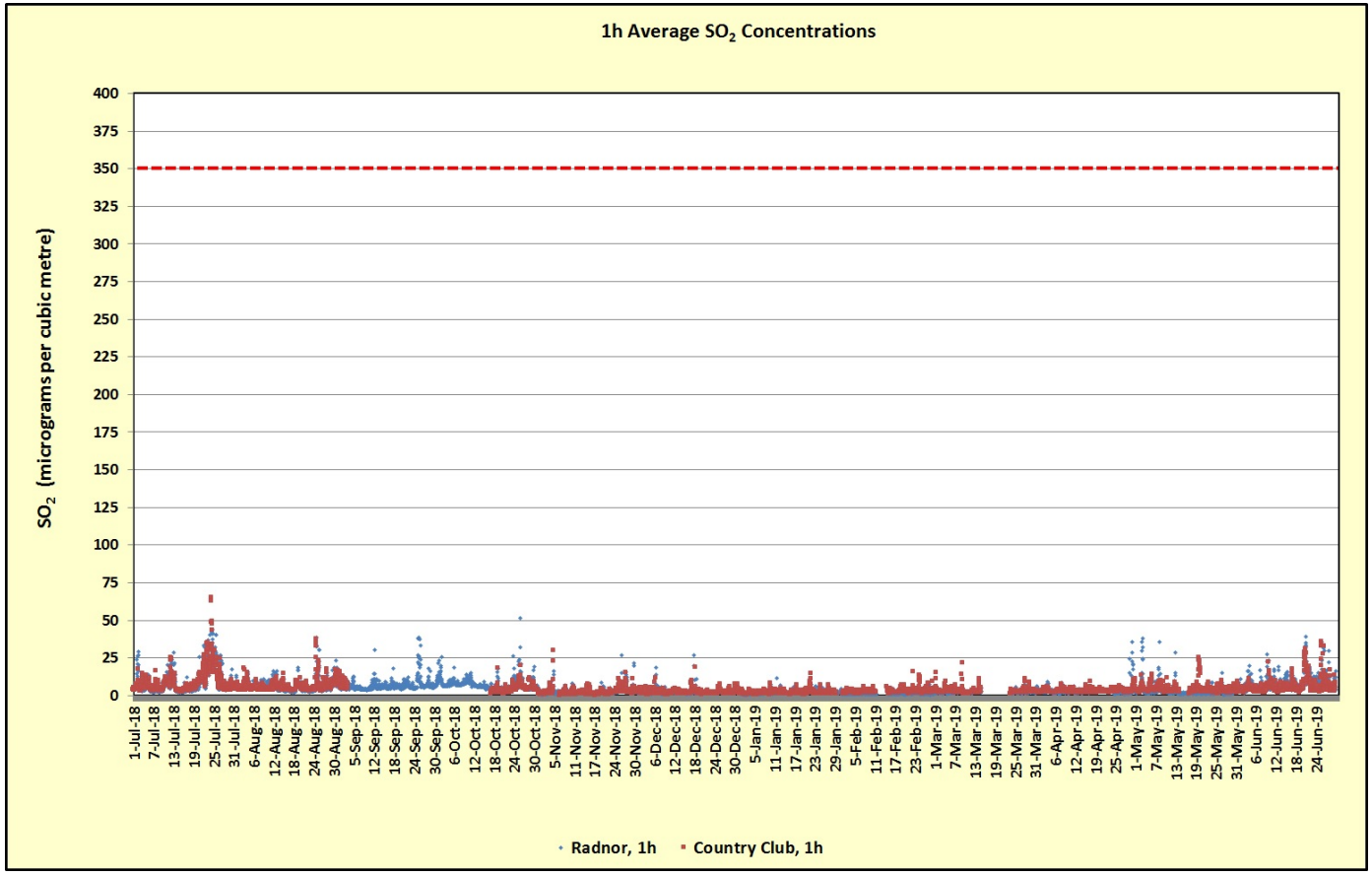


Figure B.AAQ.S.SO₂-1h: 1-hr Average SO_2 – Jul2018 to Jun2019

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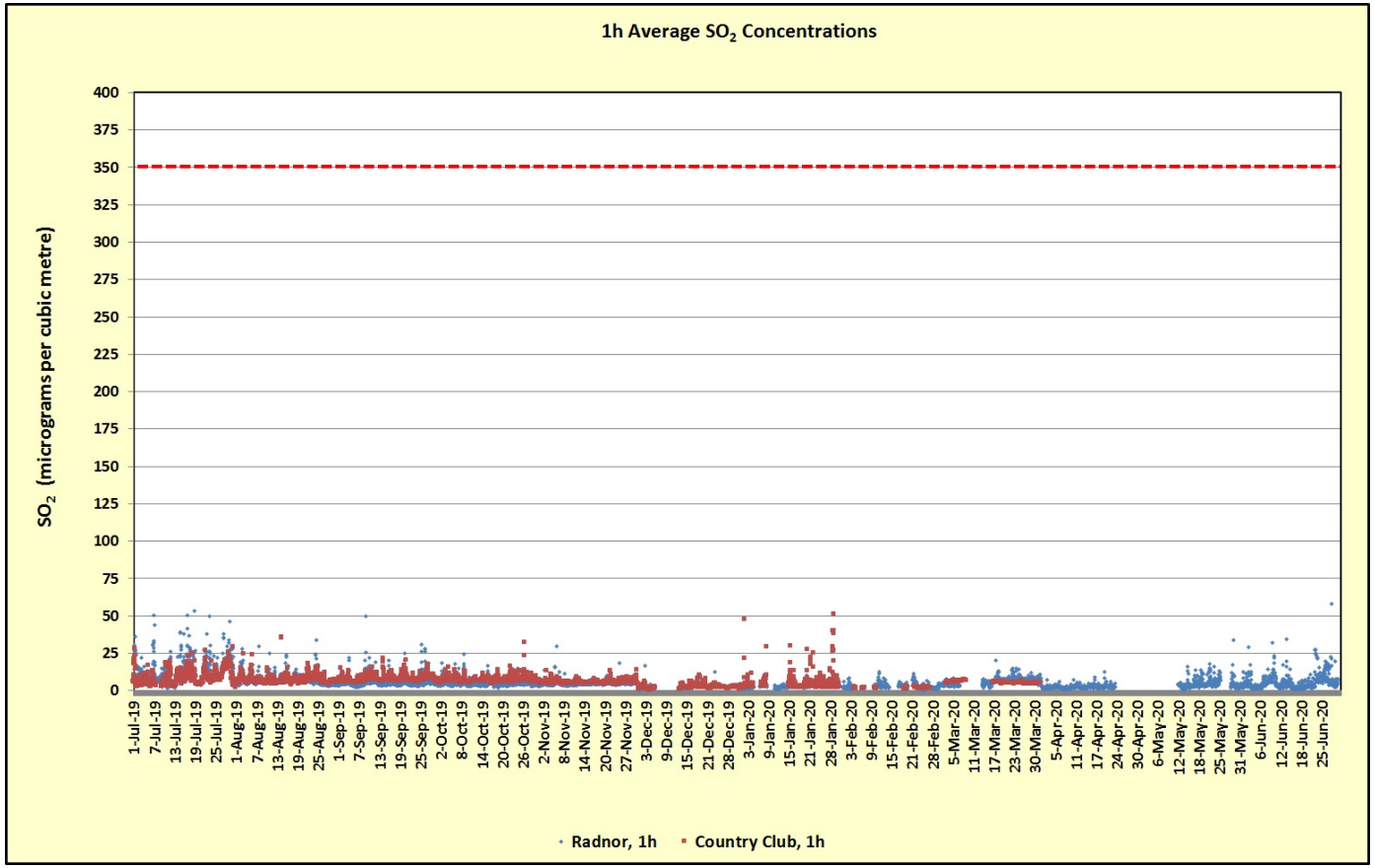


Figure B.AAQ.S.SO₂-1h: 1-hr Average SO_2 – Jul2019 to Jun2020

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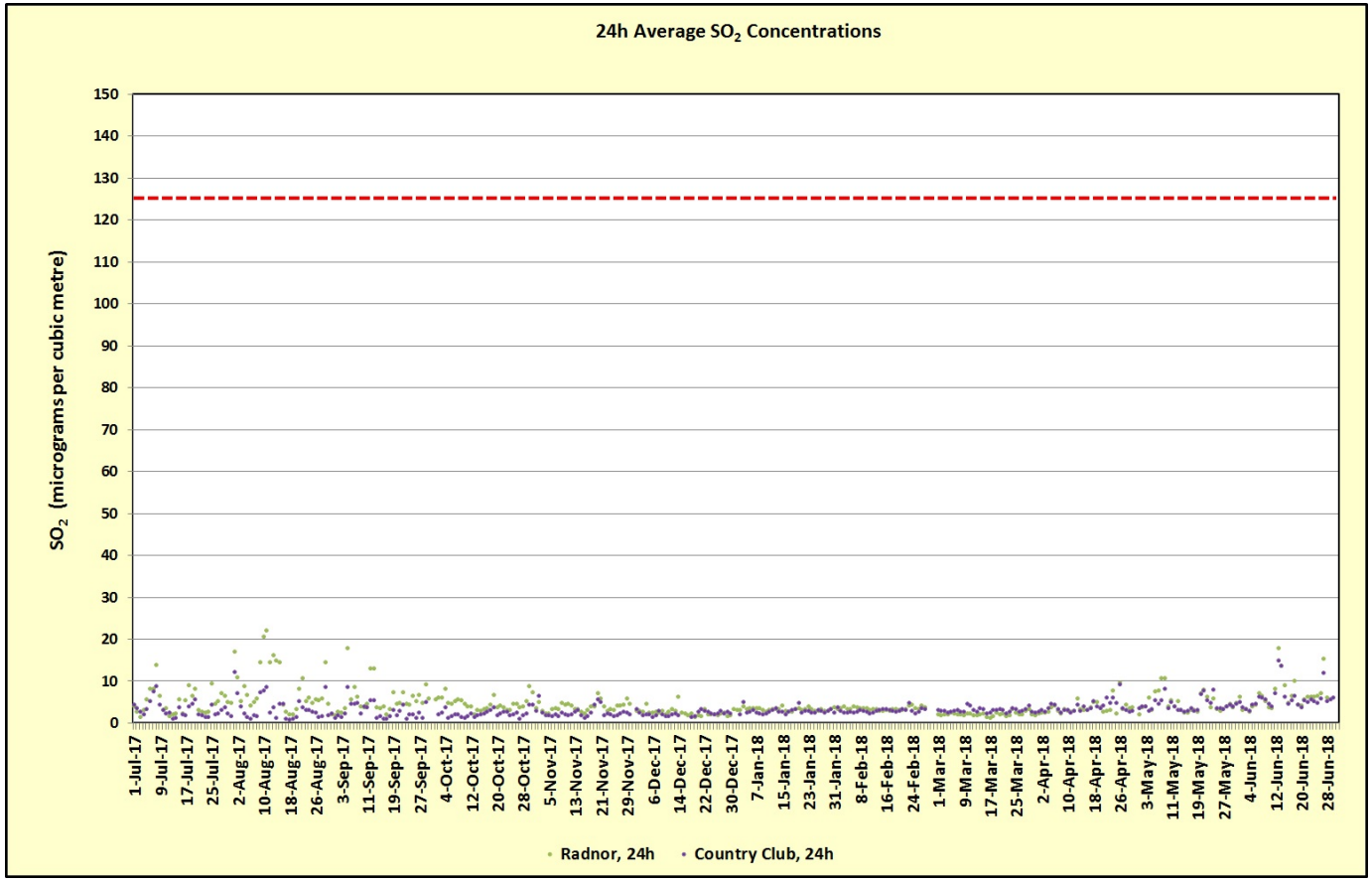


Figure B.AAQ.S.SO_2-24h: 24-hr Average SO_2 – Jul2017 to Jun2018

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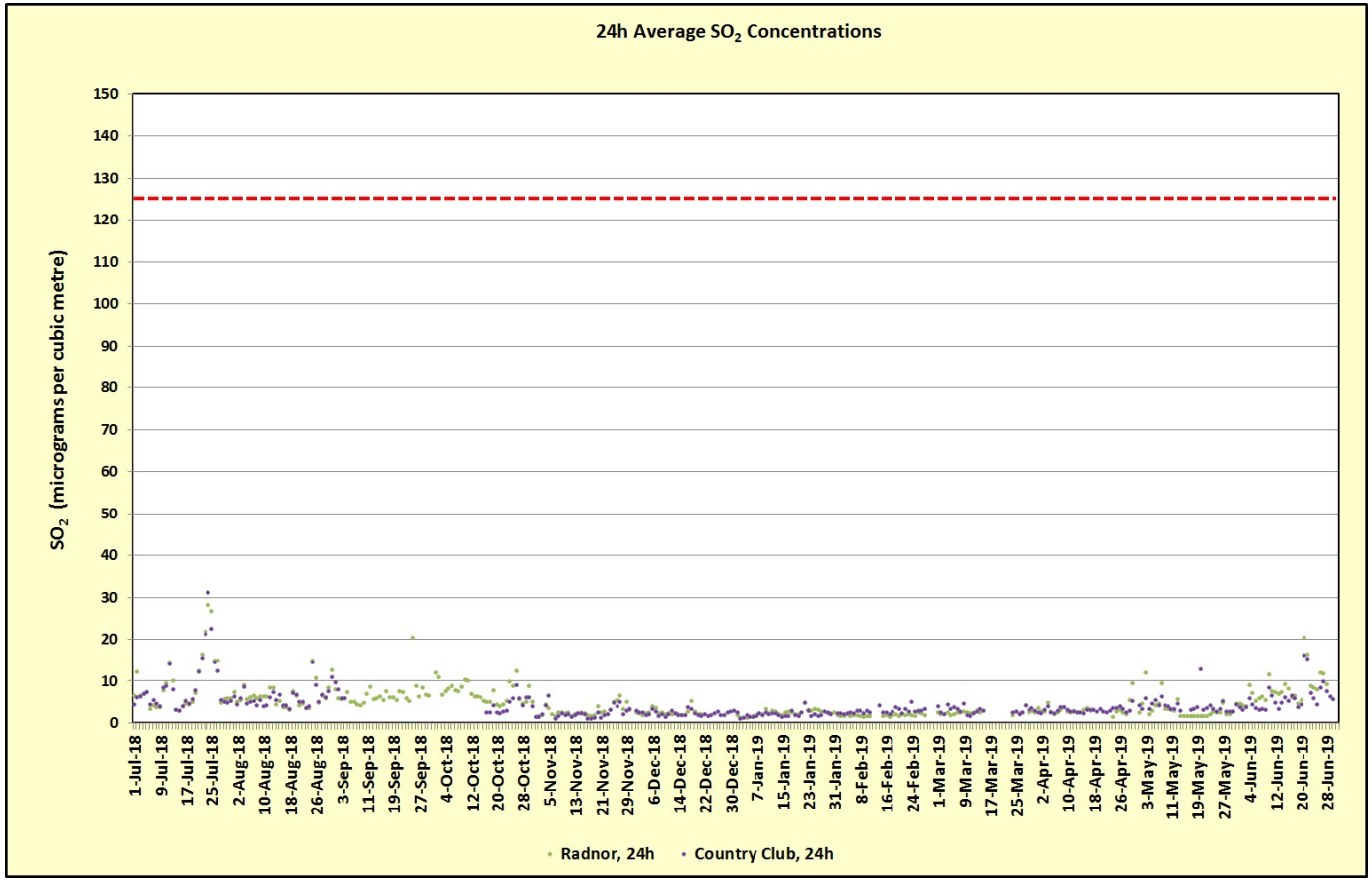


Figure B.AAQ.S.SO₂-24h: 24-hr Average SO_2 – Jul2018 to Jun2019

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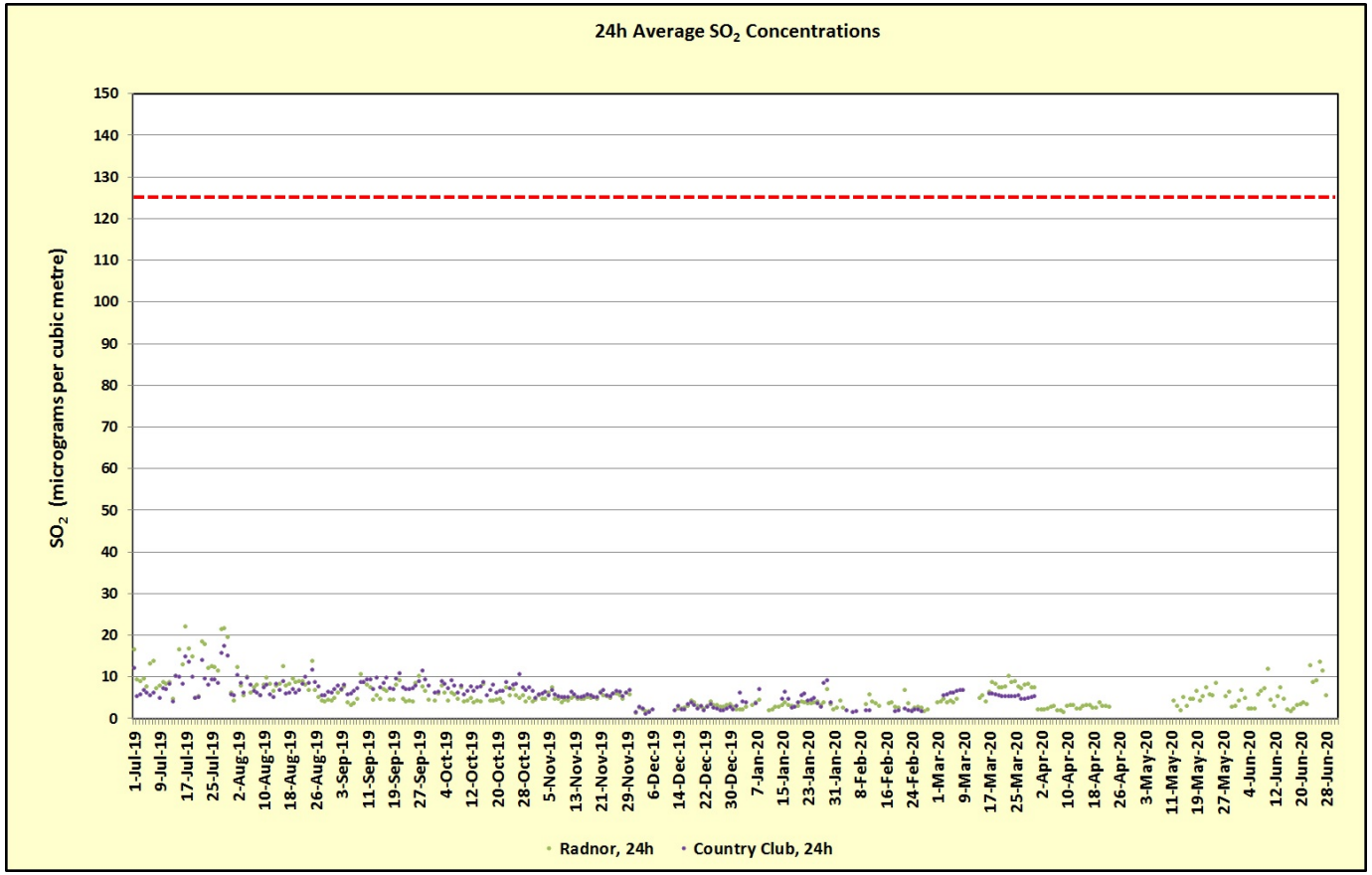


Figure B.AAQ.S.SO₂-24h: 24-hr Average SO_2 – Jul2019 to Jun2020

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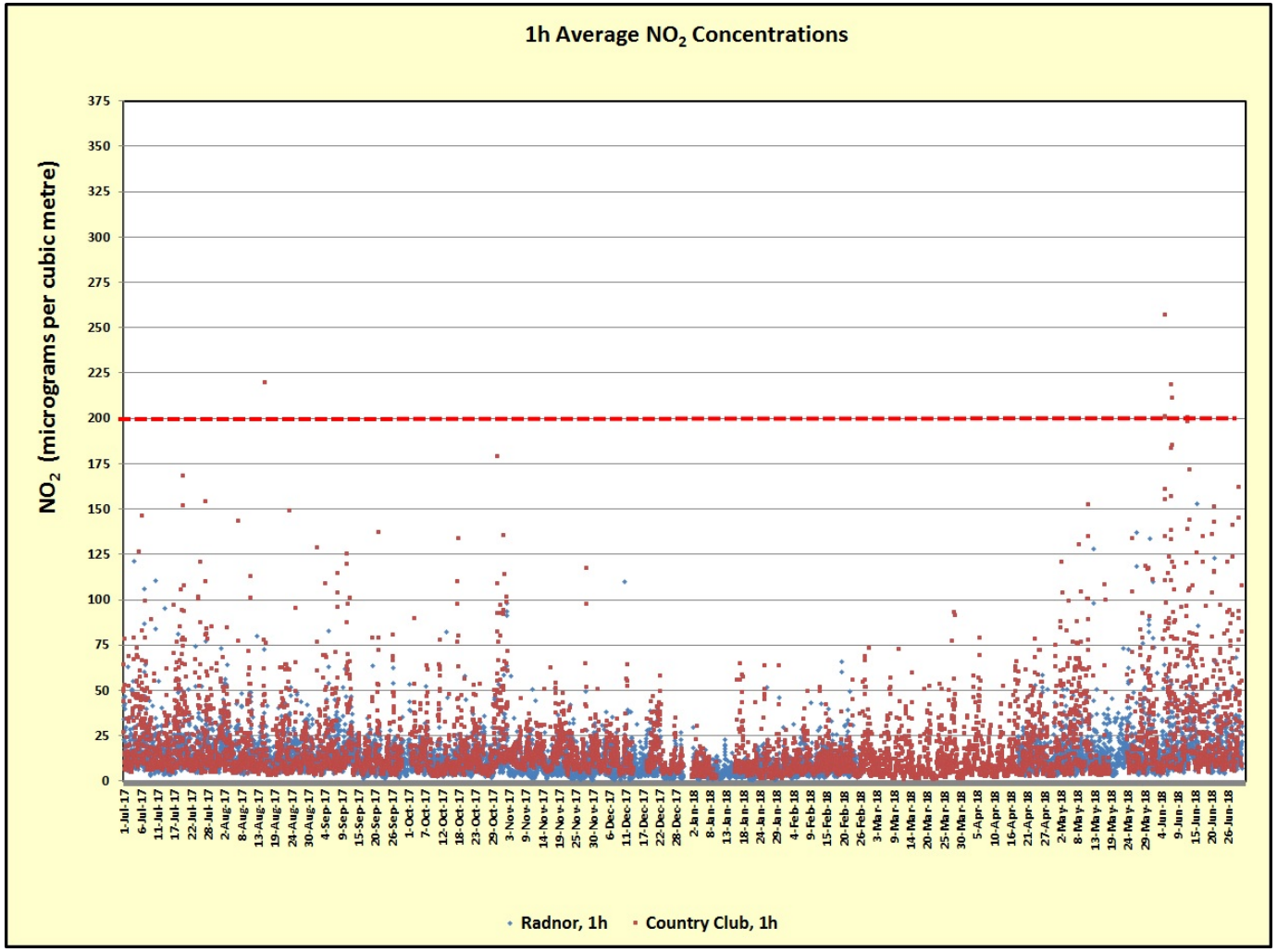


Figure B.AAQ.S.NO_2-1h: 1-hr Average NO_2 – Jul2017 to Jun2018

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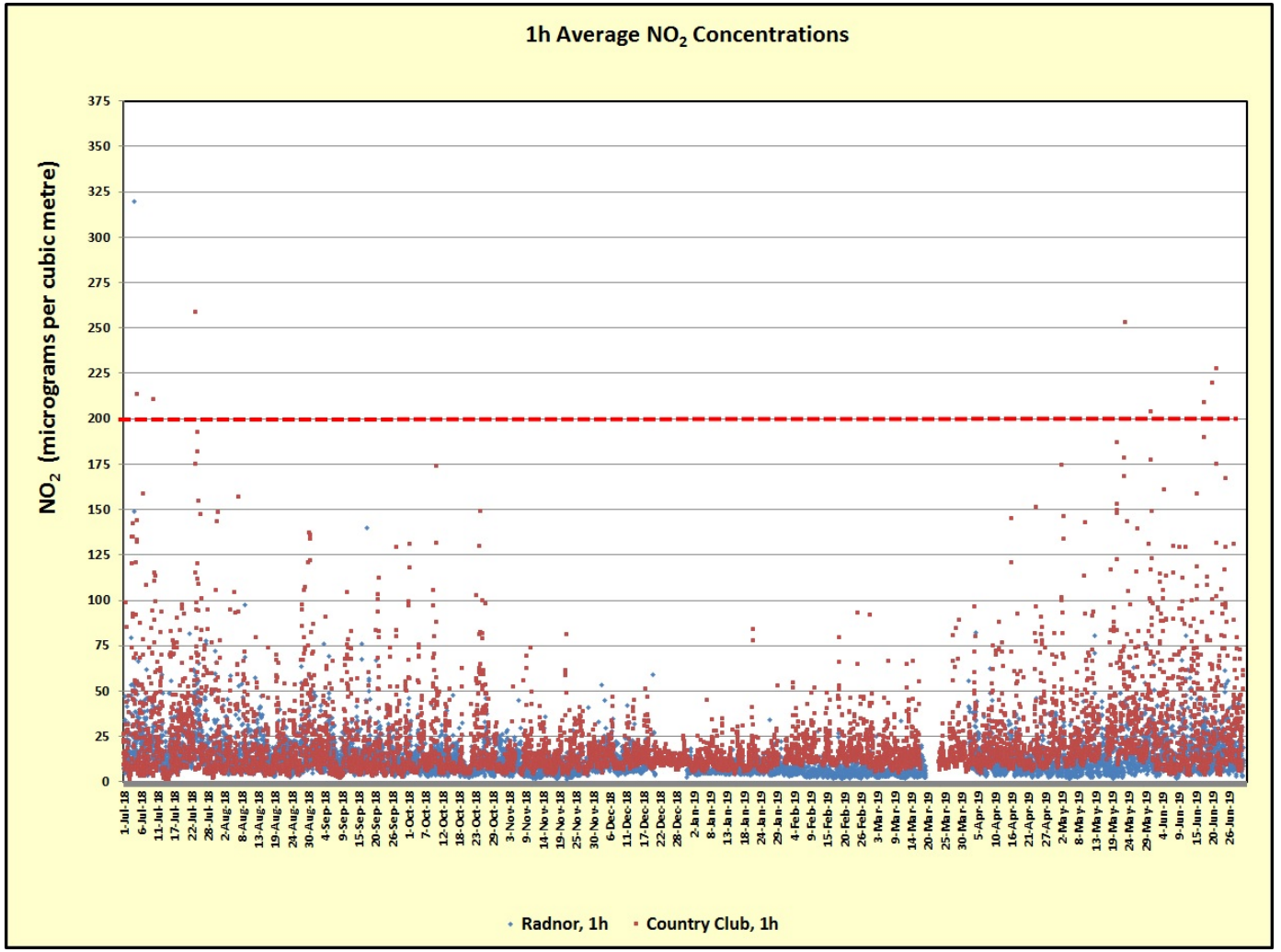


Figure B.AAQ.S.NO$_2$-1h: 1-hr Average NO_2 – Jul2018 to Jun2019

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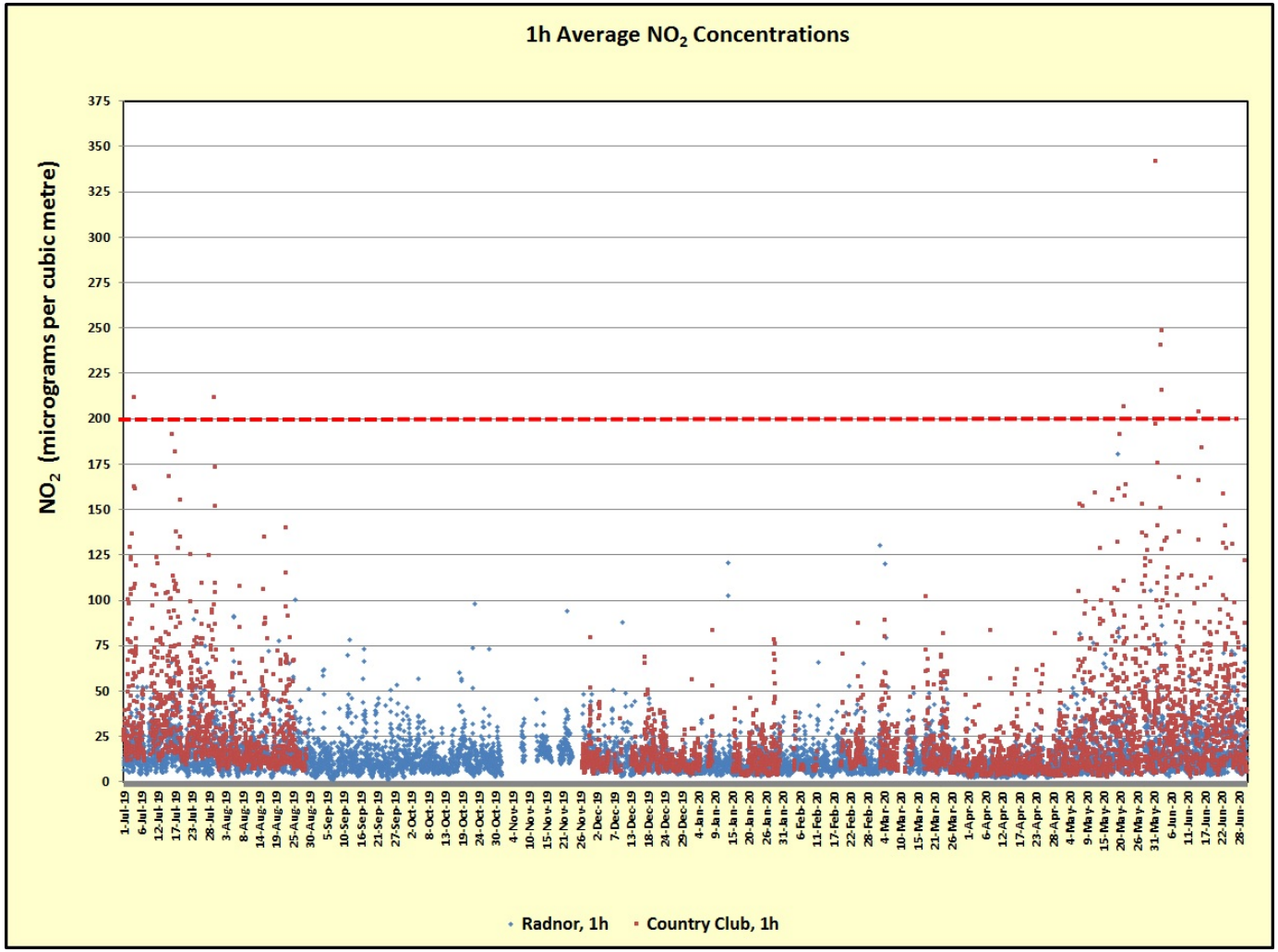


Figure B.AAQ.S.NO_2-1h: 1-hr Average NO_2 – Jul2019 to Jun2020

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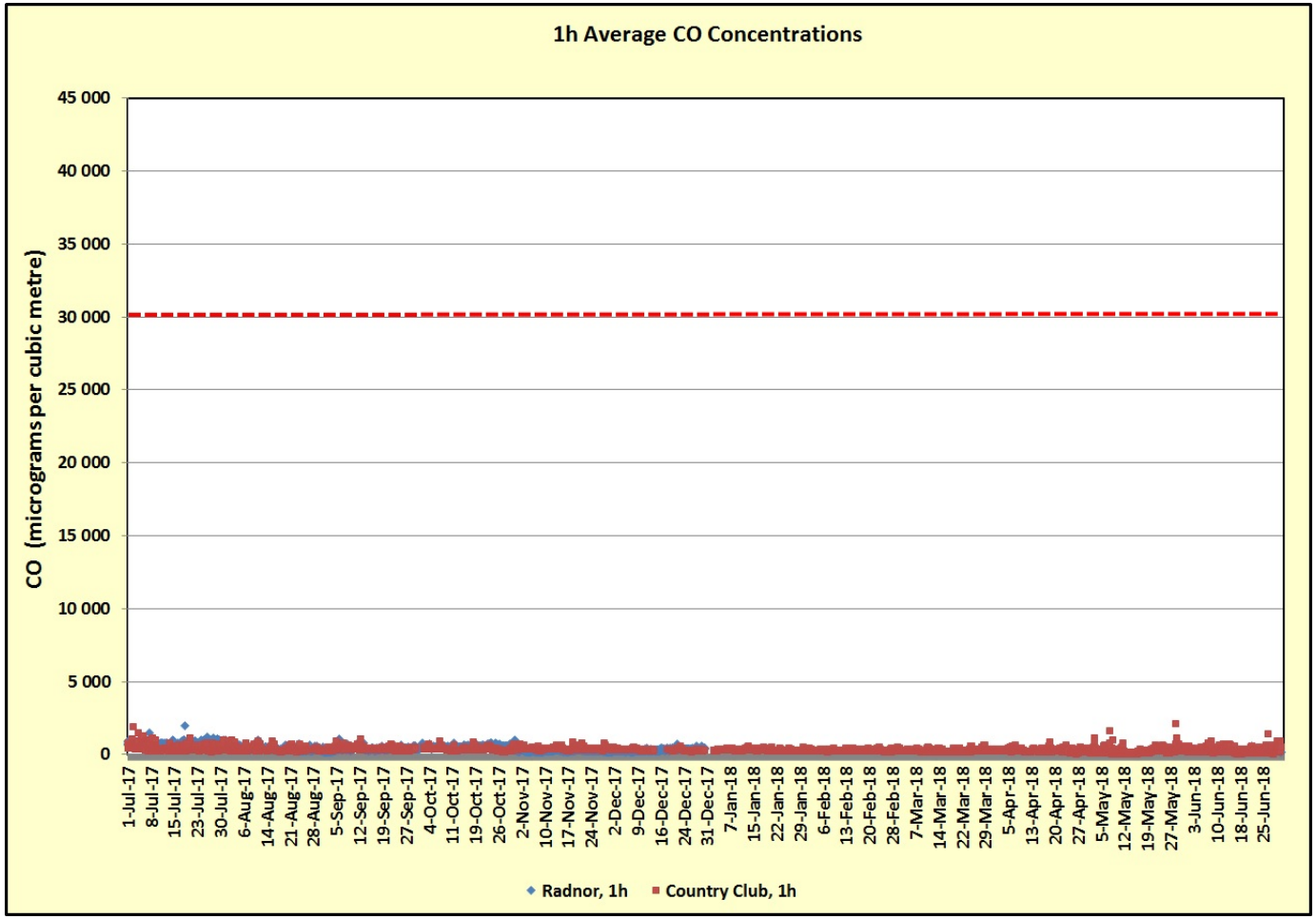


Figure B.AAQ.S.CO-1h: 1-hr Average CO – Jul2017 to Jun2018

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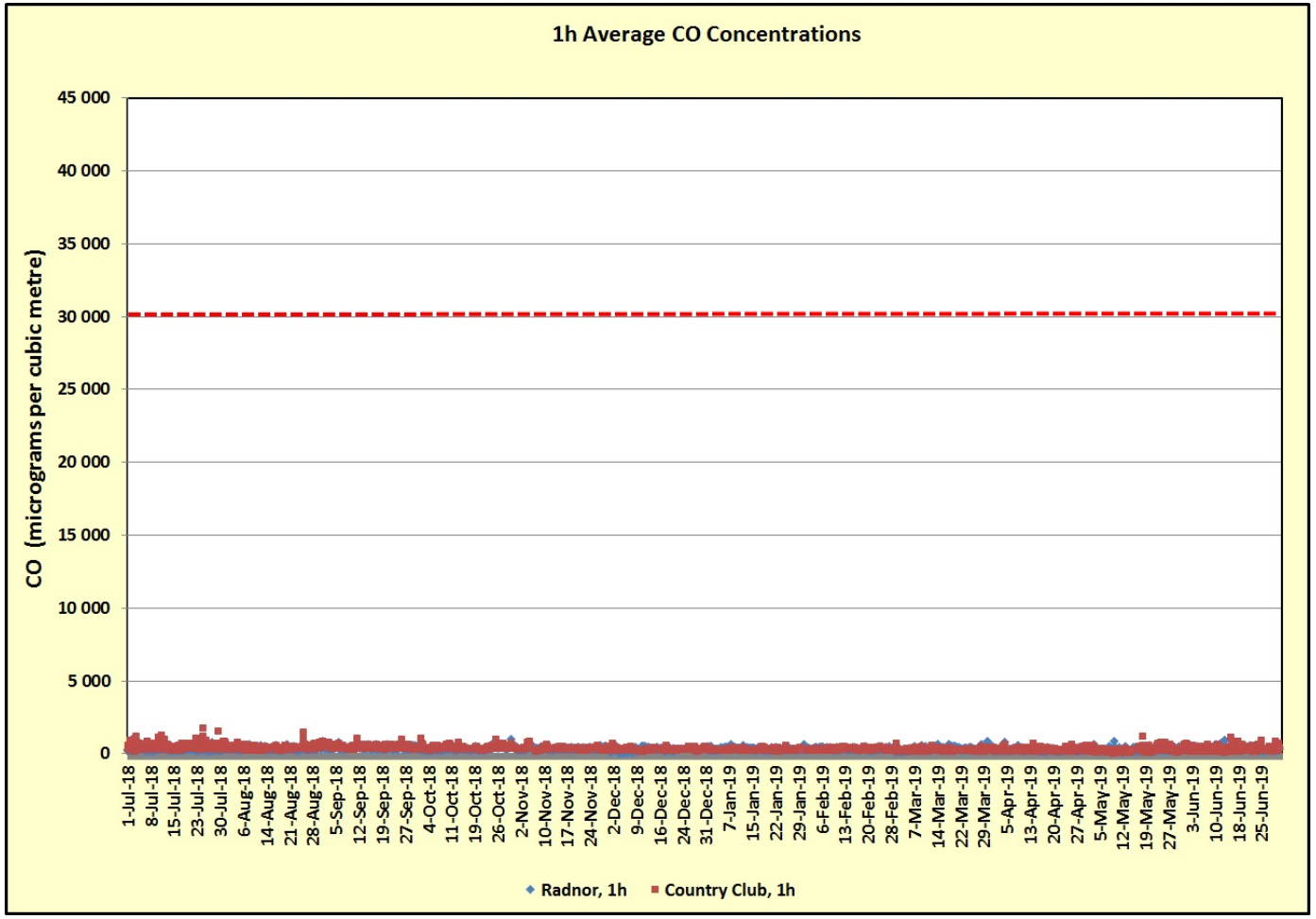


Figure B.AAQ.S.CO-1h: 1-hr Average CO – Jul2018 to Jun2019

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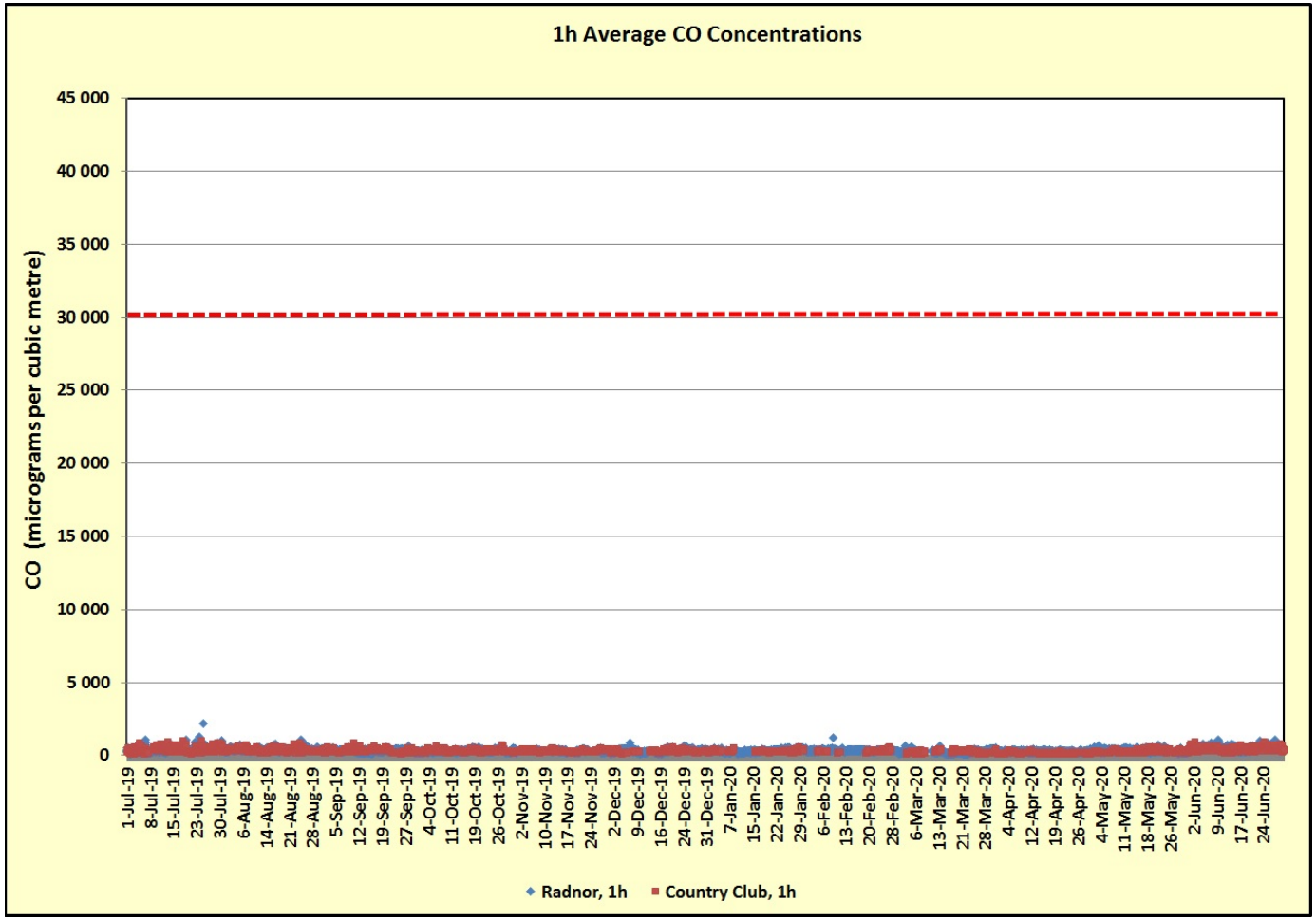


Figure B.AAQ.S.CO-1h: 1-hr Average CO – Jul2019 to Jun2020

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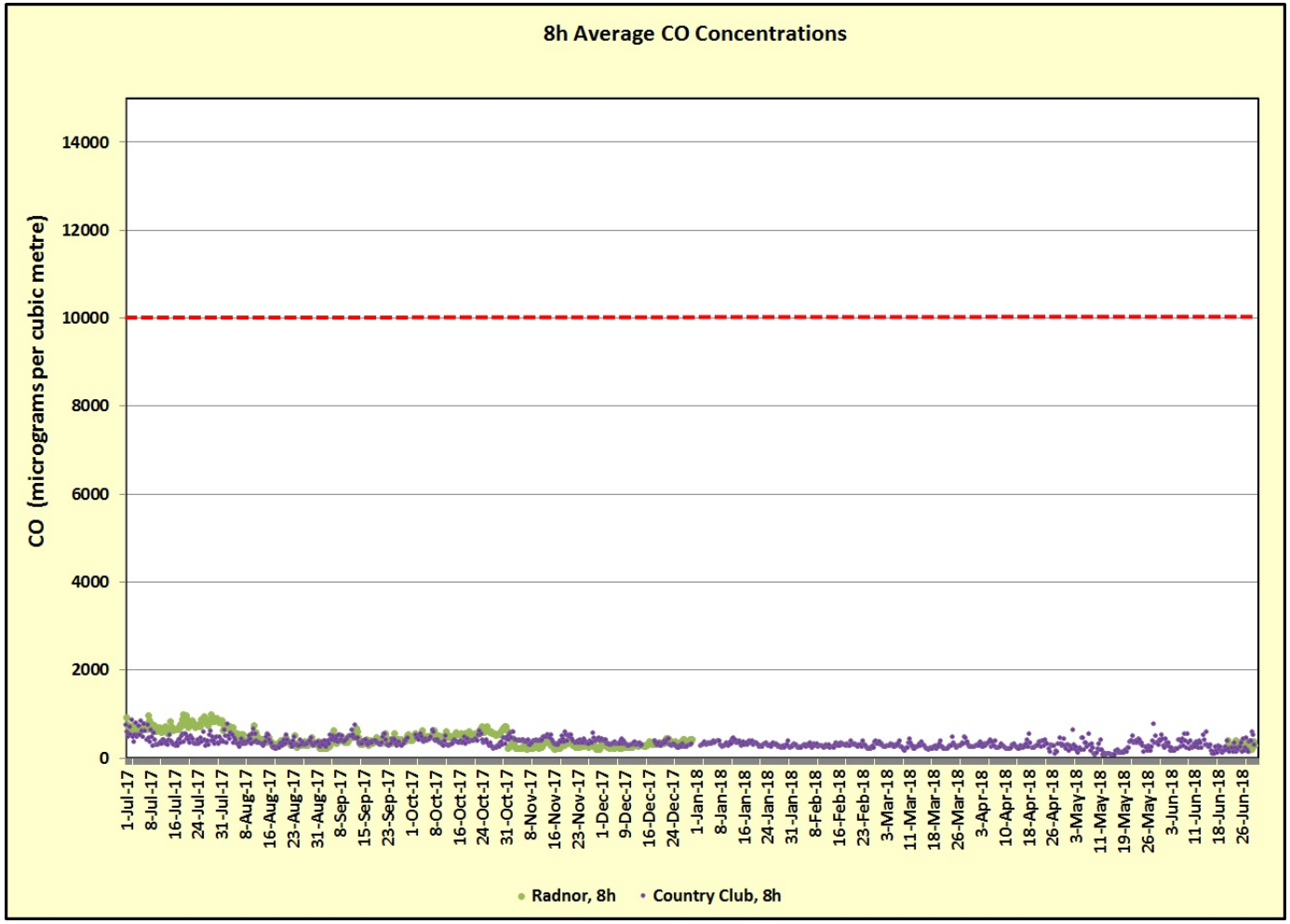


Figure B.AAQ.S.CO-8h: 8-hr Average CO – Jul2017 to Jun2018

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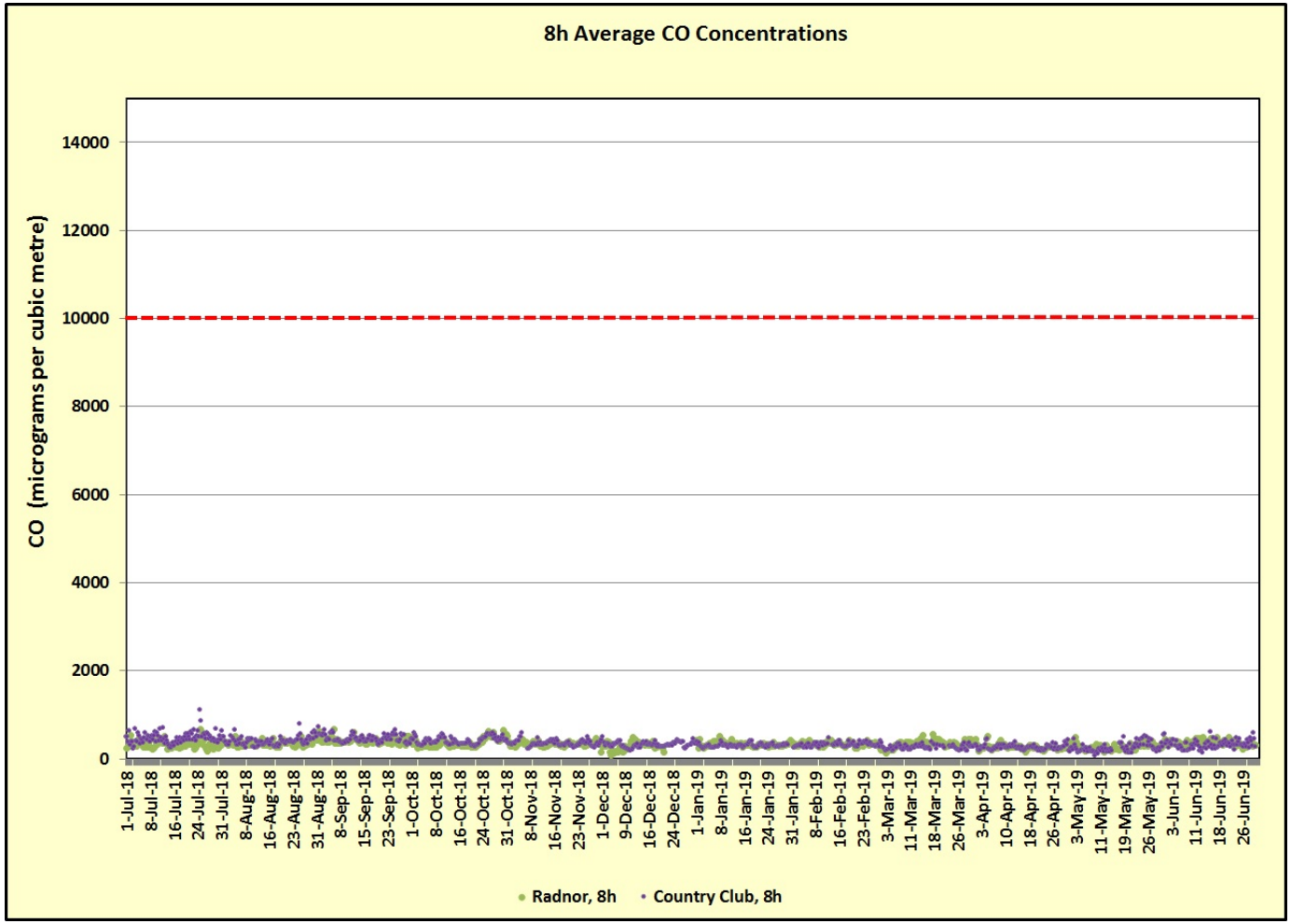


Figure B.AAQ.S.CO-8h: 8-hr Average CO – Jul2018 to Jun2019

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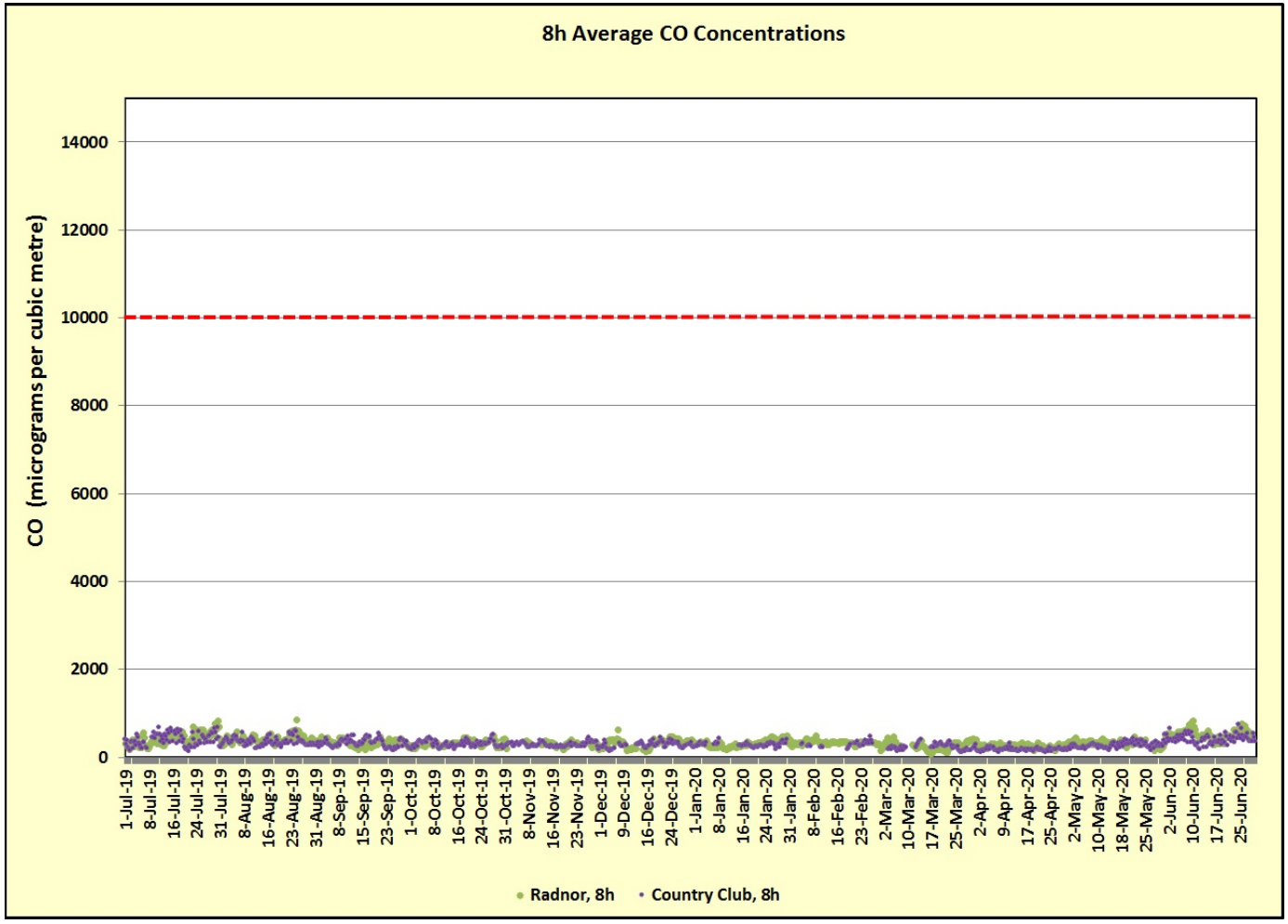


Figure B.AAQ.S.CO-8h: 8-hr Average CO – Jul2019 to Jun2020

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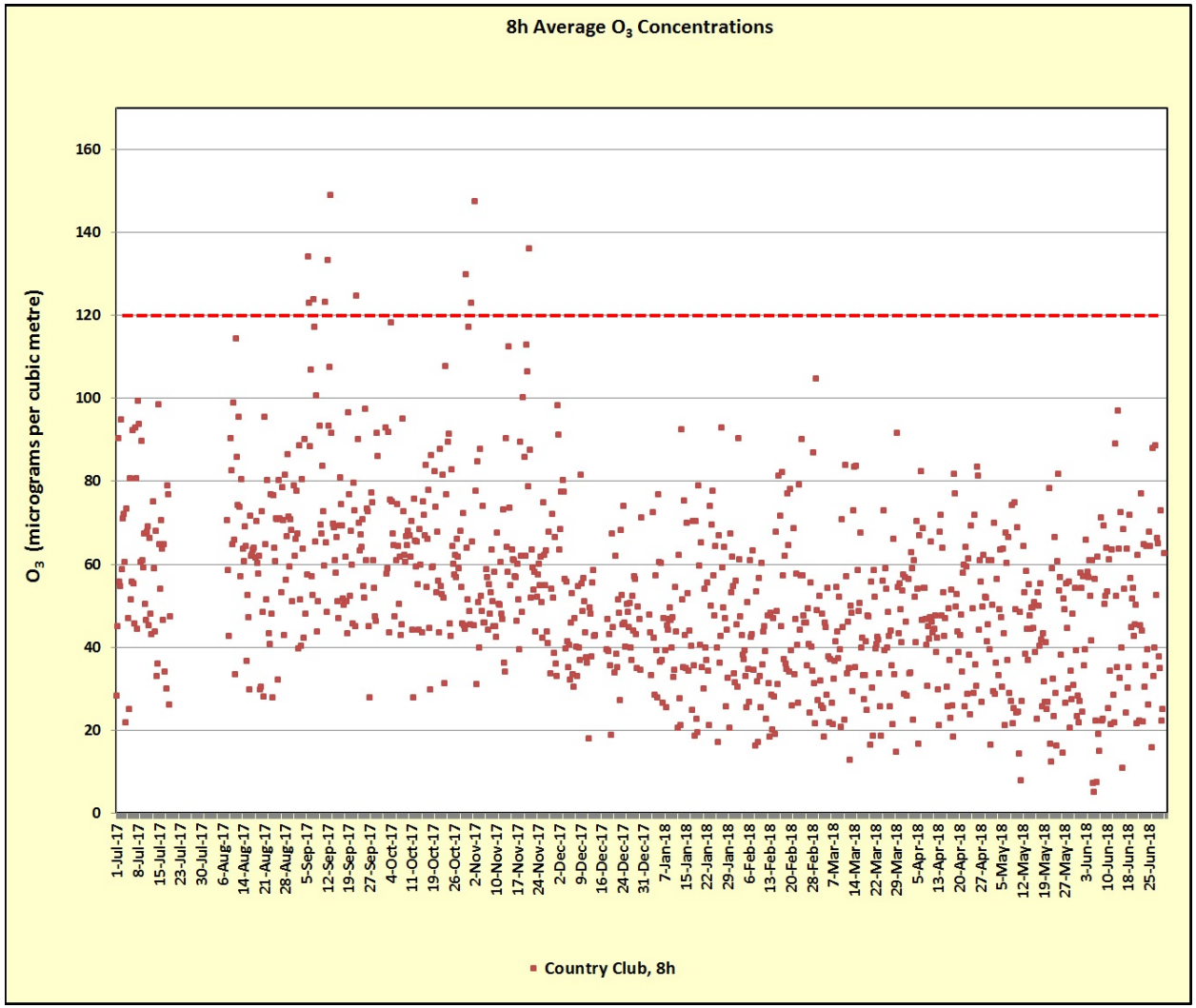


Figure B.AAQ.S.O3-8h: 8-hr Average O_3 – Jul2017 to Jun2018

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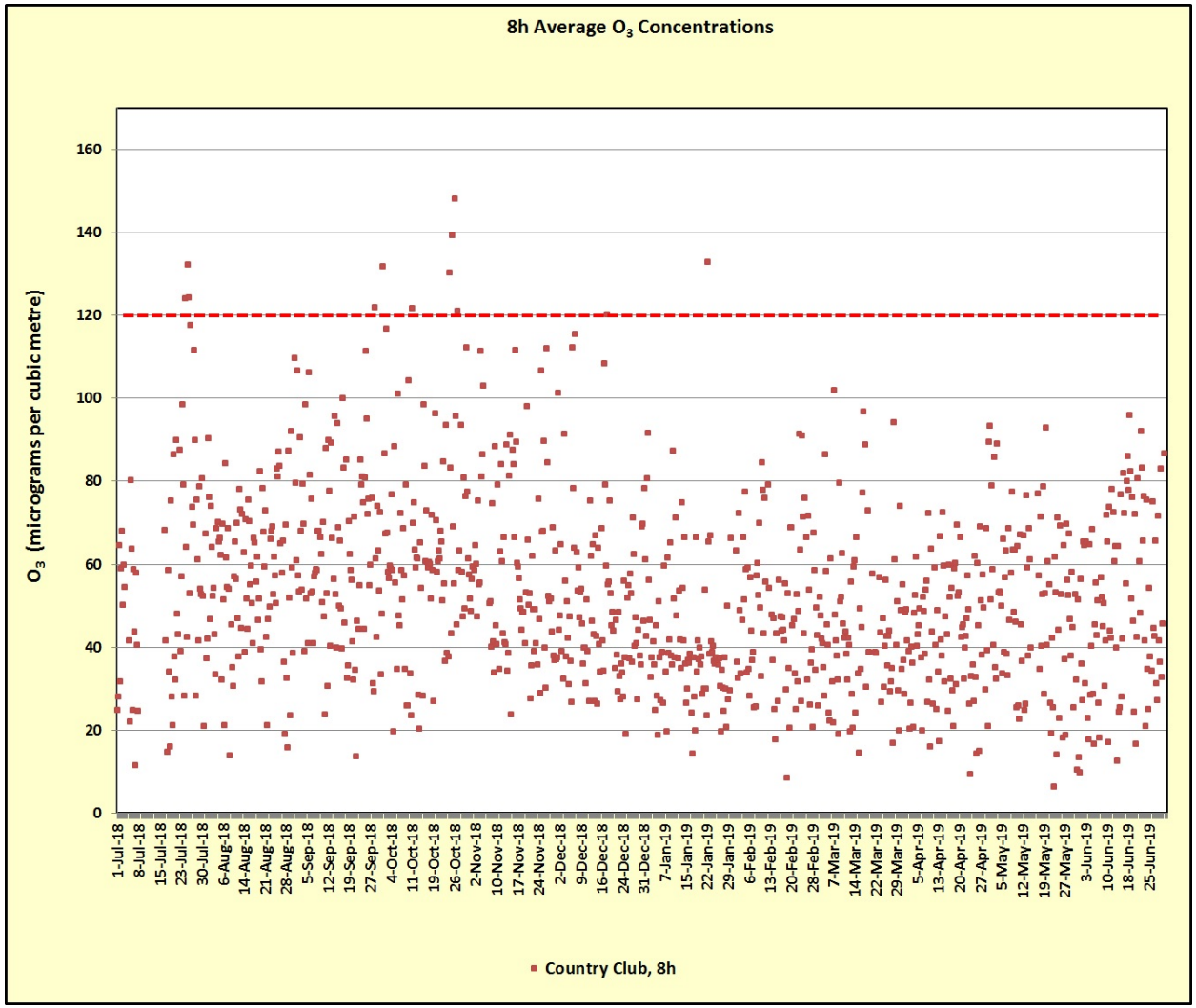


Figure B.AAQ.S.O_3-8h: 8-hr Average O_3 – Jul2018 to Jun2019

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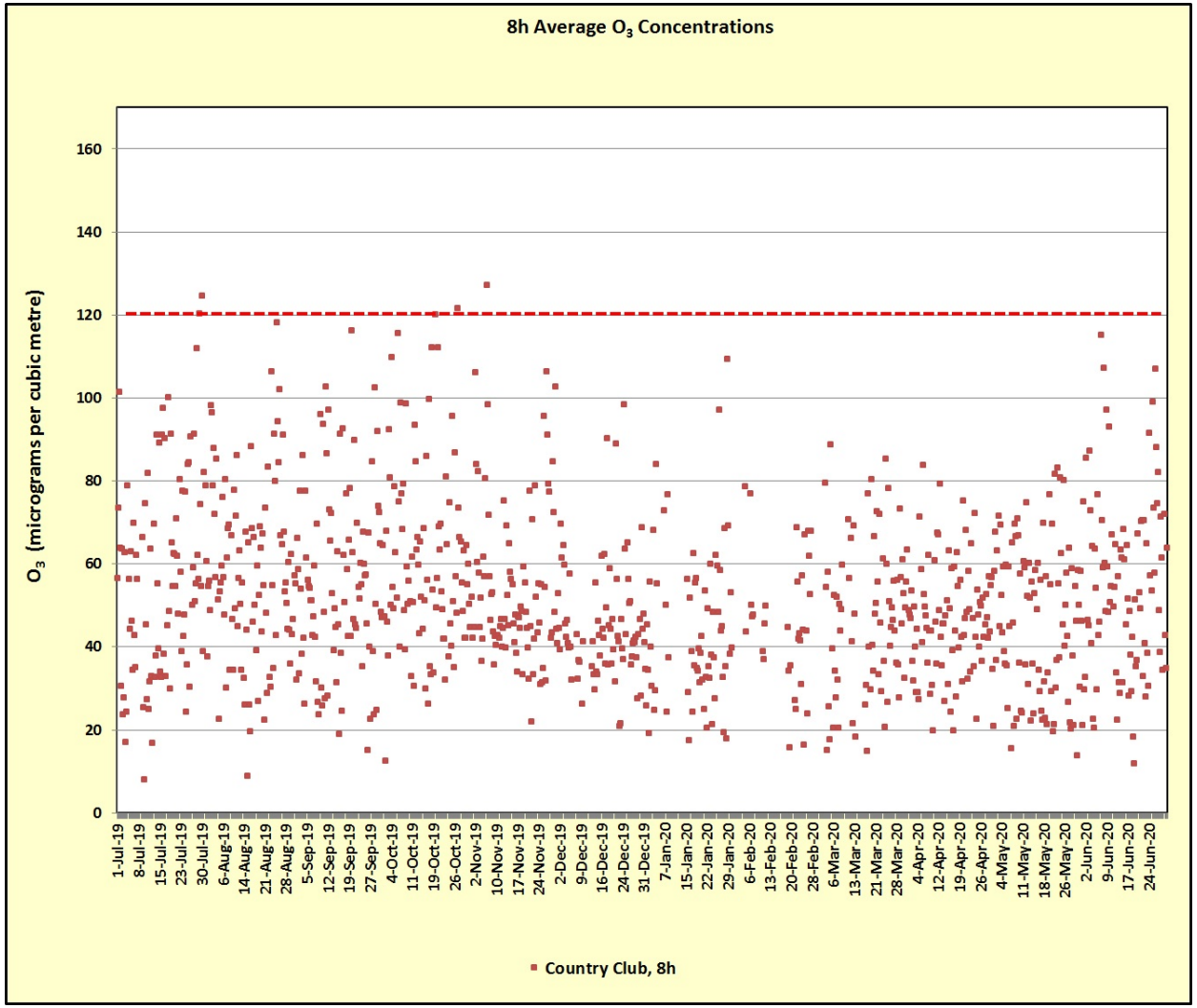


Figure B.AAQ.S.O_3-8h: 8-hr Average O_3 – Jul2019 to Jun2020

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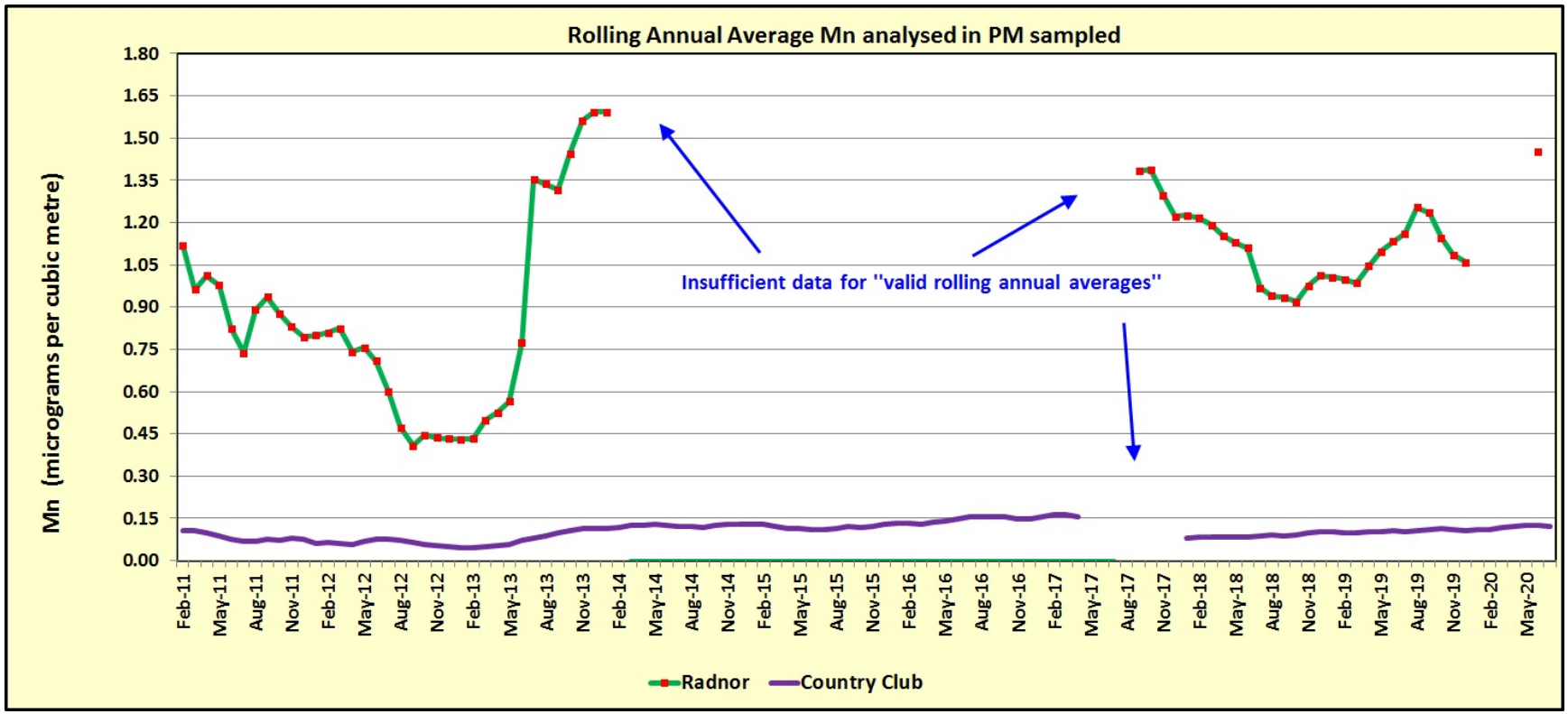


Figure B.AAQ.S.Metals-Ann: Rolling Annual Average PM_{10} metal speciation– till end Jun2020

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Monthly average Benzene sampling has been conducted at the Candy Plant (South West fence-line) by means of passive sampling.

Table B.AAQ.P.Bz: Benzene passive sampling results and exceedances for July 2017 to June 2020

Period		Ambient Air Concentration (µg/m³)	Number of Exceedances per annum
July 2017 to June 2018	**1 hour average:**	not applicable	not applicable
	24 hour average:	not applicable	not applicable
	Annual Average:	**0.1**	**0**
July 2018 to June 2019	**1 hour average:**	not applicable	not applicable
	24 hour average:	not applicable	not applicable
	Annual Average:	**0.04**	**0**
July 2019 to June 2020	**1 hour average:**	not applicable	not applicable
	24 hour average:	not applicable	not applicable
	Annual Average:	**0.1**	**0**

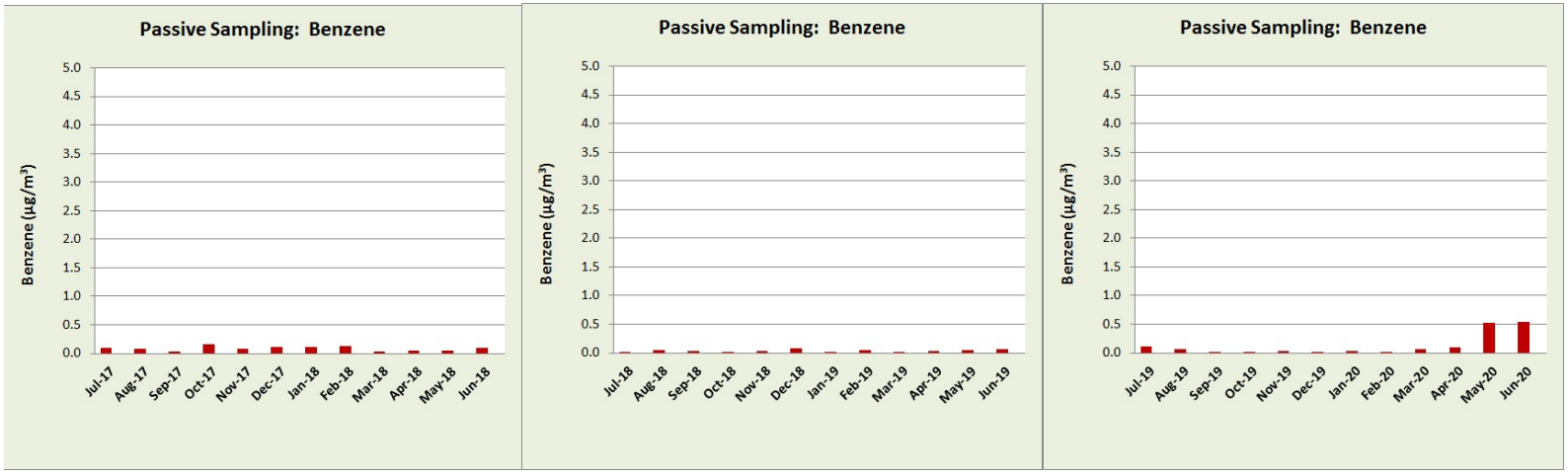


Figure B.AAQ.P.Bz-Mnth: Month Average Benzene Concentrations – Jul2017 to Jun2020

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B.AAQ.3 Compliance of Monitored Pollutant Concentrations in Ambient Air with Ambient Air Quality Standards

Table B.AAQ.S1.CA: Compliance with Ambient Air Quality Standards – Country Club AQMS – Jul2017 to Jun2018

Pollutant / Compound:		PM10			PM2.5			SO2				NO2		CO		O3
Applicable Averaging Period:		24 hours	24 hours	Annual	24 hours	24 hours	Annual	10 minute	1 hour	24 hour	Annual	1 hour	Annual	1 hour	8 hour	8 hour
Standard (S) or Guideline (G):		S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Historical Standard: Concentration in µg/m3		120	120	50	65	65	25	500	350	125	50	200	40	30000	10000	120
Current Standard: Concentration in µg/m3		75	75	40	40	40	20	500	350	125	50	200	40	30000	10000	120
Allowable Exceedances per annum (99th Percentile):		4	4	0	4	4	0	526	88	4	0	88	0	88	11	11
Period:	Findings on Investigation of Exceedances and Scatter Plots	Month Specific	Rolling Annual Total	Rolling Annual	Month Specific	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total
July-17	2 X 24h PM10 exceedances recorded in July '17 but no real time data to assess further. Traces (< 3ppm) of CO recorded from ACRW direction . Directional NOx plot indicates predominant source lies to the NNW, possibly from N3 traffic. Highest SO2 levels were recorded during SW winds.	2	Insuff. Data	Insuff. Data	Not sampled	Not sampled	Not sampled	0	0	0	0	Insuff. Data	Insuff. Data	0	0	4.00
August-17	Insufficient PM10 data for valid count of 24h exceedances but sufficient data to demonstrate non-compliance as 45 exceedances recorded from Apr 16 to Mar 17. No real time PM10 data to assess directional contributions. 2 strong diurnal NOx peaks (particularly morning 06h30 peak) evident in relation to Radnor trend. Fairly weak & similar directional trends evident for CO and SO2.	1	Insuff. Data	Insuff. Data	Not sampled	Not sampled	Not sampled	0	0	0	0	Insuff. Data	Insuff. Data	0	0	3.00
September-17	Insufficient PM10 data for valid count of total 24h exceedances for past year but sufficient data up to Mar '17 to demonstrate non-compliance with allowable frequency (4 days) of annual 24h exceedances. No real time PM10 data to assess directional contributions. 2 diurnal peaks evident for NOx and to a lesser extent for CO. CO from ACRW direction is evident but low.	0	Insuff. Data	Insuff. Data	Not sampled	Not sampled	Not sampled	0	0	0	0	Insuff. Data	Insuff. Data	0	0	10.00
October-17	Insufficient PM10 data for valid count of 24h exceedances but sufficient data up to Mar '17 to demonstrate non-compliance. No real time PM10 data to assess directional contributions. O3 almost exceeding allowable 11 exceedances per year. No directional O3 trend evident, and di-urnal plot confirms photochemical related link between O3 & daily ambient temp profiles. Strong di-urnal NOx trend evident with highest NOx from NNW vector. Elevated CO from ACRW	0	Insuff. Data	Insuff. Data	Not sampled	Not sampled	Not sampled	0	0	0	0	Insuff. Data	Insuff. Data	0	0	10.00

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Pollutant / Compound:		PM10			PM2.5			SO2				NO2		CO		O3
Applicable Averaging Period:		24 hours	24 hours	Annual	24 hours	24 hours	Annual	10 minute	1 hour	24 hour	Annual	1 hour	Annual	1 hour	8 hour	8 hour
Standard (S) or Guideline (G):		S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Historical Standard: Concentration in µg/m3		120	120	50	65	65	25	500	350	125	50	200	40	30000	10000	120
Current Standard: Concentration in µg/m3		75	75	40	40	40	20	500	350	125	50	200	40	30000	10000	120
Allowable Exceedances per annum (99th Percentile):		4	4	0	4	4	0	526	88	4	0	88	0	88	11	11
Period:	Findings on Investigation of Exceedances and Scatter Plots	Month Specific	Rolling Annual Total	Rolling Annual	Month Specific	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total
	direction is barely evident & well below the standards.															
November-17	No 24h PM10 exceedances in Nov '17. Insufficient PM10 data to assess compliance with anual standard. No real time PM10 data to assess directional contributions. O3 now exceeds allowable 11 exceedances of 8h standard per year. Weak directional O3 trend evident, most elevated from SE vector. Elevated SO2 from SE and NW vectors but well below the standard.	0	Insuff. Data	Insuff. Data	Not sampled	Not sampled	Not sampled	0	0	0	0	Insuff. Data	Insuff. Data	0	0	13.00
December-17	Compliance now recorded for annual PM10 exceedances of 24h standard, as fewer 24h exceedances in winter '17 compared to winter '16. SO2 predominantly originated from 100° to 200° (SE to S) vector in Dec '17. Elevated di-urnal SO2 at 4pm only occurred on 1 and 29 Dec '17. No strong directional trends for NOx, CO, O3. Ozone now complies with allowable 8h average exceedances (11 allowed).	0	3	0	Not sampled	Not sampled	Not sampled	0	0	0	0	Insuff. Data	Insuff. Data	0	0	11.00
January-18	Daily PM10 and 8h ozone currently compliant but by a narrow margin. Directional & di-urnal plots indicates SO2 source/s lying to the SE, with maximum levels recorded during mid-afternoons and evenings. Morning and evening di-urnal NOx peaks are evident. None of the pollutants measured indicate elevated impacts from direction of ACRW.	0	3	0	Not sampled	Not sampled	Not sampled	0	0	0	0	Insuff. Data	Insuff. Data	0	0	11.00
February-18	Daily PM10 and 8h ozone currently still compliant with annual allowable exceedances, but only by a narrow margin. Directional & di-urnal plots for Feb '18 once again indicates SO2 source/s lying to the ESE, with maximumimpacts recorded during mid to late afternoons. Morning (7am) and evening (9pm) di-urnal NOx peaks are evident.	0	3	0	Not sampled	Not sampled	Not sampled	0	0	0	0	Insuff. Data	Insuff. Data	0	0	11.00

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Pollutant / Compound:		PM10			PM2.5			SO2				NO2		CO		O3
Applicable Averaging Period:		24 hours	24 hours	Annual	24 hours	24 hours	Annual	10 minute	1 hour	24 hour	Annual	1 hour	Annual	1 hour	8 hour	8 hour
Standard (S) or Guideline (G):		S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Historical Standard: Concentration in µg/m3		120	120	50	65	65	25	500	350	125	50	200	40	30000	10000	120
Current Standard: Concentration in µg/m3		75	75	40	40	40	20	500	350	125	50	200	40	30000	10000	120
Allowable Exceedances per annum (99th Percentile):		4	4	0	4	4	0	526	88	4	0	88	0	88	11	11
Period:	Findings on Investigation of Exceedances and Scatter Plots	Month Specific	Rolling Annual Total	Rolling Annual	Month Specific	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total
	None of the directional pollutant plots indicated elevated impacts from direction of ACRW in Feb '18.															
March-18	Daily PM10 and 8h ozone currently still compliant with annual allowable exceedances, but only by a narrow margin. Extremely high ozone levels recorded over short duration during thunderstorm on evening of 16 Mar '18. CO and NOx predominantly recorded from NNW direction in Mar '18, not from ACRW direction. Elevated (but compliant) SO2 levels were recorded from direction of ACRW for approx 1 hour during Mar '18	0	3	0	Not sampled	Not sampled	Not sampled	0	0	0	0	1	0	0	0	11.00
April-18	Daily PM10 and 8h ozone remains compliant with annual allowable exceedances, but only by a very narrow margin. Directional contribution of PM10 from ACRW cannot be assessed as real time PM10 is not recorded at Club station. Elevated ozone (which relates primarily to photochemical activity) is unlikely to be related to ACRW activities which is confirmed by the directional ozone scatter plot (Appendix A, Fig A.5.).	0	3	0	Not sampled	Not sampled	Not sampled	0	0	0	0	1	0	0	0	11.00
May-18	No exceedances recorded at Club in May '18. 11 exceedances of the 8h ozone standard recorded over past year, only 11 are allowed so compliance by a narrow margin only. Increasing long term ozone trend evident, not ACRW related. 3 exceedances of the 24h PM10 standard recorded over past year, only 4 allowed so compliance by a narrow margin only. Elevated CO from NNE vector may be related to ACRW but levels remain well below the ambient CO standards. Elevated SO2 recorded from the SSE vector.	0	3	0	Not sampled	Not sampled	Not sampled	0	0	0	0	1	0	0	0	11.00

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Pollutant / Compound:		PM10			PM2.5			SO2				NO2		CO		O3
Applicable Averaging Period:		24 hours	24 hours	Annual	24 hours	24 hours	Annual	10 minute	1 hour	24 hour	Annual	1 hour	Annual	1 hour	8 hour	8 hour
Standard (S) or Guideline (G):		S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Historical Standard: Concentration in µg/m3		120	120	50	65	65	25	500	350	125	50	200	40	30000	10000	120
Current Standard: Concentration in µg/m3		75	75	40	40	40	20	500	350	125	50	200	40	30000	10000	120
Allowable Exceedances per annum (99th Percentile):		4	4	0	4	4	0	526	88	4	0	88	0	88	11	11
Period:	Findings on Investigation of Exceedances and Scatter Plots	Month Specific	Rolling Annual Total	Rolling Annual	Month Specific	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total
June-18	2 exceedances of the daily PM10 standard were recorded on 7 and on 13 June 2018. The wind direction on 7 June was predominantly from the NNW vector, and the wind direction on 13 June ranged between NNW and S vectors. Based upon the predominant wind directions on these 2 exceedance days, the main contributing source was unlikely to be located in the direction of ACRW. 5 exceedances of the daily PM10 standard were recorded over the past year which represents non-compliance.	2	5	0	Not sampled	Not sampled	Not sampled	0	0	0	0	6	0	0	0	11.00

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Table B.AAQ.S1.CA: Compliance with Ambient Air Quality Standards – Country Club AQMS – Jul2018 to Jun2019

Pollutant / Compound:		PM10			PM2.5			SO2				NO2		CO		O3
Applicable Averaging Period:		24 hours	24 hours	Annual	24 hours	24 hours	Annual	10 minute	1 hour	24 hour	Annual	1 hour	Annual	1 hour	8 hour	8 hour
Standard (S) or Guideline (G):		S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Historical Standard: Concentration in µg/m3		120	120	50	65	65	25	500	350	125	50	200	40	30000	10000	120
Current Standard: Concentration in µg/m3		75	75	40	40	40	20	500	350	125	50	200	40	30000	10000	120
Allowable Exceedances per annum (99th Percentile):		4	4	0	4	4	0	526	88	4	0	88	0	88	11	11
Period:	Findings on Investigation of Exceedances and Scatter Plots	Month Specific	Rolling Annual Total	Rolling Annual	Month Specific	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total
July-18	3 x 24h PM10 exceedances this month, so 6 exceedance over past year which represents non-compliance over past 2 months at this "residential / background station". Widespread grass fires were observed locally and regionally in July. PM10 exceedances occurred during relatively warm pre-frontal synoptic conditions. 14 exceedances of 8h ozone standard over past year represents non-compliance as only 11 allowed. Scatter plot provides limited directional / source information due to complex photochemical reactions between O3 precursors such as NOx, VOCs and sunlight.	3	6	0	Not sampled	Not sampled	Not sampled	0	0	0	0	9	0	0	0	14.00
August-18	One 24h PM10 exceedance was recorded this month (4 Aug '18), and six 24h exceedances recorded over the past year. This represents non-compliance with respect to the allowable number (4) of 24h PM10 exceedances at this "residential / background station". This PM10 exceedance occurred during relatively warm pre-frontal synoptic conditions. 14 exceedances of 8h ozone standard were recorded over past year which represents non-compliance as only 11 are allowed. Elevated ozone arises from complex photochemical reactions between O3 precursors such as NOx, VOCs and sunlight, and is not asssociated with ACRW activities.	1	6	0	Not sampled	Not sampled	Not sampled	0	0	0	0	8	0	0	0	14.00
September-18	No exceedances of the SA AAQ standards were recorded in Sep '18 at this "residential / background station". The total number of 24h PM10 exceedances over the past year however remains non-compliant as 6 exceedances were recorded, only 4 are allowed per annum. These PM10 exceedances occurred during relatively warm, high ozone, poor visibility pre-frontal synoptic weather conditions hence likely to be	0	6	0	Not sampled	Not sampled	Not sampled	0	0	0	0	8	0	0	0	8.00

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Pollutant / Compound:		PM10			PM2.5			SO2				NO2		CO		O3
Applicable Averaging Period:		24 hours	24 hours	Annual	24 hours	24 hours	Annual	10 minute	1 hour	24 hour	Annual	1 hour	Annual	1 hour	8 hour	8 hour
Standard (S) or Guideline (G):		S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Historical Standard: Concentration in µg/m3		120	120	50	65	65	25	500	350	125	50	200	40	30000	10000	120
Current Standard: Concentration in µg/m3		75	75	40	40	40	20	500	350	125	50	200	40	30000	10000	120
Allowable Exceedances per annum (99th Percentile):		4	4	0	4	4	0	526	88	4	0	88	0	88	11	11
Period:	Findings on Investigation of Exceedances and Scatter Plots	Month Specific	Rolling Annual Total	Rolling Annual	Month Specific	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total
	related to complex photochemical reactions between NOx and VOCs.															
October-18	There were no exceedances of the 24h PM10 standard in Oct '18, but 6 exceedances were recorded over the past year which represents non-compliance (only 4 allowed). Although real time directional PM10 data is not recorded here, non-compliance appears to be closely related to seasonal and synoptic weather patterns as opposed to localised sources. 13 exceedances of the 8h O3 standard represents non-compliance as only 11 are allowed per annum. Although the ozone directional plot does not indicate specific directional sources, elevated O3 is typically recorded on relatively warmer days when PM levels are also elevated, so may be related to complex photochemical reactions between NOx and VOCs.	0	6	0	Not sampled	Not sampled	Not sampled	0	0	0	0	8	0	0	0	13.00
November-18	No exceedances of the 24h PM10 standard were recorded in Nov '18. However, 6 exceedances were recorded over the past year which represents non-compliance as only 4 are allowed per annum. 10 exceedances of the 8h O3 standard represents "borderline compliance" as 11 are allowed per annum. Although uncharacteristically high O3 was recorded on 14 Nov '18 (approx 8pm during light S winds), the O3 standard was not exceeded.	0	6	0	Not sampled	Not sampled	Not sampled	0	0	0	0	8	0	0	0	10.00

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Pollutant / Compound:		PM10			PM2.5			SO2				NO2		CO		O3
Applicable Averaging Period:		24 hours	24 hours	Annual	24 hours	24 hours	Annual	10 minute	1 hour	24 hour	Annual	1 hour	Annual	1 hour	8 hour	8 hour
Standard (S) or Guideline (G):		S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Historical Standard: Concentration in µg/m3		120	120	50	65	65	25	500	350	125	50	200	40	30000	10000	120
Current Standard: Concentration in µg/m3		75	75	40	40	40	20	500	350	125	50	200	40	30000	10000	120
Allowable Exceedances per annum (99th Percentile):		4	4	0	4	4	0	526	88	4	0	88	0	88	11	11
Period:	Findings on Investigation of Exceedances and Scatter Plots	Month Specific	Rolling Annual Total	Rolling Annual	Month Specific	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total
December-18	Although no exceedances were recorded during Dec '18, this station has recorded 11 exceedances of the 8h ozone standard over the past year. As only 11 exceedances are allowed, this station is currently "borderline compliant" with respect to ozone. The Dec '18 directional ozone plot indicated slightly elevated ozone concentrations originating from the SE vector (i.e. not from ACRW direction) over a 1h total duration. Slightly elevated SO2 also appeared to have originated from the same general direction which suggests a common source. The annual average PM10 Mn levels remain below the WHO annual guideline.	0	6	0	Not sampled	Not sampled	Not sampled	0	0	0	0	8	0	0	0	11.00
January-19	Since Jun '18 this station has remained non-compliant with respect to the maximum number of allowable exceedances of the 24h PM10 standard per annum. Over the current Feb '18 to Jan '19 review period, 6 exceedances were recorded, only 4 are allowed per annum. With regards to the 8h ozone standard, this station has recorded 12 exceedances over the past year, ie non-compliance as only 11 exceedances are allowed per annum. Although O3 is not commonly emitted from specific emission sources, the Jan '18 directional plot indicated the highest ozone concentrations originated from the SE vector and not from ACRW's direction. Slightly elevated SO2 also appeared to have originated from the same general direction, ie not from ACRW.	0	6	0	Not sampled	Not sampled	Not sampled	0	0	0	0	8	0	0	0	12.00
February-19	This station remains non-compliant with respect to the maximum number of allowable exceedances of the 24h PM10 standard per annum. 6 exceedances were recorded over the Mar '18 to Feb '19 review period, and only 4 are allowed per annum. With regards to the 8h ozone standard, this station also remains non-compliant as 12 exceedances were recorded over the past year and only 11 exceedances are allowed per annum. The Feb '19 directional plot indicated the highest ozone concentrations originated from the	0	6	0	Not sampled	Not sampled	Not sampled	0	0	0	0	8	0	0	0	12.00

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Pollutant / Compound:		PM10			PM2.5			SO2				NO2		CO		O3
Applicable Averaging Period:		24 hours	24 hours	Annual	24 hours	24 hours	Annual	10 minute	1 hour	24 hour	Annual	1 hour	Annual	1 hour	8 hour	8 hour
Standard (S) or Guideline (G):		S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Historical Standard: Concentration in µg/m3		120	120	50	65	65	25	500	350	125	50	200	40	30000	10000	120
Current Standard: Concentration in µg/m3		75	75	40	40	40	20	500	350	125	50	200	40	30000	10000	120
Allowable Exceedances per annum (99th Percentile):		4	4	0	4	4	0	526	88	4	0	88	0	88	11	11
Period:	Findings on Investigation of Exceedances and Scatter Plots	Month Specific	Rolling Annual Total	Rolling Annual	Month Specific	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total
	SSE vector. Slightly elevated SO2 appeared to have originated from the between the E and SSE vectors. These vectors do not coincide with the ACRW plant.															
March-19	This station remains non-compliant with respect to the maximum number of allowable exceedances of the 24h PM10 standard per annum. 6 exceedances were recorded over the Apr '18 to Mar '19 review period, and only 4 are allowed per annum. With regards to the 8h ozone standard, this station also remains non-compliant as 12 exceedances were recorded over the past year and only 11 exceedances are allowed per annum. The Mar '19 directional plot indicated the highest ozone concentrations originated from the SE (140°) vector. Elevated SO2 was also recorded from the same SE vector which suggests a localised source of SO2 which does not coincide with the ACRW plant.	0	6	0	Not sampled	Not sampled	Not sampled	0	0	0	0	8	0	0	0	12.00
April-19	The Club station remains non-compliant with respect to the maximum number of allowable exceedances of the 24h PM10 standard per annum as 6 exceedances were recorded over the May '18 to Apr '19 review period. Only 4 are allowed per annum. With regards to the 8h ozone standard, this station remains non-compliant as 12 exceedances were recorded, only 11 exceedances are allowed per annum. The Apr '19 directional plot once again indicated the highest ozone concentrations originated from the SE (140°) vector. Elevated SO2 was also recorded from a similar direction which suggests source/s of SO2 lying in the opposite direction to the ACRW plant.	0	6	0	Not sampled	Not sampled	Not sampled	0	0	0	0	8	0	0	0	12.00

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Pollutant / Compound:		PM10			PM2.5			SO2				NO2		CO		O3
Applicable Averaging Period:		24 hours	24 hours	Annual	24 hours	24 hours	Annual	10 minute	1 hour	24 hour	Annual	1 hour	Annual	1 hour	8 hour	8 hour
Standard (S) or Guideline (G):		S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Historical Standard: Concentration in µg/m3		120	120	50	65	65	25	500	350	125	50	200	40	30000	10000	120
Current Standard: Concentration in µg/m3		75	75	40	40	40	20	500	350	125	50	200	40	30000	10000	120
Allowable Exceedances per annum (99th Percentile):		4	4	0	4	4	0	526	88	4	0	88	0	88	11	11
Period:	Findings on Investigation of Exceedances and Scatter Plots	Month Specific	Rolling Annual Total	Rolling Annual	Month Specific	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total
May-19	The Club station remains non-compliant with respect to the maximum number of allowable exceedances of the 24h PM10 standard per annum. 7 exceedances were recorded over the Jun '18 to May '19 review period, only 4 are allowed per annum. One PM10 excedance of 78 µg/m3 occurred on 27 May '19 when winds barely blew from ACRW (< 1hr) on this day. With regards to the 8h ozone standard, this station remains non-compliant as 12 exceedances were recorded, only 11 exceedances are allowed per annum. The May '19 directional plot did not indicate predominant source direction/s from which elevated ozone may have originated.	1	7	0	Not sampled	Not sampled	Not sampled	0	0	0	0	10	0	0	0	12.00
June-19	The Club background station remains non-compliant with respect to both PM10 and O3. Two exceedances of the 24h PM10 standard were recorded in Jun '19 on consecutive days, 21 and 22 Jun '19. These days were characterised by relatively warm pre-frontal / decreasing barometric pressure conditions. The winds barely blew from the direction of ACRW over this period, with the predominant (59%) winds having blown from the NW quadrant. Although there were no exceedances of the 8h O3 standard in Jun '19, 12 exceedances were recorded over the past year, only 11 are allowed.	2	7	0	Not sampled	Not sampled	Not sampled	0	0	0	0	8	0	0	0	12.00

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Table B.AAQ.S1.CA: Compliance with Ambient Air Quality Standards – Country Club AQMS – Jul2019 to Jun2020

Pollutant / Compound:		PM10			PM2.5			SO2				NO2		CO		O3
Applicable Averaging Period:		24 hours	24 hours	Annual	24 hours	24 hours	Annual	10 minute	1 hour	24 hour	Annual	1 hour	Annual	1 hour	8 hour	8 hour
Standard (S) or Guideline (G):		S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Historical Standard: Concentration in µg/m3		120	120	50	65	65	25	500	350	125	50	200	40	30000	10000	120
Current Standard: Concentration in µg/m3		75	75	40	40	40	20	500	350	125	50	200	40	30000	10000	120
Allowable Exceedances per annum (99th Percentile):		4	4	0	4	4	0	526	88	4	0	88	0	88	11	11
Period:	Findings on Investigation of Exceedances and Scatter Plots	Month Specific	Rolling Annual Total	Rolling Annual	Month Specific	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total
July-19	As with the Radnor station, the Club background station also recorded a record breaking number of 24h PM10 exceedances in Jul '19 (total = 13) so this station remains non-compliant with respect to PM10. 17 exceedances of the 24h PM10 standard were recorded over the past year. All of the exceedances occurred during adverse (stable, relatively warm) meteorological conditions indicating the strong influence of meteorology.	13	17	0	Not sampled	Not sampled	Not sampled	0	0	0	0	7	0	0	0	11.00
August-19	Although no exceedances of the 24h PM10 standard were recorded in Aug '19, this station remains non-compliant with respect to 24h PM10 as 16 exceedances were recorded over the past year. Real time PM10 is not recorded at this station. As recorded previously, the directional SO2 plot shows maximum SO2 levels were generally recorded during SSW wind directions which suggests that an SO2 source/s lies along this vector. The concentrations however remain below the relevant SO2 standards.	0	16	0	Not sampled	Not sampled	Not sampled	0	0	0	0	7	0	0	0	11.00
September-19	No 24h PM10 standard exceedances were recorded in Sep '19 but this station remains non-compliant with respect to 24h PM10 as 16 exceedances were recorded over the past year. Only 4 exceedances are allowed per annum. None of the gaseous pollutant scatter plots indicated any specific directional emission sources of any significance.	0	16	0	Not sampled	Not sampled	Not sampled	0	0	0	0	7	0	0	0	10.00
October-19	No 24h PM10 standard exceedances were recorded in Oct '19 but this station remains non-compliant with respect to 24h PM10 as 16 exceedances were recorded over the past year. Only 4 exceedances are allowed per annum. None of the gaseous pollutant scatter plots indicated any specific directional emission sources of any significance, with the exception of	0	16	0	Not sampled	Not sampled	Not sampled	0	0	0	0	7	0	0	0	5.00

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Pollutant / Compound:		PM10			PM2.5			SO2				NO2		CO		O3
Applicable Averaging Period:		24 hours	24 hours	Annual	24 hours	24 hours	Annual	10 minute	1 hour	24 hour	Annual	1 hour	Annual	1 hour	8 hour	8 hour
Standard (S) or Guideline (G):		S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Historical Standard: Concentration in µg/m3		120	120	50	65	65	25	500	350	125	50	200	40	30000	10000	120
Current Standard: Concentration in µg/m3		75	75	40	40	40	20	500	350	125	50	200	40	30000	10000	120
Allowable Exceedances per annum (99th Percentile):		4	4	0	4	4	0	526	88	4	0	88	0	88	11	11
Period:	Findings on Investigation of Exceedances and Scatter Plots	Month Specific	Rolling Annual Total	Rolling Annual	Month Specific	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total
	SO2 which recorded very slightly elevated levels during ESE wind directions.															
November-19	No exceedances of the AAQ standards were recorded in Nov '19 as pollutant concentrations were generally very low. However this station remains non-compliant with respect to 24h PM10 as only 4 exceedances are allowed per annum. Over the past year, 16 exceedances of the 24h PM10 standard were recorded. None of the gaseous pollutant scatter plots indicated any specific directional emission sources of any significance, with the exception of SO2 which recorded very slightly elevated levels when winds blew from the SE quadrant.	0	16	0	Not sampled	Not sampled	Not sampled	0	0	0	0	7	0	0	0	6.00
December-19	There were no exceedances of the AAQ standards in Dec '19 as pollutant concentrations were generally very low. However this station remains non-compliant with respect to 24h PM10 as only 4 exceedances are allowed per annum. Over the past year, 16 exceedances of the 24h PM10 standard were recorded. None of the gaseous pollutant scatter plots indicated any specific directional emission sources of any significance, with the exception of SO2 which recorded very slightly elevated levels when winds blew from the SE quadrant but not from ACRW's direction.	0	16	0	Not sampled	Not sampled	Not sampled	0	0	0	0	7	0	0	0	5.00
January-20	There were no exceedances of the AAQ standards in Jan '20. This station however still remains non-compliant with respect to 24h PM10 as only 4 exceedances are allowed per annum. Over the past year, 16 exceedances of the 24h PM10 standard were recorded. Elevated SO2 and NOx was recorded from the NNW vector which wasnt so evident previously.	0	16	0	Not sampled	Not sampled	Not sampled	0	0	0	0	7	0	0	0	4.00

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Pollutant / Compound:		PM10			PM2.5			SO2				NO2		CO		O3
Applicable Averaging Period:		24 hours	24 hours	Annual	24 hours	24 hours	Annual	10 minute	1 hour	24 hour	Annual	1 hour	Annual	1 hour	8 hour	8 hour
Standard (S) or Guideline (G):		S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Historical Standard: Concentration in µg/m3		120	120	50	65	65	25	500	350	125	50	200	40	30000	10000	120
Current Standard: Concentration in µg/m3		75	75	40	40	40	20	500	350	125	50	200	40	30000	10000	120
Allowable Exceedances per annum (99th Percentile):		4	4	0	4	4	0	526	88	4	0	88	0	88	11	11
Period:	Findings on Investigation of Exceedances and Scatter Plots	Month Specific	Rolling Annual Total	Rolling Annual	Month Specific	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total
February-20	There were no exceedances of the AAQ standards in Feb '20. This station still remains non-compliant with respect to 24h PM10 as only 4 exceedances are allowed per annum. None of the Feb '20 pollutant scatter plots indicated elevated impacts (i.e. above background levels) from the direction of ACRW.	0	16	0	Not sampled	Not sampled	Not sampled	0	0	0	0	7	0	0	0	4.00
March-20	There were no exceedances of the AAQ standards in Mar '20 but this station still remains non-compliant with respect to 24h PM10 as only 4 exceedances are allowed per annum. None of the Mar '20 scatter plots indicated elevated impacts (i.e. above background levels) from the direction of ACRW. Elevated NOX was recorded from the NNW vector which does not coincide with ACRW. PM10 metal results delayed by lockdown so will appear in May '20 report	0	16	0	Not sampled	Not sampled	Not sampled	0	0	0	0	7	0	0	0	4.00
April-20	No exceedances of the AAQ standards were recorded in Apr '20 but this station still remains non-compliant with respect to 24h PM10 as only 4 exceedances are allowed per annum. The scatter plots indicate the highest NOx levels originated predominantly from the NW quadrant, a similar observation to Mar '20. CO and NOx trends indicate uncharacteristic improvements in air quality likely to be associated with lower human activity hence lower emissions since the Covid-19 Lockdown commenced on 27 Mar '20.	Not Sampled	16	0	Not sampled	Not sampled	Not sampled	0	0	0	0	7	0	0	0	4.00
May-20	No exceedances of the AAQ standards were recorded in May '20 but this station remains non-compliant with respect to 24h PM10 as only 4 exceedances are allowed per annum. The scatter plot again indicates the highest NOx levels originated predominantly from the NW quadrant. CO and NOx both follow distinct di-urnal cycles with elevated levels (di-urnal peaks) recorded on most early mornings and evenings. Uncharacteristic improvements in air quality are particularly evident with the abnormal seasonal	0	15	0	Not sampled	Not sampled	Not sampled	0	0	0	0	6	0	0	0	4.00

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Pollutant / Compound:		PM10			PM2.5			SO2				NO2		CO		O3
Applicable Averaging Period:		24 hours	24 hours	Annual	24 hours	24 hours	Annual	10 minute	1 hour	24 hour	Annual	1 hour	Annual	1 hour	8 hour	8 hour
Standard (S) or Guideline (G):		S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Historical Standard: Concentration in µg/m3		120	120	50	65	65	25	500	350	125	50	200	40	30000	10000	120
Current Standard: Concentration in µg/m3		75	75	40	40	40	20	500	350	125	50	200	40	30000	10000	120
Allowable Exceedances per annum (99th Percentile):		4	4	0	4	4	0	526	88	4	0	88	0	88	11	11
Period:	Findings on Investigation of Exceedances and Scatter Plots	Month Specific	Rolling Annual Total	Rolling Annual	Month Specific	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total
	NOx trends which is assumed to be related to less activity during the Covid-19 Lockdown.															
June-20	None of the SA AAQ standards were exceeded in June '20 but this station remains non-compliant with respect to 24h PM10 as only 4 exceedances are allowed per annum. 13 exceedances were recorded over the latest July 2019 to June 2020 review period.	0	13	0	Not sampled	Not sampled	Not sampled	Insuff. Data	Insuff. Data	Insuff. Data	Insuff. Data	8	0	0	0	4.00

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Table B.AAQ.S2.CA: Compliance with Ambient Air Quality Standards – Radnor AQMS – Jul2017 to Jun2018

Pollutant / Compound:		PM10			PM2.5			SO2				NO2		CO		O3
Applicable Averaging Period:		24 hours	24 hours	Annual	24 hours	24 hours	Annual	10 minute	1 hour	24 hour	Annual	1 hour	Annual	1 hour	8 hour	8 hour
Standard (S) or Guideline (G):		S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Historical Standard: Concentration in µg/m3		120	120	50	65	65	25	500	350	125	50	200	40	30000	10000	120
Current Standard: Concentration in µg/m3		75	75	40	40	40	20	500	350	125	50	200	40	30000	10000	120
Allowable Exceedances per annum (99th Percentile):		4	4	0	4	4	0	526	88	4	0	88	0	88	11	11
Period:	Findings on Investigation of Exceedances and Scatter Plots	Month Specific	Rolling Annual Total	Rolling Annual	Month Specific	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total
July-17	2 X 24h PM10 exceedances recorded in July '17. Directional PM10 plot indicates predominant source lies between the WSW & SSW sectors. SO2 was evident from ACRW direction but no exceedances. CO from ACRW direction reduced this month. (lower since last week Jun '17)	2	Insuff. Data	Insuff. Data	Not Sampled	Insuff. Data	Insuff. Data	Insuff. Data	Insuff. Data	Insuff. Data	Insuff. Data	Insuff. Data	Insuff. Data	Insuff. Data	Insuff. Data	Not sampled
August-17	All six 24h PM10 exceedances recorded over past year were between May 17 and Aug 17. Only 4 allowed per annum. Aug 17 directional plot shows major PM10 source lies along the SSW (200° to 222°) vector. SO2 also evident from this direction. Aug 17 diurnal plots show highest PM10 and SO2 between midnight and 8am.	1	6	0	Not Sampled	Insuff. Data	Insuff. Data	0	0	0	0	0	0	0	0	Not sampled
September-17	12 months' PM10 data not yet available but non-compliance with allowable (4) 24h exceedances is evident from previous 9 months' data. PM10 Mn exceeds annual WHO guideline. Sep '17 data shows elevated PM10 from S and E, not from ACRW direction. SO2 evident from ACRW direction but below ambient standards. CO evident from ACRW direction, lower than a few months ago. Higher CO recorded from SW to W direction than from ACRW direction	2	8	0	Not Sampled	Insuff. Data	Insuff. Data	0	0	0	0	0	0	0	0	Not sampled
October-17	8 X daily PM10 exceedances over past year (4 allowed), and PM10 Mn exceeds WHO guideline. Oct '17 directional PM10 plot shows highest PM10 from 90° to 100° (E) vector, the 20° to 30° (NNE) vector and the 180° to 190° (S) vector. Elevated PM10 from ACRW direction is not evident. Di-urnal PM10 plot shows highest PM10 during early evenings (18h00). Elevated SO2 from ACRW vector but well below SO2 standards. NOx does not show a strong directional trend. CO remains low, higher from WSW vector than from ACRW direction.	0	8	0	Not Sampled	Insuff. Data	Insuff. Data	0	0	0	0	0	0	0	0	Not sampled

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Pollutant / Compound:		PM10			PM2.5			SO2				NO2		CO		O3
Applicable Averaging Period:		24 hours	24 hours	Annual	24 hours	24 hours	Annual	10 minute	1 hour	24 hour	Annual	1 hour	Annual	1 hour	8 hour	8 hour
Standard (S) or Guideline (G):		S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Historical Standard: Concentration in µg/m3		120	120	50	65	65	25	500	350	125	50	200	40	30000	10000	120
Current Standard: Concentration in µg/m3		75	75	40	40	40	20	500	350	125	50	200	40	30000	10000	120
Allowable Exceedances per annum (99th Percentile):		4	4	0	4	4	0	526	88	4	0	88	0	88	11	11
Period:	Findings on Investigation of Exceedances and Scatter Plots	Month Specific	Rolling Annual Total	Rolling Annual	Month Specific	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total
November-17	8 daily PM10 exceedances over past year, only 4 allowed. PM10 Mn exceeding annual WHO guideline. Nov '17 directional PM10 plot shows highest PM10 from 30° to 100° (E) vector, and from the 150° to 200° (S) vector, similar to Oct '17. Elevated PM10 from ACRW direction is not evident. Di-urnal PM10 plot showed highest PM10 between from 4pm to 6am. Low SO2 levels from ACRW vector for 1h (total) in Nov '17 and well below SO2 standards. NOx and CO showed no impacts from ACRW direction.	0	8	0	Not Sampled	Insuff. Data	Insuff. Data	0	0	0	0	0	0	0	0	Not sampled
December-17	Still 8 daily PM10 exceedances over past year, no exceedances recorded since Sep '17. Clear evidence of PM source lying between 40° and 100° (NE to E) vector from Radnor in Dec '17, possibly from neighbouring property, not from ACRW direction. SO2 from ACRW vector barely evident, SO2 predominantly originated from 140° to 170° (SE to S) vector. CO from ACRW direction evident in Dec '17, but CO concentrations much lower than standards.	0	8	0	Not Sampled	Insuff. Data	Insuff. Data	0	0	0	0	0	0	0	0	Not sampled
January-18	Daily PM10 non-compliant as > 4 exceedances over past year.Ongoing non-compliance with WHO PM Mn guideline. Directional & di-urnal plots indicates PM10 source/s lying to the E/NE of station (ie not from direction of ACRW), particularly evident during early mornings and late eveings. None of the pollutants measured indicate elevated impacts from direction of ACRW.	0	8	0	0	Insuff. Data	Insuff. Data	0	0	0	0	0	0	0	0	Not sampled
February-18	Daily PM10 non-compliant as 8 exceedances over past year, only 4 allowed. Ongoing non-compliance still evident wrt annual WHO PM Mn guideline. The Feb '18 directional PM10 plot indicates PM10 source/s lying to the E/NE of Radnor station (ie not from direction of ACRW). Di-urnal PM10 plot indicates elevated PM10 predominated during evenings between 6pm and 10pm. None of the directional pollutant plots indicated elevated impacts from direction of ACRW in Feb '18.	0	8	0	0	Insuff. Data	Insuff. Data	0	0	0	0	0	0	0	0	Not sampled

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Pollutant / Compound:		PM10			PM2.5			SO2				NO2		CO		O3
Applicable Averaging Period:		24 hours	24 hours	Annual	24 hours	24 hours	Annual	10 minute	1 hour	24 hour	Annual	1 hour	Annual	1 hour	8 hour	8 hour
Standard (S) or Guideline (G):		S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Historical Standard: Concentration in µg/m3		120	120	50	65	65	25	500	350	125	50	200	40	30000	10000	120
Current Standard: Concentration in µg/m3		75	75	40	40	40	20	500	350	125	50	200	40	30000	10000	120
Allowable Exceedances per annum (99th Percentile):		4	4	0	4	4	0	526	88	4	0	88	0	88	11	11
Period:	Findings on Investigation of Exceedances and Scatter Plots	Month Specific	Rolling Annual Total	Rolling Annual	Month Specific	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total
March-18	Daily PM10 non-compliant as 8 exceedances recorded, only 4 allowed per annum. Non-compliance still evident wrt annual WHO PM Mn guideline. Although the Mar '18 directional PM10 plot indicates no specific directional source/s of PM10, elevated PM10 from the direction of ACRW was noticeably absent. Di-urnal PM10 plot indicates elevated PM10 predominated during the early mornings and evenings, and noticeably lower during the day times.	0	8	0	0	Insuff. Data	Insuff. Data	0	0	0	0	0	0	Insuff. Data	Insuff. Data	Not sampled
April-18	Daily PM10 non-compliant as 8 exceedances recorded over past year, 4 allowed per annum. April 2018 scatter plot (Appendix B, Fig B.1.) shows relatively low PM10 impacts from direction of ACRW in relation to impacts from other directions. Dust generated from adjacent unpaved road likely to contribute to elevated PM10. Non-compliance wrt annual WHO PM Mn guideline is evident and likely to be related to localised Mn rich dust near Radnor station. Elevated SO2 was evident from direction of ACRW for one hour during April (Appendix B, Fig B.2), but no SO2 exceedances were recorded.	0	8	0	0	Insuff. Data	Insuff. Data	0	0	0	0	0	0	Insuff. Data	Insuff. Data	Not sampled
May-18	Daily PM10 non-compliant as 6 exceedances recorded over past year, 4 allowed per annum. Mar 2018 scatter plot shows low PM10 impacts originating from direction of ACRW in relation to impacts from other directions such as the NNE and SSW vectors. Ongoing non-compliance with annual WHO PM Mn guideline is possibly related to localised Mn rich dust / soil near Radnor station. Elevated SO2 was evident from direction of ACRW but levels remained well below the ambient SO2 standards.	0	6	0	Not Sampled	Insuff. Data	Insuff. Data	0	0	0	0	0	0	Insuff. Data	Insuff. Data	Not sampled

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Pollutant / Compound:		PM10			PM2.5			SO2				NO2		CO		O3
Applicable Averaging Period:		24 hours	24 hours	Annual	24 hours	24 hours	Annual	10 minute	1 hour	24 hour	Annual	1 hour	Annual	1 hour	8 hour	8 hour
Standard (S) or Guideline (G):		S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Historical Standard: Concentration in µg/m3		120	120	50	65	65	25	500	350	125	50	200	40	30000	10000	120
Current Standard: Concentration in µg/m3		75	75	40	40	40	20	500	350	125	50	200	40	30000	10000	120
Allowable Exceedances per annum (99th Percentile):		4	4	0	4	4	0	526	88	4	0	88	0	88	11	11
Period:	Findings on Investigation of Exceedances and Scatter Plots	Month Specific	Rolling Annual Total	Rolling Annual	Month Specific	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total
June-18	Daily PM10 non-compliant as 7 exceedances recorded over past year, 4 allowed per annum. June 2018 scatter plot shows relatively low PM10 impacts originating from direction of ACRW in relation to impacts from other directions such as the ENE and WSW vectors. Ongoing non-compliance with annual WHO PM Mn guideline may be related to localised Mn rich dust / soil near Radnor station. Elevated CO and SO2 was evident from direction of ACRW but levels remained well below the respective ambient standards.	2	7	0	Not Sampled	Insuff. Data	Insuff. Data	0	0	0	0	0	0	Insuff. Data	Insuff. Data	Not sampled

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Table B.AAQ.S2.CA: Compliance with Ambient Air Quality Standards – Radnor AQMS – Jul2018 to Jun2019

Pollutant / Compound:		PM10			PM2.5			SO2				NO2		CO		O3
Applicable Averaging Period:		24 hours	24 hours	Annual	24 hours	24 hours	Annual	10 minute	1 hour	24 hour	Annual	1 hour	Annual	1 hour	8 hour	8 hour
Standard (S) or Guideline (G):		S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Historical Standard: Concentration in µg/m3		120	120	50	65	65	25	500	350	125	50	200	40	30000	10000	120
Current Standard: Concentration in µg/m3		75	75	40	40	40	20	500	350	125	50	200	40	30000	10000	120
Allowable Exceedances per annum (99th Percentile):		4	4	0	4	4	0	526	88	4	0	88	0	88	11	11
Period:	Findings on Investigation of Exceedances and Scatter Plots	Month Specific	Rolling Annual Total	Rolling Annual	Month Specific	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total
July-18	Daily PM10 non-compliant as 8 exceedances recorded over past year, only 4 are allowed. Widespread grass fires were observed locally and regionally in July. PM10 exceedances occurred during relatively warm pre-frontal synoptic conditions. PM10 scatter plot indicates elevated PM10 (& NOx & SO2) originated most frequently from the NNW to NNE vectors. ACRW, unpaved areas and grasslands where grass fires were observed lie within this quadrant. PM Mn levels continue to exceed the annual WHO PM Mn guideline.	3	8	0	Not Sampled	Insuff. Data	Insuff. Data	0	0	0	0	1	0	Insuff. Data	Insuff. Data	Not sampled
August-18	No 24h PM10 exceedances recorded in Aug '18, but PM10 levels exceed the allowable number (4) of 24h exceedances over the past year. The current annual average PM10 Mn concentration is 6 times higher than the annual WHO PM Mn guideline. The Aug '18 PM10 scatter plot indicates that PM10 impacts recorded at Radnor from ACRW's direction were on average no higher than impacts recorded from other vectors / sources.	0	7	0	Not Sampled	Insuff. Data	Insuff. Data	0	0	0	0	1	0	Insuff. Data	Insuff. Data	Not sampled
September-18	One 24h PM10 exceedance was recorded in Sep '18 (during warm prefrontal conditions) and 6 X 24h PM10 exceedances were recorded over the past year. This represents non-compliance as only 4 are allowed per annum. The Sep '18 scatter plot indicates that PM10 impacts recorded at Radnor from ACRW's direction were on average lower than impacts recorded from other vectors / sources. The current annual average PM10 Mn concentration continues to exceed the annual WHO PM Mn guideline and (based upon previous localised soil test results) indicates that Mn at Radnor originates from the local soil. Further soil sampling is planned.	1	6	0	Not Sampled	Insuff. Data	Insuff. Data	0	0	0	0	1	0	Insuff. Data	Insuff. Data	Not sampled

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Pollutant / Compound:		PM10			PM2.5			SO2				NO2		CO		O3
Applicable Averaging Period:		24 hours	24 hours	Annual	24 hours	24 hours	Annual	10 minute	1 hour	24 hour	Annual	1 hour	Annual	1 hour	8 hour	8 hour
Standard (S) or Guideline (G):		S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Historical Standard: Concentration in µg/m3		120	120	50	65	65	25	500	350	125	50	200	40	30000	10000	120
Current Standard: Concentration in µg/m3		75	75	40	40	40	20	500	350	125	50	200	40	30000	10000	120
Allowable Exceedances per annum (99th Percentile):		4	4	0	4	4	0	526	88	4	0	88	0	88	11	11
Period:	Findings on Investigation of Exceedances and Scatter Plots	Month Specific	Rolling Annual Total	Rolling Annual	Month Specific	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total
October-18	There were no exceedances of the 24h PM10 standard in Oct '18, but 6 exceedances were recorded over the past year which represents non-compliance (only 4 allowed). Whilst slightly elevated PM10 levels were recorded occasionally (max 70 minutes in total) during Oct '18 when winds blew from ACRW direction, the highest / most predominant concentrations occurred when winds blew from other directions (SE to NE vectors). The ongoing WHO annual Mn guideline exceedance appears to be related to localised source/s near the station, so various soil samples are currently being analysed to assess soil metal contents.	0	6	0	0	Insuff. Data	Insuff. Data	0	0	0	0	1	0	Insuff. Data	Insuff. Data	Not sampled
November-18	This station remains non-compliant with respect to the allowable number (max 4 / annum) of exceedances of the 24h PM10 standard per annum, but no 24h PM10 exceedances were recorded during Nov '18. Although there are no SA standards for Mn, the annual average PM10 Mn levels remain above the WHO annual guideline concentration. Mn concentrations detected in surface soil samples near this station were higher than the levels detected at other locations hence local soil is a possible contributing source of Mn. The Nov '18 directional PM10 plot did not indicate that elevated PM10 at Radnor originated from the direction of the ACRW plant.	0	6	0	0	Insuff. Data	Insuff. Data	0	0	0	0	1	0	Insuff. Data	Insuff. Data	Not sampled
December-18	Although no exceedances were recorded during Dec '18, this station still remains non-compliant with respect to the allowable number of exceedances of the 24h PM10 standard per annum, as 6 exceedances were recorded between Jan '18 and Dec '18 (only 4 are allowed per annum). The Dec '18 directional PM10 plot indicated the highest PM10 concentrations originated from the E and from the S vectors, i.e. not from the direction of the ACRW plant. The annual average PM10 Mn levels remain higher than the WHO annual guideline.	0	6	0	0	Insuff. Data	Insuff. Data	0	0	0	0	1	0	Insuff. Data	Insuff. Data	Not sampled

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Pollutant / Compound:		PM10			PM2.5			SO2				NO2		CO		O3
Applicable Averaging Period:		24 hours	24 hours	Annual	24 hours	24 hours	Annual	10 minute	1 hour	24 hour	Annual	1 hour	Annual	1 hour	8 hour	8 hour
Standard (S) or Guideline (G):		S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Historical Standard: Concentration in µg/m3		120	120	50	65	65	25	500	350	125	50	200	40	30000	10000	120
Current Standard: Concentration in µg/m3		75	75	40	40	40	20	500	350	125	50	200	40	30000	10000	120
Allowable Exceedances per annum (99th Percentile):		4	4	0	4	4	0	526	88	4	0	88	0	88	11	11
Period:	Findings on Investigation of Exceedances and Scatter Plots	Month Specific	Rolling Annual Total	Rolling Annual	Month Specific	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total
January-19	For the past 12 months this station has remained non-compliant with respect to the maximum number of allowable exceedances of the 24h PM10 standard per annum. Over the current Feb '18 to Jan '19 review period, 6 exceedances were recorded, only 4 are allowed per annum. The Jan '19 directional PM10 plot indicated the highest PM10 concentrations originated from the NE to E vector, and to a lesser extent from the S to SSW vector. Neither of these source directions correspond to the ACRW plant. Although traces (ie significantly below the AQ stds) of CO and SO2 were occasionally recorded from the direction of ACRW during Jan '18, the total duration of impact was approximately 1 hour in Jan '18.	0	6	0	0	Insuff. Data	Insuff. Data	0	0	0	0	1	0	Insuff. Data	Insuff. Data	Not sampled
February-19	This station remains non-compliant with respect to the maximum number of allowable exceedances of the 24h PM10 standard per annum. 6 exceedances were recorded over the Mar '18 to Feb '19 review period, only 4 are allowed per annum. The Feb '19 directional PM10 plot indicated the highest PM10 concentrations were recorded when winds blew from between the SE and SW vectors which do not coincide with ACRW. Elevated NOx was recorded from the direction of ACRW for 20 minutes during Feb '19. There was no indication of elevated CO and SO2 from the direction of ACRW during Feb '19.	0	6	0	0	Insuff. Data	Insuff. Data	0	0	0	0	1	0	Insuff. Data	Insuff. Data	Not sampled
March-19	This station remains non-compliant with respect to the maximum number of allowable exceedances of the 24h PM10 standard per annum. 6 exceedances were recorded over the Apr '18 to Mar '19 review period, only 4 are allowed per annum. The Mar '19 directional PM10 plot did not indicate elevated concentrations from ACRW direction. Traces CO and SO2 were recorded from the direction of ACRW (for less than an hour) during Mar '19, but the concentrations were well below the AQ standards.	Not Sampled	6	0	0	Insuff. Data	Insuff. Data	0	0	0	0	1	0	0	0	Not sampled

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Pollutant / Compound:		PM10			PM2.5			SO2				NO2		CO		O3
Applicable Averaging Period:		24 hours	24 hours	Annual	24 hours	24 hours	Annual	10 minute	1 hour	24 hour	Annual	1 hour	Annual	1 hour	8 hour	8 hour
Standard (S) or Guideline (G):		S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Historical Standard: Concentration in µg/m3		120	120	50	65	65	25	500	350	125	50	200	40	30000	10000	120
Current Standard: Concentration in µg/m3		75	75	40	40	40	20	500	350	125	50	200	40	30000	10000	120
Allowable Exceedances per annum (99th Percentile):		4	4	0	4	4	0	526	88	4	0	88	0	88	11	11
Period:	Findings on Investigation of Exceedances and Scatter Plots	Month Specific	Rolling Annual Total	Rolling Annual	Month Specific	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total
April-19	Despite the PM10 analyser being offline in Apr '19, this station still remains non-compliant with respect to the maximum number of allowable exceedances of the 24h PM10 standard per annum as 6 exceedances were recorded over the May '18 to Apr '19 review period. Only 4 are allowed per annum. Elevated SO2 was recorded from the direction of ACRW for 2 to 3 hours in total during Apr '19, but the concentrations remained well below the AAQ standards.	Not Sampled	6	0	Not Sampled	Insuff. Data	Insuff. Data	0	0	0	0	1	0	0	0	Not sampled
May-19	This station still remains non-compliant with respect to the maximum number of allowable exceedances of the 24h PM10 standard per annum as 6 exceedances were recorded over the Jun '18 to May '19 review period, only 4 are allowed per annum. One PM10 excedance of 114µg/m3 occurred on 23 May '19 when winds blew from ACRW direction for approximately 25% on this day. No real time PM data was recorded.	1	6	0	Not Sampled	Insuff. Data	Insuff. Data	0	0	0	0	1	0	0	0	Not sampled
June-19	This station now complies with all of the relevant SA ambient air quality standards, as the number of exceedances now complies with the allowable number of exceedances per annum. PM10 remains "borderline compliant" as 4 exceedances of the 24h standard were recorded over the past year, and only 4 are allowed. Although SO2 remained well below the relevant standards, slightly elevated concentrations were recorded (over a total period of one hour) during Jun '19.	0	4	0	Not Sampled	Insuff. Data	Insuff. Data	0	0	0	0	1	0	0	0	Not sampled

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Table B.AAQ.S2.CA: Compliance with Ambient Air Quality Standards – Radnor AQMS – Jul2019 to Jun2020

Pollutant / Compound:		PM10			PM2.5			SO2				NO2		CO		O3
Applicable Averaging Period:		24 hours	24 hours	Annual	24 hours	24 hours	Annual	10 minute	1 hour	24 hour	Annual	1 hour	Annual	1 hour	8 hour	8 hour
Standard (S) or Guideline (G):		S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Historical Standard: Concentration in µg/m3		120	120	50	65	65	25	500	350	125	50	200	40	30000	10000	120
Current Standard: Concentration in µg/m3		75	75	40	40	40	20	500	350	125	50	200	40	30000	10000	120
Allowable Exceedances per annum (99th Percentile):		4	4	0	4	4	0	526	88	4	0	88	0	88	11	11
Period:	Findings on Investigation of Exceedances and Scatter Plots	Month Specific	Rolling Annual Total	Rolling Annual	Month Specific	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total
July-19	A record breaking frequency of 24h PM10 exceedances were recorded this month (Total = 9). Radnor therefore remains non-compliant with respect to 24h PM10 as 11 exceedances were recorded over the past year. July's real time wind and PM2.5 data for the 9 exceedance days did not indicate specific source direction/s for elevated PM2.5. This includes the ACRW plant which lies along the NW / NNW vector, as concentrations recorded during these winds were generally no higher than the normal / background concentrations recorded from the other wind vectors. Although elevated PM2.5 was recorded for 30mins from the direction of ACRW on 12 July, this was not one of the 9 exceedance days.	9	11	0	6	6	Insuff. Data	0	0	0	0	0	0	0	0	Not sampled
August-19	PM10 remains non-compliant wrt the 24h standard. Although one year's PM2.5 data is not yet available, 6 exceedances of the 24h standard were recorded in Jul '19, and another (one) exceedance during Aug '19. These 7 exceedances over 2 months represents non-compliance as only 4 are allowed per annum. The Aug '19 PM2.5 scatter plot indicates the highest PM2.5 levels were most commonly recorded when winds blew from the SE quadrant which does not coincide with the ACRW plant. The Aug '19 PM2.5 di-urnal plot indicates that the highest PM2.5 levels were generally recorded between 9pm and 5pm. The PM2.5 exceedance was recorded on 25 Aug '19 which coincided with the nearby Geurnica / Metallica fire. Maximum PM2.5 levels on this day were recorded between 11h30 and 14h30.	0	11	0	1	7	Insuff. Data	0	0	0	0	0	0	0	0	Not sampled

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Pollutant / Compound:		PM10			PM2.5			SO2				NO2		CO		O3
Applicable Averaging Period:		24 hours	24 hours	Annual	24 hours	24 hours	Annual	10 minute	1 hour	24 hour	Annual	1 hour	Annual	1 hour	8 hour	8 hour
Standard (S) or Guideline (G):		S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Historical Standard: Concentration in µg/m3		120	120	50	65	65	25	500	350	125	50	200	40	30000	10000	120
Current Standard: Concentration in µg/m3		75	75	40	40	40	20	500	350	125	50	200	40	30000	10000	120
Allowable Exceedances per annum (99th Percentile):		4	4	0	4	4	0	526	88	4	0	88	0	88	11	11
Period:	Findings on Investigation of Exceedances and Scatter Plots	Month Specific	Rolling Annual Total	Rolling Annual	Month Specific	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total
September-19	No 24h PM2.5 or PM10 standard exceedances were recorded in Sep '19 but this station remains non-compliant with respect to both 24h PM10 and 24h PM2.5 as only 4 exceedances are allowed per annum. Over the past year, 10 exceedances of the 24h PM10 standard and 7 exceedances of the 24h PM2.5 standard were recorded. Although very limited (13% data recovery) real time PM2.5 data was recorded this month, elevated PM2.5 originated from the NNW vector (ACRW direction) for maximum duration of 1h. Although SO2, NOx and CO levels remained well below the relevant AAQ standards, slightly elevated levels of these 3 pollutants were recorded occasionally during Sep '19 when the winds blew from ACRW's direction towards Radnor. Impacts from another SO2 source to the S is also evident.	0	10	0	0	7	Insuff. Data	0	0	0	0	0	0	0	0	Not sampled
October-19	No 24h PM2.5 or PM10 standard exceedances were recorded in Oct '19 but this station remains non-compliant with respect to both 24h PM10 and 24h PM2.5 as only 4 exceedances are allowed per annum. Over the past year, 10 exceedances of the 24h PM10 standard and 7 exceedances of the 24h PM2.5 standard were recorded to date. Traces of SO2 and CO were detected when winds blew from ACRW's direction but levels remained well below the relevant AAQ standards. Impacts from other SO2 sources were also detected during S and NNE winds.	0	10	0	0	7	Insuff. Data	0	0	0	0	0	0	0	0	Not sampled
November-19	No exceedances of the AAQ standards were recorded in Nov '19 as pollutant concentrations were generally very low. However this station remains non-compliant with respect to both 24h PM10 and 24h PM2.5 as only 4 exceedances are allowed per annum. Over the past year, 10 exceedances of the 24h PM10 standard and 7 exceedances of the 24h PM2.5 standard were recorded. Traces of SO2 were detected (marginally above background levels over a total duration of 30 mins) when winds blew from	0	10	0	Not Sampled	7	Insuff. Data	0	0	0	0	0	0	0	0	Not sampled

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Pollutant / Compound:		PM10			PM2.5			SO2				NO2		CO		O3
Applicable Averaging Period:		24 hours	24 hours	Annual	24 hours	24 hours	Annual	10 minute	1 hour	24 hour	Annual	1 hour	Annual	1 hour	8 hour	8 hour
Standard (S) or Guideline (G):		S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Historical Standard: Concentration in µg/m3		120	120	50	65	65	25	500	350	125	50	200	40	30000	10000	120
Current Standard: Concentration in µg/m3		75	75	40	40	40	20	500	350	125	50	200	40	30000	10000	120
Allowable Exceedances per annum (99th Percentile):		4	4	0	4	4	0	526	88	4	0	88	0	88	11	11
Period:	Findings on Investigation of Exceedances and Scatter Plots	Month Specific	Rolling Annual Total	Rolling Annual	Month Specific	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total
	ACRW's direction, but levels remained well below the relevant AAQ standards.															
December-19	There were no exceedances of the AAQ standards in Dec '19 as pollutant concentrations were generally very low. This station however remains non-compliant with respect to both 24h PM10 and 24h PM2.5 as only 4 exceedances are allowed per annum. Over the past year, 10 exceedances of the 24h PM10 standard and 7 exceedances of the 24h PM2.5 standard were recorded. Traces of elevated SO2 were recorded (marginally above background levels) when winds blew from the SSE vector but this does not coincide with ACRW's direction. CO and NOx concentrations recorded from ACRW's direction remained lower than the concentrations recorded from the other vectors.	Not Sampled	10	Insuff. Data	Not Sampled	7	Insuff. Data	0	0	0	0	0	0	0	0	Not sampled
January-20	No exceedances of the AAQ standards were recorded in Jan '20. This station however remains non-compliant with respect to both 24h PM10 and 24h PM2.5 as only 4 exceedances are allowed per annum. Traces of elevated CO was recorded from ACRW's direction but the levels were below the normal background levels recorded from other vectors and also remained well below the ambient CO standards.	Not Sampled	10	Insuff. Data	Not Sampled	7	Insuff. Data	0	0	0	0	0	0	0	0	Not sampled
February-20	No exceedances were recorded in Feb '20 but this station remains non-compliant with respect to both 24h PM10 and 24h PM2.5 as only 4 exceedances are allowed per annum. None of the Feb '20 pollutant scatter plots indicated elevated impacts (i.e. above background levels) from the direction of ACRW.	Not Sampled	10	Insuff. Data	Not Sampled	7	Insuff. Data	0	0	0	0	0	0	0	0	Not sampled

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Pollutant / Compound:		PM10			PM2.5			SO2				NO2		CO		O3
Applicable Averaging Period:		24 hours	24 hours	Annual	24 hours	24 hours	Annual	10 minute	1 hour	24 hour	Annual	1 hour	Annual	1 hour	8 hour	8 hour
Standard (S) or Guideline (G):		S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Historical Standard: Concentration in µg/m3		120	120	50	65	65	25	500	350	125	50	200	40	30000	10000	120
Current Standard: Concentration in µg/m3		75	75	40	40	40	20	500	350	125	50	200	40	30000	10000	120
Allowable Exceedances per annum (99th Percentile):		4	4	0	4	4	0	526	88	4	0	88	0	88	11	11
Period:	Findings on Investigation of Exceedances and Scatter Plots	Month Specific	Rolling Annual Total	Rolling Annual	Month Specific	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total
March-20	No PM10 exceedances were recorded in Mar '20 as the analyser was still offsite being repaired. This station still remains non-compliant with respect to both 24h PM10 and 24h PM2.5 as only 4 exceedances are allowed per annum. Elevated SO2 (i.e. slightly above the normal / background levels) were detected over a total duration of 1 hour (6 X 10mins) during Mar '20 when winds blew from ACRW direction towards Radnor, but the maximum concentration was well below the 10min SO2 standard. Traces of CO were also detected from ACRW's direction.	Not Sampled	10	Insuff. Data	Not Sampled	7	Insuff. Data	0	0	0	0	0	0	0	0	Not sampled
April-20	PM2.5 and PM10 analyser spares delayed by Covid-19 Lockdown so analyser is still offline. Despite poor data recovery this station still remains non-compliant with respect to both 24h PM10 and 24h PM2.5 as only 4 exceedances are allowed per annum. Slightly elevated SO2 and NOx were once again detected when winds blew from ACRW direction towards Radnor. As ACRW plant was offline due to lockdown this suggests another SO2 & NOX source lies to the NNW (351°) of Radnor. CO and NOx trends indicate uncharacteristic improvements in air quality likely to be associated with lower human activity hence lower emissions since the Covid-19 Lockdown commenced on 27 Mar '20.	Not Sampled	10	Insuff. Data	Not Sampled	7	Insuff. Data	0	0	0	0	0	0	0	0	Not sampled
May-20	PM10 analyser repairs completed so online again from mid May '20. Real time / continuous PM10 sensor installed to assist with PM10 exceedance investigations. No exceedances recorded this month but PM10 and PM2.5 remains non-compliant due to the number of annual 24h standard exceedances over past year (only 4 are allowed per annum). Scatter plots show traces of SO2 and CO from direction of ACRW plant (NNW) but levels remained well below respectiove AAQ standards. April '20 data showed elevated SO2 and NOx originating from the same vector but ACRW plant was shutdown. Another emission source lying to the NNW of Radnor may therefore	0	9	Insuff. Data	Not Sampled	7	Insuff. Data	0	0	0	0	0	0	0	0	Not sampled

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Pollutant / Compound:		PM10			PM2.5			SO2				NO2		CO		O3
Applicable Averaging Period:		24 hours	24 hours	Annual	24 hours	24 hours	Annual	10 minute	1 hour	24 hour	Annual	1 hour	Annual	1 hour	8 hour	8 hour
Standard (S) or Guideline (G):		S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Historical Standard: Concentration in µg/m3		120	120	50	65	65	25	500	350	125	50	200	40	30000	10000	120
Current Standard: Concentration in µg/m3		75	75	40	40	40	20	500	350	125	50	200	40	30000	10000	120
Allowable Exceedances per annum (99th Percentile):		4	4	0	4	4	0	526	88	4	0	88	0	88	11	11
Period:	Findings on Investigation of Exceedances and Scatter Plots	Month Specific	Rolling Annual Total	Rolling Annual	Month Specific	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual	Rolling Annual Total	Rolling Annual Total	Rolling Annual Total
	be responsible such as trucks idling at adjacent property entrance gate, only a few meters from the monitoring station.															
June-20	2 PM10 exceedances were recorded on 25 & 26 Jun '20 during warm pre-frontal poor visibility synoptic conditions. Real time PM10 scatter plot does not indicate a specific source direction and none of the real time PM10 peaks on those days originated from the direction of ACRW. Exceedances therefore attributed to the usual increase in photochemical activity associated with relatively warm wintertime pre-frontal synoptic conditions. Station remains non-compliant with respect to the number of allowable PM10 and PM2.5 exceedances per annum. Monthly scatter plots shows PM10, CO, NOx and SO2 originating from the same NW quadrant as ACRWwhich was particularly evident overnight.	2	11	Insuff. Data	Not Sampled	7	Insuff. Data	0	0	0	0	0	0	0	0	Not sampled

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B.M Comparison of Modelling Results versus Monitored Results

In view of other non-Enterpise related sources which could potentially contribute to the ambient concentration of the pollutant(s) associated with this study, a full comparison of modelling versus monitored data is not possible. However, ad-hoc comparison of modelled and monitored data was done to assist with the development of the investigation.

Modelling results from section 5.3 for Mn annual averages compare well with monitored results in terms of orders of magnitude.

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Appendix C: Modelling Procedure and Settings

In terms of Section 53(f) of the National Environmental Management: Air Quality Act (NEM:AQA), 2004 (Act No. 39 of 2004), the Department of Environmental Affairs (DEA) has developed and published a CODE OF PRACTICE FOR AIR DISPERSION MODELLING IN AIR QUALITY MANAGEMENT IN SOUTH AFRICA under GN533, "REGULATIONS REGARDING AIR DISPERSION MODELLING, 2014" in Government Gazette No. 37804 on 11 July 2014. In addition to the following information, please also refer to detailed information contained in Appendix RADM with respect detail regarding the information required in the air dispersion modelling study report.

C.1 Modelling Domain: Receptors, Modelled Facility and Terrain Features

The extent of the modelling domain, receptors, modelled facility and terrain features can be seen in Figure C.1 on the following page, in terms of the colour scheme used in the maps as provided in Table C.1 below. The sensitive discrete receptors are indicated on Figure C.2.

Table C.1: Details of the on-site buildings used in the study

Point source	
Area source	
Volume source	
Open pit source	
Flare source	
Line source	
Grid	
Discrete receptor	
Boundry receptor	
Building	
Roadway	

The modelling results were obtained over receptor points placed up to a distance of 20km x 20km around the Enterprise. Table C.2 provides a summary of the receptor grid spacing used in the modelling.

Table C.2: Receptor grid spacing used

Recommended grid spacing for receptor grids		
Resolution	**Recommended receptor spacing**	**Spacing used due to model source complexity**
50m	General area of maximum impact, property boundary and over steep terrain	Used 50m for sensitive areas. Discrete receptors were provided for the nearest sensitive areas.
100m	5km from the facility of interest	Used 100m between 0 and 2km from the facility of interest
250m	10km from the facility of interest	Used 250m between 2km and 4km from the facility of interest
1000m	Beyond 10km from the facility of interest	Used 1000m beyond 4km from the facility of interest

Additional notes with respect to the dispersion modelling:

- Building downwash was included in view of structures in close proximity to the point sources which could play a role – refer Figure C.5 and Table C.3;
- As a worst-case, although the site is located in/near an urban area, a half-life of 4 hours was not applied to SO_2 emissions, i.e. modelled as rural;

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- All NO_X emissions were interpreted and modelled as NO_2;
- In view of this study forming part of an environmental authorisation and / or impact assessment associated with a Listed Activity in terms of Section 21 of NEM:AQA, i.e. associated with an Atmospheric Emission Licence, deposition was not accounted for;
- Modelling was done for elevated terrain and not in terms of flat terrain;
- Abnormal emissions were applicable for this investigation in view of the specific operations – abnormal Emissions from Primary Point Sources (Stacks) when APCE is not available: when applicable, it is modelled during the most stable atmospheric condition (i.e. poorest dispersion potential), which is usually around midnight and the abnormal emissions were modelled to occur during this period;
  Abnormal emissions were included for ACRW, but not for the other sources/operations included due to limited availability of related information;
- The hours of emission for the current and/or future sources are applied in terms of their operation, i.e. either batch, intermittent or continuous;
- Metals are modelled if the investigation warrants the modelling thereof in terms of adding additional value in terms of decision making. Hence with manganese being relevant for this Enterprise, it was also modelled;
- The impact of the secondary emissions from stockpiles, product/material handling and roads are accounted for in the ambient air monitoring data referenced in Section 5.1.1 and Appendix B, and considering the objective of each individual investigation, the merits of modelling the secondary emissions need to be considered. It is thus not always worthwhile to model the secondary emissions for each investigation, considering the resources required for complex modelling.
  In view of the objective of this study being to assess baseline impact, it was decided to model all the existing and/or expected future secondary emissions from planned activities (planned Sinter Plant at ACRW) in addition to the point sources;
  No information regarding fugitive/secondary emissions from the other sources/operations were available to include;
- The locations (coordinates) and dimension (exit heights and diameters) of the proposed new stacks P30, P31 and P32 for the planned Sinter Plant at ACRW, were assumed based the available information at the time of the study;
- Tapping emissions: Modelled as:
  - 95% captured, of which 96% abated and stacked;
  - 5% remaining as fugitive tapping emissions at a release height of 20m which is the estimated height of the building;
- Refer Section D.1 for further assumptions and exclusions where relevant.

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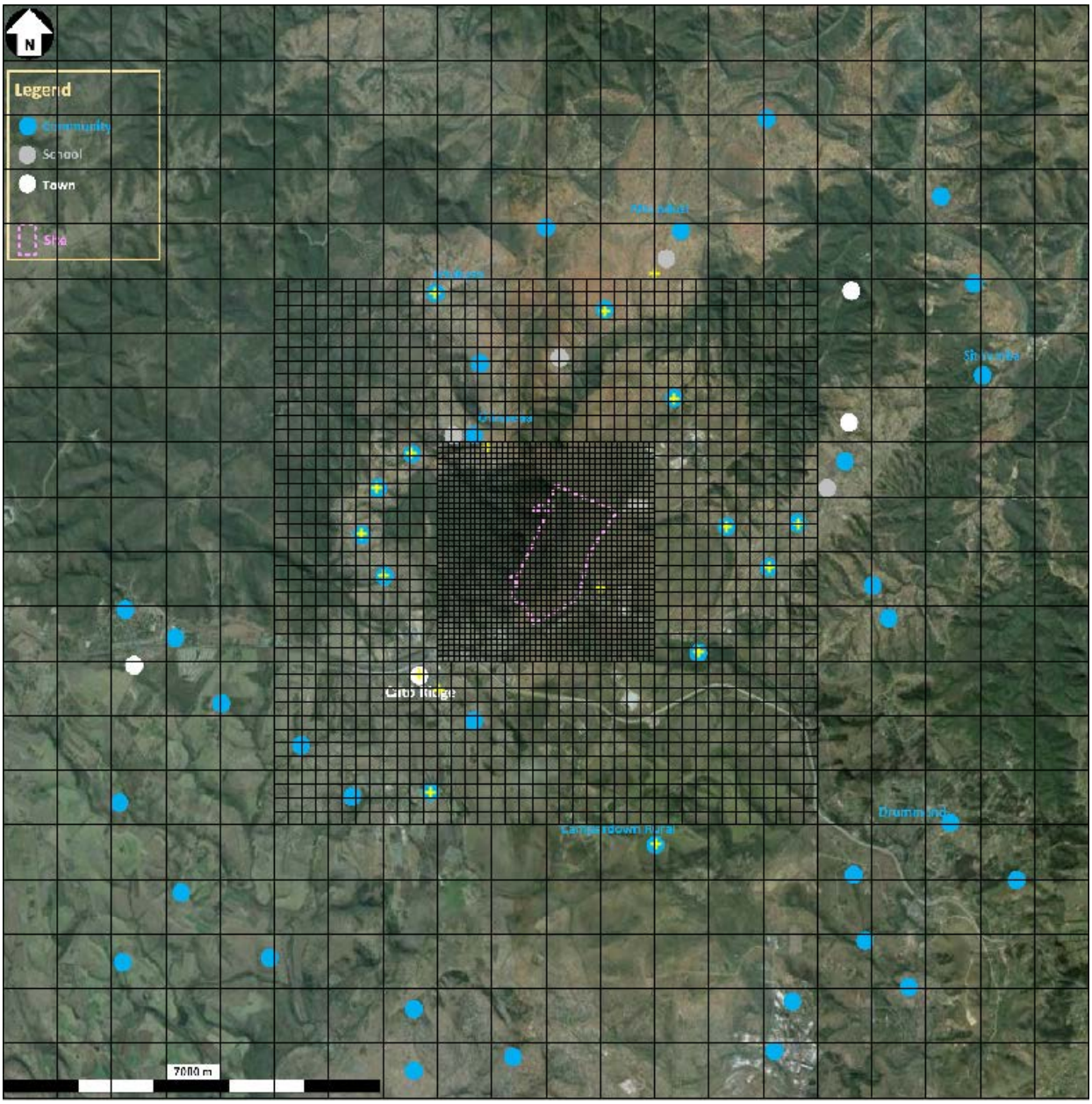


Figure C.1: Modelling Domain: Modelled Receptors and Enterprise

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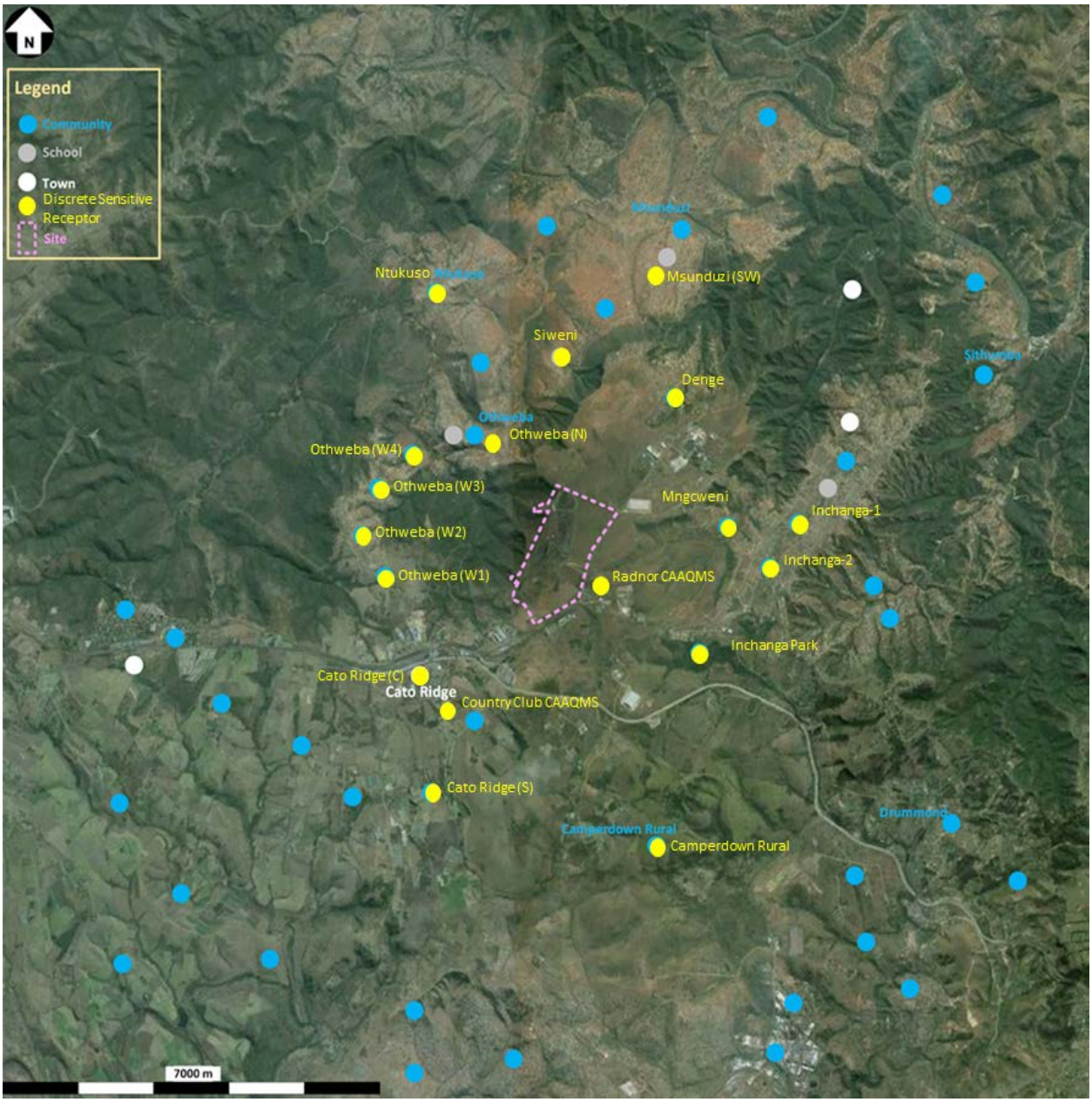


Figure C.2: Modelling Domain indicating Sensitive Discrete Receptors and Enterprise

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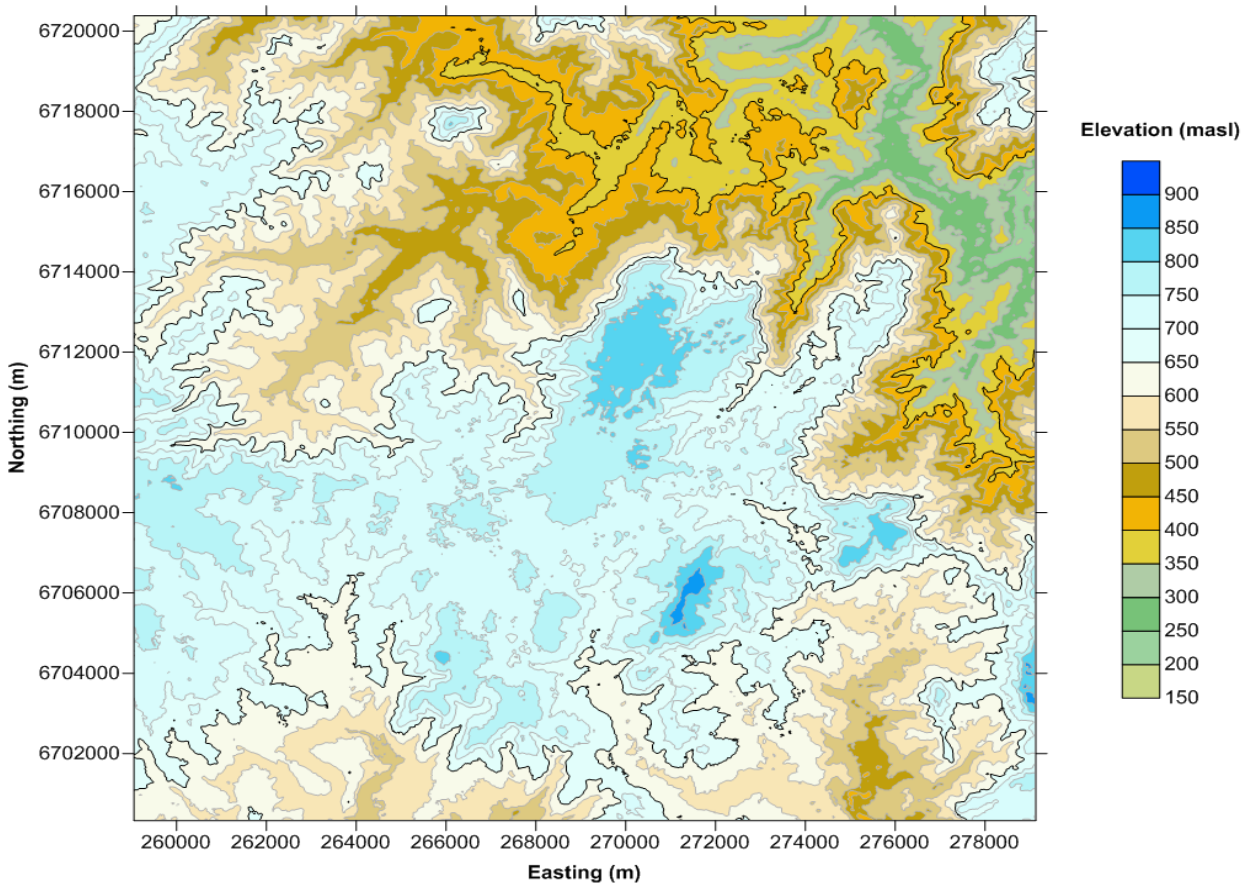


Figure C.3: Topography (relief contours in meters) of the area surrounding the Enterprise (20km x 20km)

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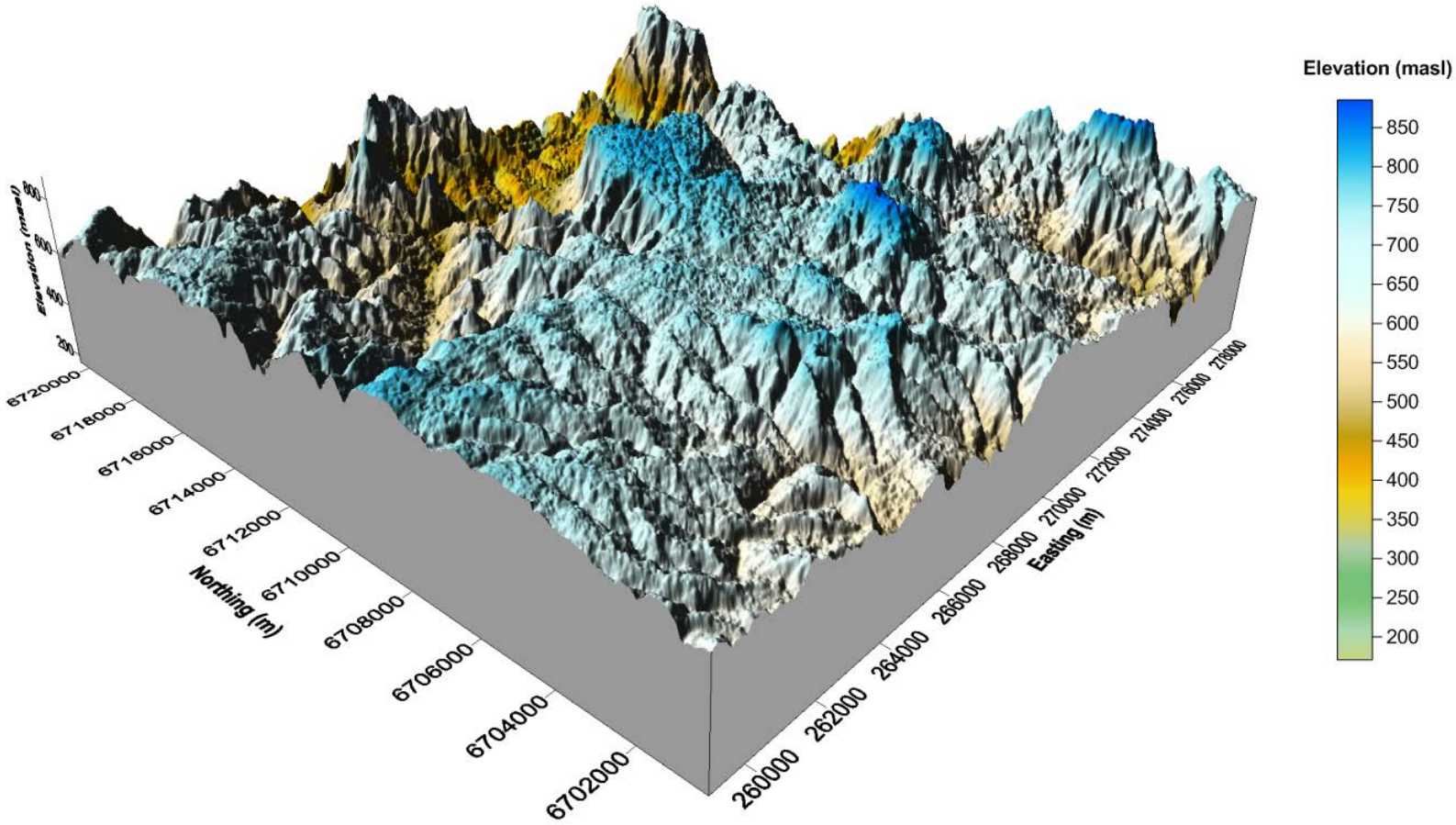


Figure C.4: Topography (surface profile) of the area surrounding the Enterprise (20km x 20km)

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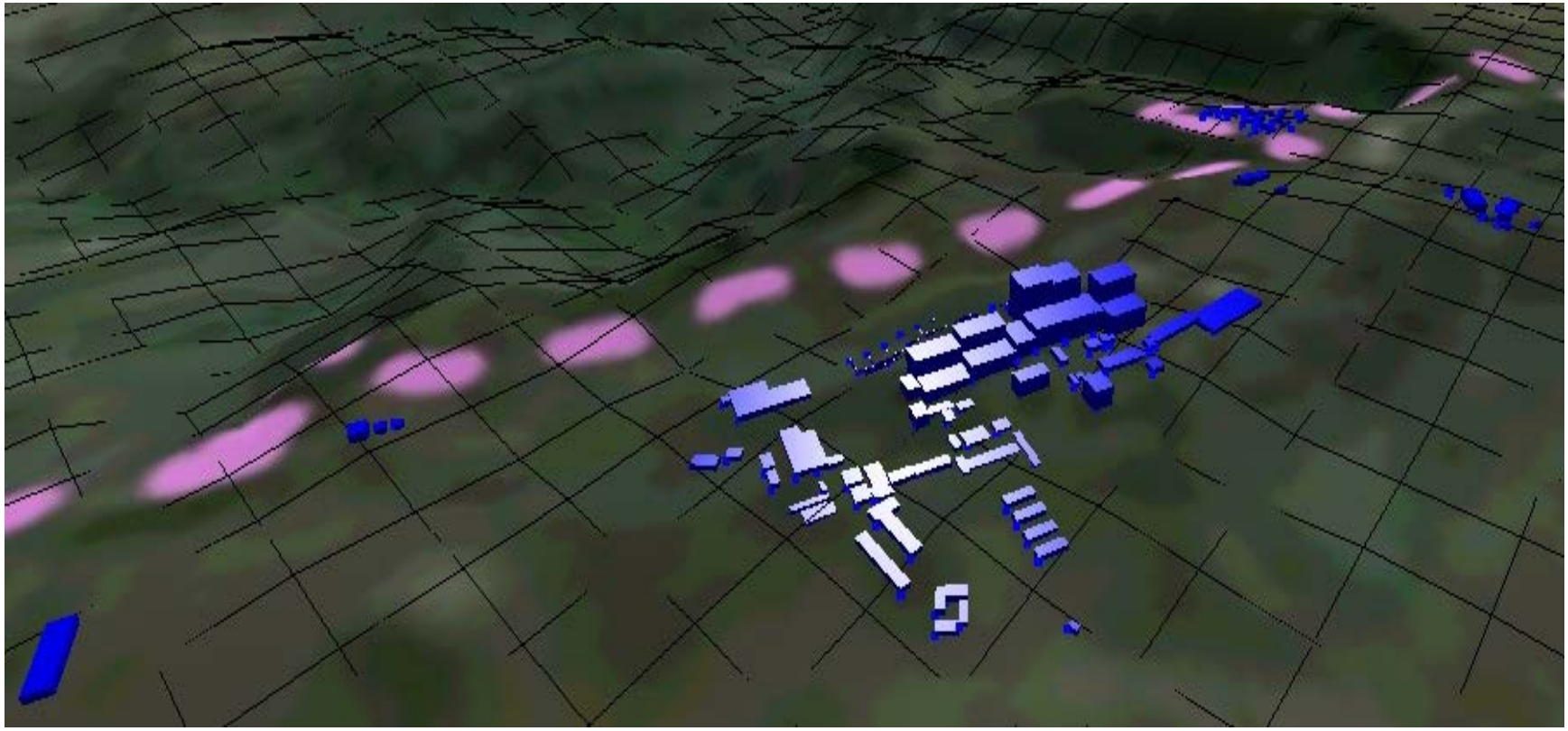


Figure C.5: Illustration of ACRW Buildings included in the AQIA Study

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Table C.3: Information of the Buildings included in the AQIA Study

Buildings				
Building number	Location (UTM)		Elevation	Height
	Easting	Northing	m	m
BLD1	268951.2	6710310.8	775.27	6
BLD2	268975.5	6710299.5	776.95	6
BLD3	268950.7	6710310.5	775.23	1
BLD4	268959.9	6710329.7	777.39	6
BLD5	268983.9	6710318.6	779.52	6
BLD6	268959.5	6710329.5	777.35	1
BLD7	268968.7	6710348.7	780.71	6
BLD8	268992.4	6710337.6	783.19	6
BLD9	268968.1	6710348.5	780.62	1
BLD10	268977.4	6710367.6	787.35	6
BLD11	269000.9	6710356.7	789.64	6
BLD12	268976.8	6710367.4	787.16	1
BLD13	268986.1	6710386.5	789.11	6
BLD14	269009.4	6710375.7	793.67	6
BLD15	268985.6	6710386.4	789.03	1
BLD16	268994.8	6710405.5	789.41	6
BLD17	269017.9	6710394.7	794.43	6
BLD18	268994.2	6710405.3	789.32	1
BLD19	268942.5	6710291.8	775.5	6
BLD20	269003.5	6710424.5	790.66	6
BLD21	269026.4	6710413.8	798.32	6
BLD22	269002.9	6710424.3	790.54	1
BLD23	268974.7	6710291.1	776.89	6
BLD24	268978.4	6710289.1	777.29	6
BLD25	268974.2	6710291	776.86	6
BLD26	268977.1	6710296.4	777.15	6
BLD27	268980.8	6710294.3	777.76	6
BLD28	268976.7	6710296.2	777.08	6
BLD29	268979.5	6710301.7	777.68	6
BLD30	268983.2	6710299.6	778.38	6
BLD31	268979.1	6710301.5	777.59	6
BLD32	268981.9	6710306.9	778.36	6
BLD33	268985.7	6710304.9	779.17	6
BLD34	268981.6	6710306.8	778.29	6
BLD35	268984.4	6710312.2	779.23	6
BLD36	268988.1	6710310.2	780.1	6
BLD37	268983.9	6710312.1	779.09	6
BLD38	268986.8	6710317.5	780.25	6
BLD39	268990.5	6710315.4	781.13	6
BLD40	268986.4	6710317.3	780.13	6
BLD41	268989.2	6710322.7	781.27	6
BLD42	268992.9	6710320.7	782.16	6
BLD43	268988.9	6710322.6	781.18	6
BLD44	268991.6	6710328	782.3	6
BLD45	268995.3	6710326	783.19	6
BLD46	268991.2	6710327.8	782.18	6
BLD47	268994.1	6710333.3	783.36	6

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Buildings				
Building number	Location (UTM)		Elevation	Height
	Easting	Northing	m	m
BLD48	268997.8	6710331.2	784.24	6
BLD49	268993.6	6710333.2	783.22	6
BLD50	268996.5	6710338.6	784.39	6
BLD51	269000.2	6710336.5	785.27	6
BLD52	268996	6710338.5	784.25	6
BLD53	268998.9	6710343.8	785.84	6
BLD54	269002.6	6710341.8	786.35	6
BLD55	268998.5	6710343.6	785.68	6
BLD56	269001.3	6710349.1	787.82	6
BLD57	269005	6710347.1	788.3	6
BLD58	269000.9	6710348.9	787.67	6
BLD59	269003.7	6710354.4	789.75	6
BLD60	269007.5	6710352.3	789.71	6
BLD61	269003.3	6710354.2	789.6	6
BLD62	269006.2	6710359.6	791.4	6
BLD63	269009.9	6710357.6	791.03	6
BLD64	269005.8	6710359.6	791.39	6
BLD65	269008.6	6710364.9	792.7	6
BLD66	269012.3	6710362.9	792.3	6
BLD67	269008.2	6710364.7	792.65	6
BLD68	269011	6710370.2	793.94	6
BLD69	269014.7	6710368.1	793.48	6
BLD70	269010.6	6710370	793.9	6
BLD71	269013.4	6710375.4	793.87	6
BLD72	269017.2	6710373.4	794.03	6
BLD73	269013.1	6710375.3	793.86	6
BLD74	269015.9	6710380.7	793.98	6
BLD75	269019.6	6710378.7	794.28	6
BLD76	269015.4	6710380.6	793.94	6
BLD77	269018.3	6710386	794.33	6
BLD78	269022	6710383.9	794.76	6
BLD79	269017.9	6710385.8	794.27	6
BLD80	269020.7	6710391.3	794.92	6
BLD81	269024.4	6710389.2	795.49	6
BLD82	269020.3	6710391.1	794.84	6
BLD83	269023.1	6710396.5	795.75	6
BLD84	269026.9	6710394.5	796.49	6
BLD85	269022.8	6710396.4	795.67	6
BLD86	269025.6	6710401.8	796.87	6
BLD87	269029.3	6710399.8	797.71	6
BLD88	269025.1	6710401.7	796.72	6
BLD89	269028	6710407.1	798.14	6
BLD90	269031.7	6710405	799.03	6
BLD91	269027.6	6710406.9	797.99	6
BLD92	268972.2	6710285.8	776.72	6
BLD93	269030.4	6710412.4	799.53	6
BLD94	269034.1	6710410.3	800.49	6
BLD95	269030	6710412.2	799.37	6

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Buildings				
Building number	Location (UTM)		Elevation	Height
	Easting	Northing	m	m
BLD96	269007.8	6710469.2	786.92	6
BLD97	269044.2	6710452	803.64	1
BLD98	269007.3	6710468.9	786.82	1
BLD99	269016.5	6710488.1	783.79	6
BLD100	269052.9	6710470.9	799.72	1
BLD101	269016	6710488	783.64	1
BLD102	269025.2	6710507.1	780.5	6
BLD103	269061.6	6710489.9	794.34	1
BLD104	269024.6	6710506.9	780.45	1
BLD105	269033.9	6710526.1	776.33	6
BLD106	269070.3	6710508.8	789.92	1
BLD107	269033.3	6710525.9	776.31	1
BLD108	269042.5	6710545	772.07	6
BLD109	269078.9	6710527.8	786.56	1
BLD110	269042	6710544.7	772.13	1
BLD111	268999.2	6710450.2	788.37	6
BLD112	269051.1	6710564	767.77	6
BLD113	269087.6	6710546.8	783.29	1
BLD114	269050.6	6710563.7	767.83	1
BLD115	268687.7	6709650.8	778.3	8
BLD116	268629.8	6709898.6	774.39	8
BLD117	268643.6	6709911.1	775.88	5
BLD118	268652.1	6709924.8	776.22	4
BLD119	268930.2	6710091.2	778.26	5
BLD120	268952.2	6710114.9	780.94	5
BLD121	268884.3	6710167.1	775.64	8
BLD122	268915.8	6710197	775.81	8
BLD123	268880.6	6710158.9	775.39	5
BLD124	268990.1	6710124.5	786.26	5
BLD125	269009.1	6710117.1	784.88	5
BLD126	268980.9	6710156.9	787.22	5
BLD127	268997.8	6710171.1	786.31	5
BLD128	269040	6710166.7	784.19	5
BLD129	269053.4	6710106.8	781.25	5
BLD130	269055.6	6710141.8	784.07	5
BLD131	269066.4	6710110.2	781.48	5
BLD132	269085.7	6710154.3	785.63	5
BLD133	269063.8	6710163.3	784.85	5
BLD134	269101.5	6710165.1	787.07	5
BLD135	269076	6710181.5	785.37	5
BLD136	269102.4	6710187.7	788.23	5
BLD137	269113.1	6710209.9	787.44	5
BLD138	269119.4	6710143.7	789.98	5
BLD139	269133.9	6710143.4	790.6	5
BLD140	269128.7	6710118.7	786.59	5
BLD141	269212.2	6710133.3	781.14	5
BLD142	269226.4	6710116.1	771.58	5
BLD143	269234.7	6710137	780.28	5

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Buildings				
Building number	Location (UTM)		Elevation	Height
	Easting	Northing	m	m
BLD144	269218.4	6710138.4	782.66	5
BLD145	269320.2	6710179.3	785.22	5
BLD146	269257.1	6710211.8	787.37	5
BLD147	269239.1	6710220.3	787.07	5
BLD148	269220.9	6710228.7	788.62	5
BLD149	269202.4	6710236.8	789.1	5
BLD150	269135.4	6710248.1	784.41	5
BLD151	269143	6710253.6	782.94	5
BLD152	269159.6	6710309.9	785.24	5
BLD153	269111.3	6710265.1	784.28	5
BLD154	269117.3	6710277.5	783.42	5
BLD155	269134.9	6710305.8	786.63	5
BLD156	269123.5	6710425.3	794.98	5
BLD157	269186.8	6710392.2	793.36	20
BLD158	269161.8	6710403	795.12	5
BLD159	269166.7	6710408.9	795.33	5
BLD160	269175.8	6710415.8	795.57	5
BLD161	269147.9	6710453	799.34	5
BLD162	269157.1	6710469.6	801.1	5
BLD163	269165.6	6710474.2	801.71	5
BLD164	269174.8	6710440.2	797.99	5
BLD165	269220	6710460.4	805.15	5
BLD166	269200.8	6710488.4	805.43	5
BLD167	269200.1	6710498	806.02	5
BLD168	269217	6710566.7	800.58	5
BLD169	269059.7	6710263.9	783.97	12
BLD170	269067.6	6710283.1	783.04	5
BLD171	269082.9	6710287.7	783.7	5
BLD172	269089.5	6710303	786.35	5
BLD173	269024.6	6710287.7	781.37	15
BLD174	269018.1	6710305.4	784.21	30
BLD175	269040.5	6710296.3	783.63	15
BLD176	269040.1	6710355.4	791.93	30
BLD177	269062.2	6710345.7	793.18	15
BLD178	269074.8	6710399.8	800.47	15
BLD179	269059.3	6710432.2	807.1	40
BLD180	269087.4	6710419.8	803.46	20
BLD181	269074.3	6710466.5	802.66	40
BLD182	269102.5	6710454.1	802.1	20
BLD183	269113.6	6710490.2	800.96	20
BLD184	269118.5	6710501.4	800.7	40
BLD185	269141.3	6710491.2	801.9	20
BLD186	268941.9	6711140.2	768.84	5
BLD187	268945.4	6711158.8	769.01	5
BLD188	268964.4	6711153.7	771.62	5
BLD189	268974.5	6711171.5	771.42	5
BLD190	268981.4	6711151.7	773.34	5
BLD191	269011.9	6711138.1	773	5

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Buildings				
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	Easting	Northing	m	m
BLD192	269038.8	6711118.2	769.16	5
BLD193	268993.2	6711185.5	772.04	5
BLD194	269004.7	6711166.9	774.44	5
BLD195	269025.9	6711160.3	776.05	5
BLD196	269033.9	6711139.3	772.96	5
BLD197	269048.5	6711139.9	773.81	5
BLD198	269060.7	6711132.7	772.89	5
BLD199	269027.1	6711189.8	775.78	5
BLD200	269056.3	6711180.2	780.97	5
BLD201	269054.1	6711162.4	778.17	5
BLD202	269073.2	6711159	778.85	5
BLD203	269052.8	6711203.5	779.47	5
BLD204	269076.9	6711201.4	782.48	5
BLD205	269088.2	6711186.9	782.87	5
BLD206	269092.5	6711153.2	779.2	3
BLD207	269356.3	6711055.7	801.94	5
BLD208	269359	6711047.8	804.32	5
BLD209	269376.8	6711030.6	809.26	10
BLD210	269428.8	6711039.7	809.61	10
BLD211	269425.1	6711046.5	807.63	10
BLD212	269411.5	6710981.4	813.08	5
BLD213	269437	6710980.1	812.26	5
BLD214	269471.9	6711022.7	808.79	5
BLD215	269123.2	6710355.5	786.99	22
BLD216	269133	6710907	801.22	9
BLD217	269143	6710925	803.81	6
BLD218	269184.7	6710903.7	803.88	6
BLD219	269122.5	6710879.5	797.29	9
AVIBLD1	271864.6	6712538.1	801.14	6
AVIBLD2	271805.1	6712457.5	798.49	12
AVIBLD3	271830.4	6712296.9	789.19	9
AVIDLD4	271861.2	6712320.8	792.13	6
MCRBLD	270599.4	6711299.6	799.93	9
SHUBLD1	270597.6	6709646.5	796.12	6
MRLBLD1	270380.4	6709563.4	798.11	6
MRLBLD2	270450.7	6709419.7	800.35	6
CRLBLD1	270465.1	6709384.6	806.26	6
CRMBLD1	268277.8	6708685.3	768.26	4
SFSBLD1	268159.6	6708715.7	764.32	9
SFSBLD2	268182	6708776.3	767.33	9
SFSBLD3	268260.2	6708848.2	775.7	9
SFSBLD4	268146.8	6708982.3	772.7	9
SFSBLD5	268039.9	6708972.7	755.71	5
VLBLD1	270629.8	6707541.3	740.73	9

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Appendix D:Additional Emission Inventory Estimation Information

Section D.1 below provides additional summary of the assumptions and calculations used for the emission inventory used in this study. Sections D.2 to D.7 thereafter cover a summary of the literature which is used for the compilation of an emission inventory for secondary/fugitive sources when relevant/applicable.

D.1 Emission Inventory Summary of Assumptions and Calculations

D.1.1 Scenarios' Key Assumptions

- Secondary emissions were calculated/estimated per the methodology provided in Sections D.2 to D.7;
- Secondary emissions from stockpiles, roads, loading/unloading and raw material primary transfer points were included in the assessment and the associated emissions calculated per the parameter referenced in Section D.1.3, based on assumed parameters for:
    - Diesel consumption for the various production scenarios: estimated based on other similar operations per quantities of material moved and typical other vehicle usage. Diesel consumption and or its contribution/impact could potentially be conservatively overestimated;
    - Silt content of the various storage/stockpiles and material types: most applicable conservative figures used per Table D.1;
    - Moisture content of the various storage/stockpiles and material types: most applicable conservative figures used per Table D.1;
- The quantities/volumes of materials used to estimate the secondary emissions were estimated and is referenced the D.0-X tables;
- Seasonal wind ratios for wind dependant emissions: Calculated per Meteorological Data;
- All areas/volumes of secondary emission sources are estimations;
- In view of the objective of this study being to assess baseline impact, it was decided to model all the existing and/or expected future secondary emissions from planned activities (planned Sinter Plant at ACRW) in addition to the point sources;
- No information regarding fugitive/secondary emissions from the other sources/operations were available to include;
- Mining, and milling is not applicable in this assessment;
- Crushing is applicable to this assessment and referenced in Section D.1.3;
- $PM_{2.5}$ emissions for secondary sources (assumed 30% of PM_{10}) and the metal content was assumed based on expected figures from other similar operations and estimated per the expected average content for each of the defined areas;
- Assumed control efficiencies for fugitive secondary dust emission sources are referenced in Section D.1.3;
- Tapping emissions are applicable for this study, and were simulated as tapping at same time/after one another (conservative worst-case);
- Tapping emissions: Duration of 10min every 2 hours per furnace;
- Based on site data, it is assumed that 5% of tapping emissions remain fugitive, whilst 95% are captured and PM abated at an estimated efficiency of 96%;

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- The D.0-X tables contain the emissions for each of the different sources[15], which also includes associated abnormal emission characteristics, if applicable or relevant as well as the emission concentrations and other source parameters used for this study; inclusive of fraction/percentages of PM emission to be emitted as PM_{10} and $PM_{2.5}$ from the different defined sources.
- Furnace Clean Gas stacks' emissions were modelled at expected pre-flare volumetric rates and temperatures with CO emissions as if flared;
- Manganese (Mn) emissions are based on monitoring / sampling data and associated uncertainties apply;
- Abnormal emissions were applicable for this investigation in view of the specific operations – abnormal Emissions from Primary Point Sources (Stacks) when APCE is not available: when applicable, it is modelled during the most stable atmospheric condition (i.e. poorest dispersion potential), which is usually around midnight and the abnormal emissions were modelled to occur during this period;
  Abnormal emissions were included for ACRW, but not for the other sources/operations included due to limited availability of related information;
- Based on site data, it was assumed that furnace raw gas abnormal emissions occur 0.025% of production time, which equates to approximately 7.2min per month per furnace, and 0.14% for the CRA (60min per month);
- Vehicle emissions emanating from traffic on the N3 which passes Cato Ridge was included in the assessment based on available traffic data obtained from Mikros Traffic Monitoring (Pty) Ltd. for the period of 2019 (pre COVID-19);
  EnviroNgaka estimated the emissions which could potentially emanate from that traffic on the N3 which is included in the domain of the study;
  Refer section D.1.2 of this report with respect to the N3 traffic emissions which were estimated based on the UK National Atmospheric Emissions Inventory 2019 emission factors for motor-way road transport, 31/03/2021;
  It was also assumed that 100% of Heavy vehicles consume diesel as fuel and 33.5% and 66.5% of light vehicles consume diesel and petrol respectively;
- The tables following on the next page provide a summary of the ACRW point sources;

[15] Information is based on actual emission concentration ranges from historical emission sampling reports and estimations per design criteria in the absence of sampling data, unless stated otherwise;

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Table D.0-1.1(a): Primary Point Sources and Associated Emissions for Scenario 1 –ACRW (Includes estimated emission during abnormal incidents – when relevant)

	Units	P1 (Furnace 1)	P14 (Furnace 1 - Vent 1)	P15 (Furnace 1 - Vent 2)	P2 (Furnace 2)	P16 (Furnace 2 - Vent 1)	P17 (Furnace 2 - Vent 2)	P3 (Furnace 3)	P18 (Furnace 3 - Vent)	P4 (Furnace 4)	P19 (Furnace 4 - Vent)	P5 (Furnace 3 & 4 VAI Standby)	P6 (Furnace 5)	P20 (Furnace 5 - Vent 1)	P21 (Furnace 5 - Vent 2)	P22 (Furnace 5 - Vent 3)
Release Height	m	36.60	36.62	36.62	36.60	36.62	36.62	39.00	34.50	39.00	34.50	39.00	22.00	47.00	47.00	47.00
Stack Exit Diameter	m	2.200	1.700	1.700	2.700	1.700	1.700	0.430	0.780	0.430	0.780	0.500	11.193	2.650	2.650	2.650
Gas Exit Temperature (aver)	°C	105.0	250.0	250.0	105.0	250.0	250.0	45.0	250.0	45.0	250.0	45.0	60.0	250.0	250.0	250.0
Gas Exit Velocity (aver)	m /s	19.817	5.479	5.479	13.157	5.479	5.479	17.025	8.508	17.025	8.508	25.183	2.940	1.242	1.242	1.242
Operating	hours /day	23.000	0.006	0.006	23.000	0.006	0.006	19.000	0.006	19.000	0.006	4.000	23.000	0.006	0.006	0.006
	hours /month	729.82	0.182	0.182	729.82	0.18	0.18	583.85	0.18	583.85	0.18	145.96	729.82	0.18	0.18	0.18
Material Produced / Consumed	ton /month	4841	1	1	4841	1	1	2399	1	2399	1	1200	5999	0	0	0
Material Produced / Consumed	ton /hour	6.63	3.32	3.32	6.63	3.32	3.32	4.11	4.11	4.11	4.11	8.22	8.22	2.74	2.74	2.74
Emission Flow Rate	m3 /s	75.3	12.4	12.4	75.3	12.4	12.4	2.5	4.1	2.5	4.1	4.9	289.3	6.8	6.8	6.8
	Nm3 /s	49.7	5.9	5.9	49.7	5.9	5.9	1.9	1.9	1.9	1.9	3.9	216.9	3.3	3.3	3.3
SO2	mg SO2 /Nm3	20	84	84	20	84	84	500	500	500	500	500	10	222	222	222
	g SO2 /s	0.995	0.497	0.497	0.995	0.497	0.497	0.970	0.970	0.970	0.970	1.941	2.176	0.725	0.725	0.725
Air Pollution Control: Total Removal Required	%	95.30%	95.30%	95.30%	95.30%	95.30%	95.30%	67.76%	67.76%	67.76%	67.76%	67.76%	65.22%	65.22%	65.22%	65.22%
NO2	mg NO2 /Nm3	50	209	209	50	209	209	400	400	400	400	400	50	1109	1109	1109
	g NO2 /s	2.487	1.244	1.244	2.487	1.244	1.244	0.776	0.776	0.776	0.776	1.553	10.879	3.626	3.626	3.626
	ton NO2 /year	75.174	0.010	0.010	75.174	0.010	0.010	19.380	0.006	19.380	0.006	8.160	328.785	0.029	0.029	0.029
Air Pollution Control: Total Removal Required	%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Dust (PM)	mg Dust (PM) /Nm3	10	4655	4655	15	4655	4655	50	11765	50	11765	50	10	6983	6983	6983
	g Dust (PM) /s	0.497	27.638	27.638	0.746	27.638	27.638	0.097	22.831	0.097	22.831	0.194	2.169	22.831	22.831	22.831
	ton Dust (PM) /year	15.035	0.218	0.218	22.552	0.218	0.218	2.423	0.180	2.423	0.180	1.020	65.550	0.180	0.180	0.180
Air Pollution Control: Estimated Removal Efficiency	%	99.10%	0.00%	0.00%	98.65%	0.00%	0.00%	99.58%	0.00%	99.58%	0.00%	99.58%	96.83%	0.00%	0.00%	0.00%
PM10	% PM10 in emitted TSP	100%	50%	50%	100%	50%	50%	70%	50%	70%	50%	70%	100%	50%	50%	50%
	mg PM10 /Nm3	10	2328	2328	15	2328	2328	35	5882	35	5882	35	10	3492	3492	3492
	g PM10 /s	0.4975	13.8188	13.8188	0.746	13.819	13.819	0.068	11.416	0.068	11.416	0.136	2.169	11.416	11.416	11.416
	ton PM10 /year	15.035	0.109	0.109	22.552	0.109	0.109	1.696	0.090	1.696	0.090	0.714	65.550	0.090	0.090	0.090
PM2.5	ppm PM2.5 in emitted TSP	95%	40%	40%	95%	40%	40%	50%	15%	50%	15%	50%	95%	40%	40%	40%
	mg PM2.5 /Nm3	10	1862	1862	14	1862	1862	25	1765	25	1765	25	10	2793	2793	2793
	g PM2.5 /s	0.4726	11.0550	11.0550	0.709	11.055	11.055	0.049	3.425	0.049	3.425	0.097	2.061	9.132	9.132	9.132
	ton PM2.5 /year	14.283	0.087	0.087	21.425	0.087	0.087	1.211	0.027	1.211	0.027	0.510	62.273	0.072	0.072	0.072
NH3	mg NH3 /Nm3	n/ap	0.000	0.000	n/ap	0.000	0.000	n/ap	0.000	n/ap	0.000	n/ap	n/ap	0.000	0.000	0.000

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	Units	P1 (Furnace 1)	P14 (Furnace 1 - Vent 1)	P15 (Furnace 1 - Vent 2)	P2 (Furnace 2)	P16 (Furnace 2 - Vent 1)	P17 (Furnace 2 - Vent 2)	P3 (Furnace 3)	P18 (Furnace 3 - Vent)	P4 (Furnace 4)	P19 (Furnace 4 - Vent)	P5 (Furnace 3 & 4 VAI Standby)	P6 (Furnace 5)	P20 (Furnace 5 - Vent 1)	P21 (Furnace 5 - Vent 2)	P22 (Furnace 5 - Vent 3)
	g NH3 /s	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	ton NH3 /year	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
C6H6	mg C6H6 /Nm3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	g C6H6 /s	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	ton C6H6 /year	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CO	mg CO /Nm3	250	1047	1047	250	1047	1047	184649	184649	184649	184649	184649	71	1571	1571	1571
	g CO /s	12.4	6.2	6.2	12.4	6.2	6.2	358.3	358.3	358.3	358.3	716.7	15.4	5.1	5.1	5.1
	ton CO /year	376	0	0	376	0	0	8946	3	8946	3	3767	466	0	0	0
CO2	mg CO2 /Nm3	47755	200092	200092	47755	200092	200092	474779	474779	474779	474779	474779	13572	300137	300137	300137
	g CO2 /s	2375.71	1187.86	1187.86	2375.71	1187.86	1187.86	921.37	921.37	921.37	921.37	1842.75	2943.81	981.27	981.27	981.27
	ton CO2 /year	71799	9	9	71799	9	9	23003	7	23003	7	9685	88968	8	8	8
Mn	ppm Mn in emitted TSP	374290	374290	374290	374290	374290	374290	266574	266574	266574	266574	266574	374290	374290	374290	374290
	ug Mn /Nm3	3743	1742503	1742503	5614	1742503	1742503	13329	3136159	13329	3136159	13329	3743	2613754	2613754	2613754
	mg Mn /s	186.20	10344.47	10344.47	279.30	10344.47	10344.47	25.87	6086.15	25.87	6086.15	51.73	811.82	8545.42	8545.42	8545.42
	kg Mn /year	5627.35	81.56	81.56	8441.03	81.56	81.56	645.77	47.98	645.77	47.98	271.90	24534.74	67.37	67.37	67.37

Table D.0-1.1(b): Primary Point Sources and Associated Emissions for Scenario 1 –ACRW (Includes estimated emission during abnormal incidents – when relevant)

	Units	P8 (Furnace 6 OGP)	P7 (Furnace 6 VAI)	P23 (Furnace 6 - Vent)	P9 (CRA)	CRA (Uncontrolled Releases)	Tapping fumes - Furnace 1	Tapping fumes - Furnace 2	Tapping fumes - Furnace 3	Tapping fumes - Furnace 4	Tapping fumes - Furnace 5	Tapping fumes - Furnace 6	P10 (FF&D-FTF)	P11 (HC C&S)	P12 (LC C&S)
Release Height	m	45.40	45.40	44.31	28.18	10.00	20.00	20.00	20.00	20.00	20.00	20.00	56.53	20.00	20.00
Stack Exit Diameter	m	0.470	0.500	0.900	2.838	3.000	45.135	45.135	45.135	45.135	45.135	45.135	3.500	1.300	1.300
Gas Exit Temperature (aver)	°C	45.0	45.0	250.0	80.0	250.0	70.0	70.0	70.0	70.0	70.0	70.0	25.0	30.0	30.0
Gas Exit Velocity (aver)	m /s	28.500	25.183	12.781	15.482	3.000	0.500	0.500	0.500	0.500	0.500	0.500	15.000	15.752	14.166
Operating	hours /day	19.000	4.000	0.006	23.000	0.034	3.000	3.000	2.000	2.000	4.000	4.000	24.000	24.000	23.034
	hours /month	583.85	145.96	0.18	728.98	1.02	105.32	105.32	65.25	65.25	130.50	130.50	730.00	730.00	730.00
Material Produced / Consumed	ton /month	4799	1200	1	6491	9	4842	4842	3000	3000	6000	6000	27684	27684	6500
Material Produced / Consumed	ton /hour	8.22	8.22	8.22	8.90	8.90	6.63	6.63	4.11	4.11	8.22	8.22	37.92	37.92	8.90
Emission Flow Rate	m3 /s	4.9	4.9	8.1	97.9	21.2	800.0	800.0	800.0	800.0	800.0	800.0	144.3	20.9	18.8
	Nm3 /s	3.9	3.9	3.9	69.3	10.1	582.2	582.2	582.2	582.2	582.2	582.2	120.9	17.2	15.5
SO2	mg SO2 /Nm3	500	500	500	39	269	1	1	1	1	1	1	76	12	3
	g SO2 /s	1.941	1.941	1.941	2.721	2.721	0.727	0.727	0.727	0.727	0.727	0.727	9.206	0.211	0.052

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	Units	P8 (Furnace 6 OGP)	P7 (Furnace 6 VAI)	P23 (Furnace 6 - Vent)	P9 (CRA)	CRA (Uncontrolled Releases)	Tapping fumes - Furnace 1	Tapping fumes - Furnace 2	Tapping fumes - Furnace 3	Tapping fumes - Furnace 4	Tapping fumes - Furnace 5	Tapping fumes - Furnace 6	P10 (FF&D-FTF)	P11 (HC C&S)	P12 (LC C&S)
Air Pollution Control: Total Removal Required	%	67.76%	67.76%	67.76%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
NO2	mg NO2 /Nm3	400	400	400	18	122	0	0	0	0	0	0	11	10	10
	g NO2 /s	1.553	1.553	1.553	1.237	1.237	0.031	0.031	0.031	0.031	0.031	0.031	1.316	0.172	0.155
	ton NO2 /year	38.760	8.160	0.012	37.375	0.055	0.122	0.122	0.081	0.081	0.163	0.163	41.493	5.432	4.688
Air Pollution Control: Total Removal Required	%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Dust (PM)	mg Dust (PM) /Nm3	50	50	11765	30	24434	2	2	2	2	2	2	2	20	30
	g Dust (PM) /s	0.194	0.194	45.662	2.078	247.336	1.091	1.091	1.091	1.091	1.091	1.091	0.186	0.344	0.465
	ton Dust (PM) /year	4.845	1.020	0.360	62.790	10.920	4.302	4.302	2.868	2.868	5.737	5.737	5.861	10.863	14.064
Air Pollution Control: Estimated Removal Efficiency	%	99.58%	99.58%	0.00%	99.16%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	95.03%	99.89%	99.37%
PM10	% PM10 in emitted TSP	70%	70%	50%	100%	65%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	mg PM10 /Nm3	35	35	5882	30	15882	2	2	2	2	2	2	2	20	30
	g PM10 /s	0.136	0.136	22.831	2.078	160.769	1.091	1.091	1.091	1.091	1.091	1.091	0.186	0.344	0.465
	ton PM10 /year	3.392	0.714	0.180	62.790	7.098	4.302	4.302	2.868	2.868	5.737	5.737	5.861	10.863	14.064
PM2.5	ppm PM2.5 in emitted TSP	50%	50%	15%	95%	55%	100%	100%	100%	100%	100%	100%	100%	95%	95%
	mg PM2.5 /Nm3	25	25	1765	29	13438	2	2	2	2	2	2	2	19	29
	g PM2.5 /s	0.097	0.097	6.849	1.974	136.035	1.091	1.091	1.091	1.091	1.091	1.091	0.186	0.327	0.441
	ton PM2.5 /year	2.423	0.510	0.054	59.651	6.006	4.302	4.302	2.868	2.868	5.737	5.737	5.861	10.320	13.361
NH3	mg NH3 /Nm3	n/ap	n/ap	0.000	n/ap	0.000	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap
	g NH3 /s	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	ton NH3 /year	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
C6H6	mg C6H6 /Nm3	0.000	0.000	0.000	0.982	6.719	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	g C6H6 /s	0.000	0.000	0.000	0.068	0.068	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	ton C6H6 /year	0.000	0.000	0.000	2.056	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CO	mg CO /Nm3	184649	184649	184649	167	1141	13	13	13	13	13	13	46	5	5
	g CO /s	716.7	716.7	716.7	11.5	11.5	7.4	7.4	7.4	7.4	7.4	7.4	5.6	0.1	0.1
	ton CO /year	17893	3767	6	349	1	29	29	20	20	39	39	176	3	2
CO2	mg CO2 /Nm3	474779	474779	474779	6877	47046	106	106	106	106	106	106	385	236	915
	g CO2 /s	1842.75	1842.75	1842.75	476.23	476.23	61.93	61.93	61.93	61.93	61.93	61.93	46.50	4.06	14.17
	ton CO2 /year	46006	9685	15	14393	21	244	244	163	163	326	326	1467	128	429
Mn	ppm Mn in emitted TSP	266574	266574	266574	567167	567167	50000	50000	50000	50000	50000	50000	50000	150000	200000
	ug Mn /Nm3	13329	13329	3136159	17015	13857888	94	94	94	94	94	94	77	3000	6000
	mg Mn /s	51.73	51.73	12172.31	1178.36	######	54.57	54.57	54.57	54.57	54.57	54.57	9.29	51.67	92.94
	kg Mn /year	1291.55	271.90	95.97	35612.40	6193.46	215.12	215.12	143.42	143.42	286.83	286.83	293.06	1629.49	2812.83

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Table D.0-1.1(c): Primary Point Sources and Associated Emissions for Scenario 1 –ACRW (Includes estimated emission during abnormal incidents – when relevant)

	Units	P13 (BRIQUETTING PLANT)	P30 (SP: Proportioning & Crushing)	P31 (SP: Sintering & Cooling)	P32 (SP: Cooling Building)
Release Height	m	6.40	15.00	10.00	25.00
Stack Exit Diameter	m	0.300	0.890	0.700	1.610
Gas Exit Temperature (aver)	°C	30.0	30.0	30.0	30.0
Gas Exit Velocity (aver)	m /s	7.123	12.502	20.210	15.009
Operating	hours /day	24.000	24.000	24.000	24.000
	hours /month	730.00	730.00	730.00	730.00
Material Produced / Consumed	ton /month	5977	12629	12629	12629
Material Produced / Consumed	ton /hour	8.19	17.30	17.30	17.30
Emission Flow Rate	m3 /s	0.5	7.8	7.8	30.6
	Nm3 /s	0.4	6.4	6.4	25.2
SO2	mg SO2 /Nm3	0	15	100	100
	g SO2 /s	0.000	0.096	0.641	2.517
Air Pollution Control: Total Removal Required	%	0.00%	0.00%	0.00%	0.00%
NO2	mg NO2 /Nm3	1	30	100	100
	g NO2 /s	0.000	0.192	0.641	2.517
	ton NO2 /year	0.013	6.062	20.206	79.380
Air Pollution Control: Total Removal Required	%	0.00%	0.00%	0.00%	0.00%
Dust (PM)	mg Dust (PM) /Nm3	30	50	50	50
	g Dust (PM) /s	0.012	0.320	0.320	1.259
	ton Dust (PM) /year	0.392	10.103	10.103	39.690
Air Pollution Control: Estimated Removal Efficiency	%	0.00%	0.00%	0.00%	0.00%
PM10	% PM10 in emitted TSP	100%	100%	100%	100%
	mg PM10 /Nm3	30	50	50	50
	g PM10 /s	0.012	0.320	0.320	1.259
	ton PM10 /year	0.392	10.103	10.103	39.690
PM2.5	ppm PM2.5 in emitted TSP	100%	95%	95%	75%
	mg PM2.5 /Nm3	30	48	48	38
	g PM2.5 /s	0.012	0.304	0.304	0.944
	ton PM2.5 /year	0.392	9.598	9.598	29.768
NH3	mg NH3 /Nm3	30.000	n/ap	n/ap	n/ap
	g NH3 /s	0.012	0.000	0.000	0.000
	ton NH3 /year	0.392	0.000	0.000	0.000

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	Units	P13 (BRIQUETTING PLANT)	P30 (SP: Proportioning & Crushing)	P31 (SP: Sintering & Cooling)	P32 (SP: Cooling Building)
C6H6	mg C6H6 /Nm3	n/ap	n/ap	n/ap	n/ap
	g C6H6 /s	0.000	0.000	0.000	0.000
	ton C6H6 /year	0.000	0.000	0.000	0.000
CO	mg CO /Nm3	0	150	150	10000
	g CO /s	0.0	1.0	1.0	251.7
	ton CO /year	0	30	30	7938
CO2	mg CO2 /Nm3	1965	2000	2000	75000
	g CO2 /s	0.81	12.81	12.81	1887.85
	ton CO2 /year	26	404	404	59535
Mn	ppm Mn in emitted TSP	150000	100000	200000	100000
	ug Mn /Nm3	4500	5000	10000	5000
	mg Mn /s	1.87	32.04	64.07	125.86
	kg Mn /year	58.86	1010.30	2020.59	3969.02

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D.1.2 Estimated Vehicle Emissions for the N3 Freeway passing Cato Ridge

The following tables provide a summary of the estimated traffic emissions on the N3 passing Cato Ridge, south bound and north bound respectively based on available 2019 traffic volumes (pre COVID-19)

Table D.0-N3(a): Estimated Traffic Emissions on N3 Passing Cato Ridge – South Bound

| Light and Heavy Vehicle Volumes for 2019 | | |

Table D.0-N3(b): Estimated Traffic Emissions on N3 Passing Cato Ridge – North Bound

Light and Heavy Vehicle Volumes for 2019																																							
Site	1478 - Cato Ridge IC NB ON																																						
Description	Northern Side of Cato Ridge I/C (NB Only)						**Estimated emissions (kg):**										**Estimated emission factors (g/s/m²):**										**Combined LV & HV: Estimated emission factors (g/s/m²):**									
Distance of N3 investigated	**9.769**	**km**					PM_{10}	$PM_{2.5}$	NO_x as NO_2	SO_2	CO	NH_3	VOC	C_6H_6	N_2O	PM_{10}	$PM_{2.5}$	NO_x as NO_2	SO_2	CO	NH_3	VOC	C_6H_6	N_2O		PM_{10}	$PM_{2.5}$	NO_x as NO_2	SO_2	CO	NH_3	VOC	C_6H_6	N_2O
				Diesel	Petrol																																		
Month	**Light veh.**	**Ratio**		33.50%	66.50%																					**Month**									
January	614107	1.83		205725.85	408381.16		17.843	17.843	1314.76	3.44001	2540.9	121.024	69.376	3.54871	11.8429	5.68278E-08	5.68278E-08	4.18737E-06	1.0956E-08	8.09247E-06	3.85449E-07	2.20954E-07	1.13022E-08	3.77182E-08	January	9.64E-08	9.64E-08	6.01E-06	2.61E-08	9.33E-06	4.26E-07	3.21E-07	1.14E-08	2.51E-07
February	552659	1.65		185140.77	367518.24		16.0576	16.0576	1183.21	3.0958	2286.66	108.915	62.4342	3.19362	10.6579	5.6621E-08	5.6621E-08	4.17213E-06	1.09162E-08	8.06303E-06	3.84046E-07	2.2015E-07	1.12611E-08	3.75809E-08	February	9.93E-08	9.93E-08	6.14E-06	2.73E-08	9.39E-06	4.28E-07	3.28E-07	1.13E-08	2.67E-07
March	640490	1.91		214564.15	425925.85		18.6095	18.6095	1371.25	3.5878	2650.06	126.224	72.3565	3.70117	12.3517	5.92692E-08	5.92692E-08	4.36726E-06	1.14267E-08	8.44014E-06	4.02008E-07	2.30447E-07	1.17878E-08	3.93386E-08	March	9.98E-08	9.98E-08	6.24E-06	2.70E-08	9.70E-06	4.44E-07	3.33E-07	1.19E-08	2.57E-07
April	334920	1.00		112198.2	222721.8		9.73116	9.73116	717.043	1.8761	1385.75	66.004	37.8361	1.93538	6.45884	3.20257E-08	3.20257E-08	2.35982E-06	6.17434E-09	4.56057E-06	2.17222E-07	1.2452E-07	6.36944E-09	2.12563E-08	April	5.87E-08	5.87E-08	3.59E-06	1.64E-08	5.39E-06	2.45E-07	1.92E-07	6.42E-09	1.65E-07
May	549477	1.64		184074.8	365402.21		15.9651	15.9651	1176.4	3.07798	2273.49	108.288	62.0748	3.17523	10.5965	5.08471E-08	5.08471E-08	3.74668E-06	9.80299E-09	7.2408E-06	3.44883E-07	1.97701E-07	1.01127E-08	3.37486E-08	May	9.26E-08	9.26E-08	5.67E-06	2.58E-08	8.54E-06	3.88E-07	3.03E-07	1.02E-08	2.59E-07
June	545211	1.63		182645.69	362565.32		15.8412	15.8412	1167.26	3.05408	2255.84	107.447	61.5928	3.15058	10.5142	5.21341E-08	5.21341E-08	3.84151E-06	1.00511E-08	7.42408E-06	3.53612E-07	2.02705E-07	1.03687E-08	3.46028E-08	June	9.14E-08	9.14E-08	5.65E-06	2.51E-08	8.65E-06	3.94E-07	3.02E-07	1.04E-08	2.46E-07
July	622343	1.86		208484.91	413858.1		18.0823	18.0823	1332.4	3.48615	2574.98	122.648	70.3065	3.5963	12.0017	5.75899E-08	5.75899E-08	4.24353E-06	1.1103E-08	8.20101E-06	3.90618E-07	2.23918E-07	1.14538E-08	3.8224E-08	July	1.03E-07	1.03E-07	6.32E-06	2.84E-08	9.61E-06	4.37E-07	3.38E-07	1.15E-08	2.81E-07
August	592332	1.77		198431.22	393900.78		17.2103	17.2103	1268.15	3.31804	2450.81	116.733	66.9161	3.42288	11.423	5.48128E-08	5.48128E-08	4.03889E-06	1.05675E-08	7.80553E-06	3.71781E-07	2.13112E-07	1.09015E-08	3.63807E-08	August	9.81E-08	9.81E-08	6.03E-06	2.72E-08	9.16E-06	4.16E-07	3.23E-07	1.10E-08	2.69E-07
September	613425	1.83		205497.38	407927.63		17.8232	17.8232	1313.3	3.43619	2538.08	120.89	69.299	3.54477	11.8297	5.86568E-08	5.86568E-08	4.32214E-06	1.13087E-08	8.35294E-06	3.97854E-07	2.28066E-07	1.1666E-08	3.89321E-08	September	1.03E-07	1.03E-07	6.35E-06	2.81E-08	9.72E-06	4.43E-07	3.39E-07	1.17E-08	2.75E-07
October	598684	1.79		200559.14	398124.86		17.3949	17.3949	1281.74	3.35362	2477.09	117.985	67.6337	3.45958	11.5454	5.54006E-08	5.54006E-08	4.0822E-06	1.06809E-08	7.88924E-06	3.75768E-07	2.15405E-07	1.10184E-08	3.67709E-08	October	1.04E-07	1.04E-07	6.31E-06	2.92E-08	9.39E-06	4.25E-07	3.37E-07	1.11E-08	2.96E-07
November	582777	1.74		195230.3	387546.71		16.9327	16.9327	1247.69	3.26451	2411.27	114.85	65.8367	3.36766	11.2387	5.57262E-08	5.57262E-08	4.1062E-06	1.07437E-08	7.93561E-06	3.77977E-07	2.16671E-07	1.10831E-08	3.6987E-08	November	1.03E-07	1.03E-07	6.30E-06	2.90E-08	9.42E-06	4.27E-07	3.37E-07	1.12E-08	2.93E-07
December	661385	1.97		221563.98	439821.03		19.2166	19.2166	1415.98	3.70485	2736.52	130.342	74.7171	3.82191	12.7546	6.12027E-08	6.12027E-08	4.50974E-06	1.17995E-08	8.71549E-06	4.15123E-07	2.37965E-07	1.21723E-08	4.06219E-08	December	1.00E-07	1.00E-07	6.31E-06	2.68E-08	9.93E-06	4.55E-07	3.37E-07	1.22E-08	2.51E-07
Subtotals:	**6907810**			**2314116.4**	**4593693.7**		**200.708**	**200.708**	**14789.2**	**38.6951**	**28581.5**	**1361.35**	**780.38**	**39.9178**	**133.215**																						
Weekday	**Light veh.**	**Ratio**																							**Weekday**									
Monday	997332	1.18		334106.22	663225.78		28.9776	28.9776	2135.22	5.5867	4126.52	196.548	112.669	5.76323	19.2333	3.38781E-08	3.38781E-08	2.49632E-06	6.53148E-09	4.82436E-06	2.29787E-07	1.31723E-07	6.73786E-09	2.24858E-08	Monday	7.48E-08	7.48E-08	4.38E-06	2.22E-08	6.10E-06	2.72E-07	2.35E-07	6.81E-09	2.43E-07
Tuesday	989614	1.17		331520.69	658093.31		28.7534	28.7534	2118.7	5.5437	4094.59	195.027	111.797	5.71863	19.0844	2.9913E-08	2.9913E-08	2.20414E-06	5.76703E-09	4.25971E-06	2.02892E-07	1.16306E-07	5.94925E-09	1.98541E-08	Tuesday	7.87E-08	7.87E-08	4.45E-06	2.45E-08	5.78E-06	2.53E-07	2.40E-07	6.04E-09	2.82E-07
Wednesday	971087	1.15		325314.15	645772.86		28.2151	28.2151	2079.04	5.43969	4017.93	191.376	109.704	5.61157	18.7271	3.53335E-08	3.53335E-08	2.60356E-06	6.81208E-09	5.03162E-06	2.39659E-07	1.37382E-07	7.02733E-09	2.34518E-08	Wednesday	8.62E-08	8.62E-08	4.95E-06	2.63E-08	6.62E-06	2.92E-07	2.66E-07	7.12E-09	2.97E-07
Thursday	1019096	1.21		341397.16	677698.84		29.61	29.61	2181.82	5.70862	4216.57	200.837	115.128	5.889	19.653	1.84763E-08	1.84763E-08	1.36143E-06	3.56212E-09	2.6311E-06	1.2532E-07	7.18386E-08	3.67467E-09	1.22633E-08	Thursday	7.03E-08	7.03E-08	3.75E-06	2.34E-08	4.25E-06	1.79E-07	2.03E-07	3.77E-09	2.91E-07
Friday	1167544	1.39		391127.24	776416.76		33.9232	33.9232	2499.64	6.54017	4830.78	230.092	131.898	6.74683	22.5158	3.03127E-08	3.03127E-08	2.2336E-06	5.84409E-09	4.31663E-06	2.05603E-07	1.1786E-07	6.02875E-09	2.01194E-08	Friday	7.49E-08	7.49E-08	4.29E-06	2.29E-08	5.71E-06	2.52E-07	2.31E-07	6.11E-09	2.60E-07
Saturday	920601	1.09		308401.34	612199.67		26.7482	26.7482	1970.95	5.15688	3809.04	181.426	104.001	5.31983	17.7535	3.00773E-08	3.00773E-08	2.21626E-06	5.79872E-09	4.28312E-06	2.04007E-07	1.16945E-07	5.98195E-09	1.99632E-08	Saturday	5.73E-08	5.73E-08	3.47E-06	1.62E-08	5.13E-06	2.32E-07	1.86E-07	6.03E-09	1.66E-07
Sunday	842536	1.00		282249.56	560286.44		24.48	24.48	1803.82	4.71959	3486.04	166.042	95.1818	4.86872	16.2481	3.43324E-08	3.43324E-08	2.52979E-06	6.61907E-09	4.88906E-06	2.32868E-07	1.33489E-07	6.82822E-09	2.27874E-08	Sunday	6.04E-08	6.04E-08	3.73E-06	1.66E-08	5.70E-06	2.60E-07	2.00E-07	6.87E-09	1.63E-07
Subtotals:	**6907810**			**2314116.4**	**4593693.7**		**200.708**	**200.708**	**14789.2**	**38.6951**	**28581.5**	**1361.35**	**780.38**	**39.9178**	**133.215**																						
				Diesel	Petrol																				**Ratio's against minimum rate:**									
Month	**Heavy veh.**	**Ratio**		100.00%	0.00%																				Minimum	5.87E-08	5.87E-08	3.59E-06	1.64E-08	5.39E-06	2.45E-07	1.92E-07	6.42E-09	1.65E-07
January	143031	1.53		143031	0		12.4308	12.4308	573.527	4.766	387.968	12.8179	31.4566	0.02202	66.9289	3.95905E-08	3.95905E-08	1.82662E-06	1.51791E-08	1.23563E-06	4.08236E-08	1.00186E-07	7.01299E-11	2.1316E-07	January	1.64	1.64	1.67	1.59	1.73	1.74	1.67	1.77	1.52
February	139230	1.49		139230	0		12.1004	12.1004	558.286	4.63934	377.658	12.4773	30.6207	0.02143	65.1503	4.26675E-08	4.26675E-08	1.96858E-06	1.63589E-08	1.33167E-06	4.39964E-08	1.07972E-07	7.55805E-11	2.29728E-07	February	1.69	1.69	1.71	1.66	1.74	1.75	1.71	1.77	1.62
March	146309	1.57		146309	0		12.7157	12.7157	586.671	4.87523	396.859	13.1117	32.1776	0.02252	68.4628	4.04979E-08	4.04979E-08	1.86848E-06	1.5527E-08	1.26395E-06	4.17592E-08	1.02482E-07	7.17372E-11	2.18046E-07	March	1.70	1.70	1.74	1.64	1.80	1.81	1.73	1.85	1.56
April	93339	1.00		93339	0		8.11206	8.11206	374.272	3.11019	253.18	8.36471	20.5279	0.01437	43.6764	2.66971E-08	2.66971E-08	1.23174E-06	1.02358E-08	8.33225E-07	2.75286E-08	6.75583E-08	4.72908E-11	1.43741E-07	April	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
May	150966	1.62		150966	0		13.1204	13.1204	605.345	5.0304	409.491	13.529	33.2018	0.02324	70.6419	4.17869E-08	4.17869E-08	1.92795E-06	1.60212E-08	1.30418E-06	4.30884E-08	1.05744E-07	7.40206E-11	2.24986E-07	May	1.58	1.58	1.58	1.57	1.58	1.59	1.58	1.59	1.57
June	137252	1.47		137252	0		11.9285	11.9285	550.354	4.57343	372.292	12.3	30.1857	0.02113	64.2247	3.92573E-08	3.92573E-08	1.81124E-06	1.50514E-08	1.22523E-06	4.048E-08	9.93423E-08	6.95396E-11	2.11366E-07	June	1.56	1.56	1.57	1.53	1.60	1.61	1.57	1.63	1.49
July	162795	1.74		162795	0		14.1485	14.1485	652.777	5.42456	441.577	14.5891	35.8033	0.02506	76.1771	4.50611E-08	4.50611E-08	2.07902E-06	1.72766E-08	1.40637E-06	4.64646E-08	1.14029E-07	7.98205E-11	2.42615E-07	July	1.75	1.75	1.76	1.73	1.78	1.79	1.76	1.80	1.70
August	156280	1.67		156280	0		13.5822	13.5822	626.653	5.20747	423.905	14.0053	34.3705	0.02406	73.1285	4.32578E-08	4.32578E-08	1.99582E-06	1.65852E-08	1.35009E-06	4.46051E-08	1.09466E-07	7.66261E-11	2.32906E-07	August	1.67	1.67	1.68	1.65	1.70	1.70	1.68	1.71	1.63
September	153407	1.64		153407	0		13.3325	13.3325	615.133	5.11174	416.112	13.7478	33.7386	0.02362	71.7841	4.3878E-08	4.3878E-08	2.02443E-06	1.6823E-08	1.36944E-06	4.52446E-08	1.11035E-07	7.77247E-11	2.36245E-07	September	1.75	1.75	1.77	1.71	1.80	1.81	1.77	1.83	1.67
October	174208	1.87		174208	0		15.1404	15.1404	698.541	5.80486	472.534	15.6119	38.3133	0.02682	81.5176	4.82202E-08	4.82202E-08	2.22477E-06	1.84878E-08	1.50497E-06	4.97221E-08	1.22023E-07	8.54164E-11	2.59624E-07	October	1.76	1.76	1.76	1.78	1.74	1.74	1.76	1.73	1.80
November	166146	1.78		166146	0		14.4397	14.4397	666.214	5.53622	450.667	14.8894	36.5403	0.02558	77.7451	4.75216E-08	4.75216E-08	2.19254E-06	1.822E-08	1.48316E-06	4.90017E-08	1.20256E-07	8.4179E-11	2.55863E-07	November	1.76	1.76	1.75	1.76	1.75	1.74	1.75	1.74	1.77
December	140996	1.51		140996	0		12.2539	12.2539	565.367	4.69819	382.448	12.6356	31.0091	0.02171	65.9766	3.90272E-08	3.90272E-08	1.80063E-06	1.49632E-08	1.21805E-06	4.02428E-08	9.87602E-08	6.91321E-11	2.10128E-07	December	1.71	1.71	1.76	1.63	1.84	1.86	1.75	1.91	1.52
Subtotals:	**1763959**			**1763959**	**0**		**153.305**	**153.305**	**7073.14**	**58.7777**	**4784.69**	**158.08**	**387.945**	**0.27156**	**825.414**																						
Weekday	**Heavy veh.**	**Ratio**																							Minimum	5.73E-08	5.73E-08	3.47E-06	1.62E-08	4.25E-06	1.79E-07	1.86E-07	3.77E-09	1.63E-07
Monday	247981	1.57		247981	0		21.5519	21.5519	994.357	8.26308	672.642	22.2232	54.5381	0.03818	116.038	4.09202E-08	4.09202E-08	1.88796E-06	1.56889E-08	1.27713E-06	4.21947E-08	1.03555E-07	7.24853E-11	2.2032E-07	Monday	1.31	1.31	1.26	1.37	1.44	1.52	1.27	1.81	1.49
Tuesday	301035	1.90		301035	0		26.1628	26.1628	1207.09	10.0309	816.549	26.9777	66.2062	0.04634	140.864	4.87376E-08	4.87376E-08	2.24864E-06	1.86861E-08	1.52111E-06	5.02555E-08	1.23333E-07	8.63328E-11	2.62409E-07	Tuesday	1.37	1.37	1.28	1.51	1.36	1.42	1.29	1.60	1.73
Wednesday	308072	1.95		308072	0		26.7744	26.7744	1235.31	10.2654	835.637	27.6083	67.7539	0.04743	144.157	5.0836E-08	5.0836E-08	2.34546E-06	1.94907E-08	1.58661E-06	5.24194E-08	1.28643E-07	9.005E-11	2.73708E-07	Wednesday	1.50	1.50	1.43	1.62	1.56	1.63	1.43	1.89	1.82
Thursday	313809	1.98		313809	0		27.273	27.273	1258.31	10.4566	851.198	28.1225	69.0156	0.04831	146.841	5.17827E-08	5.17827E-08	2.38914E-06	1.98537E-08	1.61615E-06	5.33955E-08	1.31038E-07	9.17269E-11	2.78805E-07	Thursday	1.23	1.23	1.08	1.44	1.00	1.00	1.09	1.00	1.78
Friday	270073	1.71		270073	0		23.4719	23.4719	1082.94	8.99922	732.566	24.203	59.3968	0.04158	126.376	4.45657E-08	4.45657E-08	2.05616E-06	1.70866E-08	1.39091E-06	4.59537E-08	1.12775E-07	7.89428E-11	2.39947E-07	Friday	1.31	1.31	1.24	1.41	1.34	1.41	1.24	1.62	1.59
Saturday	164885	1.04		164885	0		14.3301	14.3301	661.158	5.49421	447.246	14.7764	36.2629	0.02538	77.1551	2.72082E-08	2.72082E-08	1.25533E-06	1.04317E-08	8.49177E-07	2.80557E-08	6.88517E-08	4.81962E-11	1.46493E-07	Saturday	1.00	1.00	1.00	1.00	1.21	1.30	1.00	1.60	1.02
Sunday	158104	1.00		158104	0		13.7408	13.7408	633.967	5.26825	428.853	14.1687	34.7716	0.02434	73.982	2.60893E-08	2.60893E-08	1.2037E-06	1.00027E-08	8.14254E-07	2.69019E-08	6.60201E-08	4.62141E-11	1.40468E-07	Sunday	1.05	1.05	1.08	1.02	1.34	1.45	1.07	1.83	1.00
Subtotals:	**1763959**			**1763959**	**0**		**153.305**	**153.305**	**7073.14**	**58.7777**	**4784.69**	**158.08**	**387.945**	**0.27156**	**825.414**																						

Emissions in g/km (m-way, per UK fleet in 2019)	PM_{10}	$PM_{2.5}$	NO_x as NO_2	SO_2	CO	NH_3	VOC	C_6H_6	N_2O
Petrol LVs	0.0014184	0.00142	0.05785	0.000509	0.6219492	0.02828	0.01502	0.00084	0.00097
Diesel LVs	0.0060627	0.00606	0.53937	0.0007012	0.0296817	0.00409	0.00471	9.3E-05	0.00397
HV (Artic HGV's	0.0088965	0.0089	0.41046	0.0034109	0.2776613	0.00917	0.02251	1.6E-05	0.0479

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D.1.3 Secondary/Fugitive area and or line sources – ACRW

The relevant emission sources are primary point sources from the processes referred to and secondary sources with due consideration of partial paved roads and vegetated/grassed areas.

When relevant/applicable fugitive emissions from secondary area and or line sources such as stockpiles and gravel roads, are assessed in accordance with the information and methodology provided as follows below, based on the expected quantities of material consumed or processed and moved for different scenarios considered.

The Secondary Emissions for ACRW were assessed per the following information:

Scenario 1 – Baseline – ACRW:

Referenced Baseline Materials		Scenario 1: Baseline per hour
Product 1: Product: HC FeMn	tonne /hr	37.9
Product 2: Product: LC/MC FeMn	tonne /hr	8.9
Product 3: Product: Briquettes	tonne /hr	8.2
Other: By-Product / Waste: Slag	tonne /hr	29.3
Other: APCE Solid Waste: Baghouse Dust	tonne /hr	1.7
Other: APCE Solid Waste: Slimes Dust / Tailings	tonne /hr	0.4
Other: Ore (incl. Briquettes)	tonne /hr	70.6
Other: Reductant	tonne /hr	17.4
Other: Flux - Quartz	tonne /hr	3.3
Other: Flux - Dolomite	tonne /hr	0.4
Other: Paste	tonne /hr	0.7
Other: Mn Scrap	tonne /hr	0.5
Other: Coolant - Low C Fines	tonne /hr	0.3
Other: Coolant - Medium C Fines	tonne /hr	1.0
Other: CRA Slag	tonne /hr	0.4
Other: HC Metal	tonne /hr	10.5
Other: Gas: Argon	tonne /hr	0.1
Other: Gas: Nitrogen	tonne /hr	0.0
Other: Gas: Oxygen	tonne /hr	0.9
Other: Skulls	tonne /hr	0.0
Other: LP gas	tonne /hr	0.0
Other: Briquetting: Stockpiled furnace dust and sludge (DSF) (Max)	tonne /hr	1.7
Other: Briquetting: Fresh occurring furnace dust from Baghouse (Max)	tonne /hr	0.8
Other: Briquetting: Sludge from the filter press (Max)	tonne /hr	0.3
Other: Briquetting: Fine -3mm metal / Ore (Max)	tonne /hr	2.1
Other: Briquetting: Metal Recovery Plant spiral fines (Max)	tonne /hr	0.6
Other: Briquetting: Metal recovery plant fine middling fraction (Max)	tonne /hr	2.1
Other: Briquetting: Additional 5% Binder (Max)	tonne /hr	0.4
Other: Briquetting: Additional water (Max)	tonne /hr	0.2
Other: Briquetting: CRA dust (Max)	tonne /hr	1.0
Vehicles: Diesel consumption	litres /hr	81.0

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Exhaust Emission Factors for Various Classes of Mining Equipment is provided in the Table below (NPI, 2001) and amended for reduced sulphur content diesel
{ page 17 (24 of 69) - Emission Estimation Technique Manual for Mining Version 2.3 }

Equipment Type	Emission Factor (kg/1000 litre of fuel/diesel)					
	PM_{10}	CO	NO_X (as NO_2)	SO_X [1] (as SO_2)	VOCs (exhaust)	Emission Fator Rating
Tractor: Track Type	3.03	9.40	34.16	0.95	3.31	C
Tractor: Wheeled	5.57	32.19	52.35	0.95	7.74	C
Tractor: Dozer	17.70	14.73	34.29	0.95	1.58	C
Sraper	3.27	10.16	30.99	0.95	2.28	C
Grader	2.66	6.55	30.41	0.95	1.53	C
Off-highway Truck	17.70	14.73	34.29	0.95	1.58	C
Loader: Wheeled	3.51	11.79	38.50	0.95	5.17	C
Loader: Track type	2.88	9.93	30.73	0.95	4.85	C

[1] Calculated for 500ppm S diesel

Typical Diesel Consumption Rates for mining/handling conditions:

Vehicle Type	Consumption Rate (litre /hr)
Truck	29.4
Loader	19.6
LCV	4.0
Tractor	10.0

Foreseen Continuously Working Vehicle Inventory for Site of Works

Vehicle Type	Scenario 2: Future
Truck type	1
Loader type	2
LCV type	1
Tractor type	1

Estimated Quantities of Material Mined/Handled	Scenario 2: Future
Key Activity / Material	**tonne /hr**
Mining of Ore	0
Overburden (Waste Rock)	0
ROM Ore	0
Solid Raw Materials	93
Product/s	47
Waste material/s	23
Estimated Diesel Consumptions	**litres /day**
Total	**1943**
Truck type	692
Loader type	922
LCV type	94
Tractor type	235

Overall Estimated Diesel Combustion Emissions (g/s)

	PM_{10}	CO	NO_X (as NO_2)	SO_X [1] (as SO_2)	VOCs (exhaust)	Emission Fator Rating
Scenario 2: Future	**0.196**	**0.281**	**0.776**	**0.021**	**0.077**	C
Truck type	0.142	0.118	0.274	0.008	0.013	C
Loader type	0.034	0.116	0.369	0.010	0.053	C
LCV type	0.003	0.007	0.033	0.001	0.002	C
Tractor type	0.018	0.040	0.099	0.003	0.009	C

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	Wheel Generated Emission Estimation at expected control efficiency (eg. Wetting of gravel road):														Wind Generated Emission Est (at expected control efficiency, eg wetting) for lowest season:	Loading/Unloading Generated Emission Estimation (at expected control efficiency, eg wetting):	Crushing & Screening	Blasting	OTHER	TOTAL FOR AREA (EXCLUDING BLASTING & OTHER)	Wheels: Expected Control Dust Control Efficiency Achieved	Wind: Expected Control Dust Control Efficiency Achieved	Loading / Unloading: Expected Control Dust Control Efficiency Achieved
	Number Return trips /day	Number of: -loads /day (Loading) -tonne /day (Crushing)	Distance in km	VKT /day	VKT /hr	Silt Content	Moisture Content	Weight-Empty (tonne)	Weight-Loaded (tonne)	Weight-MEAN (tonne)	EF_{10} (kg/VKT)	PM_{10} (kg/hr)	Surface Area (m^2)	PM_{10} ($g/(s.m^2)$)	PM_{10} ($g/(s.m^2)$)	PM_{10} ($g/(s.m^2)$)	PM_{10} ($g/(s.m^2)$)	PM_{10} ($g/(s.m^2)$ per blast)	PM_{10} ($g/(s.m^2)$)	PM_{10} ($g/(s.m^2)$)	%	%	%
Scenario 2: Future																							
A__A09HC: Area_HighCarbonC&S	**n/ap**	24	n/ap	n/ap	n/ap	**9.5%**	**5.4%**	n/ap	n/ap	n/ap	n/ap	n/ap	**1455.40**	**n/ap**	**0.000000093**	**0.0000003**	**0.0000061**	n/ap	n/ap	**0.00000683**	**95.0%**	**95.0%**	**95.0%**
A__A10LC: Area_LowCarbonC&S	**n/ap**	7	n/ap	n/ap	n/ap	**9.5%**	**5.4%**	n/ap	n/ap	n/ap	n/ap	n/ap	**952.84**	**n/ap**	**0.000000093**	**0.0000001**	**0.0000028**	n/ap	n/ap	**0.00000334**	**95.0%**	**95.0%**	**95.0%**
A__A14BP: Area_BriquettingPlant	**n/ap**	n/ap	n/ap	n/ap	n/ap	**13.0%**	**7.0%**	n/ap	n/ap	n/ap	n/ap	n/ap	**4373.26**	**n/ap**	**0.000000127**	**n/ap**	n/ap	n/ap	n/ap	**0.00000013**	**95.0%**	**95.0%**	**95.0%**
A__A03RS: Area_RawMaterialStorage	**n/ap**	58	n/ap	n/ap	n/ap	**8.0%**	**5.7%**	n/ap	n/ap	n/ap	n/ap	n/ap	**43471.55**	**n/ap**	**0.000000314**	**0.0000001**	n/ap	n/ap	n/ap	**0.00000071**	**80.0%**	**80.0%**	**80.0%**
A__A15BS: Area_BriquettingPlantStockpiles	**n/ap**	7	n/ap	n/ap	n/ap	**13.0%**	**7.0%**	n/ap	n/ap	n/ap	n/ap	n/ap	**4373.26**	**n/ap**	**0.000000127**	**0.0000000**	n/ap	n/ap	n/ap	**0.00000045**	**95.0%**	**95.0%**	**95.0%**
A__A12ES: Area_ExportStockpile_South	**n/ap**	2	n/ap	n/ap	n/ap	**9.5%**	**5.4%**	n/ap	n/ap	n/ap	n/ap	n/ap	**3379.85**	**n/ap**	**0.000000093**	**0.0000000**	n/ap	n/ap	n/ap	**0.00000010**	**95.0%**	**95.0%**	**95.0%**
A__A12EN: Area_ExportStockpile_North	**n/ap**	2	n/ap	n/ap	n/ap	**9.5%**	**5.4%**	n/ap	n/ap	n/ap	n/ap	n/ap	**3379.85**	**n/ap**	**0.000000093**	**0.0000000**	n/ap	n/ap	n/ap	**0.00000010**	**95.0%**	**95.0%**	**95.0%**
A__A11SN: Area_SlagDisposal_New	**n/ap**	17	n/ap	n/ap	n/ap	**5.3%**	**0.9%**	n/ap	n/ap	n/ap	n/ap	n/ap	**59731.99**	**n/ap**	**0.000000104**	**0.0000000**	n/ap	n/ap	n/ap	**0.00000012**	**90.0%**	**90.0%**	**90.0%**
A__A01SO: Area_SlagDisposal_Old	**n/ap**	n/ap	n/ap	n/ap	n/ap	**5.3%**	**0.9%**	n/ap	n/ap	n/ap	n/ap	n/ap	**56729.63**	**n/ap**	**0.000000518**	**n/ap**	n/ap	n/ap	n/ap	**0.00000052**	**50.0%**	**50.0%**	**50.0%**
A__A02CT: Area_SlagPondCoolingTrenches	**n/ap**	17	n/ap	n/ap	n/ap	**5.3%**	**0.9%**	n/ap	n/ap	n/ap	n/ap	n/ap	**10333.48**	**n/ap**	**0.000000104**	**0.0000001**	n/ap	n/ap	n/ap	**0.00000050**	**90.0%**	**90.0%**	**90.0%**
A__A13IO: Area_Product&RM_InOutLoading_NEW	**n/ap**	58	n/ap	n/ap	n/ap	**9.5%**	**5.4%**	n/ap	n/ap	n/ap	n/ap	n/ap	**10389.19**	**n/ap**	**0.000000093**	**0.0000001**	n/ap	n/ap	n/ap	**0.00000050**	**95.0%**	**95.0%**	**95.0%**
A__A05BN: Area_BaghouseDustStorage_NEW	**n/ap**	1	n/ap	n/ap	n/ap	**13.0%**	**7.0%**	n/ap	n/ap	n/ap	n/ap	n/ap	**8919.56**	**n/ap**	**0.000000127**	**0.0000000**	n/ap	n/ap	n/ap	**0.00000013**	**95.0%**	**95.0%**	**95.0%**
A__A06PS: Area_ProductStorage	**n/ap**	24	n/ap	n/ap	n/ap	**9.5%**	**5.4%**	n/ap	n/ap	n/ap	n/ap	n/ap	**9114.33**	**n/ap**	**0.000000093**	**0.0000001**	n/ap	n/ap	n/ap	**0.00000014**	**95.0%**	**95.0%**	**95.0%**
A__A07ST: Area_SlimesDamsTailings	**n/ap**	n/ap	n/ap	n/ap	n/ap	**13.0%**	**7.0%**	n/ap	n/ap	n/ap	n/ap	n/ap	**20633.84**	**n/ap**	**0.000000127**	**n/ap**	n/ap	n/ap	n/ap	**0.00000013**	**95.0%**	**95.0%**	**95.0%**
A__A08MR: Area_MRP	**n/ap**	17	n/ap	n/ap	n/ap	**5.3%**	**0.9%**	n/ap	n/ap	n/ap	n/ap	n/ap	**43409.53**	**n/ap**	**0.000000207**	**0.0000000**	n/ap	n/ap	n/ap	**0.00000055**	**80.0%**	**80.0%**	**80.0%**
A__L0901: Road_Unpaved_Hostel_L09_01	**0**	n/ap	**0.1229**	n/ap	n/ap	**5.3%**	**0.9%**	n/ap	n/ap	n/ap	n/ap	n/ap	**860.30**	**n/ap**	**0.000000052**	**n/ap**	n/ap	n/ap	n/ap	**0.00000005**	**95.0%**	**95.0%**	**95.0%**
A__L0902: Road_Unpaved_Hostel_L09_02	**0**	n/ap	**0.5555**	n/ap	n/ap	**5.3%**	**0.9%**	n/ap	n/ap	n/ap	n/ap	n/ap	**3888.50**	**n/ap**	**0.000000052**	**n/ap**	n/ap	n/ap	n/ap	**0.00000005**	**95.0%**	**95.0%**	**95.0%**
A__L0903: Road_Unpaved_Hostel_L09_03	**0**	n/ap	**0.2961**	n/ap	n/ap	**5.3%**	**0.9%**	n/ap	n/ap	n/ap	n/ap	n/ap	**2072.70**	**n/ap**	**0.000000052**	**n/ap**	n/ap	n/ap	n/ap	**0.00000005**	**95.0%**	**95.0%**	**95.0%**
A__L0904: Road_Unpaved_Hostel_L09_04	**0**	n/ap	**0.2622**	**0**	**0.0**	**5.3%**	**0.9%**	n/ap	n/ap	n/ap	n/ap	n/ap	**1835.40**	**n/ap**	**0.000000052**	**n/ap**	n/ap	n/ap	n/ap	**0.00000005**	**95.0%**	**95.0%**	**95.0%**
A__L0905: Road_Unpaved_Hostel_L09_05	**0**	n/ap	**0.0761**	**0**	**0.0**	**5.3%**	**0.9%**	n/ap	n/ap	n/ap	n/ap	n/ap	**532.70**	**n/ap**	**0.000000052**	**n/ap**	n/ap	n/ap	n/ap	**0.00000005**	**95.0%**	**95.0%**	**95.0%**
A__L0906: Road_Unpaved_Hostel_L09_06	**0**	n/ap	**0.0279**	**0**	**0.0**	**5.3%**	**0.9%**	n/ap	n/ap	n/ap	n/ap	n/ap	**195.30**	**n/ap**	**0.000000052**	**n/ap**	n/ap	n/ap	n/ap	**0.00000005**	**95.0%**	**95.0%**	**95.0%**
A__L0907: Road_Unpaved_Hostel_L09_07	**0**	n/ap	**0.0988**	**0**	**0.0**	**5.3%**	**0.9%**	n/ap	n/ap	n/ap	n/ap	n/ap	**691.60**	**n/ap**	**0.000000052**	**n/ap**	n/ap	n/ap	n/ap	**0.00000005**	**95.0%**	**95.0%**	**95.0%**
A__L0908: Road_Unpaved_Hostel_L09_08	**0**	n/ap	**0.0286**	**0**	**0.0**	**5.3%**	**0.9%**	n/ap	n/ap	n/ap	n/ap	n/ap	**200.20**	**n/ap**	**0.000000052**	**n/ap**	n/ap	n/ap	n/ap	**0.00000005**	**95.0%**	**95.0%**	**95.0%**
A__L1001: Road_Unpaved_MRP-Storage_L10_01	**101**	n/ap	**0.2035**	**41**	**1.4**	**2.6%**	**7.4%**	**5.0**	**5.0**	**5.0**	0.141	0.193	**814.00**	**0.000003290**	**0.000000025**	**n/ap**	n/ap	n/ap	n/ap	**0.00000730**	**95.0%**	**95.0%**	**95.0%**
A__L1002: Road_Unpaved_MRP-Storage_L10_02	**101**	n/ap	**0.0490**	**10**	**0.3**	**2.6%**	**7.4%**	**5.0**	**5.0**	**5.0**	0.141	0.046	**196.00**	**0.000003290**	**0.000000025**	**n/ap**	n/ap	n/ap	n/ap	**0.00000730**	**95.0%**	**95.0%**	**95.0%**
A__L1003: Road_Unpaved_MRP-Storage_L10_03	**101**	n/ap	**0.0438**	**9**	**0.3**	**2.6%**	**7.4%**	**5.0**	**5.0**	**5.0**	0.141	0.042	**175.20**	**0.000003290**	**0.000000025**	**n/ap**	n/ap	n/ap	n/ap	**0.00000730**	**95.0%**	**95.0%**	**95.0%**
A__L1004: Road_Unpaved_MRP-Storage_L10_04	**101**	n/ap	**0.0528**	**11**	**0.4**	**2.6%**	**7.4%**	**5.0**	**5.0**	**5.0**	0.141	0.050	**211.20**	**0.000003290**	**0.000000025**	**n/ap**	n/ap	n/ap	n/ap	**0.00000730**	**95.0%**	**95.0%**	**95.0%**
A__L1005: Road_Unpaved_MRP-Storage_L10_05	**101**	n/ap	**0.0968**	**20**	**0.7**	**2.6%**	**7.4%**	**5.0**	**5.0**	**5.0**	0.141	0.092	**387.20**	**0.000003290**	**0.000000025**	**n/ap**	n/ap	n/ap	n/ap	**0.00000730**	**95.0%**	**95.0%**	**95.0%**
A__L1006: Road_Unpaved_MRP-Storage_L10_06	**101**	n/ap	**0.0722**	**15**	**0.5**	**2.6%**	**7.4%**	**5.0**	**5.0**	**5.0**	0.141	0.068	**288.80**	**0.000003290**	**0.000000025**	**n/ap**	n/ap	n/ap	n/ap	**0.00000730**	**95.0%**	**95.0%**	**95.0%**
A__L1007: Road_Unpaved_MRP-Storage_L10_07	**101**	n/ap	**0.0778**	**16**	**0.5**	**2.6%**	**7.4%**	**5.0**	**5.0**	**5.0**	0.141	0.074	**311.20**	**0.000003290**	**0.000000025**	**n/ap**	n/ap	n/ap	n/ap	**0.00000730**	**95.0%**	**95.0%**	**95.0%**
A__L1008: Road_Unpaved_MRP-Storage_L10_08	**101**	n/ap	**0.0164**	**3**	**0.1**	**2.6%**	**7.4%**	**5.0**	**5.0**	**5.0**	0.141	0.016	**65.60**	**0.000003290**	**0.000000025**	**n/ap**	n/ap	n/ap	n/ap	**0.00000730**	**95.0%**	**95.0%**	**95.0%**
A__L1009: Road_Unpaved_MRP-Storage_L10_09	**101**	n/ap	**0.0562**	**11**	**0.4**	**2.6%**	**7.4%**	**5.0**	**5.0**	**5.0**	0.141	0.053	**224.80**	**0.000003290**	**0.000000025**	**n/ap**	n/ap	n/ap	n/ap	**0.00000730**	**95.0%**	**95.0%**	**95.0%**
A__L1010: Road_Unpaved_MRP-Storage_L10_10	**101**	n/ap	**0.0433**	**9**	**0.3**	**2.6%**	**7.4%**	**5.0**	**5.0**	**5.0**	0.141	0.041	**173.20**	**0.000003290**	**0.000000025**	**n/ap**	n/ap	n/ap	n/ap	**0.00000730**	**95.0%**	**95.0%**	**95.0%**
A__L1011: Road_Unpaved_MRP-Storage_L10_11	**101**	n/ap	**0.2528**	**51**	**1.7**	**2.6%**	**7.4%**	**5.0**	**5.0**	**5.0**	0.141	0.240	**1011.20**	**0.000003290**	**0.000000025**	**n/ap**	n/ap	n/ap	n/ap	**0.00000730**	**95.0%**	**95.0%**	**95.0%**
A__L0101: Road_Unpaved_SlagDisposal_Old_L01_01	**106**	n/ap	**0.1120**	**24**	**0.8**	**5.3%**	**0.9%**	**10.0**	**50.0**	**30.0**	0.599	0.475	**840.00**	**0.000007859**	**0.000000052**	**n/ap**	n/ap	n/ap	n/ap	**0.00001127**	**95.0%**	**95.0%**	**95.0%**
A__L0102: Road_Unpaved_SlagDisposal_Old_L01_02	**106**	n/ap	**0.1857**	**39**	**1.3**	**5.3%**	**0.9%**	**10.0**	**50.0**	**30.0**	0.599	0.788	**1392.75**	**0.000007859**	**0.000000052**	**n/ap**	n/ap	n/ap	n/ap	**0.00001127**	**95.0%**	**95.0%**	**95.0%**
A__L0103: Road_Unpaved_SlagDisposal_Old_L01_03	**106**	n/ap	**0.1000**	**21**	**0.7**	**5.3%**	**0.9%**	**10.0**	**50.0**	**30.0**	0.599	0.424	**750.00**	**0.000007859**	**0.000000052**	**n/ap**	n/ap	n/ap	n/ap	**0.00001127**	**95.0%**	**95.0%**	**95.0%**
A__L0201: Road_Unpaved_SlagPondCoolingTrenches_L02	**50**	n/ap	**0.1727**	**17**	**0.6**	**5.3%**	**0.9%**	**10.0**	**50.0**	**30.0**	0.599	0.342	**604.45**	**0.000007859**	**0.000000052**	**n/ap**	n/ap	n/ap	n/ap	**0.00001127**	**95.0%**	**95.0%**	**95.0%**
A__L0202: Road_Unpaved_SlagPondCoolingTrenches_L02	**50**	n/ap	**0.0596**	**6**	**0.2**	**5.3%**	**0.9%**	**10.0**	**50.0**	**30.0**	0.599	0.118	**208.60**	**0.000007859**	**0.000000052**	**n/ap**	n/ap	n/ap	n/ap	**0.00001127**	**95.0%**	**95.0%**	**95.0%**
A__L0203: Road_Unpaved_SlagPondCoolingTrenches_L02	**50**	n/ap	**0.0783**	**8**	**0.3**	**5.3%**	**0.9%**	**10.0**	**50.0**	**30.0**	0.599	0.155	**274.05**	**0.000007859**	**0.000000052**	**n/ap**	n/ap	n/ap	n/ap	**0.00001127**	**95.0%**	**95.0%**	**95.0%**
A__L0204: Road_Unpaved_SlagPondCoolingTrenches_L02	**50**	n/ap	**0.0433**	**4**	**0.1**	**5.3%**	**0.9%**	**10.0**	**50.0**	**30.0**	0.599	0.086	**151.55**	**0.000007859**	**0.000000052**	**n/ap**	n/ap	n/ap	n/ap	**0.00001127**	**95.0%**	**95.0%**	**95.0%**
A__L0301: Road_Paved_RawMaterial_L03_01	**76**	n/ap	**0.3691**	**56**	**1.9**	**8.0%**	**5.7%**	**5.0**	**5.0**	**5.0**	0.388	0.723	**1107.30**	**0.000003627**	**0.000000031**	**n/ap**	n/ap	n/ap	n/ap	**0.00000764**	**98.0%**	**98.0%**	**98.0%**
A__L0302: Road_Paved_RawMaterial_L03_02	**76**	n/ap	**0.2968**	**45**	**1.5**	**8.0%**	**5.7%**	**5.0**	**5.0**	**5.0**	0.388	0.581	**890.40**	**0.000003627**	**0.000000031**	**n/ap**	n/ap	n/ap	n/ap	**0.00000764**	**98.0%**	**98.0%**	**98.0%**
A__L0303: Road_Paved_RawMaterial_L03_03	**76**	n/ap	**0.0222**	**3**	**0.1**	**8.0%**	**5.7%**	**5.0**	**5.0**	**5.0**	0.388	0.043	**66.60**	**0.000003627**	**0.000000031**	**n/ap**	n/ap	n/ap	n/ap	**0.00000764**	**98.0%**	**98.0%**	**98.0%**
A__L0304: Road_Paved_RawMaterial_L03_04	**76**	n/ap	**0.0174**	**3**	**0.1**	**8.0%**	**5.7%**	**5.0**	**5.0**	**5.0**	0.388	0.034	**52.20**	**0.000003627**	**0.000000031**	**n/ap**	n/ap	n/ap	n/ap	**0.00000764**	**98.0%**	**98.0%**	**98.0%**
A__L0305: Road_Paved_RawMaterial_L03_05	**76**	n/ap	**0.3199**	**48**	**1.6**	**8.0%**	**5.7%**	**5.0**	**5.0**	**5.0**	0.388	0.627	**959.70**	**0.000003627**	**0.000000031**	**n/ap**	n/ap	n/ap	n/ap	**0.00000764**	**98.0%**	**98.0%**	**98.0%**
A__L0306: Road_Paved_RawMaterial_L03_06	**76**	n/ap	**0.0563**	**9**	**0.3**	**8.0%**	**5.7%**	**5.0**	**5.0**	**5.0**	0.388	0.110	**168.90**	**0.000003627**	**0.000000031**	**n/ap**	n/ap	n/ap	n/ap	**0.00000764**	**98.0%**	**98.0%**	**98.0%**
A__L0401: Road_Unpaved_BHDustStorage_Old_L04_01	**50**	n/ap	**0.0170**	**2**	**0.1**	**13.0%**	**7.0%**	**10.0**	**50.0**	**30.0**	1.343	0.075	**59.50**	**0.000017622**	**0.000000127**	**n/ap**	n/ap	n/ap	n/ap	**0.00002111**	**95.0%**	**95.0%**	**95.0%**
A__L0501: Road_Unpaved_BHDustStorage_New_L05_01	**50**	n/ap	**0.0700**	**7**	**0.2**	**13.0%**	**7.0%**	**10.0**	**50.0**	**30.0**	1.343	0.311	**245.00**	**0.000017622**	**0.000000127**	**n/ap**	n/ap	n/ap	n/ap	**0.00002111**	**95.0%**	**95.0%**	**95.0%**

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	Wheel Generated Emission Estimation at expected control efficiency (eg. Wetting of gravel road):														Wind Generated Emission Est (at expected control efficiency, eg wetting) for lowest season:	Loading/Unloading Generated Emission Estimation (at expected control efficiency, eg wetting):	Crushing & Screening	Blasting	OTHER	TOTAL FOR AREA (EXCLUDING BLASTING & OTHER)	Wheels: Expected Control Dust Control Efficiency Achieved	Wind: Expected Control Dust Control Efficiency Achieved	Loading / Unloading: Expected Control Dust Control Efficiency Achieved
	Number Return trips /day	Number of: -loads /day (Loading) -tonne /day (Crushing)	Distance in km	VKT /day	VKT /hr	Silt Content	Moisture Content	Weight-Empty (tonne)	Weight-Loaded (tonne)	Weight-MEAN (tonne)	EF_{10} (kg/VKT)	PM_{10} (kg/hr)	Surface Area (m^2)	PM_{10} (g/($s.m^2$))	PM_{10} (g/($s.m^2$))	PM_{10} (g/($s.m^2$))	PM_{10} (g/($s.m^2$))	PM_{10} (g/($s.m^2$) per blast)	PM_{10} (g/($s.m^2$))	PM_{10} (g/($s.m^2$))	%	%	%
Scenario 2: Future																							
A_L0601: Road_Paved_ProductStorage_L06_01	50	n/ap	0.0495	5	0.2	9.5%	5.4%	10.0	50.0	30.0	1.013	0.166	173.25	0.000001329	0.000000009	n/ap	n/ap	n/ap	n/ap	0.00000470	99.5%	99.5%	99.5%
A_L0602: Road_Paved_ProductStorage_L06_02	50	n/ap	0.0461	5	0.2	9.5%	5.4%	10.0	50.0	30.0	1.013	0.154	161.35	0.000001329	0.000000009	n/ap	n/ap	n/ap	n/ap	0.00000470	99.5%	99.5%	99.5%
A_L0603: Road_Paved_ProductStorage_L06_03	50	n/ap	0.0284	3	0.1	9.5%	5.4%	10.0	50.0	30.0	1.013	0.095	99.40	0.000001329	0.000000009	n/ap	n/ap	n/ap	n/ap	0.00000470	99.5%	99.5%	99.5%
A_L0604: Road_Paved_ProductStorage_L06_04	50	n/ap	0.0487	5	0.2	9.5%	5.4%	10.0	50.0	30.0	1.013	0.163	170.45	0.000001329	0.000000009	n/ap	n/ap	n/ap	n/ap	0.00000470	99.5%	99.5%	99.5%
A_L0605: Road_Paved_ProductStorage_L06_05	50	n/ap	0.0466	5	0.2	9.5%	5.4%	10.0	50.0	30.0	1.013	0.156	163.10	0.000001329	0.000000009	n/ap	n/ap	n/ap	n/ap	0.00000470	99.5%	99.5%	99.5%
A_L0701: Road_Unpaved_SlimesDams(Tailings)_L07_01	0	n/ap	0.0150	0	0.0	13.0%	7.0%	n/ap	n/ap	n/ap	n/ap	n/ap	52.50	n/ap	0.000000127	n/ap	n/ap	n/ap	n/ap	0.00000013	95.0%	95.0%	95.0%
A_L0801: Road_Paved_Main_L08_01	212	n/ap	0.0447	19	0.6	5.3%	0.9%	3.6	3.6	3.6	0.230	0.146	223.50	0.000000904	0.000000005	n/ap	n/ap	n/ap	n/ap	0.00000559	99.5%	99.5%	99.5%
A_L0802: Road_Paved_Main_L08_02	212	n/ap	0.0897	38	1.3	5.3%	0.9%	3.6	3.6	3.6	0.230	0.292	448.50	0.000000904	0.000000005	n/ap	n/ap	n/ap	n/ap	0.00000559	99.5%	99.5%	99.5%
A_L0803: Road_Paved_Main_L08_03	212	n/ap	0.1785	76	2.5	5.3%	0.9%	3.6	3.6	3.6	0.230	0.581	892.50	0.000000904	0.000000005	n/ap	n/ap	n/ap	n/ap	0.00000559	99.5%	99.5%	99.5%
A_L0804: Road_Paved_Main_L08_04	212	n/ap	0.2232	95	3.2	5.3%	0.9%	3.6	3.6	3.6	0.230	0.727	1116.00	0.000000904	0.000000005	n/ap	n/ap	n/ap	n/ap	0.00000559	99.5%	99.5%	99.5%
A_L0805: Road_Paved_Main_L08_05	212	n/ap	0.1272	54	1.8	5.3%	0.9%	3.6	3.6	3.6	0.230	0.414	636.00	0.000000904	0.000000005	n/ap	n/ap	n/ap	n/ap	0.00000559	99.5%	99.5%	99.5%
A_L0806: Road_Paved_Main_L08_06	212	n/ap	0.2266	96	3.2	5.3%	0.9%	3.6	3.6	3.6	0.230	0.738	1133.00	0.000000904	0.000000005	n/ap	n/ap	n/ap	n/ap	0.00000559	99.5%	99.5%	99.5%
A_L0807: Road_Paved_Main_L08_07	212	n/ap	0.1364	58	1.9	5.3%	0.9%	3.6	3.6	3.6	0.230	0.444	682.00	0.000000904	0.000000005	n/ap	n/ap	n/ap	n/ap	0.00000559	99.5%	99.5%	99.5%
A_L0808: Road_Paved_Main_L08_08	212	n/ap	0.0606	26	0.9	5.3%	0.9%	3.6	3.6	3.6	0.230	0.197	303.00	0.000000904	0.000000005	n/ap	n/ap	n/ap	n/ap	0.00000559	99.5%	99.5%	99.5%
A_L0809: Road_Paved_Main_L08_09	212	n/ap	0.2317	98	3.3	5.3%	0.9%	3.6	3.6	3.6	0.230	0.754	1158.50	0.000000904	0.000000005	n/ap	n/ap	n/ap	n/ap	0.00000559	99.5%	99.5%	99.5%
A_L0810: Road_Paved_Main_L08_10	212	n/ap	0.0905	38	1.3	5.3%	0.9%	3.6	3.6	3.6	0.230	0.295	452.50	0.000000904	0.000000005	n/ap	n/ap	n/ap	n/ap	0.00000559	99.5%	99.5%	99.5%
A_L0811: Road_Paved_Main_L08_11	212	n/ap	0.0340	14	0.5	5.3%	0.9%	3.6	3.6	3.6	0.230	0.111	170.00	0.000000904	0.000000005	n/ap	n/ap	n/ap	n/ap	0.00000559	99.5%	99.5%	99.5%
A_L0812: Road_Paved_Main_L08_12	212	n/ap	0.0752	32	1.1	5.3%	0.9%	3.6	3.6	3.6	0.230	0.245	376.00	0.000000904	0.000000005	n/ap	n/ap	n/ap	n/ap	0.00000559	99.5%	99.5%	99.5%
A_L0813: Road_Paved_Main_L08_13	212	n/ap	0.0934	40	1.3	5.3%	0.9%	3.6	3.6	3.6	0.230	0.304	467.00	0.000000904	0.000000005	n/ap	n/ap	n/ap	n/ap	0.00000559	99.5%	99.5%	99.5%
A_L0814: Road_Paved_Main_L08_14	212	n/ap	0.0382	16	0.5	5.3%	0.9%	3.6	3.6	3.6	0.230	0.124	191.00	0.000000904	0.000000005	n/ap	n/ap	n/ap	n/ap	0.00000559	99.5%	99.5%	99.5%
A_L0815: Road_Paved_Main_L08_15	212	n/ap	0.0285	12	0.4	5.3%	0.9%	3.6	3.6	3.6	0.230	0.093	142.50	0.000000904	0.000000005	n/ap	n/ap	n/ap	n/ap	0.00000559	99.5%	99.5%	99.5%
A_L0816: Road_Paved_Main_L08_16	212	n/ap	0.1209	51	1.7	5.3%	0.9%	3.6	3.6	3.6	0.230	0.394	604.50	0.000000904	0.000000005	n/ap	n/ap	n/ap	n/ap	0.00000559	99.5%	99.5%	99.5%
A_L0817: Road_Paved_Main_L08_17	212	n/ap	0.1320	56	1.9	5.3%	0.9%	3.6	3.6	3.6	0.230	0.430	660.00	0.000000904	0.000000005	n/ap	n/ap	n/ap	n/ap	0.00000559	99.5%	99.5%	99.5%
A_L1101: Road_Unpaved_SlagDisposal_New_L11_01	99	n/ap	0.0746	15	0.5	5.3%	0.9%	10.0	50.0	30.0	0.599	0.295	522.20	0.000007859	0.000000052	n/ap	n/ap	n/ap	n/ap	0.00001127	95.0%	95.0%	95.0%
A_L1102: Road_Unpaved_SlagDisposal_New_L11_02	99	n/ap	0.1943	39	1.3	5.3%	0.9%	10.0	50.0	30.0	0.599	0.770	1360.10	0.000007859	0.000000052	n/ap	n/ap	n/ap	n/ap	0.00001127	95.0%	95.0%	95.0%
A_L1103: Road_Unpaved_SlagDisposal_New_L11_03	99	n/ap	0.0564	11	0.4	5.3%	0.9%	10.0	50.0	30.0	0.599	0.223	394.80	0.000007859	0.000000052	n/ap	n/ap	n/ap	n/ap	0.00001127	95.0%	95.0%	95.0%
A_L1104: Road_Unpaved_SlagDisposal_New_L11_04	99	n/ap	0.0723	14	0.5	5.3%	0.9%	10.0	50.0	30.0	0.599	0.286	506.10	0.000007859	0.000000052	n/ap	n/ap	n/ap	n/ap	0.00001127	95.0%	95.0%	95.0%
A_L1105: Road_Unpaved_SlagDisposal_New_L11_05	99	n/ap	0.1720	34	1.1	5.3%	0.9%	10.0	50.0	30.0	0.599	0.681	1204.00	0.000007859	0.000000052	n/ap	n/ap	n/ap	n/ap	0.00001127	95.0%	95.0%	95.0%
A_L1106: Road_Unpaved_SlagDisposal_New_L11_06	99	n/ap	0.1074	21	0.7	5.3%	0.9%	10.0	50.0	30.0	0.599	0.425	751.80	0.000007859	0.000000052	n/ap	n/ap	n/ap	n/ap	0.00001127	95.0%	95.0%	95.0%
A_L1107: Road_Unpaved_SlagDisposal_New_L11_07	99	n/ap	0.0575	11	0.4	5.3%	0.9%	10.0	50.0	30.0	0.599	0.228	402.50	0.000007859	0.000000052	n/ap	n/ap	n/ap	n/ap	0.00001127	95.0%	95.0%	95.0%
A_L1108: Road_Unpaved_SlagDisposal_New_L11_08	99	n/ap	0.0612	12	0.4	5.3%	0.9%	10.0	50.0	30.0	0.599	0.242	428.40	0.000007859	0.000000052	n/ap	n/ap	n/ap	n/ap	0.00001127	95.0%	95.0%	95.0%
A_L1109: Road_Unpaved_SlagDisposal_New_L11_09	99	n/ap	0.0918	18	0.6	5.3%	0.9%	10.0	50.0	30.0	0.599	0.364	642.60	0.000007859	0.000000052	n/ap	n/ap	n/ap	n/ap	0.00001127	95.0%	95.0%	95.0%
A_L1110: Road_Unpaved_SlagDisposal_New_L11_10	99	n/ap	0.0464	9	0.3	5.3%	0.9%	10.0	50.0	30.0	0.599	0.184	324.80	0.000007859	0.000000052	n/ap	n/ap	n/ap	n/ap	0.00001127	95.0%	95.0%	95.0%
A_L1111: Road_Unpaved_SlagDisposal_New_L11_11	99	n/ap	0.1262	25	0.8	5.3%	0.9%	10.0	50.0	30.0	0.599	0.500	883.40	0.000007859	0.000000052	n/ap	n/ap	n/ap	n/ap	0.00001127	95.0%	95.0%	95.0%
A_L1112: Road_Unpaved_SlagDisposal_New_L11_12	99	n/ap	0.1104	22	0.7	5.3%	0.9%	10.0	50.0	30.0	0.599	0.437	772.80	0.000007859	0.000000052	n/ap	n/ap	n/ap	n/ap	0.00001127	95.0%	95.0%	95.0%
A_L1113: Road_Unpaved_SlagDisposal_New_L11_13	99	n/ap	0.0899	18	0.6	5.3%	0.9%	10.0	50.0	30.0	0.599	0.356	629.30	0.000007859	0.000000052	n/ap	n/ap	n/ap	n/ap	0.00001127	95.0%	95.0%	95.0%
A_L1201: Road_Paved_ExportStorage_L12_01	71	n/ap	0.0975	14	0.5	9.5%	5.4%	10.0	50.0	30.0	1.013	0.466	487.50	0.000001329	0.000000009	n/ap	n/ap	n/ap	n/ap	0.00000470	99.5%	99.5%	99.5%
A_L1202: Road_Paved_ExportStorage_L12_02	71	n/ap	0.2119	30	1.0	9.5%	5.4%	10.0	50.0	30.0	1.013	1.014	1059.50	0.000001329	0.000000009	n/ap	n/ap	n/ap	n/ap	0.00000470	99.5%	99.5%	99.5%
A_L1203: Road_Paved_ExportStorage_L12_03	71	n/ap	0.0743	11	0.4	9.5%	5.4%	10.0	50.0	30.0	1.013	0.355	371.50	0.000001329	0.000000009	n/ap	n/ap	n/ap	n/ap	0.00000470	99.5%	99.5%	99.5%
A_L1204: Road_Paved_ExportStorage_L12_04	71	n/ap	0.1258	18	0.6	9.5%	5.4%	10.0	50.0	30.0	1.013	0.602	629.00	0.000001329	0.000000009	n/ap	n/ap	n/ap	n/ap	0.00000470	99.5%	99.5%	99.5%
A_L1205: Road_Paved_ExportStorage_L12_05	71	n/ap	0.0306	4	0.1	9.5%	5.4%	10.0	50.0	30.0	1.013	0.146	153.00	0.000001329	0.000000009	n/ap	n/ap	n/ap	n/ap	0.00000470	99.5%	99.5%	99.5%
A_L1206: Road_Paved_ExportStorage_L12_06	71	n/ap	0.1841	26	0.9	9.5%	5.4%	10.0	50.0	30.0	1.013	0.881	920.50	0.000001329	0.000000009	n/ap	n/ap	n/ap	n/ap	0.00000470	99.5%	99.5%	99.5%
A_L1207: Road_Paved_ExportStorage_L12_07	71	n/ap	0.0848	12	0.4	9.5%	5.4%	10.0	50.0	30.0	1.013	0.406	424.00	0.000001329	0.000000009	n/ap	n/ap	n/ap	n/ap	0.00000470	99.5%	99.5%	99.5%
A_L1208: Road_Paved_ExportStorage_L12_08	71	n/ap	0.3353	47	1.6	9.5%	5.4%	10.0	50.0	30.0	1.013	1.604	1676.50	0.000001329	0.000000009	n/ap	n/ap	n/ap	n/ap	0.00000470	99.5%	99.5%	99.5%
A_L1301: Road_Paved_NewEntrance_L13_01	220	n/ap	0.4213	185	6.2	5.3%	0.9%	5.3	23.4	14.4	0.430	2.653	2949.10	0.000000000	0.000000000	n/ap	n/ap	n/ap	n/ap	0.00000405	100.0%	100.0%	100.0%
A_L1401: Road_Paved_NewP&RMAccess_L14_01	220	n/ap	0.1672	73	2.4	5.3%	0.9%	5.3	23.4	14.4	0.430	1.053	1170.40	0.000000000	0.000000000	n/ap	n/ap	n/ap	n/ap	0.00000405	100.0%	100.0%	100.0%
A_L1402: Road_Paved_NewP&RMAccess_L14_02	220	n/ap	0.1410	62	2.1	5.3%	0.9%	5.3	23.4	14.4	0.430	0.888	987.00	0.000000000	0.000000000	n/ap	n/ap	n/ap	n/ap	0.00000405	100.0%	100.0%	100.0%
A_L1403: Road_Paved_NewP&RMAccess_L14_03	220	n/ap	0.6987	307	10.2	5.3%	0.9%	5.3	23.4	14.4	0.430	4.400	4890.90	0.000000000	0.000000000	n/ap	n/ap	n/ap	n/ap	0.00000405	100.0%	100.0%	100.0%
2__A16SP: Area_SinterPlant_MatH	1064	10	0.1000	213	7.1	8.0%	5.7%	6.1	15.3	10.7	0.547	3.880	2205.99	0.000024432	0.000000078	0.0000001	Included	n/ap	n/ap	0.00003168	95.0%	95.0%	95.0%

Factor applied to abovementioned rates where relevant to account for wind speeds in excess of 5.4m/s with rainfall less than 0.254mm:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wind Generated:	3.98	1.59	1.54	1.37	1.00	3.01	2.54	3.45	4.23	8.52	1.61	1.93
Loading/Unloading:	1.30	1.36	1.03	1.00	1.03	1.15	1.17	1.27	1.23	1.50	1.60	1.19

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Expected Mn content in the ACRW secondary sources is referenced in Table D.0-M.

Table D.0-M: Secondary sources: ACRW Expected Manganese content

FeMn Production:

ID	Description	Mn
		w/w%
A__A09HC	Area_HighCarbonC&S	70.0%
A__A10LC	Area_LowCarbonC&S	78.0%
A__A14BP	Area_BriquettingPlant	30.4%
A__A03RS	Area_RawMaterialStorage	30.4%
A__A15BS	Area_BriquettingPlantStockpiles	30.4%

ID	Description	Mn
		w/w%
A__A12ES	Area_ExportStockpile_South	75.0%
A__A12EN	Area_ExportStockpile_North	70.0%

ID	Description	Mn
		w/w%
A__A11SN	Area_SlagDisposal_New	0.4%
A__A01SO	Area_SlagDisposal_Old	0.4%
A__A02CT	Area_SlagPondCoolingTrenches	17.9%
A__A13IO	Area_Product&RM_InOutLoading_NEW	72.5%
A__A05BN	Area_BaghouseDustStorage_NEW	33.2%
A__A06PS	Area_ProductStorage	72.5%
A__A07ST	Area_SlimesDamsTailings	20.2%
A__A08MR	Area_MRP	17.9%
2__A16SP	Area_SinterPlant_MatH	30.4%

ID	Description	Mn
		w/w%
A__L0901	Road_Unpaved_Hostel_L09_01	0.1%
A__L0902	Road_Unpaved_Hostel_L09_02	0.1%
A__L0903	Road_Unpaved_Hostel_L09_03	0.1%
A__L0904	Road_Unpaved_Hostel_L09_04	0.1%
A__L0905	Road_Unpaved_Hostel_L09_05	0.1%
A__L0906	Road_Unpaved_Hostel_L09_06	0.1%
A__L0907	Road_Unpaved_Hostel_L09_07	0.1%
A__L0908	Road_Unpaved_Hostel_L09_08	0.1%
A__L1001	Road_Unpaved_MRP-Storage_L10_01	17.9%
A__L1002	Road_Unpaved_MRP-Storage_L10_02	17.9%
A__L1003	Road_Unpaved_MRP-Storage_L10_03	17.9%
A__L1004	Road_Unpaved_MRP-Storage_L10_04	17.9%
A__L1005	Road_Unpaved_MRP-Storage_L10_05	17.9%
A__L1006	Road_Unpaved_MRP-Storage_L10_06	17.9%
A__L1007	Road_Unpaved_MRP-Storage_L10_07	17.9%
A__L1008	Road_Unpaved_MRP-Storage_L10_08	17.9%
A__L1009	Road_Unpaved_MRP-Storage_L10_09	17.9%
A__L1010	Road_Unpaved_MRP-Storage_L10_10	17.9%
A__L1011	Road_Unpaved_MRP-Storage_L10_11	17.9%
A__L0101	Road_Unpaved_SlagDisposal_Old_L01_01	0.4%
A__L0102	Road_Unpaved_SlagDisposal_Old_L01_02	0.4%
A__L0103	Road_Unpaved_SlagDisposal_Old_L01_03	0.4%
A__L0201	Road_Unpaved_SlagPondCoolingTrenches_L02_01	17.9%
A__L0202	Road_Unpaved_SlagPondCoolingTrenches_L02_02	17.9%
A__L0203	Road_Unpaved_SlagPondCoolingTrenches_L02_03	17.9%
A__L0204	Road_Unpaved_SlagPondCoolingTrenches_L02_04	17.9%
A__L0301	Road_Paved_RawMaterial_L03_01	30.4%
A__L0302	Road_Paved_RawMaterial_L03_02	30.4%
A__L0303	Road_Paved_RawMaterial_L03_03	30.4%
A__L0304	Road_Paved_RawMaterial_L03_04	30.4%
A__L0305	Road_Paved_RawMaterial_L03_05	30.4%
A__L0306	Road_Paved_RawMaterial_L03_06	30.4%
A__L0401	Road_Unpaved_BHDustStorage_Old_L04_01	0.1%
A__L0501	Road_Unpaved_BHDustStorage_New_L05_01	33.2%

ID	Description	Mn
		w/w%
A__L0601	Road_Paved_ProductStorage_L06_01	36.3%
A__L0602	Road_Paved_ProductStorage_L06_02	36.3%
A__L0603	Road_Paved_ProductStorage_L06_03	36.3%
A__L0604	Road_Paved_ProductStorage_L06_04	36.3%
A__L0605	Road_Paved_ProductStorage_L06_05	36.3%
A__L0701	Road_Unpaved_SlimesDams(Tailings)_L07_01	20.2%
A__L0801	Road_Paved_Main_L08_01	5.1%
A__L0802	Road_Paved_Main_L08_02	5.1%
A__L0803	Road_Paved_Main_L08_03	5.1%
A__L0804	Road_Paved_Main_L08_04	5.1%
A__L0805	Road_Paved_Main_L08_05	5.1%
A__L0806	Road_Paved_Main_L08_06	5.1%
A__L0807	Road_Paved_Main_L08_07	5.1%
A__L0808	Road_Paved_Main_L08_08	5.1%
A__L0809	Road_Paved_Main_L08_09	5.1%
A__L0810	Road_Paved_Main_L08_10	5.1%
A__L0811	Road_Paved_Main_L08_11	5.1%
A__L0812	Road_Paved_Main_L08_12	5.1%
A__L0813	Road_Paved_Main_L08_13	5.1%
A__L0814	Road_Paved_Main_L08_14	5.1%
A__L0815	Road_Paved_Main_L08_15	5.1%
A__L0816	Road_Paved_Main_L08_16	5.1%
A__L0817	Road_Paved_Main_L08_17	5.1%
A__L1101	Road_Unpaved_SlagDisposal_New_L11_01	0.4%
A__L1102	Road_Unpaved_SlagDisposal_New_L11_02	0.4%
A__L1103	Road_Unpaved_SlagDisposal_New_L11_03	0.4%
A__L1104	Road_Unpaved_SlagDisposal_New_L11_04	0.4%
A__L1105	Road_Unpaved_SlagDisposal_New_L11_05	0.4%
A__L1106	Road_Unpaved_SlagDisposal_New_L11_06	0.4%
A__L1107	Road_Unpaved_SlagDisposal_New_L11_07	0.4%
A__L1108	Road_Unpaved_SlagDisposal_New_L11_08	0.4%
A__L1109	Road_Unpaved_SlagDisposal_New_L11_09	0.4%
A__L1110	Road_Unpaved_SlagDisposal_New_L11_10	0.4%
A__L1111	Road_Unpaved_SlagDisposal_New_L11_11	0.4%
A__L1112	Road_Unpaved_SlagDisposal_New_L11_12	0.4%
A__L1113	Road_Unpaved_SlagDisposal_New_L11_13	0.4%
A__L1201	Road_Paved_ExportStorage_L12_01	36.3%
A__L1202	Road_Paved_ExportStorage_L12_02	36.3%
A__L1203	Road_Paved_ExportStorage_L12_03	36.3%
A__L1204	Road_Paved_ExportStorage_L12_04	36.3%
A__L1205	Road_Paved_ExportStorage_L12_05	36.3%
A__L1206	Road_Paved_ExportStorage_L12_06	36.3%
A__L1207	Road_Paved_ExportStorage_L12_07	36.3%
A__L1208	Road_Paved_ExportStorage_L12_08	36.3%
A__L1301	Road_Paved_NewEntrance_L13_01	3.1%
A__L1401	Road_Paved_NewP&RMAccess_L14_01	3.1%
A__L1402	Road_Paved_NewP&RMAccess_L14_02	3.1%
A__L1403	Road_Paved_NewP&RMAccess_L14_03	3.1%

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In 2005 a report on a study conducted in Australia to review the status of, and identify and recommend ways to improve, emission estimation methodologies for fugitive (non-combustion) $PM_{2.5}$, PM_{10}, TSP and metals/metal compounds in particulate matter from mining (non-coal) and other industrial activities for the National Pollutant Inventory (NPI) reporting (Pitts, 2005), was published. In this study we used the appropriate equations for estimating fugitive dust emissions for each of the activities which have been identified. The report presents a review of the status of techniques listed in USEPA AP-42 and the USA's Toxic Release Inventory (US TRI), as well as the Canadian National Pollutant Release Inventory (NPRI), with comparison to current NPI techniques.

This section will give the equations that were used, along with the recommendations made for each of them in the document "Improvement of Fugitive Particulate Matter Emission Estimation Techniques".

Where ratings were assigned to equations, the rating system is as follows:

- A: Excellent;
- B: Above average;
- C: Average;
- D: Below average; and
- E: Poor.

D.2 Blasting

Emissions from blasting activities at a site can be expected to be similar to the type of blasts at Crushed stone processing plants where the rock and crushed stone products generally are loosened by drilling holes in the rock and then blasting it (USEPA, 2004).

Section 11.19.2 of AP-42, "Crushed stone processing and Pulvurised mineral processing", says the following with regards to blasting: "*Emission factor estimates for stone quarry blasting operations are not presented because of the sparsity and unreliability of available tests. While a procedure for estimating blasting emissions is presented in Section 11.9, Western Surface Coal Mining, that procedure should not be applied to stone quarries because of dissimilarities in blasting techniques, material blasted, and size of blast areas.*" (USEPA, 2004)

The equation for estimating particulate emissions from blasting given in Section 11.9 of AP-42 is as follows:

$$EF_{30}\,(kg/blast) = 0.00022\,A^{1.5} \qquad \text{(D.1)}$$

with: A = Blasting area (m^2)

According to Pitts, there are currently no other equations available to estimate particulate emissions from blasting (Pitts, 2005). The values of PM_{10} emissions from blasting are then estimated at 52% of TSP emissions predicted by Equation D.1, which is based on material handing PM_{10}/TSP ratios. Equation D.1 can therefore be used as follows for estimated PM_{10} emissions:

$$EF_{10}\,(kg/blast) = 0.0001144\,A^{1.5} \qquad \text{(D.2)}$$

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Of note is that the equation was based on the blast area ranging from approximately 700 m^2 up to 8 000 m^2 and a maximum area of 9 600 m^2 (Pitts, 2005).

Based on the study by Pitts in 2005 and the recent recommendation in the Crushed Stone Processing and Pulverized Mineral Processing guide (Section 11.19.2 of AP-42) it is seen that there is little if any justification for the equations for the non-coal mining industry (Pitts, 2005).

But, Pitts however recommends that though there is little support for the application of the current AP-42 blasting equation presented here, and despite it being dropped from AP-42 Crushed Stone Processing and Pulverized Mineral Processing guide (Section 11.19.2), it is recommended that this equation be retained in the interim until future studies provide a better estimate (Pitts, 2005).

It is not clear from any of the AP-42 documents where blasting is discussed, if the current equation could be applicable in determine emissions for decline shaft blasting. It should also be noted that since the majority of the blasting will be done below ground level, the equation might therefore not be applicable to this application. Another factor is that of the duration of the activities, with the blasting expected to last for only an estimated 6 week period, and therefore is expected not to adversely affect the ambient air quality.

If a blasting event does occur, it is not expected to have any significant change in the ambient air quality for longer than 1 hour at a time, with the dust settling very quickly after the event.

D.3 Material Handling Load-in/Load-out

For this application the emission factor prescribed in AP-42 Section 13.2.4 Aggregate Handling and Storage Piles refers.

Either adding aggregate material to a storage pile or removing it usually involves dropping the material onto a receiving surface. Truck dumping on the pile or loading out from the pile to a truck with a front-end loader are examples of batch drop operations. Adding material to the pile by a conveyor stacker is an example of a continuous drop operation (USEPA, 1995a).

The quantity of particulate emissions generated by either type of drop operation may be estimated using the following empirical expression (USEPA, 1995a):

$$E\,(kg/Mg) = k\,(0.0016)\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}} \qquad \text{(D.3)}$$

with: E = Emission factor (kg/Mg)
k = particle size multiplier
U = mean wind speed (m/s)
M = Material moisture content (%)

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Equation D.3 replaced a previous, and outdated, equation that used the silt content as well as the drop height to estimate the emissions (Pitts, 2005). The particle size multiplier used in Equation D.3 to estimate the PM_{10} emissions is k = 0.35. The equation can therefore be written as:

$$EF_{10}\,(kg/Mg) = 0.00056\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}} \qquad \text{(D.4)}$$

Pitts reported that for application in metalliferous mines, due to the fact that there was no Australian data available for comparison, the AP-42 equation is recommended as the only available option, though it was considered that this equation may underestimate actual emissions by a factor of 5 to 10 (Pitts, 2005).

D.4 Wheel generated dust from unpaved roads

In October 2001, the USEPA published a new draft section 13.2.2 "Unpaved roads" for AP-42 and requested comments. This draft (Pitts, 2005):

- proposed two separate emission factor models for public and industrial roads;
- incorporated speed as an input parameter for public roads to overcome the shortcoming of the previous model which over-predicted emissions for low vehicle speeds; and
- revised the watering control effectiveness discussion.

In December 2003 the USEPA finalised this revision with slight changes (Pitts, 2005). The current AP-42 equation for vehicles travelling on unpaved surfaces at industrial sites is (Quality rating is B):

$$EF_{10}\,(kg/VKT) = 0.423\left(\frac{s}{12}\right)^{0.9}\left(\frac{W}{2.7}\right)^{0.45}$$

(D.5)

with: s = silt content of the road (%)
W = mean vehicle weight (ton)

The equation for vehicles travelling on publicly accessible roads, dominated by light duty vehicles, is (Pitts, 2005):

$$EF_{10}\,(kg/VKT) = 0.508\left(\frac{s}{12}\right)^{0.9}\left(\frac{S}{30}\right)^{0.5}\left(\frac{M}{0.5}\right)^{-0.2} - C \qquad \text{(D.6)}$$

with: s = silt content of the road (%)
S = average vehicle speed (km/hr)
M = Material moisture content (%)
C = emission factor for 1980's vehicle fleet exhaust, brake wear and tyre wear equal to (0.000133kg/VKT)

The quality rating for this equation is also B.

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For estimating the various parameters, AP-42 recommends the use of site-specific silt content information and where this is absent provides mean values for industrial roads. For surface moisture, AP-42 strongly recommends site-specific measurements be undertaken due to the significant variation that can occur between different types of road surfaces and discourages the use of the default moisture content of 0.5% (Pitts, 2005).

The effect of rainfall can be estimated simply by the following equation (USEPA, 2003):

$$EF_{xt} = EF\left(\frac{365-p)}{365}\right) \quad \text{(D.7)}$$

with: EF_{xt} = annual size-specific emission factor extrapolated for natural mitigation (kg/VKT)
EF = emission factor from Equations D.5 and D.6
p = number of days in a year with at least 0.254 mm (0.01 in) of precipitation

The USEPA emphasizes however that the simple assumption underlying Equation D.7 have not been verified in any rigorous manner. For this reason, the quality ratings for either approach should be downgraded one letter from the rating that would be applied to Equations D.5 and D.6 (Resulting in a C rating for these equations).

With road watering, the degree of control is determined based on the ratio of the “controlled” to “uncontrolled” road moistures. These are to be measured for periods with typical traffic with the uncontrolled moisture content measured at least 24-hours after watering or rain, with the average controlled value measured “either as a series of samples between water applications or a single sample at the midpoint” (USEPA, 2003). This ratio will vary with season and vehicle frequency such that representative sampling, particularly of hot summer time conditions, is required.

By doubling the surface moisture content of the road the AP-42 estimates that a 75% control is achieved with greater than 90% control achieved by increasing the moisture five times, as can be seen from Figure D.1 (USEPA, 2003).

Pitts recommended that the recent December 2003 USEPA AP-42 unpaved road equations be implemented into the NPI Fugitive Emissions Manual (Pitts, 2005), and these equations (Equation D.5 combined with Equation D.7) were used as an estimation for “uncontrolled” road moisture calculations. However, if the roads are watered (as is currently planned) to raise the moisture content more than five times its usual content, the expected emissions will be negligible, as can be seen from Figure D.1.

When developing watering control plans for roads that do not yet exist, it is strongly recommended that the moisture cycle be established by sampling similar roads in the same geographic area (USEPA, 2003).

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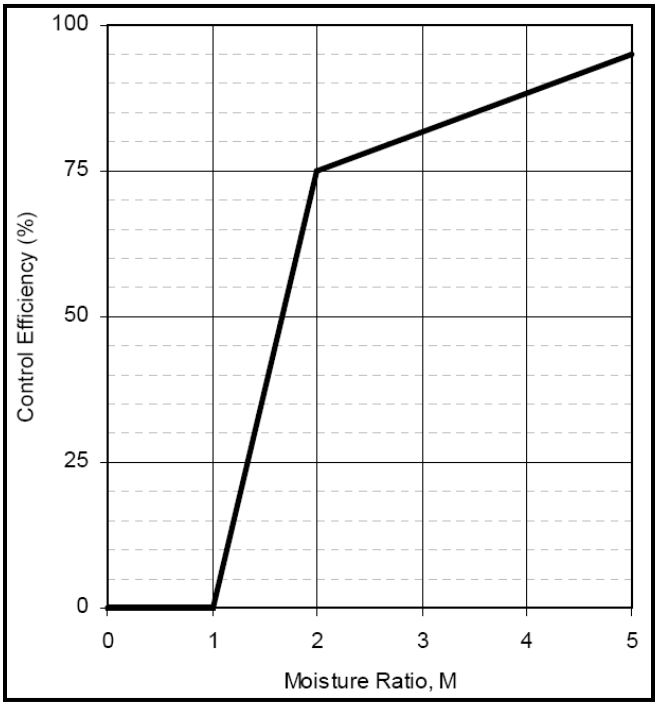


Figure D.1: Watering control for unpaved travel surfaces (USEPA, 2003)

D.5 Wind erosion from Industrial Areas and Mine Sites

The current AP-42 method was developed by Cowherd in 1983 for coal stockpiles based on wind tunnel testing of coal storage piles and other areas such as overburden. Critical to this method is that it is based on wind tunnel tests showing that particulate emissions decay rapidly, with a half-life of a few minutes during an erosion event, because there is limited availability of erodible material. This is unlike the active sand stockpiles on which Equation D.10 (which is discussed later on in the document) was developed. Based on the wind tunnel observations, the method assumes that because the erosion potential increases rapidly with wind speed, the particulate matter emissions between times when the surface area is disturbed can be approximated by the particulate matter emitted only during the peak one minute wind. That is, no particulate matter is assumed emitted for lower wind gusts which exceed the threshold velocity or the method allows for particulate matter from these events by calibrating the coefficients in the equation (Pitts, 2005).

In the method of Cowherd, the current AP-42 method, the erosion potential (P) of each particulate matter event for a dry, exposed surface is defined as (USEPA, 1995b):

$$P\,(g/m^2) = 58\,(u_* - u_{*t})^2 + 25\,(u_* - u_{*t}) \quad \text{for } u_* > u_{*t}$$
$$P\,(g/m^2) = 0 \quad \text{for } u_* \le u_{*t} \qquad \text{(D.8)}$$

with: u_* = friction velocity (m/s)
u_{*t} = threshold friction velocity (m/s)

The friction velocity (u_*) is a measure of wind shear stress on the erodible surface, as determined from the slope of the logarithmic velocity profile.

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The threshold friction velocity (as cm/s) (u_{*t}) can be estimated using an appropriate correlation. The EPA Manual recommends that the aggregate size distribution mode (in mm) should be used to determine the uncorrected threshold friction velocity (as cm/s) from Figure D.2. The correlation of Figure D.3 is then used to correct the threshold friction velocity for the presence of non-erodible elements (greater than about 1 cm). It is important to note that the correlation of Figure D.2 shows that there is significant scatter about the regression line (Anon, 2005?). The referenced document describes in detail how to further calculate the threshold friction velocity.

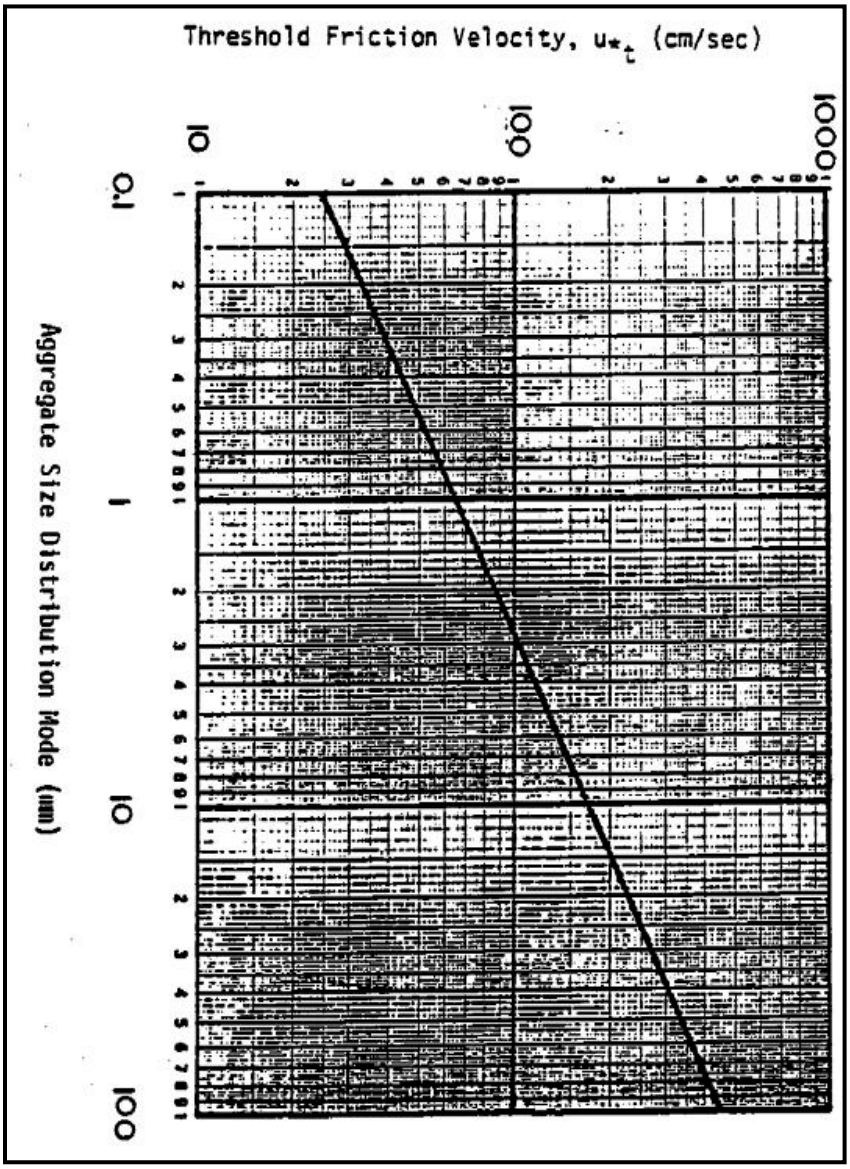


Figure D.2: Relation of threshold friction velocity to size distribution mode (USEPA, 1988)

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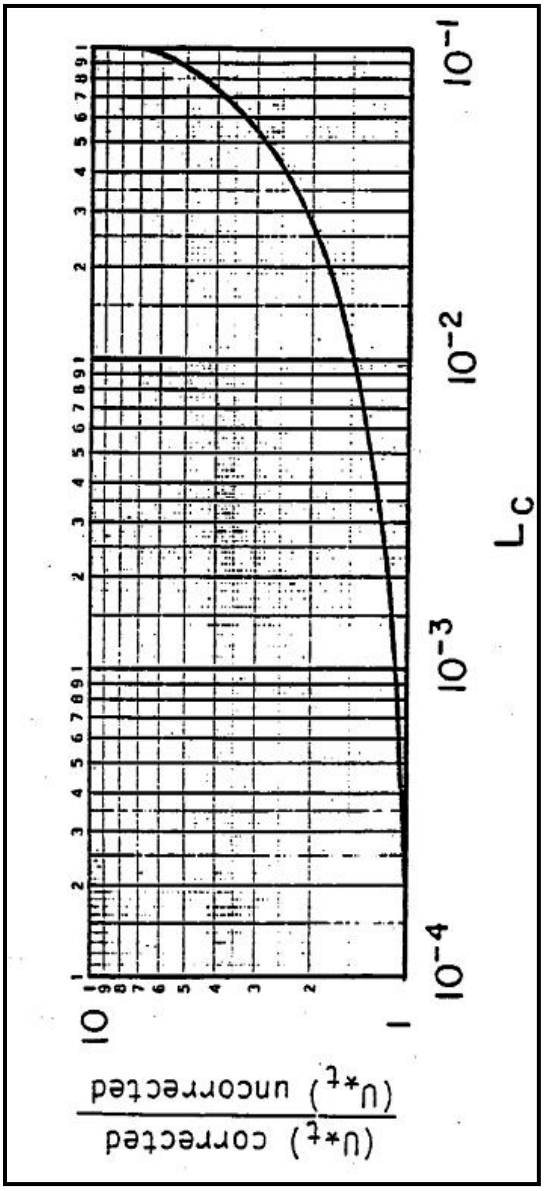


Figure D.3: Increase in threshold friction velocity with L_c (USEPA, 1988)

The AP-42 emission factor for wind-generated particulate emissions from mixtures of erodible and non-erodible surface material subject to disturbance may be expressed per year as follows (USEPA, 1995b):

$$EF(g/m^2/year) = k\sum_{i=1}^{N} P_i \qquad \text{(D.9)}$$

with: k = particle size multiplier (k=0.5 for PM_{10} estimates)
N = number of disturbances per year
P_i = erosion potential corresponding to the observed (or probable) fastest mile of wind for the i^{th} period between disturbances (g/m^2)

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A disturbance (N) is defined as an action which results in the exposure of fresh surface material. On a storage pile, this would occur whenever aggregate material is either added to or removed from the old surface. A disturbance of an exposed area may also result from the turning of surface material to a depth exceeding the size of the largest pieces of material present (USEPA, 1988).

The NPI Mining Manual suggests the use of Equation D.10, and therefore did not adopt the USEPA method current at the time as introduced in Equations D.8 and D.9 (Pitts, 2005). The current NPI emission factor equation for estimating the PM_{10} component of wind erosion is (NPI, 2001):

$$EF_{10}\,(kg/ha/day) = 0.95\left(\frac{s}{1.5}\right)\left(\frac{365-p}{235}\right)\left(\frac{f}{15}\right) \qquad \text{(D.10)}$$

with: s = silt content (%)
p = number of days in a year with at least 0.254 mm (0.01 in) of precipitation
f = the percentage of time the unobstructed wind at the mean pile height exceeds 5.4 m/s

This equation was developed to estimate wind erosion on **active** storage piles. It is rated C for application in the sand and gravel industry and D for other industries using the USEPA quality rating for emission factors (Pitts, 2005). It is important to note that the storage pile is active, that is either the surface is being disturbed frequently enough such that fresh material is available for wind erosion, or the surface is not depleted or crusted.

Pitts found that though the current NPI equation is considered indicative only, there appears to be no ready replacement, with the existing AP-42 equation considered to be based on little data for non-coal mines and difficult to implement (e.g. estimation of threshold friction velocities) (Pitts, 2005). He recommended that the current NPI equation (Equation D.10) should be retained in the interim.

D.6 Silt and moisture content of different materials

Typical silt and moisture content of materials at various industries can be seen in Table D.1 (USEPA, 1995a).

Typical silt content values of surface material on industrial unpaved roads can be seen in Table D.2 (USEPA, 2003).

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Table D.1: Typical silt and moisture content of materials at various industries (USEPA, 1995a)

Industry	No. Of Facilities	Material	Silt Content (%)			Moisture Content (%)		
			No. Of Samples	Range	Mean	No. Of Samples	Range	Mean
Iron and steel production	9	Pellet ore	13	1.3 - 13	4.3	11	0.64 - 4.0	2.2
		Lump ore	9	2.8 - 19	9.5	6	1.6 - 8.0	5.4
		Coal	12	2.0 - 7.7	4.6	11	2.8 - 11	4.8
		Slag	3	3.0 - 7.3	5.3	3	0.25 - 2.0	0.92
		Flue dust	3	2.7 - 23	13	1	—	7
		Coke breeze	2	4.4 - 5.4	4.9	2	6.4 - 9.2	7.8
		Blended ore	1	—	15	1	—	6.6
		Sinter	1	—	0.7	0	—	—
		Limestone	3	0.4 - 2.3	1.0	2	ND	0.2
Stone quarrying and processing	2	Crushed limestone	2	1.3 - 1.9	1.6	2	0.3 - 1.1	0.7
		Various limestone products	8	0.8 - 14	3.9	8	0.46 - 5.0	2.1
Taconite mining and processing	1	Pellets	9	2.2 - 5.4	3.4	7	0.05 - 2.0	0.9
		Tailings	2	ND	11	1	—	0.4
Western surface coal mining	4	Coal	15	3.4 - 16	6.2	7	2.8 - 20	6.9
		Overburden	15	3.8 - 15	7.5	0	—	—
		Exposed ground	3	5.1 - 21	15	3	0.8 - 6.4	3.4
Coal-fired power plant	1	Coal (as received)	60	0.6 - 4.8	2.2	59	2.7 - 7.4	4.5
Municipal solid waste landfills	4	Sand	1	—	2.6	1	—	7.4
		Slag	2	3.0 - 4.7	3.8	2	2.3 - 4.9	3.6
		Cover	5	5.0 - 16	9.0	5	8.9 - 16	12
		Clay/dirt mix	1	—	9.2	1	—	14
		Clay	2	4.5 - 7.4	6.0	2	8.9 - 11	10
		Fly ash	4	78 - 81	80	4	26 - 29	27
		Misc. fill materials	1	—	12	1	—	11

[a] References 1-10. ND = no data.

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Table D.2: Typical silt content values of surface material on industrial unpaved roads (USEPA, 2003)

Industry	Road Use Or Surface Material	Plant Sites	No. Of Samples	Silt Content (%)	
				Range	Mean
Copper smelting	Plant road	1	3	16 - 19	17
Iron and steel production	Plant road	19	135	0.2 - 19	6.0
Sand and gravel processing	Plant road	1	3	4.1 - 6.0	4.8
	Material storage area	1	1	-	7.1
Stone quarrying and processing	Plant road	2	10	2.4 - 16	10
	Haul road to/from pit	4	20	5.0-15	8.3
Taconite mining and processing	Service road	1	8	2.4 - 7.1	4.3
	Haul road to/from pit	1	12	3.9 - 9.7	5.8
Western surface coal mining	Haul road to/from pit	3	21	2.8 - 18	8.4
	Plant road	2	2	4.9 - 5.3	5.1
	Scraper route	3	10	7.2 - 25	17
	Haul road (freshly graded)	2	5	18 - 29	24
Construction sites	Scraper routes	7	20	0.56-23	8.5
Lumber sawmills	Log yards	2	2	4.8-12	8.4
Municipal solid waste landfills	Disposal routes	4	20	2.2 - 21	6.4

D.7 Exhaust Emission Factors

Exhaust Emission Factors for Various Classes of Mining Equipment can be seen in Table D.3 (NPI, 2001)

Table D.3: Exhaust Emission Factors for Various Classes of Mining Equipment (NPI, 2001)

Equipment Type	Emission Factor (kg/1000 litre of fuel)					
	PM_{10}[1]	CO	NO_x	SO_x[2] (as SO_2)	VOCs (exhaust)	Emission Factor Rating
Track type tractor	3.03	9.4	34.16	1.7	3.31	C
Wheeled tractor	5.57	32.19	52.35	1.7	7.74	C
Wheeled dozer	17.7	14.73	34.29	1.7	1.58	C
Scraper	3.27	10.16	30.99	1.7	2.28	C
Grader	2.66	6.55	30.41	1.7	1.53	C
Off-highway truck	17.7	14.73	34.29	1.7	1.58	C
Wheeled loader	3.51	11.79	38.5	1.7	5.17	C
Track type loader	2.88	9.93	30.73	1.7	4.85	C

[2] SO2 emission rate to be corrected in accordance with sulphur content of the fuel combusted

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Appendix E: NEMA Potential Impact/Risk Assessment Methodology

E.1 Significance Rating System

The assessment of the significance of impacts for a proposed development is, by its nature, a matter of judgement. The following impact assessment methodology ensures that specialists address all relevant factors that contribute to significance (avoiding arbitrary assessment). For each predicted impact, criteria are applied to establish the significance of the impact based on likelihood and consequence, both without mitigation being applied (pre-mitigation) and with the implementation of the recommended mitigation measure(s) (post-mitigation). "Significant impact" means an impact that may have a notable effect on one or more aspects of the environment or may result in non-compliance with accepted environmental quality standards, thresholds or targets and is determined through rating the positive and negative effects of an impact on the environment based on criteria such as duration, magnitude, intensity and probability of occurrence" (2014 EIA regulations, as amended).

The criteria that contribute to the **consequence** of the impact are:

Intensity: the degree to which pre-development conditions are changed, which also includes the **type** of impact (being either a positive or negative impact); the **duration** (length of time that the impact will continue); and the **extent** (spatial scale) of the impact;

The sensitivity of the receiving environment and/or sensitive receptors are incorporated into the consideration of consequence by appropriately adjusting the thresholds or scales of the intensity, duration and extent criteria based on expert knowledge.

For each impact, the specialist applies professional judgement to ascribe a numerical rating for each criterion per the following tables:

Table E.1: Definition of Intensity Ratings

Rating	Criteria	
	Negative impacts (Type of impact = -1)	**Positive impacts** (Type of impact = +1)
7	Complete destruction (irreversible and irreplaceable loss) of natural or social systems, resources (e.g. species) and human health. No chance of these processes or resources ever being restored to their pre-impact condition.	Noticeable, sustainable benefits that improve the quality and extent of natural or social systems or resources, including formal protection.
6	Very high degree of damage to natural or social systems or resources. These processes or resources may restore to their pre-project condition over very long periods of time (more than a typical human lifetime).	Great improvement to ecosystem or social processes and services or resources.
5	Serious damage to components of natural or social systems or resources and the contravention of legislated standards.	Ongoing and widespread benefits to natural or social systems or resources.
4	High degree damage to natural or social system components, species or resources.	Average to intense positive benefits for natural or social systems or resources.
3	Moderate damage to natural or social system components, species or resources.	Average, ongoing positive benefits for natural or social systems or resources.
2	Minor damage to natural or social system components, species or resources. Likely to recover over time. Ecosystems and valuable social processes are not affected.	Low positive impacts on natural or social systems or resources.
1	Negligible damage to individual components of natural or social systems or resources, such that it is hardly noticeable.	Limited low-level benefits to natural or social systems or resources.

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Table E.2: Definition of Duration Ratings

Rating	Criteria
7	**Permanent:** The impact will remain indefinitely.
6	**Beyond project life**: The impact will remain for some time after the life of the project.
5	**Project life:** The impact will cease after the operational life span of the project
4	**Long-term**: The impact will continue for 6-15 years.
3	**Medium-term:** The impact will continue for 2-5 years.
2	**Short-term:** The impact will continue for between 1 month and 2 years.
1	**Immediate**: The impact will continue for less than 1 month.

Table E.3: Definition of Extent Ratings

Rating	Criteria
7	**International:** The effect will occur across international borders.
6	**National:** The impact will affect the entire country.
5	**Province/ Region:** The impact will affect the entire province or region
4	**Municipal Area:** The impact will affect the whole municipal area.
3	**Local:** The impact will extend across the study area and the LAP area.
2	**Limited:** The impact will be limited to the study area.
1	**Very limited:** The impact will be limited to the footprint of the development and will not extend to the boundaries of the study area.

The consequence is then established using the formula:

Consequence = type x (intensity + duration + extent)

Depending on the numerical result, the impact's consequence would be extremely, highly, moderately or slightly detrimental; or neutral; or slightly, moderately, highly or extremely beneficial per the following table.

Table E.4: Application of Consequence Ratings

Range		Significance rating
-21	-18	Extremely detrimental
-17	-14	Highly detrimental
-13	-10	Moderately detrimental
-9	-6	Slightly detrimental
-5	5	Negligible
6	9	Slightly beneficial
10	13	Moderately beneficial
14	17	Highly beneficial
18	21	Extremely beneficial

To determine the significance of an impact, the probability (or likelihood) of that impact occurring is also considered. In assigning probability, the specialist considers the likelihood of occurrence and takes cognisance of uncertainty and detectability of the impact. The most suitable numerical rating for probability is selected and applied with the consequence according to the following equation:

Significance = consequence x probability

When assigning a probability to an impact, it is vitally important to distinguish this from the concepts of frequency and confidence, with which it is sometimes confused.

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Probability: refers to the likelihood that an impact will occur (refer Table E.5).

Table E.5: Definition of Probability Ratings

Rating	Criteria
7	**Certain/ Definite:** There are sound scientific reasons to expect that the impact will definitely occur.
6	**Almost certain/Highly probable:** It is most likely that the impact will occur.
5	**Likely:** This impact has occurred numerous times here or elsewhere in a similar environment and with a similar type of development and could very conceivably occur.
4	**Probable:** This impact has occurred here or elsewhere in a similar environment and with a similar type of development and could conceivably occur.
3	**Unlikely:** This impact has not happened yet but could happen.
2	**Rare/ improbable:** The impact is conceivable, but only in extreme circumstances. The possibility of the impact manifesting is very low due to the design, experience or implementation of adequate mitigation measures.
1	**Highly unlikely/None:** The impact is expected never to happen or has a very low chance of occurring.

Frequency: refers to the regularity with which an impact occurs. To illustrate the difference between frequency and probability, it must be considered that something that happens infrequently may still be a certainty (i.e. have a high probability). For instance, Halley's Comet only comes close to the sun every 75 to 76 years (i.e. it has a very low frequency), but it is still a certainty.

Depending on the numerical result of this calculation, the impact would fall into a significance category of negligible, minor, moderate or major, and the type would be either positive or negative (refer Table E.7).

Table E.6: Application of Significance Ratings

Range		Significance rating
-147	-109	Major - negative
-108	-73	Moderate - negative
-72	-36	Minor - negative
-35	-1	Negligible - negative
0	0	Neutral
1	35	Negligible - positive
36	72	Minor - positive
73	108	Moderate - positive
109	147	Major - positive

Confidence: refers to the degree of certainty of a prediction. Confidence may be related to impact assessment criteria (extent, intensity, duration or probability) and is not necessarily only related to probability. Confidence may be influenced by any factors that introduce uncertainty into a prediction. The specialists appointed to contribute to this impact assessment have empirical knowledge of their respective fields and can thus comment on their confidence in their findings based on the availability of data and the certainty of their findings. All specialists should include a short assessment and description of their confidence rating in their impact assessment report (refer Table E.7).

Table E.7: Definition of Confidence Ratings

Rating	Criteria
Low	Judgement is based on intuition, and some major assumptions are used to assess the impact that may prove untrue.
Medium	Determination is based on common sense and general knowledge. The assumptions made, whilst having a degree of uncertainty, are fairly robust.
High	Substantive supportive data or evidence exists to verify the assessment.

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Once the significance of an impact occurring without mitigation has been established, the specialist must apply their professional judgement to assign ratings for the same impact after the proposed mitigation has been implemented.

Lastly, two further points are important when applying these criteria to impacts:

Specialists need to assess the impact, **not** the source or origin of the impact (i.e. the activity that causes the impact). For instance, although the activity that causes a specific impact may take place over a long period of time, this does not necessarily imply that the impact itself will persist for the same length of time. The assessment must focus on the impact (the change in the environment) rather than on the activity that causes an impact.

Consider the direct impact of the **proposed project design**. If the design of a project avoids an area where a highly sensitive or irreplaceable resource occurs, it would be a mistake to assume that this resource would experience an impact simply because the resource occurs within the boundaries of the study area. For example, if a wetland or archaeological site occurs on portion A, but the project is located on portion B, the wetland or archaeological site may not be directly affected.

E.2 Significance Rating: Project Phases

Based on the information reviewed for this investigation and the results of the associated dispersion modelling impact assessment conducted for the different scenarios, the following impact risk ratings apply as findings from this study, specific to the scope of the study. The following impact risk rating tables each apply to all three of the Proposed Development Areas (Study Areas 1, 2 and 3).

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E.2.1 Significance Impact Rating: Pre-Construction Phase

Table E.2.1: Significance Impact Rating: Pre-Construction Phase

Activity / Potential Impact	Significance PRE-mitigation								Summary of Mitigation Measure/s	Significance POST-mitigation								Monitoring Method/s
	Intensity	Duration	Extent	Probability	Total (Consequence)	Status (+ / -)	Significance			Intensity	Duration	Extent	Probability	Total (Consequence)	Status (+ / -)	Significance		
Pre-Construction Phase																		
Technical surveys: Increased movement	-1	2	2	7	-5	-	-35	**Negligible - negative**	*- Manage site access and control movement on site;* *- Practice dust suppression techniques;*	-1	2	1	7	-4	-	-28	**Negligible - negative**	*DFO monitoring - current and additional locations to be established for proposed development area to serve as additional baseline information*
Engineering and Environmental studies	0	2	2	7	4	+	28	**Negligible - positive**	*None required*	0	2	2	7	4	+	28	**Negligible - positive**	*None required*

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E.2.2 Significance Impact Rating: Construction Phase

Table E.2.2: Significance Impact Rating: Construction Phase

Activity / Potential Impact	Significance PRE-mitigation								Summary of Mitigation Measure/s	Significance POST-mitigation								Monitoring Method/s
	Intensity	Duration	Extent	Probability	Total (Consequence)	Status (+ / -)	Significance			Intensity	Duration	Extent	Probability	Total (Consequence)	Status (+ / -)	Significance		
Construction Phase																		
Fugitive dust: Increased LCV	-2	2	2	7	-6	-	-42	**Minor - negative**	*- Manage site access and control movement on site;* *- Practice dust suppression techniques;*	-1	2	2	7	-5	-	-35	**Negligible - negative**	*- DFO monitoring;* *- PM_{10}/ $PM_{2.5}$ monitoring;*
Fugitive dust: Excavation work	-2	2	2	7	-6	-	-42	**Minor - negative**	*Practice dust suppression techniques;*	-1	2	2	7	-5	-	-35	**Negligible - negative**	*- DFO monitoring;* *- PM_{10}/ $PM_{2.5}$ monitoring;*
Fugitive dust: Movement of material	-2	2	2	7	-6	-	-42	**Minor - negative**	*Practice dust suppression techniques;*	-1	2	2	7	-5	-	-35	**Negligible - negative**	*- DFO monitoring;* *- PM_{10}/ $PM_{2.5}$ monitoring;*
Additional noxious vehicle exhaust fumes	-2	2	2	7	-6	-	-42	**Minor - negative**	*- Manage vehicle fleet and movement of vehicles on sites;* *- Given NOx concentrations which could potentially impact on neighbouring sensitive receptors it is recommended to consider alternative options to limit NOx emissions from vehicles utilised;* *- Limit the use of vehicles in poorly ventilated areas;* *- Where possible/practical, plan layout of sites not to affect air quality to the extent whereby exceedances of standards could occur;*	-1	2	2	7	-5	-	-35	**Negligible - negative**	*Noxious fume monitoring, recommended for:* *1) the N, E, S and W boundaries of each development area;* *2) sensitive receptor(s) located near the development areas, such as Denge, Mngcweni, Inchanga Park and Othweba(N) and assess against relevant National Ambient Air Quality Standards;* *3) On-site (development areas) to assess compliance to Occupational Exposure;*

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E.2.3 Significance Impact Rating: Operational Phase

Table E.2.3: Significance Impact Rating: Operational Phase

Activity / Potential Impact	Significance PRE-mitigation								Summary of Mitigation Measure/s	Significance POST-mitigation								Monitoring Method/s
	Intensity	Duration	Extent	Probability	Total (Consequence)	Status (+ / -)	Significance			Intensity	Duration	Extent	Probability	Total (Consequence)	Status (+ / -)	Significance		
Operational Phase																		
Fine Fugitive dust: Stockpiles (if applicable- since mainly storage sites foreseen)	-2	2	2	5	-6	-	-30	**Negligible - negative**	*- Practice dust suppression techniques;*	-1	2	2	5	-5	-	-25	**Negligible - negative**	*- DFO monitoring;* *- PM_{10}/ $PM_{2.5}$ monitoring;*
Fugitive dust: Movement of material (if applicable- since mainly storage sites foreseen)	-2	2	2	5	-6	-	-30	**Negligible - negative**	*- Practice dust suppression techniques;*	-1	2	2	5	-5	-	-25	**Negligible - negative**	*- DFO monitoring;* *- PM_{10}/ $PM_{2.5}$ monitoring;*
Fugitive dust: Vehicle movement on gravel roads	-2	2	2	7	-6	-	-42	**Minor - negative**	*- Practice dust suppression techniques;* *- Consider alternative techniques to reduce the extent by which vehicles are used to move material;*	-1	2	2	7	-5	-	-35	**Negligible - negative**	*- DFO monitoring;* *- PM_{10}/ $PM_{2.5}$ monitoring;*
Additional quantity of noxious vehicle exhaust fumes	-2	2	2	7	-6	-	-42	**Minor - negative**	*- Manage vehicle fleet and movement of vehicles on sites;* *- Given NOx concentrations which could potentially impact on neighbouring sensitive receptors it is recommended to consider alternative options to limit NOx emissions from vehicles utilised;* *- Limit the use of vehicles in poorly ventilated areas;* *- Where possible/practical, plan layout of sites not to affect air quality to the extent whereby exceedances of standards could occur;*	-1	2	2	7	-5	-	-35	**Negligible - negative**	*Noxious fume monitoring, recommended for:* *1) the N, E, S and W boundaries of each development area;* *2) sensitive receptor(s) located near the development areas, such as Denge, Mngcweni, Inchanga Park and Othweba(N) and assess against relevant National Ambient Air Quality Standards;* *3) On-site (development areas) to assess compliance to Occupational Exposure;*

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Activity / Potential Impact	Significance PRE-mitigation								Summary of Mitigation Measure/s	Significance POST-mitigation								Monitoring Method/s
	Intensity	Duration	Extent	Probability	Total (Consequence)	Status (+ / -)	Significance			Intensity	Duration	Extent	Probability	Total (Consequence)	Status (+ / -)	Significance		
Emission of primary pollutants: PM, PM_{10}, $PM_{2.5}$ and metals such as Mn (if applicable- since mainly storage sites foreseen)	-5	5	5	7	-15	-	-105	**Moderate - negative**	*- Implementation of adequate/very efficient abatement and mitigation technology to improve the control efficiency of Air Pollution Control Equipment (APCE) and reduce the pollutants of concern. The estimated required abatement efficiencies need to meet with relevant regulations and by-laws;* *- Without the implementation of control measures to prevent/limit the probability, duration, extent and magnitude of uncontrolled emissions from point sources, the resulting significance could be high;* *- Required to minimise the release of uncontrolled emissions to an absolute minimum since the impact thereof is significant;* *- Uncontrolled releases need to be limited with an availability/utilisation of at least 99.5%, ideally 99.8% (in terms of production time) for the abatement at design/required efficiencies or better;* *- Recommended that activities which could potentially be considered in any of the study areas should preferably not contribute further to levels of Mn in the airshed;*	-1	5	3	7	-9	-	-63	**Minor - negative**	*- With the implementation of adequate control measures to prevent/limit the probability, duration, extent and magnitude of controlled emissions from point sources, the resulting significance could be low as indicated;* *- Monitoring of records of uncontrolled emissions which should include date, time, duration and production capacity at time;*

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Activity / Potential Impact	Significance PRE-mitigation								Summary of Mitigation Measure/s	Significance POST-mitigation								Monitoring Method/s
	Intensity	Duration	Extent	Probability	Total (Consequence)	Status (+ / -)	Significance			Intensity	Duration	Extent	Probability	Total (Consequence)	Status (+ / -)	Significance		
Emission of gaseous pollutants: such as NOx (if applicable- since mainly storage sites foreseen)	-5	5	4	7	-14	-	-98	**Moderate - negative**	*- Implementation of adequate/very efficient abatement and mitigation technology to improve the control efficiency of the current APCE to reduce the pollutants of concern. The estimated required abatement efficiencies need to meet with relevant regulations and by-laws;* *- Without the implementation of control measures to prevent / limit the probability, duration, extent and magnitude of uncontrolled emissions from point sources, the resulting significance could be high;* *- Required to minimise the release of uncontrolled emissions to an absolute minimum since the impact thereof is significant;* *- Uncontrolled releases need to be limited since it could lead/contribute to exceedances of the National Ambient Air Quality Standard/s;*	-1	5	3	7	-9	-	-63	**Minor - negative**	*- With the implementation of control measures to prevent / limit the probability, duration, extent and magnitude of uncontrolled emissions from point sources, the resulting significance will be extremely low as indicated;* *- Monitoring of records of uncontrolled emissions which should include date, time, duration and production capacity at time;*

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E.2.4 Significance Impact Rating: Decommissioning Phase

Table E.2.4: Significance Impact Rating: Decommissioning Phase

Activity / Potential Impact	Significance PRE-mitigation								Summary of Mitigation Measure/s	Significance POST-mitigation								Monitoring Method/s
	Intensity	Duration	Extent	Probability	Total (Consequence)	Status (+ / -)	Significance			Intensity	Duration	Extent	Probability	Total (Consequence)	Status (+ / -)	Significance		
Decommissioning Phase																		
Fugitive dust: Increased LCV	-2	2	2	7	-6	-	-42	**Minor - negative**	*- Manage site access and control movement on site;* *- Practice dust suppression techniques;*	-1	2	2	7	-5	-	-35	**Negligible - negative**	*- DFO monitoring;* *- PM_{10}/ $PM_{2.5}$ monitoring;*
Fugitive dust: Movement of material	-2	2	2	7	-6	-	-42	**Minor - negative**	*Practice dust suppression techniques;*	-1	2	2	7	-5	-	-35	**Negligible - negative**	*- DFO monitoring;* *- PM_{10}/ $PM_{2.5}$ monitoring;*
Fine Fugitive dust: Stockpiles (if applicable- since mainly storage sites foreseen)	-2	2	2	5	-6	-	-30	**Negligible - negative**	*Practice dust suppression techniques;*	-1	2	2	5	-5	-	-25	**Negligible - negative**	*- DFO monitoring;* *- PM_{10}/ $PM_{2.5}$ monitoring;*
Additional quantity of noxious vehicle exhaust fumes	-2	2	2	7	-6	-	-42	**Minor - negative**	*- Manage vehicle fleet and movement of vehicles on sites;* *- Given NOx concentrations which could potentially impact on neighbouring sensitive receptors it is recommended to consider alternative options to limit NOx emissions from vehicles utilised;* *- Limit the use of vehicles in poorly ventilated areas;* *- Where possible/practical, plan layout of sites not to affect air quality to the extent whereby exceedances of standards could occur;*	-1	2	2	7	-5	-	-35	**Negligible - negative**	*Noxious fume monitoring, recommended for:* *1) the N, E, S and W boundaries of each development area;* *2) sensitive receptor(s) located near the development areas, such as Denge, Mngcweni, Inchanga Park and Othweba(N) and assess against relevant National Ambient Air Quality Standards;* *3) On-site (development areas) to assess compliance to Occupational Exposure;*

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E.2.5 Significance Impact Rating: Post-Construction/Closure/Rehabilitation Phases

Table E.2.5: Significance Impact Rating: Post-Construction/Closure/Rehabilitation Phase

Activity / Potential Impact	Significance PRE-mitigation								Summary of Mitigation Measure/s	Significance POST-mitigation								Monitoring Method/s
	Intensity	Duration	Extent	Probability	Total (Consequence)	Status (+ / -)	Significance			Intensity	Duration	Extent	Probability	Total (Consequence)	Status (+ / -)	Significance		
Post-Construction/Closure/Rehabilitation Phases																		
Fugitive dust: Increased LCV	-2	2	2	7	-6	-	-42	**Minor - negative**	*- Manage site access and control movement on site;* *- Practice dust suppression techniques;*	-1	2	2	7	-5	-	-35	**Negligible - negative**	*- DFO monitoring;* *- PM_{10}/ $PM_{2.5}$ monitoring;*
Fugitive dust: Excavation work	-2	2	2	7	-6	-	-42	**Minor - negative**	*Practice dust suppression techniques;*	-1	2	2	7	-5	-	-35	**Negligible - negative**	*- DFO monitoring;* *- PM_{10}/ $PM_{2.5}$ monitoring;*
Fugitive dust: Movement of material	-2	2	2	7	-6	-	-42	**Minor - negative**	*Practice dust suppression techniques;*	-1	2	2	7	-5	-	-35	**Negligible - negative**	*- DFO monitoring;* *- PM_{10}/ $PM_{2.5}$ monitoring;*
Fine Fugitive dust: Stockpiles (if applicable- since mainly storage sites foreseen)	-2	2	2	5	-6	-	-30	**Negligible - negative**	*Practice dust suppression techniques;*	-1	2	2	5	-5	-	-25	**Negligible - negative**	*- DFO monitoring;* *- PM_{10}/ $PM_{2.5}$ monitoring;*
Additional quantity of noxious vehicle exhaust fumes	-2	2	2	7	-6	-	-42	**Minor - negative**	*- Manage vehicle fleet and movement of vehicles on sites;* *- Given NOx concentrations which could potentially impact on neighbouring sensitive receptors it is recommended to consider alternative options to limit NOx emissions from vehicles utilised;* *- Limit the use of vehicles in poorly ventilated areas;* *- Where possible/practical, plan layout of sites not to affect air quality to the extent whereby exceedances of standards could occur;*	-1	2	2	7	-5	-	-35	**Negligible - negative**	*Noxious fume monitoring, recommended for:* *1) the N, E, S and W boundaries of each development area;* *2) sensitive receptor(s) located near the development areas, such as Denge, Mngcweni, Inchanga Park and Othweba(N) and assess against relevant National Ambient Air Quality Standards;* *3) On-site (development areas) to assess compliance to Occupational Exposure;*

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E.2.6 Significance Impact Rating: Post-Closure Phase

Table E.2.6: Significance Impact Rating: Post-Closure Phase

Activity / Potential Impact	Significance PRE-mitigation								Summary of Mitigation Measure/s	Significance POST-mitigation								Monitoring Method/s
	Intensity	Duration	Extent	Probability	Total (Consequence)	Status (+ / -)	Significance			Intensity	Duration	Extent	Probability	Total (Consequence)	Status (+ / -)	Significance		
Post-Closure Phase																		
Fine Fugitive dust: Stockpiles (if applicable- since mainly storage sites foreseen) and roads	-2	2	2	5	-6	-	-30	**Negligible - negative**	*Practice dust suppression techniques;*	-1	2	2	5	-5	-	-25	**Negligible - negative**	*DFO monitoring;*

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Appendix F: Enterprise Air Quality Management – Key Actions / Plans

F.1 Air Quality Management – Current Key Actions/Plans

1) In accordance with the risk assessment conducted and in conjunction with the findings of Section 5.1, it is foreseen that the following tabled points will assist to improve the ambient air quality and reduce the expected impact to the ambient air quality of the surrounding communities;

2) The following tabled actions are therefore recommended as possible planned / future actions for the air quality management plan. The table provides a summary of the key aspects/impacts, possible mitigation measures and associated possible monitoring methods:

Table F.1: Summary of Activity, Mitigation Measure and Monitoring Actions

Activity / Potential Impact	Summary of Mitigation Measure/s	Monitoring Method/s
Pre-Construction Phase		
Technical surveys: Increased movement	*- Manage site access and control movement on site;* *- Practice dust suppression techniques;*	*DFO monitoring - current and additional locations to be established for proposed development area to serve as additional baseline information*
Engineering and Environmental studies	*None required*	*None required*
Construction Phase		
Fugitive dust: Increased LCV	*- Manage site access and control movement on site;* *- Practice dust suppression techniques;*	*- DFO monitoring;* *- PM10 / PM2.5 monitoring;*
Fugitive dust: Excavation work	*Practice dust suppression techniques;*	*- DFO monitoring;* *- PM10 / PM2.5 monitoring;*
Fugitive dust: Movement of material	*Practice dust suppression techniques;*	*- DFO monitoring;* *- PM10 / PM2.5 monitoring;*
Additional noxious vehicle exhaust fumes	*- Manage vehicle fleet and movement of vehicles on sites;* *- Given NOx concentrations which could potentially impact on neighbouring sensitive receptors it is recommended to consider alternative options to limit NOx emissions from vehicles utilised;* *- Limit the use of vehicles in poorly ventilated areas;* *- Where possible/practical, plan layout of sites not to affect air quality to the extent whereby exceedances of standards could occur;*	*Noxious fume monitoring, recommended for:* *1) the N, E, S and W boundaries of each development area;* *2) sensitive receptor(s) located near the development areas, such as Denge, Mngcweni, Inchanga Park and Othweba(N) and assess against relevant National Ambient Air Quality Standards;* *3) On-site (development areas) to assess compliance to Occupational Exposure;*
Operational Phase		
Fine Fugitive dust: Stockpiles (if applicable-since mainly storage sites foreseen)	*- Practice dust suppression techniques;*	*- DFO monitoring;* *- PM10 / PM2.5 monitoring;*
Fugitive dust: Movement of material (if applicable-since mainly storage sites foreseen)	*- Practice dust suppression techniques;*	*- DFO monitoring;* *- PM10 / PM2.5 monitoring;*
Fugitive dust: Vehicle movement on gravel roads	*- Practice dust suppression techniques;* *- Consider alternative techniques to reduce the extent by which vehicles are used to move material;*	*- DFO monitoring;* *- PM10 / PM2.5 monitoring;*

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Activity / Potential Impact	Summary of Mitigation Measure/s	Monitoring Method/s
Additional quantity of noxious vehicle exhaust fumes	*- Manage vehicle fleet and movement of vehicles on sites;* *- Given NOx concentrations which could potentially impact on neighbouring sensitive receptors it is recommended to consider alternative options to limit NOx emissions from vehicles utilised;* *- Limit the use of vehicles in poorly ventilated areas;* *- Where possible/practical, plan layout of sites not to affect air quality to the extent whereby exceedances of standards could occur;*	*Noxious fume monitoring, recommended for:* *1) the N, E, S and W boundaries of each development area;* *2) sensitive receptor(s) located near the development areas, such as Denge, Mngcweni, Inchanga Park and Othweba(N) and assess against relevant National Ambient Air Quality Standards;* *3) On-site (development areas) to assess compliance to Occupational Exposure;*
Emission of primary pollutants: PM, PM10, PM2.5 and metals such as Mn (if applicable- since mainly storage sites foreseen)	*- Implementation of adequate/very efficient abatement and mitigation technology to improve the control efficiency of Air Pollution Control Equipment (APCE) and reduce the pollutants of concern. The estimated required abatement efficiencies need to meet with relevant regulations and by-laws;* *- Without the implementation of control measures to prevent/limit the probability, duration, extent and magnitude of uncontrolled emissions from point sources, the resulting significance could be high;* *- Required to minimise the release of uncontrolled emissions to an absolute minimum since the impact thereof is significant;* *- Uncontrolled releases need to be limited with an availability/utilisation of at least 99.5%, ideally 99.8% (in terms of production time) for the abatement at design/required efficiencies or better;* *- Recommended that activities which could potentially be considered in any of the study areas should preferably not contribute further to levels of Mn in the airshed;*	*- With the implementation of adequate control measures to prevent/limit the probability, duration, extent and magnitude of controlled emissions from point sources, the resulting significance could be low as indicated;* *- Monitoring of records of uncontrolled emissions which should include date, time, duration and production capacity at time;*
Emission of gaseous pollutants: such as NOx (if applicable- since mainly storage sites foreseen)	*- Implementation of adequate/very efficient abatement and mitigation technology to improve the control efficiency of the current APCE to reduce the pollutants of concern. The estimated required abatement efficiencies need to meet with relevant regulations and by-laws;* *- Without the implementation of control measures to prevent / limit the probability, duration, extent and magnitude of uncontrolled emissions from point sources, the resulting significance could be high;* *- Required to minimise the release of uncontrolled emissions to an absolute minimum since the impact thereof is significant;* *- Uncontrolled releases need to be limited since it could lead/contribute to exceedances of the National Ambient Air Quality Standard/s;*	*- With the implementation of control measures to prevent / limit the probability, duration, extent and magnitude of uncontrolled emissions from point sources, the resulting significance will be extremely low as indicated;* *- Monitoring of records of uncontrolled emissions which should include date, time, duration and production capacity at time;*
Decommissioning Phase		
Fugitive dust: Increased LCV	*- Manage site access and control movement on site;* *- Practice dust suppression techniques;*	*- DFO monitoring;* *- PM10 / PM2.5 monitoring;*
Fugitive dust: Movement of material	*Practice dust suppression techniques;*	*- DFO monitoring;* *- PM10 / PM2.5 monitoring;*
Fine Fugitive dust: Stockpiles (if applicable- since mainly storage sites foreseen)	*Practice dust suppression techniques;*	*- DFO monitoring;* *- PM10 / PM2.5 monitoring;*

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Activity / Potential Impact	Summary of Mitigation Measure/s	Monitoring Method/s
Additional quantity of noxious vehicle exhaust fumes	*- Manage vehicle fleet and movement of vehicles on sites;* *- Given NOx concentrations which could potentially impact on neighbouring sensitive receptors it is recommended to consider alternative options to limit NOx emissions from vehicles utilised;* *- Limit the use of vehicles in poorly ventilated areas;* *- Where possible/practical, plan layout of sites not to affect air quality to the extent whereby exceedances of standards could occur;*	*Noxious fume monitoring, recommended for:* *1) the N, E, S and W boundaries of each development area;* *2) sensitive receptor(s) located near the development areas, such as Denge, Mngcweni, Inchanga Park and Othweba(N) and assess against relevant National Ambient Air Quality Standards;* *3) On-site (development areas) to assess compliance to Occupational Exposure;*
Post-Construction/Closure/Rehabilitation Phases		
Fugitive dust: Increased LCV	*- Manage site access and control movement on site;* *- Practice dust suppression techniques;*	*- DFO monitoring;* *- PM10 / PM2.5 monitoring;*
Fugitive dust: Excavation work	*Practice dust suppression techniques;*	*- DFO monitoring;* *- PM10 / PM2.5 monitoring;*
Fugitive dust: Movement of material	*Practice dust suppression techniques;*	*- DFO monitoring;* *- PM10 / PM2.5 monitoring;*
Fine Fugitive dust: Stockpiles (if applicable- since mainly storage sites foreseen)	*Practice dust suppression techniques;*	*- DFO monitoring;* *- PM10 / PM2.5 monitoring;*
Additional quantity of noxious vehicle exhaust fumes	*- Manage vehicle fleet and movement of vehicles on sites;* *- Given NOx concentrations which could potentially impact on neighbouring sensitive receptors it is recommended to consider alternative options to limit NOx emissions from vehicles utilised;* *- Limit the use of vehicles in poorly ventilated areas;* *- Where possible/practical, plan layout of sites not to affect air quality to the extent whereby exceedances of standards could occur;*	*Noxious fume monitoring, recommended for:* *1) the N, E, S and W boundaries of each development area;* *2) sensitive receptor(s) located near the development areas, such as Denge, Mngcweni, Inchanga Park and Othweba(N) and assess against relevant National Ambient Air Quality Standards;* *3) On-site (development areas) to assess compliance to Occupational Exposure;*
Post-Closure Phase		
Fine Fugitive dust: Stockpiles (if applicable- since mainly storage sites foreseen) and roads	*Practice dust suppression techniques;*	*DFO monitoring;*

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F.2 Air Quality Management – Planned Key Actions/Plans

Whilst ensuring that legal requirements are met, it is recommended to focus attention on:

1) Maintaining measures to minimise the release of abnormal emissions (raw gas and tapping/casting fugitives) to an absolute minimum since the impact thereof is potentially significant;
2) Maintaining the application of efficient dust abatement and suppression techniques in order to minimise overall particulate emissions;
3) Limiting vehicle movement and associated diesel consumption as far as possible;
4) Limiting fugitive emissions;
5) Aforementioned points will individually and collectively minimise emissions and impact of manganese;
6) It is recommended that additional monitoring of DFO and noxious fumes be conducted to establish additional baseline ambient monitoring data prior to the commencement of construction of the proposed development and continue thereafter. In addition to current monitoring actions, Figure F.1 read with Table F.2 provides an indication of proposed additional ambient monitoring and locations.

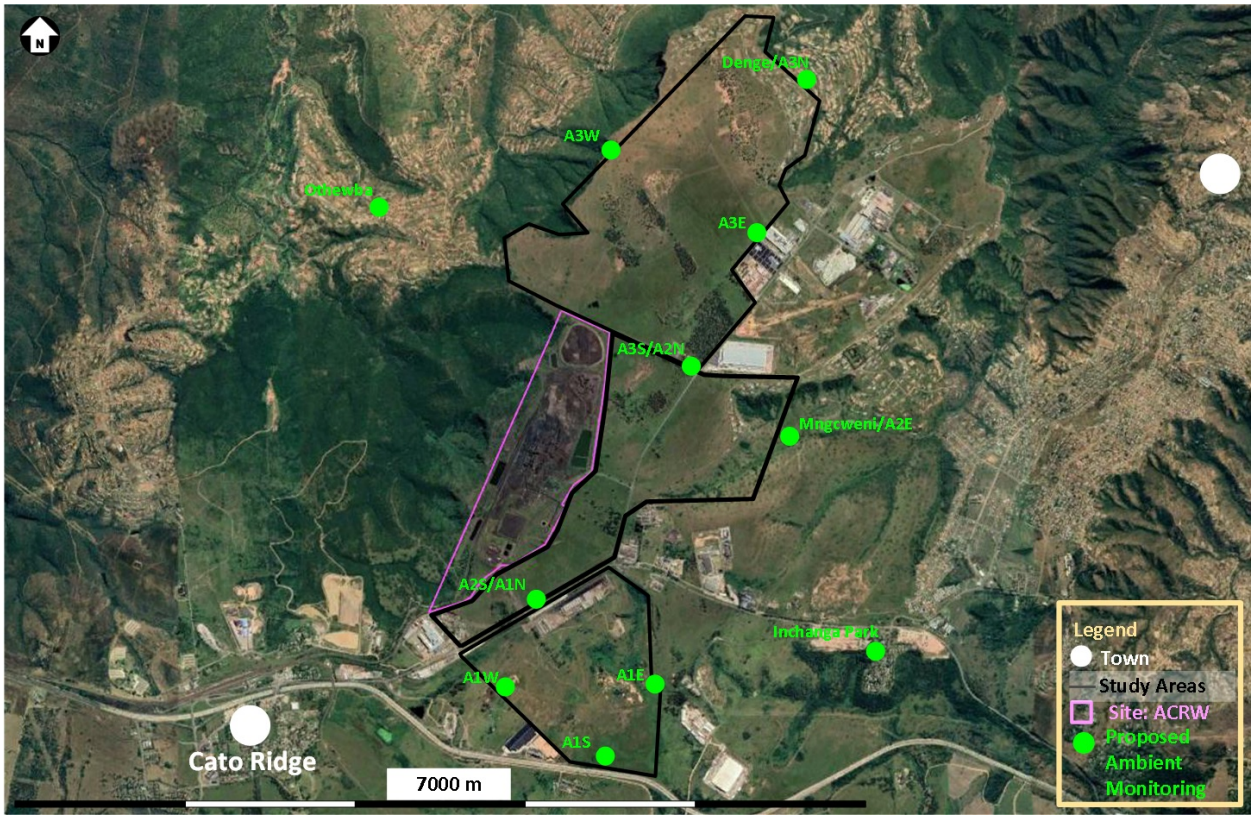


Figure F.1: Proposed Additional Ambient Monitoring

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Table F.2: Proposed Additional Ambient Monitoring

Location Description/Reference	Proposed ambient monitoring
Othweba	DFO (SANS1137) - already included under ACRW monitoring PM10, PM2.5 (Alternative methods / Indicative low-cost sensor technology) NO2 (Alternative methods / Indicative low-cost sensor technology)
A3W (West of PDA3)	DFO (SANS1137) PM10, PM2.5 (Alternative methods / Indicative low-cost sensor technology) NO2 (Alternative methods / Indicative low-cost sensor technology)
Denge / A3N (North of PDA3)	DFO (SANS1137) PM10, PM2.5 (Alternative methods / Indicative low-cost sensor technology) NO2 (Alternative methods / Indicative low-cost sensor technology)
A3E (East of PDA3)	DFO (SANS1137) PM10, PM2.5 (Alternative methods / Indicative low-cost sensor technology) NO2 (Alternative methods / Indicative low-cost sensor technology)
A3S / A2N (South of PDA3 and North of PDA2)	DFO (SANS1137) PM10, PM2.5 (Alternative methods / Indicative low-cost sensor technology) NO2 (Alternative methods / Indicative low-cost sensor technology)
MngcwenI / A2E (East of PDA2)	DFO (SANS1137) PM10, PM2.5 (Alternative methods / Indicative low-cost sensor technology) NO2 (Alternative methods / Indicative low-cost sensor technology)
A2S / A1N (South of PDA2 and North of PDA1)	DFO (SANS1137) PM10, PM2.5 (Alternative methods / Indicative low-cost sensor technology) NO2 (Alternative methods / Indicative low-cost sensor technology)
A1E (East of PDA1)	DFO (SANS1137) PM10, PM2.5 (Alternative methods / Indicative low-cost sensor technology) NO2 (Alternative methods / Indicative low-cost sensor technology)
Inchanga Park	DFO (SANS1137) - already included under ACRW monitoring PM10, PM2.5 (Alternative methods / Indicative low-cost sensor technology) NO2 (Alternative methods / Indicative low-cost sensor technology)
A1S (South of PDA1)	DFO (SANS1137) PM10, PM2.5 (Alternative methods / Indicative low-cost sensor technology) NO2 (Alternative methods / Indicative low-cost sensor technology)
A1W (West of PDA1)	DFO (SANS1137) PM10, PM2.5 (Alternative methods / Indicative low-cost sensor technology) NO2 (Alternative methods / Indicative low-cost sensor technology)

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Appendix RADM: Regulations Regarding Air Dispersion Modelling

In terms of Section 53(f) of the National Environmental Management: Air Quality Act (NEM:AQA), 2004 (Act No. 39 of 2004), the Department of Environmental Affairs (DEA) has developed and published a CODE OF PRACTICE FOR AIR DISPERSION MODELLING IN AIR QUALITY MANAGEMENT IN SOUTH AFRICA under GN533, "REGULATIONS REGARDING AIR DISPERSION MODELLING, 2014" in Government Gazette No. 37804 on 11 July 2014.

The Code of Practice is prescribed as the technical Code of Practice for air dispersion modelling which provides technical standards on the application of air dispersion models as contained in Appendix A of the aforementioned regulation. The Code of Practice for air dispersion modelling is applicable:

a. in the development of an air quality management plan, as contemplated in Chapter 3 of the Act;
b. in the development of a priority area air quality management plan, as contemplated in Section 19 of the Act;
c. in the development of an atmospheric impact report, as contemplated in Section 30 of the Act; and
d. in the development of a specialist air quality impact assessment study, as contemplated in Section 37(2)(b) of the Act;

In accordance with the application of the Code of Practice to an atmospheric impact report or a specialist air quality impact assessment study, this assessment is submitted in accordance with the prescribed format of an atmospheric impact report, as published by DEA on 11 October 2013 in Government Gazette No. 36904 under GN747 as the "REGULATIONS PRESCRIBING THE FORMAT OF THE ATMOSPHERIC IMPACT REPORT" in terms of Section 53(o) read with Section 30 of the Act.

In accordance with Section 7.2 of the Regulations Regarding Air Dispersion Modelling, 2014, the information required for the study and the report are provided as follows hereafter:

a. Table RADM.10: Information required in the Plan of Study Report; and
b. Table RADM.11: Information required in the Air Dispersion Modelling Study Report;

It provides an overview of important information included as minimum requirement in the final report to enable sufficient review and decision making by the authority. Additional relevant information provided is specified as such if applicable

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Table RADM.10: Information required in the Plan of Study

Chapter 1: Facility and modellers' information			**Submitted**	**Reference to Sections** where the information will be covered in the final Report or Specific References for the Study
			Yes/No	
1.1	**Project identification information**			
	●	Applicant details	Yes	Section 1.1: Enterprise details
	●	Facility identification	Yes	Section 1.1: Enterprise details
	●	Physical address of facility	Yes	Section 1.2: Enterprise location
	●	Air Emissions License reference number (if applicable)	Yes	Section 1.3: Authorisations: Atmospheric Emission Licence and Other
	●	Environmental authorization reference number (if applicable)	No	
	●	Modelling contractor(s), when applicable	Yes	EnviroNgaka (Pty) Ltd.
				Tel: +27 (0)12 250 3455
				Fax: +27 (0)11 252 7418
				E-Mail: info@environgaka.co.za
				URL: www.environgaka.co.za
1.2	**Project background**			
	●	Purpose(s) and objectives of the air dispersion modelling under consideration	Yes	Air Quality Impact Assessment as specialist study to assess the potential impact of emissions from sources located within a defined domain on the ambient air quality over a study area(s). Three specific study areas were defined for this investigation within the domain
	●	General descriptive narrative of the plant processes and proposed new source or modification	Yes	Section 2: Nature of Process
1.3	**Project location**			
1.3.1	**Detailed scaled layout plan of proposed project area including the following:**			
	●	UTM coordinates on horizontal and vertical axis	Yes	UTM co-ordinate system (WGS84): Grid Zone: 36 J
				Approximate Centre of Operations:
				Northing (North-south): 6710381.4 m S
				Easting (East-west): 269079.4 m E

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	●	Property lines, including fence lines	Yes	Refer Section 1.2
	●	Roads and railroads within the proposed modelling domain	Yes	Refer Section 1.2. Regional roads or railroads pass adjacent to the study areas. A regional roads passes through one of the study areas,
	●	Location and dimensions of buildings and/or structures (on or off property) which could influence dispersion	Yes	Refer Appendix C: Modelling Procedure and Settings
1.3.2	**Area map(s)**			
	●	Map of adjacent area (10km radius from proposed source) indicating the following	Yes	Refer Section 1.2
		o UTM coordinates on horizontal and vertical axis		
		o Nearby known pollution sources		
		o Schools, hospitals and old age homes within 10km of facility boundary		
		o Topographic features		
		o Any proposed or existing off-site or on-site meteorological monitoring stations		
		o Roads and railroads		
	●	Regional map that includes the following	Yes	Refer Section 1.2
		o Latitude/Longitude on horizontal and vertical axis		
		o Modelled Facility		
		o Topography features within 50km		
		o Known pollution sources within 50km		
		o Any proposed off-site meteorological monitoring stations		
1.4	**Land use determination in modelling domain**			
	●	Urban	Yes	In accordance with the Auer method specified per the US EPA, land use classified as rural (<50% urban within 3km)
	●	Rural / Agricultural		
1.5	**Elevation data (DEM) and resolution**		Yes	US Geological Survey (Earth Explorer / Data), SRTM at 30m resolution elevation data
			Yes	The investigation is over a modelling domain of 10km x 10km. DEM data used was 50km x 50km at a resolution of 50m
Chapter 2: Emissions Characteristics			**Submitted**	**Reference to Sections** where the information will be covered in the final Report or Specific References for the Study
			Yes/No	

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2.1	**Emission characteristics**		
	● Include fugitive & secondary emissions when applicable	Yes	Refer Section 4.4
	● Emission unit descriptions and capacities (including proposed emission controls)	Yes	Refer Sections 2 , 4; and Section 3.2
	● New structures or modifications to existing structures	Yes	Refer Sections 2, 3 and 4
2.2	**Operating scenarios for emission units**		
	● Operating condition to the study		
	o Normal	Yes	Refer Section 4.2
	o Upset conditions	Yes	Refer Section 4.3
	o Start-up	Yes	Refer Section 4.3
	o Standby	Yes	Refer Section 4.3
	o Shutdown	Yes	Refer Section 4.3
2.3	**Proposed emissions and source parameter table(s)**		
	● List all identifiable emissions	Yes	Refer Section 4
	● Include parameter table(s) for each operating scenario of each emission unit, which may include, but not be limited to the following:		
	o Operating scenario(s)		
	o Source location (UTM Coordinates)		
	o Point source parameters		
	o Area source parameters		
	o Volume source parameters		
	Include proposed emissions (and supporting calculations) for all identifiable emissions		
Chapter 3: Meteorological data		**Submitted Yes/No**	**Reference to Sections** where the information will be covered in the final Report or Specific References for the Study
3.1	**Surface data discussions must include:**		
	● Off-site		
	o Source of data	Yes	Meteorological data with a mesoscale model for the domain at a location approximately 399m southeast of the centre of ACRW site, informed by

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					observed/monitored data from a meteorological station located approximately 323m southeast of the centre of ACRW site.
		o	Description of station (location, tower height, etc.)	Yes	Refer Appendix A
		o	Period of record	Yes	Meteorological data for the period 2017 to 2019
		o	Demonstrate temporal and spatial representativeness	Yes	Refer Appendix A
		o	Seasonal wind-rose(s)	Yes	Refer Appendix A
		o	3-year of representative off-site data	Yes	Refer Appendix A
		o	Evaluate if off-site data complies with regulatory Code of Practice	Yes	Data complies with Code of Practice - refer Appendix A
		o	Program and version used to process data	Yes	BREEZE AERMET v9.0.0.4, executable US EPA 21112
		o	Method used to replace missing hours	Yes	
					(1) Missing data at the very beginning and at the very end of the data set should be left as "missing", with no extrapolation applied;
					(2) For only 1 or 2 hours of missing data:
					a. Linear interpolation of the data is acceptable;
					b. Caution is needed for transition periods – sunrise and sunset;
					(3) For missing data from 3 hours to 168 hours (7 days):
					a. Substitute synthesized averages from a longer-term record of data from the station;
					b. Data from a nearby representative site can be used;
					c. Alternatively, missing data indicators can be applied to flag the missing data;
					(4) For continuous periods of longer than 7 days:
					a. Synthesized data should not be used;
					b. The length of the data set should be reduced by the length of the missing data; c. To ensure adequate coverage of seasons is obtained within the data;

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		○	Method used to handle calm periods	Yes	In accordance with US EPA / EPA Victoria guidelines and requirements (refer Appendix A)
	●	On-site			
		○	Description of station (location, tower height, etc.)	Yes	Refer Appendix A
		○	Period of record	Yes	Meteorological data for the period 2017 to 2019
		○	Demonstrate spatial representativeness	Yes	Refer Appendix A
		○	Minimum 1-year of representative on-site data	Yes	Refer Appendix A
		○	Evaluate if on-site data complies with regulatory Code of Practice	Yes	Data complies with Code of Practice - refer Appendix A
		○	Program and version used to process data	Yes	BREEZE AERMET v9.0.0.4, executable US EPA 21112
		○	Method used to replace missing hours	Yes	
					(1) Missing data at the very beginning and at the very end of the data set should be left as "missing", with no extrapolation applied;
					(2) For only 1 or 2 hours of missing data:
					a. Linear interpolation of the data is acceptable;
					b. Caution is needed for transition periods – sunrise and sunset;
					(3) For missing data from 3 hours to 168 hours (7 days):
					a. Substitute synthesized averages from a longer-term record of data from the station;
					b. Data from a nearby representative site can be used;
					c. Alternatively, missing data indicators can be applied to flag the missing data;
					(4) For continuous periods of longer than 7 days:
					a. Synthesized data should not be used;
					b. The length of the data set should be reduced by the length of the missing data; c. To ensure adequate coverage of seasons is obtained within the data;
		○	Method used to handle calm periods	Yes	In accordance with US EPA / EPA Victoria guidelines and requirements (refer Appendix A)
3.2	**Discuss proposed upper air data**				

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	●	Discuss proposed upper air data from the most representative station	Yes	Mesoscale model to process upper air data (nearest SAWS upper air station is at King Shaka Int Airport.
	●	Explain why it is "most representative"	Yes	Integrated 3-D mesoscale prognostic meteorological model, incompressible, optionally non-hydrostatic, which uses a terrain-following vertical coordinate system for 3-D simulations and includes comprehensive parametrisations for cloud/rain micro-physical processes, urban/vegetative canopy and soil, as well as turbulence closure and radiative fluxes. The model also predicts local-scale flows, such as sea breezes and terrain-induced circulations, as well as other meteorological parameters, by utilising meteorological fields obtained from larger-scale synoptic analyses. The mesoscale model (TAPM) simulates upper air data adequately. Irene is the nearest station to the facility measuring upper air data and is expected to be representative of the Highveld climatic zone.
Chapter 4: Ambient impact analysis and ambient levels			**Submitted** **Yes/No**	**Reference to Sections** where the information will be covered in the final Report or Specific References for the Study
4.1	**Standards Levels**			
	●	National Ambient Air Quality Standards	Yes	Refer Section 5.1
4.2	**Background Concentrations**			
	●	Specify background values to be used including supporting documentation	Yes	Refer Appendix B
Chapter 5: Modelling procedures			**Submitted** **Yes/No**	**Reference to Sections** where the information will be covered in the final Report or Specific References for the Study
5.1	**Proposed Model**			
	●	Assessment level proposed and justification	Yes	Level 3 assessment: The investigation is specific to an area / domain of 10km x 10km. The impact from the sources included are less than 50km downwind. Standard Air Quality Impact Assessment to assess potential impact of sources over defined areas within the modelling domain. The limited modelling domain falls well with the capability of AERMOD.
	●	Dispersion model proposed	Yes	BREEZE AERMOD v10.0.0.15, executable US EPA 21112

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	●	Supporting models and input programs	Yes	BREEZE AERMAP v10.0.0.15, executable US EPA 18081 BREEZE AERMET v9.0.0.4, executable US EPA 21112
	●	Version of models and input programs	Yes	Modelling software is continually updated with the latest available updates. Versions and executables used: BREEZE AERMOD v10.0.0.15, executable US EPA 21112 BREEZE AERMAP v10.0.0.15, executable US EPA 18081 BREEZE AERMET v9.0.0.4, executable US EPA 21112
5.2	**Proposed emissions to be modelled**			
	●	Pollutants	Yes	Refer Section 4
	●	Scenarios and emissions from Chapter 3.1 that will be modelled	Yes	Refer Section 4
	●	Conversion factor utilised for converting NOX to NO2 (if applicable)	Yes	Tier 1 applied, expected Nitrous oxide (NOX) emissions modelled as expected NO2 emissions, unless simulated annual average exceeds NAAQS for NO2, then Tier 2 applied; for SO2 in urban areas, half-life of 4hours is applied
5.3	**Proposed Settings**			
	●	Recommended settings to be utilised within model	Yes	US Regulatory settings
	●	Terrain settings (simple flat/ simple elevated/ complex)	Yes	Elevated terrain
	●	Land characteristics (Bowen ratio, surface albedo, surface roughness)	Yes	In accordance with the US EPA's AERMOD Implementation Guide, the surface characteristics are determined against the latest satellite imagery from Google Earth and the Albedo {0.18-1; ave 0.64} and Bowen ratio's {0.49-1.5; ave 1.14} are based on a 5km radius surrounding the location of the meteorological data, with the surface roughness {0.15-1.09; ave 0.59} at a 5km distance around the centre of the dispersion domain.
5.4	**Proposed Grid Receptors**			
	●	Property line resolution	Yes	Refer Appendix C: Modelling Procedure and Settings
	●	Fine grid resolution	Yes	Refer Appendix C: Modelling Procedure and Settings
	●	Medium grid resolution(s)	Yes	Refer Appendix C: Modelling Procedure and Settings
	●	Course grid resolution	Yes	Refer Appendix C: Modelling Procedure and Settings
	●	Hot spot resolutions and size	n/ap	

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Table RADM.11: Information required in the Air Dispersion Modelling Study

Chapter 1: Facility and modellers' information			**Submitted**	**Report Section Reference or Specific References, Comments**
			Yes/No	
1.1	**Project identification information requirements**			
	●	Applicant	Yes	Section 1.1: Enterprise details
	●	Facility identification	Yes	Section 1.1: Enterprise details
	●	Physical address of facility	Yes	Section 1.2: Enterprise location
	●	Air Emissions License reference number (if applicable)	Yes	Section 1.3: Authorisations: Atmospheric Emission Licence and Other
	●	Environmental authorization reference number (if applicable)	No	
	●	Modelling contractor(s), when applicable	Yes	EnviroNgaka (Pty) Ltd.
				Tel: +27 (0)12 250 3455
				Fax: +27 (0)11 252 7418
				E-Mail: info@environgaka.co.za
				URL: www.environgaka.co.za
1.2	**Project background requirements**			
	●	Purpose(s) and objectives of the air dispersion modelling under consideration	Yes	Air Quality Impact Assessment as specialist study to assess the potential impact of emissions from sources located within a defined domain on the ambient air quality over a study area(s). Three specific study areas were defined for this investigation within the domain
	●	General descriptive narrative of the plant processes and proposed new source or modification	Yes	Section 2: Nature of Process
1.3	**Project location requirements**			
1.3.1	**Detailed scaled layout plan of proposed project area including the following:**			
	●	UTM coordinates of facility	Yes	UTM co-ordinate system (WGS84): Grid Zone: 36 J
				Approximate Centre of Operations:
				Northing (North-south): 6710381.4 m S

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					Easting (East-west): 269079.4 m E
	●	Property lines, including fence lines			Refer Section 1.2
	●	Roads and railroads that pass through property line			Refer Section 1.2. Regional roads or railroads pass adjacent to the study areas. A regional roads passes through one of the study areas,
	●	Location and dimensions of buildings and/or structures (on or off property) which could cause downwash			
		o	Location		Refer Appendix C: Modelling Procedure and Settings
		o	Length		Refer Appendix C: Modelling Procedure and Settings
		o	Width		Refer Appendix C: Modelling Procedure and Settings
		o	Height		Refer Appendix C: Modelling Procedure and Settings
	●	Indication of shortest distance to property line from significant sources			Refer Appendix C: Modelling Procedure and Settings
1.3.2	**Area map(s) that include the following:**				
	●	Map of adjacent area (10km radius from proposed source) indicating the following			Refer Section 1.2
		o	Latitude/Longitude on horizontal and vertical axis		
		o	Nearby known pollution sources		
		o	Schools and hospitals within 10km of facility boundary		
		o	Topographic features		
		o	Any proposed off-site or on-site meteorological monitoring stations		
		o	Roads and railroads		
	●	Regional map that includes the following			Refer Section 1.2
		o	UTM coordinates		
		o	Modelled Facility		
		o	Topography features within 50km		
		o	Known pollution sources within 50km		
		o	Any proposed off-site meteorological monitoring stations		
1.4	**Geophysical data**				

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	●	Discuss land use characterization procedures utilized to determine dispersion coefficients (urban or rural)	Yes	In accordance with the Auer method specified per the US EPA, land use classified as rural (<50% urban within 3km)
	●	Discuss the elevation data (DEM) and its resolution	Yes	US Geological Survey (Earth Explorer / Data), SRTM at 30m resolution elevation data
1.5	**Elevation data (DEM) and resolution**			
	●	Discuss DEM data utilized	Yes	The investigation is over a modelling domain of 10km x 10km. DEM data used was 50km x 50km at a resolution of 50m
Chapter 2: Emissions Characteristics			**Submitted** **Yes/No**	**Report Section Reference or Specific References, Comments**
2.1	**Emission characteristics**			
	●	Include fugitive & secondary emissions when applicable	Yes	Refer Section 4.4
	●	Emission unit descriptions and capacities (including proposed emission controls)	Yes	Refer Sections 2 , 4; and Section 3.2
	●	New structures or modifications to existing structures as a result of project	Yes	Refer Sections 2, 3 and 4
2.2	**Operating scenarios for emission units**			
	●	Operating conditions simulated in the modelling study		
		○ Normal	Yes	Refer Section 4.2
		○ Upset conditions	Yes	Refer Section 4.3
		○ Start-up	Yes	Refer Section 4.3
		○ Standby	Yes	Refer Section 4.3
		○ Shutdown	Yes	Refer Section 4.3
2.3	**Proposed emissions and source parameter table(s)**			
	●	List all identifiable emissions	Yes	Refer Section 4
	●	Include parameter table(s) for each operating scenario of each emission unit, which may include, but not be limited to the following:		
		○ Operating scenario(s)		
		○ Source location (UTM Coordinates)		

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		o	Point source parameters		
		o	Area source parameters		
		o	Volume source parameters		
			Include proposed emissions (and supporting calculations) for all identifiable emissions		
Chapter 3: Meteorological data				**Submitted** **Yes/No**	**Report Section Reference or Specific References, Comments**
3.1	**Surface data discussions must include:**				
	●	Off-site			
		o	Source of data	Yes	Meteorological data with a mesoscale model for the domain at a location approximately 399m southeast of the centre of ACRW site, informed by observed/monitored data from a meteorological station located approximately 323m southeast of the centre of ACRW site.
		o	Description of station (location, tower height, etc.)	Yes	Refer Appendix A
		o	Period of record	Yes	Meteorological data for the period 2017 to 2019
		o	Demonstrate temporal and spatial representativeness	Yes	Refer Appendix A
		o	Seasonal wind-rose(s)	Yes	Refer Appendix A
		o	3-year of representative off-site data	Yes	Refer Appendix A
		o	Evaluate if off-site data complies with regulatory Code of Practice	Yes	Data complies with Code of Practice - refer Appendix A
		o	Program and version used to process data	Yes	BREEZE AERMET v9.0.0.4, executable US EPA 21112
		o	Method used to replace missing hours	Yes	(1) Missing data at the very beginning and at the very end of the data set should be left as "missing", with no extrapolation applied;

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					(2) For only 1 or 2 hours of missing data:
					a. Linear interpolation of the data is acceptable;
					b. Caution is needed for transition periods – sunrise and sunset;
					(3) For missing data from 3 hours to 168 hours (7 days):
					a. Substitute synthesized averages from a longer-term record of data from the station;
					b. Data from a nearby representative site can be used;
					c. Alternatively, missing data indicators can be applied to flag the missing data;
					(4) For continuous periods of longer than 7 days:
					a. Synthesized data should not be used;
					b. The length of the data set should be reduced by the length of the missing data;
					c. To ensure adequate coverage of seasons is obtained within the data;
		o	Method used to handle calm periods	Yes	In accordance with US EPA / EPA Victoria guidelines and requirements (refer Appendix A)
3.1	●	On-site			
		o	Description of station (location, tower height, etc.)	Yes	Refer Appendix A
		o	Period of record	Yes	Meteorological data for the period 2017 to 2019
		o	Demonstrate spatial representativeness	Yes	Refer Appendix A
		o	Minimum 1-year of representative on-site data	Yes	Refer Appendix A
		o	Evaluate if on-site data complies with regulatory Code of Practice	Yes	Data complies with Code of Practice - refer Appendix A
		o	Program and version used to process data	Yes	BREEZE AERMET v9.0.0.4, executable US EPA 21112
		o	Method used to replace missing hours	Yes	
					(1) Missing data at the very beginning and at the very end of the data set should be left as "missing", with no extrapolation applied;
					(2) For only 1 or 2 hours of missing data:
					a. Linear interpolation of the data is acceptable;
					b. Caution is needed for transition periods – sunrise and sunset;

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					(3) For missing data from 3 hours to 168 hours (7 days):
					a. Substitute synthesized averages from a longer-term record of data from the station;
					b. Data from a nearby representative site can be used;
					c. Alternatively, missing data indicators can be applied to flag the missing data;
					(4) For continuous periods of longer than 7 days:
					a. Synthesized data should not be used;
					b. The length of the data set should be reduced by the length of the missing data; c. To ensure adequate coverage of seasons is obtained within the data;
		o	Method used to handle calm periods	Yes	In accordance with US EPA / EPA Victoria guidelines and requirements (refer Appendix A)
3.2	**Discuss upper air data utilised**				
	●		Discuss upper air data utilised from the most representative station	Yes	Mesoscale model to process upper air data (nearest SAWS upper air station is at King Shaka Int Airport.
	●		Explain why it is "most representative"	Yes	Integrated 3-D mesoscale prognostic meteorological model, incompressible, optionally non-hydrostatic, which uses a terrain-following vertical coordinate system for 3-D simulations and includes comprehensive parametrisations for cloud/rain micro-physical processes, urban/vegetative canopy and soil, as well as turbulence closure and radiative fluxes. The model also predicts local-scale flows, such as sea breezes and terrain-induced circulations, as well as other meteorological parameters, by utilising meteorological fields obtained from larger-scale synoptic analyses. The mesoscale model (TAPM) simulates upper air data adequately. Irene is the nearest station to the facility measuring upper air data and is expected to be representative of the Highveld climatic zone.

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Chapter 4: Ambient impact analysis and ambient levels		**Submitted** Yes/No	**Report Section Reference or Specific References, Comments**
4.1	**Standards Levels**		
	● National Ambient Air Quality Standards	Yes	Refer Section 5.1
4.2	**Background Concentrations**		
	● Specify background values used including supporting documentation	Yes	Refer Appendix B
Chapter 5: Modelling procedures		**Submitted** Yes/No	**Report Section Reference or Specific References, Comments**
5.1	**Model used in the study**		
	● Assessment level proposed and justification	Yes	Level 3 assessment: The investigation is specific to an area / domain of 10km x 10km. The impact from the sources included are less than 50km downwind. Standard Air Quality Impact Assessment to assess potential impact of sources over defined areas within the modelling domain. The limited modelling domain falls well with the capability of AERMOD.
	● Dispersion model used	Yes	BREEZE AERMOD v10.0.0.15, executable US EPA 21112
	● Supporting models and input programs	Yes	BREEZE AERMAP v10.0.0.15, executable US EPA 18081 BREEZE AERMET v9.0.0.4, executable US EPA 21112
	● Version of models and input programs	Yes	Modelling software is continually updated with the latest available updates. Versions and executables used: BREEZE AERMOD v10.0.0.15, executable US EPA 21112 BREEZE AERMAP v10.0.0.15, executable US EPA 18081 BREEZE AERMET v9.0.0.4, executable US EPA 21112
5.2	**Specify modelled emissions**		
	● Pollutants	Yes	Refer Section 4
	● Scenarios and emissions that were modelled	Yes	Refer Section 4

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	●	Conversion factor utilized for converting NOX to NO2	Yes	Tier 1 applied, expected Nitrous oxide (NOX) emissions modelled as expected NO2 emissions, unless simulated annual average exceeds NAAQS for NO2, then Tier 2 applied; for SO2 in urban areas, half-life of 4hours is applied
5.3	**Specify setting utilised within the model(s), which may include:**			
	●	Recommended settings utilised within model	Yes	US Regulatory settings
	●	Terrain settings (simple flat/ simple elevated/ complex)	Yes	Elevated terrain
	●	Land characteristics (Bowen ratio, surface albedo, surface roughness)	Yes	In accordance with the US EPA's AERMOD Implementation Guide, the surface characteristics are determined against the latest satellite imagery from Google Earth and the Albedo {0.18-1; ave 0.64} and Bowen ratio's {0.49-1.5; ave 1.14} are based on a 5km radius surrounding the location of the meteorological data, with the surface roughness {0.15-1.09; ave 0.59} at a 5km distance around the centre of the dispersion domain.
	●	Specify number of sectors used and why (if applicable)	Yes	8 sectors, each sector at 45 degrees
	●	Specify assumptions (if applicable)	Yes	Flagpole / Receptor height of 1.5m
	●	Include discussion on non-regulatory settings utilised and reasons why	Yes	Elevated terrain modelled which requires a non-regulatory setting on AERMOD
5.4	**Describe the receptors grids utilised within the analysis**			
	●	Property line resolution	Yes	Refer Appendix C: Modelling Procedure and Settings
	●	Fine grid resolution	Yes	Refer Appendix C: Modelling Procedure and Settings
	●	Medium grid resolution(s)	Yes	Refer Appendix C: Modelling Procedure and Settings
	●	Course grid resolution	Yes	Refer Appendix C: Modelling Procedure and Settings
	●	Hotspots and sensitive location resolutions and sizes	n/ap	
	●	Figures that show locations of receptors relative to modelled facility and terrain features	Yes	Refer Appendix C: Modelling Procedure and Settings
Chapter 6: Ambient impact results documentation			**Submitted** **Yes/No**	**Report Section Reference or Specific References, Comments**

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6	**At a minimum, the Ambient Air Quality Standards results are to be documented as follows:**			
6.1	**Table(s) of modelling results including**			
	1.	Pollutant	Yes	Refer Section 5.1
	2.	Averaging time	Yes	Refer Section 5.1
	3.	Operating scenario	Yes	Refer Section 5.1
	4.	Maximum modelled concentration	Yes	Refer Section 5.1
	5.	Receptor location of maximum impact (coordinates)	Yes	Refer Section 5.1
	6.	Receptor elevation	Yes	Refer Section 5.1
	7.	Date of maximum impact	Yes	Refer Section 5.1
	8.	Grid resolution at maximum impact	Yes	Multiple cartesian grid: sources and model complexity in accordance with South African Dispersion Modelling guidelines with sensitive receptors
	9.	Name of output e-file(s) where data was taken from	Yes	Refer data files in folder K138_2021-CRS
6.2	**Figure(s) showing source impact area including**			
	1.	UTM coordinates on horizontal and vertical axis	Yes	Refer Section 5.1 & Appendix C: Modelling Procedure and Settings
	2.	Modelled facility		
		○ Boundary	Yes	Refer Section 5.1 & Appendix C: Modelling Procedure and Settings
		○ Buildings	Yes	Refer Section 5.1 & Appendix C: Modelling Procedure and Settings
		○ Emission points	Yes	Refer Section 5.1 & Appendix C: Modelling Procedure and Settings
	3.	Topography features	Yes	Refer Section 5.1 & Appendix C: Modelling Procedure and Settings
	4.	Isopleths of impact concentrations	Yes	Refer Section 5.1
	5.	Location and value of maximum impact	Yes	Refer Section 5.1
	6.	Location and value of maximum cumulative impact	Yes	Refer Section 5.1
Chapter 7: Ambient impact supporting documentation			**Submitted** **Yes/No**	**Report Section Reference or Specific References, Comments**
7.1	**All warning and informational messages within modelling output files must be explained and evaluated**		Yes	Minor warnings / messages
7.2	**Required electronic files to be submitted with report**			
	1.	Input & output files for models	Yes	

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	2.	Input & output files for pre-processors	Yes	Input files prepared per the guidelines provided by the EPA of Victoria. Output files of AERMET.
	3.	Input & output files for post-processors	Yes	
	4.	Digital terrain files	Yes	
	5.	Plot files	Yes	
	6.	Final report	Yes	
7.3	**Report shall include a list and description of electronic files**		Yes	Refer data files in folder K138_2021-CRS
7.4	**Report shall include a discussion on deviations from the modelling protocol**		Yes	Refer Appendix C and Appendix RADM

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Appendix U:Dispersion Modelling Uncertainties

In accordance with the US EPA Guideline on Air Quality Models (US EPA, 2005) it is important to acknowledge need to address uncertainties associated with dispersion modelling. In accordance with the US EPA guideline, two key types of uncertainty exist:

A) *Reducible uncertainty*:
Resulting from uncertainties associated with the input values and with the limitations of the model in terms of its capability and calculations. More representative input data and improved model capability can hence improve reducible;

B) *Inherent uncertainty*:
This entails the uncertainty associated with numerical models used to provide numerical representation / approximation of the atmosphere's turbulent (stochastic) nature. Models provide estimations to concentrations which are averages obtained for several repetitions the same event. Therefore, an individual specific measure value can deviate significantly from the average value modelled, and this uncertainty may be responsible for a ± 50% deviation from the measured value;

As a result of these uncertainties the dispersion models may underestimate or overestimate predicted ground-level concentrations. The US EPA Guideline on Air Quality Models (US EPA, 2005) also states that: "*Models are reasonably reliable in estimating the magnitude of highest concentrations occurring sometime, somewhere within an area. For example, errors in highest estimated concentrations of +/- 10 to 40 percent are found to be typical, i.e., certainly well within the often-quoted factor of two accuracy that has long been recognized for these models. However, estimates of concentrations that occur at a specific time and site are poorly correlated with actually observed concentrations and are much less reliable.*"

U.1 Minimising / Managing Reducible Uncertainties:

The following points refer to actions undertaken in order to minimise reducible uncertainties and to apply a risk based conservative approach:

1. The objectives of the investigation should be considered, i.e. assessment level, extent, for comparison, etc.

    1.1. With due consideration of the uncertainty of dispersion models, they are to be considered as an approximation / prediction. The dispersion model utilised for this investigation is an acceptable dispersion model in terms of the application thereof.
    Confidence level: Medium to High

    1.2. The objective of this study was to the potential impact of the ACRW operation and other emissions sources for which information could be obtained, on the quality of the ambient air over three portions of the land it owns, referred to as "Study Areas 1, 2 and 3" in this report to inform future land development. Hence inherent model uncertainty would apply to all the scenarios and the results relative to each other, should therefore cancel out the associated uncertainty.
    Confidence level: High

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2. Representativeness/relevance of model input parameters and application thereof in the model.
   The use of appropriate data is one of the most important factors in modelling accuracy.
   2.1. Surface Air Meteorological Data
   Refer Appendix A and Appendix RADM – the surface air meteorological data is considered to be representative for this investigation;
   Confidence level: High;
   2.2. Upper Air Meteorological Data
   Refer Appendix RADM – data from Irene was used and is considered to be applicable for the study area;
   Confidence level: Medium;
   2.3. Emission Inventory
   Refer Appendix D – All emissions used in the simulations of the baseline scenario were based on either isokinetic measurement/sampling data from external service providers, relevant/available continuous emissions monitoring (CEM) and or conservative estimation techniques for the specific industry. The uncertainty associated with the emissions inventory needs to be accommodated in the results.
   Confidence level: Medium;

3. Understanding the model performance limitations
   Refer Appendix C

4. Demonstrating that the modelling process has been conducted appropriately and in line with both local DEA requirements and international practice, which includes following a conservative approach where greater uncertainty is associated such as conversion of NO to NO_2, SO_2 half-life, deposition, etc.
   Refer Appendix RADM

5. Where possible/available to reference/include validated actual ambient monitoring data which could be used to compare modelled results for the purpose of verification and or validation; i.e. the processes used to assist with the credibility of numerical models, whereas:
   - Verification is the process to determine that a model represents the developer's conceptual description of the model and its solution.
   - Validation is the process to determine the degree to which a model is a representation of the actual occurrences with respect to the intended purpose/objective.
     With due consideration that model verification and validation cannot prove that a model is accurate and or correct with respect to all possible scenarios/eventualities, it can assist to provide assurance that it is sufficient with respect to its intended use.
     With due consideration of limited actual ambient monitoring data within a modelling domain for comparison with the model outputs/results, it is not always possible to conduct a comprehensive verification and validation process. Hence results are therefore scrutinized as a rule in order to make sure that they make sense in terms of the modelling domain.

   For all investigations available data from relevant ambient monitoring locations are used to compare the modelled data and to identify potential other contributing sources and or over-estimation of emissions and or impact. It is endeavoured to distinctly "fingerprint" and assess the site's contribution at these locations and or identify the site's contribution at those monitoring locations.
   Agreement level: Medium –based on monitoring data of Mn available for comparison with model results.

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U.2 IPCC CONSISTENT GUIDANCE TO UNCERTAINTIES

In accordance with guidance provided by the Intergovernmental Panel on Climate Change (IPCC) regarding a consistent and common approach in terms of the handling of uncertainties, the following points refer with respect to ascertaining the degree of certainty in findings of an assessment process:

- Confidence in the validity of a finding – Qualitative Confidence Validity of Finding: it is based on the type, amount, quality and consistency of evidence such as mechanistic understanding, theory, data, models, expert judgment) and the degree of agreement;
- Quantified measures of uncertainty in a finding expressed probabilistically: it is based on statistical analysis of observations or model results, or expert judgment;

The recommended dimensions for the validity of a finding are: "limited", "medium" or "robust", and the recommended dimensions for the degree of agreement are: "low", "medium", "high". Generally, evidence is most robust when there are multiple, consistent independent lines of high-quality evidence.

- For findings with high agreement and robust evidence, present a level of confidence or a quantified measure of uncertainty;
- For findings with high agreement or robust evidence, but not both, assign confidence or quantify uncertainty when possible. Otherwise, assign the appropriate combination of summary terms for your evaluation of evidence and agreement (e.g., robust evidence, medium agreement);
- For findings with low agreement and limited evidence, assign summary terms for your evaluation of evidence and agreement;
- In any of these cases, the degree of certainty in findings that are conditional on other findings should be evaluated and reported separately.

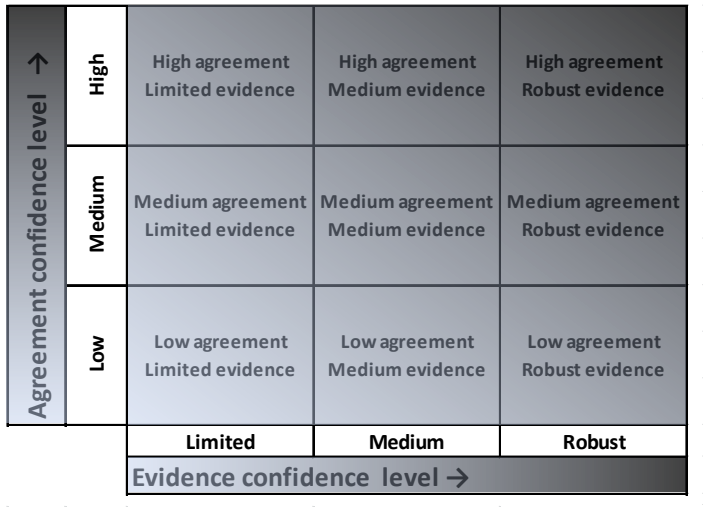


Figure U.1: A depiction of evidence and agreement statements and their relationship to confidence (Confidence increases towards the top-right corner as suggested by the increasing strength of shading)

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A level of confidence is expressed using five qualifiers: "very low," "low," "medium," "high," and "very high." It synthesizes the author teams' judgments about the validity of findings as determined through evaluation of evidence and agreement.

Figure U.1 depicts summary statements for evidence and agreement and their relationship to confidence.

- Flexibility exists in this relationship – for a given evidence and agreement statement, different confidence levels could be assigned, but increasing levels of evidence and degrees of agreement are correlated with increasing confidence;
- Confidence cannot necessarily be assigned for all combinations of evidence and agreement in Figure U.1;
- Presentation of findings with "low" and "very low" confidence should be reserved for areas of major concern, and the reasons for their presentation should be carefully explained;
- Confidence should not be interpreted probabilistically, and it is distinct from "statistical confidence." Additionally, a finding that includes a probabilistic measure of uncertainty does not require explicit mention of the level of confidence associated with that finding if the level of confidence is "high" or "very high".

Likelihood, as defined in Table U.1, provides calibrated language for describing quantified uncertainty. It can be used to express a probabilistic estimate of the occurrence of a single event or of an outcome (e.g., a climate parameter, observed trend, or projected change lying in a given range). Likelihood may be based on statistical or modelling analyses, elicitation of expert views, or other quantitative analyses. The categories defined in Table U.1 can be considered to have "fuzzy" boundaries. A statement that an outcome is "likely" means that the probability of this outcome can range from ≥66% (fuzzy boundaries implied) to 100% probability. This implies that all alternative outcomes are "unlikely" (0-33% probability).

The key findings should be characterised by using calibrated uncertainty language that conveys the most information to the reader - refer Table U.1.

Table U.1: Likelihood Scale

Term	**Likelihood of the Outcome**
Virtually certain	99-100% probability
Very likely	90-100% probability
Likely	66-100% probability
About as likely as not	33 to 66% probability
Unlikely	0-33% probability
Very unlikely	0-10% probability
Exceptionally unlikely	0-1% probability

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Appendix X: Declaration of Independence – Practitioner

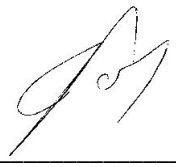
Name of Practitioner: Jan Potgieter on behalf of EnviroNgaka (Pty) Ltd.
Name of Registration Body: ECSA
Professional Registration No.: 20040140

Declaration of independence and accuracy of information provided:

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

I, Jan Potgieter on behalf of EnviroNgaka (Pty) Ltd., declare that I am independent of applicant. I have the necessary expertise to conduct the assessments required for the report and will perform the work relating the application in an objective manner, even if this results in views and findings that are not favourable to the applicant. The opinions expressed in this Report have been based on the information supplied to EnviroNgaka (Pty) Ltd. by Assmang Limited Cato Ridge Alloys (Pty) Ltd., Zutari (Pty) Ltd., their suppliers, other service providers and data providers. EnviroNgaka (Pty) Ltd. has exercised all due care in reviewing the supplied information. Whilst EnviroNgaka (Pty) Ltd. has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. EnviroNgaka (Pty) Ltd. does not accept responsibility for any errors or omissions in the supplied information and does not accept any consequential liability arising from commercial decisions or actions resulting from them. Opinions presented in this report apply to the site conditions and features as they existed at the time of EnviroNgaka (Pty) Ltd.'s investigations, and those reasonably foreseeable. These opinions do not necessarily apply to conditions and features that may arise after the date of this Report, about which EnviroNgaka (Pty) Ltd. had no prior knowledge nor had the opportunity to evaluate. I will disclose to the applicant and the air quality officer all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the air quality officer. The information provided in this atmospheric impact report is, to the best of my knowledge, in all aspects factually representative, true and correct. I am aware that the supply of false or misleading information to an air quality officer is a criminal offence in terms of section 51(1)(g) of this Act.

Signed at Brits on this 18th day of January 2022



SIGNATURE

Air Specialist
CAPACITY OF SIGNATORY

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Appendix Y: Curriculum Vitae of Practitioner

Mr. JG Potgieter, B.Eng (Chemical) Pr.Eng (20040140)

Jan Potgieter holds a degree in Chemical Engineering from the University of the North-West and registered as a Professional Engineer since 2004. He was in the service of Kynoch Fertilizer (Pty) Ltd in Potchefstroom, South Africa for 9 years in various positions as Process Engineer, Project Manager and Process Manager. He founded EnviroNgaka in 2004 and currently holds the positions of Technical Manager and Managing Director. EnviroNgaka specialises in air pollution/air quality management related work, which includes emission monitoring, emission inventory quantification, ambient air quality monitoring and assessment of ambient air quality environmental impacts. This would include, but not limited to activities such as sampling, analysis & assessment of atmospheric emissions - to determine the risk & environmental footprint; atmospheric modelling (dispersion modelling) to assess the distribution and footprint associated to emission sources, as well as source apportionment of ambient concentrations; technical assistance to industries with respect to improvement of existing designs/or proposed control technologies to mitigate atmospheric emissions; technical & specialist assistance into EIA's regarding expansions/modifications and new projects or facilities; specialist baseline and future ambient air quality impact assessments/studies; assistance for a range of air quality related projects; atmospheric risk assessments, regulatory/legal requirements and assessing abatement/control technology options and impacts on behalf of clients. He has over 15 years' experience in this field, having completed and managed numerous specialist projects, as well as air quality and impact assessments.

During his career Jan Potgieter served on the following committees/forums:

- SABS TC0146/SC01 Air Quality – Source Emissions Subcommittee
- SABS TC0146/SC03 Air Quality – Ambient Atmospheres Subcommittee
- NLA, STSA Subcommittee (Stack Testers of South Africa)
    - Member of the Working Group
- NAPCoF (The North West Air Pollution Control Forum)
    - Service Provided to the Forum

He holds the following professional registrations:

- Engineering Council of South Africa (ECSA)
    - Pr.Eng (20040140) (Chemical Engineering)

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Appendix Z: 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 aspects factually true and correct. I am aware that the supply of false or misleading information to an air quality officer is a criminal offence in terms of section 51(1)(g) of this Act.

Signed at _____ on this _____ day of _____

_____
SIGNATURE

_____
CAPACITY OF SIGNATORY

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