SOUTH32 MAMATWAN HOTAZEL MANAGANESE MINES

SECTION 12A POSTPONEMENT APPLICATION FOR THE SINTER PLANT WASTE STACK

ATMOSPHERIC IMPACT REPORT

NOVEMBER 2024

CONFIDENTIAL

SOUTH32 MAMATWAN HOTAZEL MANAGANESE MINES

SECTION 12A POSTPONEMENT APPLICATION FOR THE SINTER PLANT WASTE STACK

ATMOSPHERIC IMPACT REPORT

REPORT (VERSION 01) CONFIDENTIAL

PROJECT NO. 41107325

DATE: NOVEMBER 2024

WSP

Building 1, Maxwell Office Park
Magwa Crescent West, Waterfall City
Midrand, 1685
South Africa

Phone: +27 11 361 1300

WSP.com

QUALITY CONTROL

Issue/revision	First issue	Revision 1	Revision 2	Revision 3
Remarks	Draft	Final		
Date	26 November 2024	27 November 2024		
Prepared by	J. Lodder	J. Lodder		
Signature		Lodder, Jared (ZAJL04997) 2024.11.27 13:37:02 +02'00'		
Checked by	K. Collett	K. Collett		
Signature		Collett, Kirsten (ZAKC02294) 2024.11.27 13:41:39 +02'00'		
Authorised by	K. Collett	K. Collett		
Signature		Collett, Kirsten (ZAKC02294) 2024.11.27 13:42:04 +02'00'		
Project number	41107325	41107325		
Report number	1 of 1	1 of 1		
File reference	\\corp.pbwan.net\za\Central_Data\Projects\41100xxx\41107325 - SOUTH32 MMT S12A AQIA\00 PMO\05-Project Management\16-Deliverables\02_AIR			

ABBREVIATIONS

AEL	Atmospheric Emissions Licence
AIR	Atmospheric Impact Report
API	American Petroleum Industry
AQIA	Air Quality Impact Assessment
C_6H_6	Benzene
CO	Carbon monoxide
DEM	Digital Elevation Model
DRG	Digital Raster Graphic
g/s	Grams per second
mg/Nm^3	Milligrams per cubic meter (under normal conditions of 273 Kelvin and 101.3 kPa)
MES	Minimum Emission Standards
MMT	South32 Mamatwan Hotazel Manganese Mines
NAAQS	National ambient air quality standards
NASA	National Aeronautics and Space Administration
NAEIS	National Atmospheric Emission Inventory System
NEM:AQA	National Environmental Management: Air Quality Act 39 of 2004
NO_2	Nitrogen dioxide
NO_x	Oxides of Nitrogen
PM	Particulate matter
PM_{10}	Particulate matter less than 10 µm in diameter
$PM_{2.5}$	Particulate matter less than 2.5 µm in diameter
SAAQIS	South African Air Quality Information System
SANAS	South African National Accreditation System
SAWS	South African Weather Service
SO_2	Sulphur dioxide
SRTM	Shuttle Radar Topography Mission
USEPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
WSP	WSP Group Africa (Pty) Ltd

EXECUTIVE SUMMARY

South32 Mamatwan Hotazel Manganese Mines (South32 MMT) is an opencast manganese mine situated in the geographical area of the Northern Cape that contains approximately 80% of the world's supply of high-grade manganese. South32 MMT produces sinter of different sizes, which are shipped to markets via rail or road transport.

Due to the Sinter Plant operations, South32 MMT triggers listed activity C*ategory 4: Metallurgical Industry, Sub-category 4.5 Sinter Plant,* as per Government Notice Regulation 893 of 2013, promulgated in line with Section 21 of the National Environmental Management: Air Quality Act (Act 39 of 2004) (NEM:AQA). South32 MMT was issued with an Atmospheric Emissions License (AEL) on 09 March 2020, Licence Number NC/AEL/JTG/MAM01/2012.

The Sinter Plant consists of four stacks that are required to comply with the new plant Minimum Emission Standards (MES) of 50 mg/Nm^3 for particulate matter (PM) from 01 April 2020. Based on the stack emission testing conducted between 2022 and 2024 (results used for the emissions inventory for this study), PDD1 and PDD2 have complied, on average, with the new plant MES for PM (50 mg/Nm^3). The average concentrations from PDD3 also show compliance with the MES of 135 mg/Nm^3 (postponement granted until 31 March 2025). The Sinter Waste Stack (SWS) has not been able to achieve compliance with the more stringent MES for PM, as the current Electrostatic Precipitators (ESP) were designed for a maximum PM emission limit of 100 mg/Nm^3. South32 MMT have identified a new ESP that will, once installed, be able to achieve a maximum emission rate that is compliant with the MES for PM. As such, South32 MMT are requesting postponement from the current MES until approximately January 2027, when the new ESP has been installed and is operational. It is noted that the date is dependant on permitting and licencing of the new ESP as well as design, installation, and testing requirements, thus the date is approximate only at this stage.

WSP Group Africa (Pty) Ltd (WSP) has been appointed by South32 to undertake the postponement application in terms of Section 12A of the Amendments to the Listed Activities and Associated Minimum Emission Standards Identified in Terms of Section 21 of the NEM:AQA (GNR. 1207 of 2018) for PM from the SWS only. As part of the postponement application, an Atmospheric Impact Report (AIR) (this report) is required to assess the potential air quality impacts of the Sinter Plant on the surrounding environment.

The study assessed the potential impacts on the ambient air quality associated with the Sinter Plant stack emissions using a Level 2 (AERMOD) dispersion modelling assessment. Impacts on the ambient air quality for particulate matter (PM_{10} and $PM_{2.5}$), regulated by the National Ambient Air Quality Standards (NAAQS), were simulated. Three modelling scenarios were conducted for South32 MMT, where impacts arising from their operational activities were assessed.

- Scenario One simulated the current operating conditions whereby the SWS currently exceeds the MES for PM.
  - The actual emission rates (mg/Nm^3) obtained from the stack testing reports were used to calculate the emission rates (g/s) for input into this model/assessment.
  - The actual emission rates (mg/Nm^3) were, on average, below the MES for stacks PDD1, PDD2, and PDD3, while the emission rate for the SWS (133.44 mg/Nm^3) exceeded the MES (50 mg/Nm^3).

- Scenario Two simulated the future operating conditions where the SWS complies with the MES for PM.
  - The emission rates used for this scenario were the MES rates for all stacks, namely, PDD1, PDD2 and SWS (50 mg/Nm^3), and PDD3 (135 mg/Nm^3).
  - By using the MES for all stacks, it is noted that the emission rates, for Scenario Two are higher than Scenario One for stacks PDD1, PDD2, PDD3. This is due to the average stack testing results for these stacks remaining below the MES.
  - The higher MES emission rates were used as a conservate approach, noting that in some years, the stack testing results exceeded the MES. As such, this scenario takes into consideration that the stacks may have higher emissions in the future, compared to the previous years, yet remaining compliant with the MES.
  - As such this approach, is considered the worst-case approach to remain environmentally conservative in this assessment.
- Scenario Three simulated the postponement operating conditions where the SWS operates with a maximum MES of 200 mg/Nm^3 until such time as the new ESP is operational.
  - The emission rates used for this scenario were the MES rates for stacks PDD1 (50 mg/Nm^3), PDD2 (50 mg/Nm^3), PDD3 (135 mg/Nm^3) and SWS (200 mg/Nm^3).
  - By using the MES for stacks PDD1, PDD2 and PDD3, it is noted that the emission rates, for Scenario Three are higher than Scenario One. This is due to the average stack testing results for these stacks remaining below the MES.
  - The higher MES emission rates were used as a conservate approach, noting that in some years, the stack testing results exceeded the MES. As such, this scenario takes into consideration that the stacks may have higher emissions in the future, compared to the previous years, yet remaining compliant with the MES.
  - As such this approach, is considered the worst-case approach to remain environmentally conservative in this assessment.
  - The proposed MES of 200 mg/Nm^3 for the SWS is also considered a worst-case approach to remain environmentally conservative in this assessment.

An emissions inventory was developed using stack emission test results from 2022 (Levego, 2022), 2023 (Levego, 2023) and 2024 (Levego, 2024), conducted by Levego Environmental Services, for input into the dispersion model. Simulated pollutant dispersion outputs were compared to the NAAQS (where applicable) to assess the degree of impact. Key findings are as follows:

- Scenario One: Current Operating Conditions:
  - PM_{10} emissions do not result in exceedances of the ambient PM_{10} 24-hour (75 µg/m^3) or annual (40 µg/m^3) NAAQS as simulated for the current operations.
    - The current scenario takes into account that the stack emissions from PDD1, PDD2 and PDD3 are below the MES and are thus currently compliant with the MES.
    - The peak concentrations occur onsite; however, remaining well-below the 24-hour and annual NAAQS.
    - Maximum concentrations at all sensitive receptors, 0.51 µg/m^3 and 0.13 µg/m^3 remain well below the 24-hour and annual NAAQS, respectively.

- $PM_{2.5}$ emissions do not result in exceedances of the ambient $PM_{2.5}$ 24-hour (40 µg/m^3) or annual (20 µg/m^3) NAAQS as simulated for the current operations.
  - The current scenario takes into account that the stack emissions from PDD1, PDD2 and PDD3 are below the MES and are thus currently compliant with the MES.
  - The peak concentrations occur onsite; however, remaining well-below the 24-hour and annual NAAQS.
  - Maximum concentrations at all sensitive receptors, 0.27 µg/m^3 and 0.07 µg/m^3 remain well below the 24-hour and annual NAAQS, respectively.

- Scenario Two: MES Compliance Operating Conditions:
  - PM_{10} emissions do not result in exceedances of the ambient PM_{10} 24-hour (75 µg/m^3) or annual (40 µg/m^3) NAAQS as simulated for the future MES operations.
    - The future MES scenario takes into account that the stack emissions from PDD1, PDD2 and PDD3 are higher than the current emissions; however, remaining compliant with MES. As mentioned previously, this is to ensure that a worst-case scenario is assessed to remain environmentally conservative.
    - The peak concentrations occur onsite; however, remaining well-below the 24-hour and annual NAAQS.
    - Maximum concentrations at all sensitive receptors, 0.58 µg/m^3 and 0.09 µg/m^3 remain well below the 24-hour and annual NAAQS, respectively.
  - $PM_{2.5}$ emissions do not result in exceedances of the ambient $PM_{2.5}$ 24-hour (40 µg/m^3) or annual (20 µg/m^3) NAAQS as simulated for the future MES operations.
    - The future MES scenario takes into account that the stack emissions from PDD1, PDD2 and PDD3 are higher than the current emissions; however, remaining compliant with MES. As mentioned previously, this is to ensure that a worst-case scenario is assessed to remain environmentally conservative.
    - The peak concentrations occur onsite; however, remaining well-below the 24-hour and annual NAAQS.
    - Maximum concentrations at all sensitive receptors, 0.31 µg/m^3 and 0.05 µg/m^3 remain well below the 24-hour and annual NAAQS, respectively.

- Scenario Three: MES Postponement Operating Conditions:
  - PM_{10} emissions do not result in exceedances of the ambient PM_{10} 24-hour (75 µg/m^3) or annual (40 µg/m^3) NAAQS as simulated for the MES postponement operations.
    - The MES postponement scenario takes into account that the stack emissions from PDD1, PDD2 and PDD3 are higher than the current emissions; however, remaining compliant with MES. As mentioned previously, this is to ensure that a worst-case scenario is assessed to remain environmentally conservative.
    - The peak concentrations occur onsite; however, remaining well-below the 24-hour and annual NAAQS.
    - Maximum concentrations at all sensitive receptors, 0.80 µg/m^3 and 0.20 µg/m^3 remain well below the 24-hour and annual NAAQS, respectively.

- $PM_{2.5}$ emissions do not result in exceedances of the ambient $PM_{2.5}$ 24-hour (40 µg/m^3) or annual (20 µg/m^3) NAAQS as simulated for the MES postponement operations.
  - The MES postponement scenario takes into account that the stack emissions from PDD1, PDD2 and PDD3 are higher than the current emissions; however, remaining compliant with MES. As mentioned previously, this is to ensure that a worst-case scenario is assessed to remain environmentally conservative.
  - The peak concentrations occur onsite; however, remaining well-below the 24-hour and annual NAAQS.
  - Maximum concentrations at all sensitive receptors, 0.43 µg/m^3 and 0.10 µg/m^3 remain well below the 24-hour and annual NAAQS, respectively.
- It is evident from the dispersion modelling results, that despite adopting a worst-case approach to the MES scenarios, the PM_{10} and $PM_{2.5}$ concentrations remain well below the relevant NAAQS as well as peak concentrations remaining within the boundary of South32 MMT.

Based on the findings of this this environmentally conservative AIR, ground-level impacts associated with atmospheric emissions from the Sinter Plant stacks are assessed to be low and therefore WSP recommends that South32 MMT be granted their postponement of the MES for PM for the SWS. It is further recommended, based on this assessment, that the MES for PM is a maximum of 200 mg/Nm^3.

CONTENTS

TABLES

FIGURES

1 INTRODUCTION

South32 Mamatwan Hotazel Manganese Mines (South32 MMT) is an opencast manganese mine situated in the geographical area of the Northern Cape that contains approximately 80% of the world's supply of high-grade manganese. South32 MMT produces sinter of different sizes, which are shipped to markets via rail or road transport.

Due to the Sinter Plant operations, South32 MMT triggers listed activity C*ategory 4: Metallurgical Industry, Sub-category 4.5 Sinter Plant,* as per Government Notice Regulation 893 of 2013, promulgated in line with Section 21 of the National Environmental Management: Air Quality Act (Act 39 of 2004) (NEM:AQA). South32 MMT was issued with an Atmospheric Emissions License (AEL) on 09 March 2020, Licence Number NC/AEL/JTG/MAM01/2012.

The current AEL includes four stacks as part of the Sinter Plant, namely, De-Dust 1 (PDD1), De-Dust 2 (PDD2), De-Dust 3 (PDD3) and the Sinter Waste Stack (SWS). On 1 April 2020, stacks from Sinter Plants were required to comply with the new plant Minimum Emission Standards (MES) of 50 mg/Nm^3 for particulate matter (PM). South32 MMT had applied for postponement of the MES for PM for all four stacks, however, only PDD3 was approved for postponement, thus, PDD3 is required to comply with the MES of 135 mg/Nm^3 until 31 March 2025.

Based on the stack emission testing conducted between 2022 and 2024 (results used for the emissions inventory for this study), PDD1 and PDD2 have complied, on average, with the new plant MES for PM (50 mg/Nm^3). The average concentrations from PDD3 also show compliance with the MES of 135 mg/Nm^3. The SWS has not been able to achieve compliance with the more stringent MES for PM, as the current Electrostatic Precipitators (ESP) were designed for a maximum PM emission limit of 100 mg/Nm^3. South32 are committed to ensuring compliance with the AEL, thus, have investigated a number of ESP options to achieve compliance, which includes long and short-term upgrades, a pre-assembly upgrade and a pre-assembly new installation. The new installation has been identified as the most economical option, as well as achieving a maximum emission limit that is compliant with the MES for PM. However, the feasibility of installing the new ESP is based on the Sinter Plant continuing to operate under the current conditions (i.e. the SWS will continue to exceed the MES), whilst the ESP is being installed.

Therefore, South32 MMT are requesting postponement of the MES for PM from the SWS only, until the new ESP has been installed and is operational, which is expected approximately in January 2027. It is noted that the date is dependent on permitting and licencing of the new ESP as well as design, installation, and testing requirements, thus the date is approximate only at this stage. WSP Group Africa (Pty) Ltd (WSP) has been appointed by South32 to undertake the postponement application in terms of Section 12A of the Amendments to the Listed Activities and Associated Minimum Emission Standards Identified in Terms of Section 21 of the NEM:AQA (GNR. 1207 of 2018) for PM from the SWS only.

As part of the postponement application, an Atmospheric Impact Report (AIR) (this report) is required to assess the potential air quality impacts of the Sinter Plant on the surrounding environment.

2 ENTERPRISE DETAILS

2.1 ENTERPRISE DETAILS

Table 2-1 provides the enterprise information for South32 MMT with the details of the responsible contact personnel presented in **Table 2-2**.

Table 2-1: Facility information

Enterprise Name	South32 Mamatwan Hotazel Manganese Mines
Type of Enterprise, e.g. Company/Close Corporation/Trust, etc.	Company
Company/Close Corporation/Trust Registration Number	2003/020080/07
Registered Address	1 Peperboom Ave, Hotazel, Joe Morolong Local Municipality, 26, Northern Cape, 8490
Postal Address	1 Peperboom Ave, Hotazel, Joe Morolong Local Municipality, 26, Northern Cape, 8490
Telephone Number (General)	053 742 2646
Fax Number (General)	N/A
Industry Type/Nature of Trade	Mining
Land Use Zoning as per Town Planning Scheme	Industrial
AEL Reference Number	NC/AEL/JTG/MAM01/2012
Modelling Consultant	WSP Group Africa (Pty) Ltd
Modeller	Jared Lodder – Principal Consultant

Table 2-2: Contact details

Responsible Person	Wonder Sigwebela
Emission Control Officer	Wonder Sigwebela
Telephone Number	N/A
Cell Phone Number	072 429 6545
Fax Number	N/A
E-mail Address	Wonder.sigwebela@south32.net
After Hours Contact Details	072 429 6545

2.2 LOCATION AND EXTENT OF PLANT

South32 MMT is located within the Joe Morolong Local Municipality in the Northern Cape, approximately 25 km south of Hotazel and 35 km north of Kathu. The mining right occupies approximately 11.2 km^2 at an elevation of approximately 1,100 m above mean sea level (**Table 2-3**). A locality map, site layout of the Sinter Plant stacks and a topographical map of the region are presented in **Figure 2-1**, **Figure 2-2** and **Figure 2-3,** respectively.

Table 2-3: Location and extent of plant

Physical Address of the Plant	1 Peperboom Ave, Hotazel, Joe Morolong Local Municipality, 26, Northern Cape, 8490
Description of Site (Where No Street Address)	N/A
Coordinates of Approximate Centre of Operations	Latitude: 27°23'25.73"S, Longitude: 22°59'40.27"E (Sinter Plant)
Extent (hectares)	1,122
Elevation Above Mean Sea Level (m)	1,100
Province	Northern Cape
District Municipality	John Taolo Gaetsewe District Municipality
Local Municipality	Joe Morolong Local Municipality
Designated Priority Area (If Applicable)	N/A

2.2.1 DESCRIPTION OF SURROUNDING LAND USE

The land use surrounding South32 MMT is predominantly agricultural. South32 MMT also borders with the Tshipi Borwa Mine to the west.

2.2.2 SENSITIVE RECEPTORS

Sensitive receptors, as defined by the United States Environmental Protection Agency (USEPA) include, but are not limited to, hospitals, schools, day-care facilities, elderly housing and convalescent facilities. These are areas where the occupants are more susceptible to the adverse effects of exposure to toxic chemicals, pesticides and other pollutants. Extra care must be considered when dealing with pollutants in proximity to areas recognised as sensitive receptors.

Due to the rural location of South32 MMT, agricultural homesteads are the only sensitive receptors located within 10 km of the facility. The nearest residential area, Hotazel, is located approximately 25 km north of the facility.

For this study, sensitive receptors were sourced from Google Earth Pro™. Identified sensitive receptors are displayed in **Table 2-4** and **Figure 2-4**.

Table 2-4: Sensitive receptors within a 10 km radius of South32 MMT

ID	Description	Latitude (°S)	Longitude (°E)	Distance from Site Boundary (km)	Direction from Site Boundary
SR1	Homestead	-27.4620	22.9440	6.31	Southwest
SR2	Homestead	-27.4636	22.9509	6.82	South-southwest
SR3	Homestead	-27.4780	22.9910	7.76	South
SR4	Homestead	-27.4175	23.0124	2.48	South-southeast
SR5	Homestead	-27.4100	23.0360	4.59	East
SR6	Homestead	-27.4050	23.0770	8.62	East
SR7	Homestead	-27.3815	23.0639	6.50	East
SR8	Homestead	-27.3805	23.0628	6.44	East

ID	Description	Latitude (°S)	Longitude (°E)	Distance from Site Boundary (km)	Direction from Site Boundary
SR9	Homestead	-27.3587	23.0876	9.31	East
SR10	Homestead	-27.3599	23.0853	9.09	East
SR11	Homestead	-27.3484	23.0406	4.88	East
SR12	Homestead	-27.3538	23.0822	8.87	East
SR13	Homestead	-27.3106	23.0049	4.00	North-northeast
SR14	Homestead	-27.3990	22.9410	3.05	Southwest
SR15	Homestead	-27.3726	22.9236	4.41	Southwest
SR16	Homestead	-27.3681	22.9251	4.21	West-southwest
SR17	Homestead	-27.3620	22.9350	3.26	West
SR18	Homestead	-27.4614	22.9433	6.87	South-southwest
SR19	Homestead	-27.4768	22.9979	7.71	South

2.3 ATMOSPHERIC EMISSIONS LICENCE

South32 MMT currently hold an AEL, Licence Number NC/AEL/JTG/MAM01/2012, which expires on 31 March 2025.

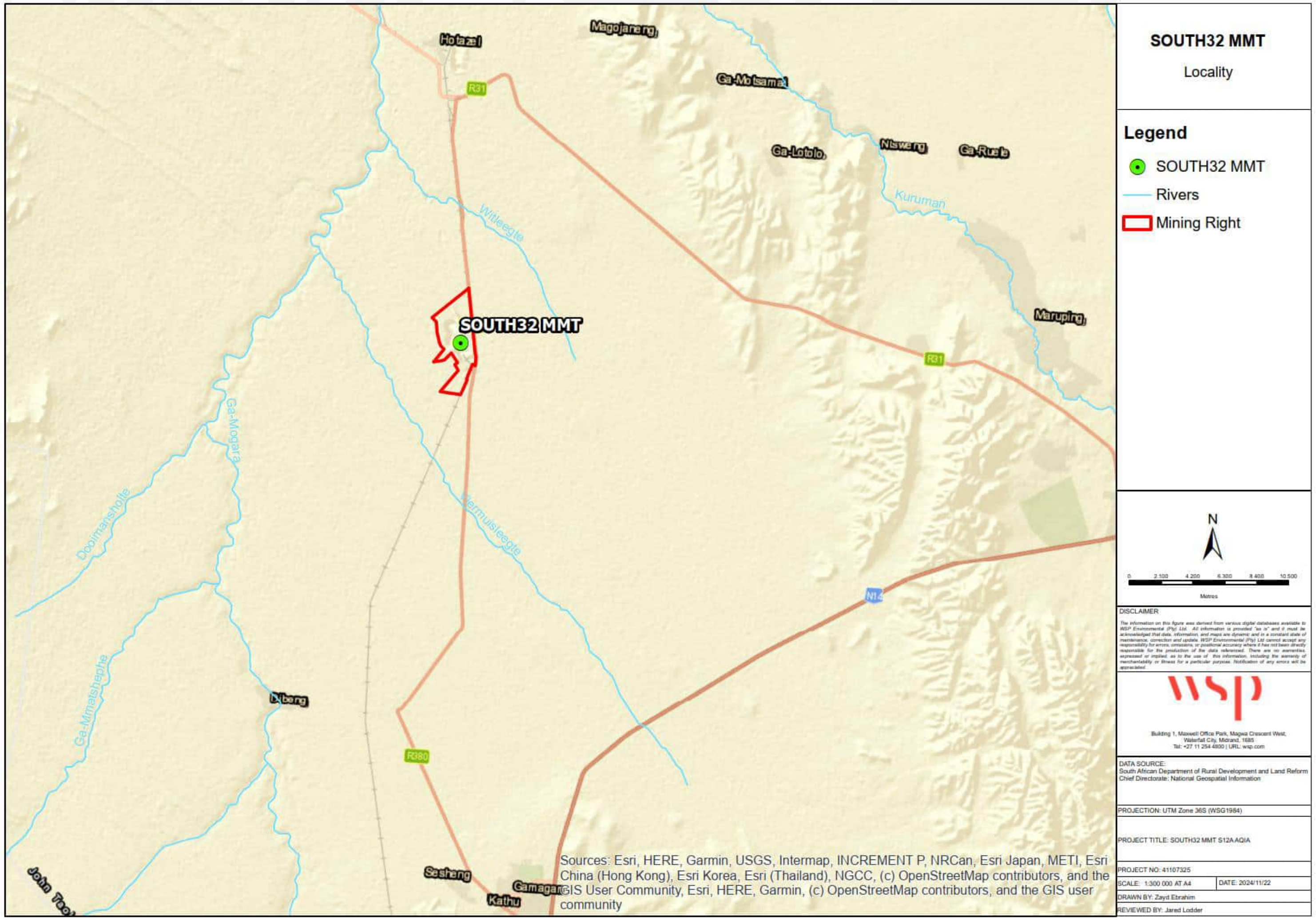


Figure 2-1: Location of South32 MMT

Figure 2-2: Location of South32 MMT Sinter Plant Stacks

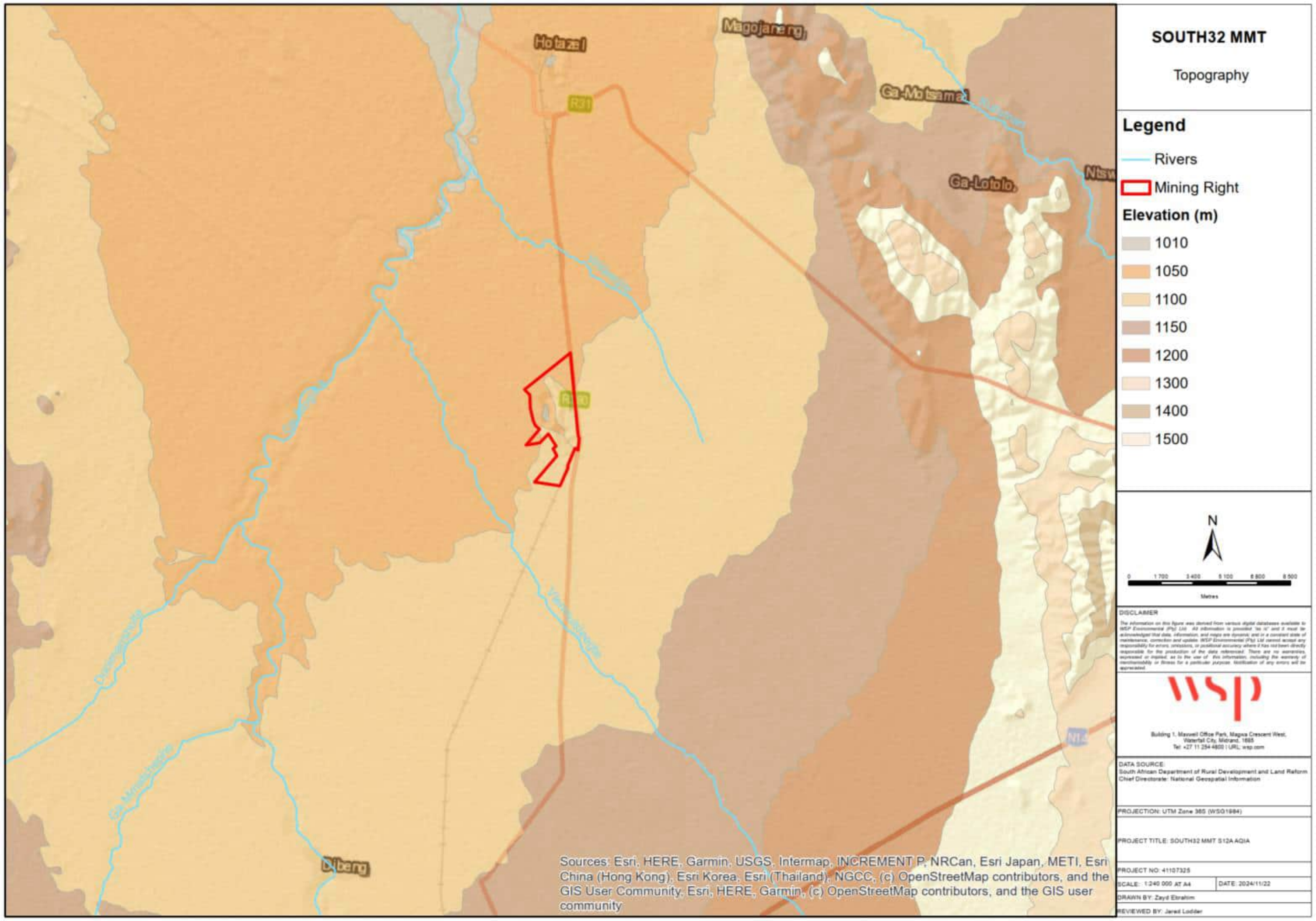


Figure 2-3: Topographical map of the region surrounding South32 MMT

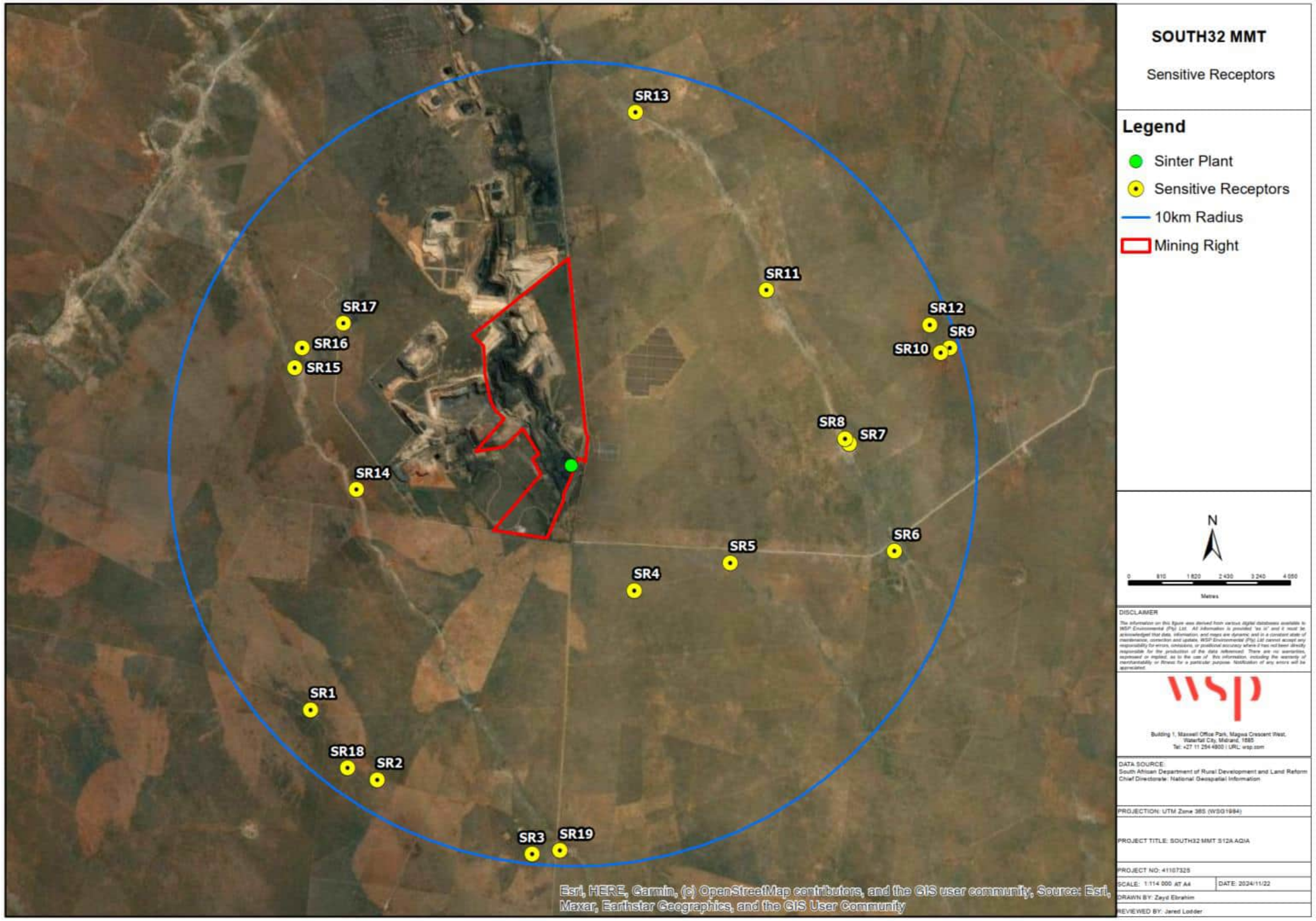


Figure 2-4: Sensitive receptors within a 10 km radius of South32 MMT

3 NATURE OF THE PROCESS

3.1 LISTED ACTIVITIES

Listed activities and associated minimum emission standards (MES) were published in Government Notice 248, Government Gazette 33064 of 2010, in line with Section 21 of NEM:AQA. An amended list of activities was published in Government Notice 893 of Government Gazette 37054 in 2013, Government Notice 551 of Government Gazette 38863 in 2015 and further in Government Notice 1207 of Government Gazette 42013 in 2018. **Table 3-1** presents the listed activity triggered by South32 MMT.

Table 3-1: Listed activity applicable to South32 MMT

Category Of Listed Activity	Subcategory Of Listed Activity	Description of the Listed Activity
4: Metallurgical industry	4.5 Sinter Plants	Sinter plants for agglomeration of fine ores using a heating process, including sinter cooling where applicable.

3.2 PROCESS DESCRIPTION

Manganese ore, recycled sinter fines, anthracite/coke and reductants are mixed and then stored in feed silos. The mixture is then placed on a moving grate machine where it is ignited to produce an agglomerated sinter. The sinter product is discharged from the moving grate into a crusher to break the sinter ore into manageable sized clumps and is then air cooled on the off-strand cooler.

The cooled down and crushed sintered ore is then graded according to size with the material larger than 6 mm placed on the final product stockpile from where it is shipped to markets via rail or road transport. The screened material smaller than 6 mm is recycled back into the feed mixer where it is included in the feed ore. Fugitive dust is extracted from the process through a series of extraction ducts with the particulate matter being captured in one of three de-dusting bag-houses.

Dust from bag-houses 1 and 2 are recycled back into the feed mixer to be included into the feed ore. Dust from bag-house 3 is captured in bulk bags for sale as reduced sinter fines. Off gas and particulate matter from the moving grate machine is extracted and scrubbed through an Electrostatic Precipitator. **Figure 3-1** illustrates a simplified process flow of the Sinter Plant.

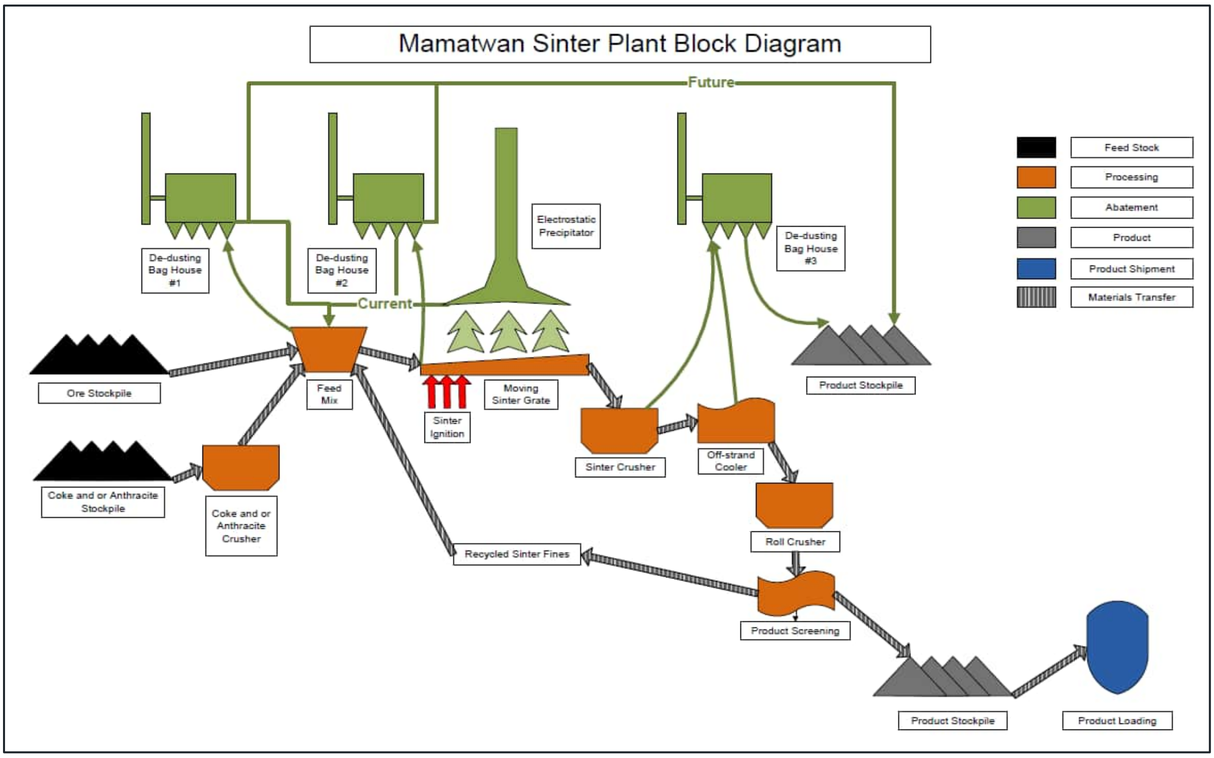


Figure 3-1: South32 MMT simplified block diagram

3.3 UNIT PROCESSES

A summary of the unit processes, function and operational hours at South32 MMT is provided in **Table 3-2**.

Table 3-2: Unit process and operational times for South32 MMT

Unit process	Function	Operational hours	Batch/ Continuous
Ore stockpile	Stockpile ore to ensure feed of raw materials	24 hours per day, 365 days per year	Continuous
Anthracite stockpile	Stockpile anthracite used as a fuel	24 hours per day, 365 days per year	Continuous
Anthracite crusher	Size of the anthracite to ensure effective burn-through	24 hours per day, 365 days per year	Continuous
Conveyor belts	To convoy and transfer raw material and product	24 hours per day, 365 days per year	Continuous
Feed mix	Combining feed ore with return fines	24 hours per day, 365 days per year	Continuous
Sinter ignition	Ignite sinter feed mix with oil burners	24 hours per day, 365 days per year	Continuous
Moving sinter grade	Agglomeration and upgrade of fine ores by application of heat	24 hours per day, 365 days per year	Continuous

Unit process	Function	Operational hours	Batch/ Continuous
Electrostatic precipitator	Extracting particulates	24 hours per day, 365 days per year	Continuous
Sinter crusher (product sizing)	Braking up sinter product into required sizes	24 hours per day, 365 days per year	Continuous
Off-strand cooler	Cooling sinter product	24 hours per day, 365 days per year	Continuous
De- dusting baghouse	Extracting fine dust from transfer points	24 hours per day, 365 days per year	Continuous
Product screening	Removing particles less than 6 mm	24 hours per day, 365 days per year	Continuous
Product stockpile	Storage of sinter product	24 hours per day, 365 days per year	Continuous
Load out of sinter product	Loading of sinter product onto trains and/or trucks	As required	Batch

4 TECHNICAL INFORMATION

4.1 RAW MATERIALS USED

Table 4-1 below provides details on the raw material, products and energy sources used at the facility.

Table 4-1: Raw materials, products and energy sources

Category	Item	Consumption / Production Rate	Unit
Raw Materials	Manganese	1,250,000	tons/annum
	Coke	95,000	tons/annum
	Anthracite	95,000	tons/annum
Products/By-Product	Manganese (Product)	1,000,000	tons/annum
	Waste (By-Product)	227,920	tons/annum
Energy	Anthracite	103	Kg/ton of anthracite
	Other	103	To be confirmed
	Coke	95	To be confirmed
	Heavy Fuel Oil	300	L/hr
	Electricity	21,758	To be confirmed

4.2 APPLIANCES AND ABATEMENT TECHNOLOGY

South32 MMT currently have appliances and abatement technology installed at the Sinter Plant as presented in **Table 4-2**.

Table 4-2: Appliances and abatement technology

Associated source code	Equipment number	Technology name and Model	Type / Description	Date Manufactured	Commission Date	Date of Significant Modification / Upgrade	Technology type	Design Capacity (m^3/hr)	Min Control Efficiency (%)	Min Utilization (%)
SWS	M-MN-HMM-MMT-P-SIN-WGAS-04520/M-MN-	Davy/Batema	Waste Gas System	1988	1999	N/A	Electrostatic Precipitator	1,160,000	98	100
PDD1	M-MN-HMM-MMT-P-SIN-DSTR-04461	Davy	De-dusting Equipment	1988	1988	2013	Baghouse filter	170,000	98	100
PDD2	M-MN-HMM-MMT-P-SIN-DSTR-04891	Air cleaning equipment	De-dusting Equipment	2002	2002	2014	Baghouse filter	146,000	98	100
PDD3	M-MN-HMM-MMT-P-SIN-DSTR-11625	Genair	De-dusting Equipment	2011	2012	N/A	Baghouse filter	182,700	98	100

5 ATMOSPHERIC EMISSIONS

An emissions inventory is a list of pollution sources, their physical and chemical parameters, as well as the quantification of emissions. Emissions were calculated using actual stack test emission results from 2022 (Levego, 2022), 2023 (Levego, 2023) and 2024 (Levego, 2024), conducted by Levego Environmental Services (see **Appendix A**). The stack emission testing results have indicated that PDD1 and PDD2 have complied, on average, with the new plant MES for PM (50 mg/Nm^3), while PDD3 has complied with the MES of 135 mg/Nm^3 (postponement granted until 31 March 2025). However, the SWS PM concentrations have exceeded the MES for PM (50 mg/Nm^3).

To understand the impact of the current operations as well as the future compliance of the SWS with the MES on the receiving environment, three modelling scenarios were conducted for South32 MMT. The three scenarios are as follows:

- Scenario One simulated the current operating conditions whereby the SWS currently exceeds the MES for PM.
  - The actual emission rates (mg/Nm^3) obtained from the stack testing reports were used to calculate the emission rates (g/s) for input into this model/assessment.
  - The actual emission rates (mg/Nm^3) were, on average, below the MES for stacks PDD1, PDD2, and PDD3, while the emission rate for the SWS (133.44 mg/Nm^3) exceeded the MES (50 mg/Nm^3).
- Scenario Two simulated the future operating conditions where the SWS complies with the MES for PM.
  - The emission rates used for this scenario were the MES rates for all stacks, namely, PDD1, PDD2 and SWS (50 mg/Nm^3), and PDD3 (135 mg/Nm^3).
  - By using the MES for all stacks, it is noted that the emission rates, for Scenario Two are higher than Scenario One for stacks PDD1, PDD2, PDD3. This is due to the average stack testing results for these stacks remaining below the MES.
  - The higher MES emission rates were used as a conservate approach, noting that in some years, the stack testing results exceeded the MES. As such, this scenario takes into consideration that the stacks may have higher emissions in the future, compared to the previous years, yet remaining compliant with the MES.
  - As such this approach, is considered the worst-case approach to remain environmentally conservative in this assessment.
- Scenario Three simulated the postponement operating conditions where the SWS operates with a maximum MES of 200 mg/Nm^3 until such time as the new ESP is operational.
  - The emission rates used for this scenario were the MES rates for stacks PDD1 (50 mg/Nm^3), PDD2 (50 mg/Nm^3), PDD3 (135 mg/Nm^3) and SWS (200 mg/Nm^3).
  - By using the MES for stacks PDD1, PDD2 and PDD3, it is noted that the emission rates, for Scenario Three are higher than Scenario One. This is due to the average stack testing results for these stacks remaining below the MES.
  - The higher MES emission rates were used as a conservate approach, noting that in some years, the stack testing results exceeded the MES. As such, this scenario takes into

consideration that the stacks may have higher emissions in the future, compared to the previous years, yet remaining compliant with the MES.

- As such this approach, is considered the worst-case approach to remain environmentally conservative in this assessment.
- The proposed MES of 200 mg/Nm^3 for the SWS is also considered a worst-case approach to remain environmentally conservative in this assessment.

Table 5-1 provides the parameters for the Sinter Plant stacks, while **Table 5-2** provides the calculated emission rates for the three scenarios (current, MES compliance, and postponement operations). The emissions rates for PM_{10} and $PM_{2.5}$ were calculated as 60% and 32%, respectively of PM (USEPA, 1986; and Zhao et al, 2017).

Table 5-1: Sinter Plant stack parameters and emission rates

Source ID	PDD1	PDD2	PDD3	SWS
Latitude	27.390211°S	27.390711°S	27.389658°S	27.391136°S
Longitude	22.994791°E	22.994108°E	22.994044°E	22.994978°E
Stack height (m)	30	30	31	41
Stack diameter (m)	1.75	1.86	1.90	3.26
Gas exit velocity (m/s)	7.05	10.25	19.23	28.50
Gas exit temperature (°C)	55.49	67.07	49.64	151.61
Operating period (hr/year)	8,760	8,760	8,760	8,760

Table 5-2: Sinter Plant emission rates for current operations (Scenario One), MES compliance operations (Scenario Two), and MES postponement operations (Scenario Three)

Emission Rates	Pollutant	PDD1			PDD2			PDD3			SWS		
		Actual	MES	Post	Actual	MES	Post	Actual	MES	Post	Actual	MES	Post
Measured Emission Rate (mg/Nm^3)	PM	45.55	50.00	50.00	37.85	50.00	50.00	72.02	135.00	135.00	133.44	50.00	200
	PM_{10}	27.33	30.00	30.00	22.71	30.00	30.00	43.21	81.00	81.00	80.07	30.00	120
	$PM_{2.5}$	14.58	16.00	16.00	12.11	16.00	16.00	23.05	43.20	43.20	42.70	16.00	64
Calculated Emission Rate (g/s)	PM_{10}	3.36E-01	3.68E-01	3.68E-01	4.40E-01	5.81E-01	5.81E-01	1.73E+00	3.24E+00	3.24E+00	1.04E+01	3.91E+00	1.56E+01
	$PM_{2.5}$	1.79E-01	1.96E-01	1.96E-01	2.34E-01	3.10E-01	3.10E-01	9.22E-01	1.73E+00	1.73E+00	5.57E+00	2.09E+00	8.34E+00
Notes:	- PM_{10} emission rate calculated as 60% of total PM (USEPA, 1986; and Zhao et al, 2017) - $PM_{2.5}$ emission rate calculated as 32% of total PM (USEPA, 1986; and Zhao et al, 2017) - MES emissions rates are worst case for PDD1, PDD2 and PDD3 (i.e. are higher than current actual measured results), yet remain compliant with the MES, to remain environmentally conservative. - Postponement "Post" emission rates are worst case for PDD1, PDD2 and PDD3 (i.e. are higher than current actual measured results), yet remain compliant with the MES, to remain environmentally conservative. Emissions rates for SWS is 200 mg/nm^3.												

5.1 EMERGENCY INCIDENTS

South32 has implemented several interventions at the Sinter Plant, to reduce emissions from all four stacks, which include, but are not limited to, resistivity and isokinetic/performance testing, optimisation of existing ESP's, and refurbishment of ESP's. While these interventions have assisted South32 MMT in reducing emissions from the De-Dust stacks, the SWS stack emissions remain elevated. As such, the SWS has not been able to achieve compliance with the more stringent MES for PM (50 mg/Nm^3), as the current Electrostatic Precipitators (ESP) were designed for a maximum PM emission limit of 100 mg/Nm^3.

6 IMPACT OF ENTERPRISE ON THE RECEIVING ENVIRONMENT

6.1 ANALYSIS OF EMISSIONS ON HUMAN HEALTH

6.1.1 REGULATORY FRAMEWORK FOR AIR QUALITY

Until 2004, South Africa's approach to air pollution control was driven by the Atmospheric Pollution Prevention Act 45 of 1965 (APPA) which was repealed with the promulgation of NEM:AQA. NEM:AQA represents a shift in South Africa's approach to air quality management, from source-based control to integrated effects-based management. The objectives of NEM:AQA are to:

- Protect the environment by providing reasonable measures for:
  - The protection and enhancement of air quality.
  - The prevention of air pollution and ecological degradation.
  - Securing ecologically sustainable development while promoting justifiable economic and social development.
  - Give effect to everyone's right "*to an environment that is not harmful to their health and well-being*".

Significant functions detailed in NEM:AQA include:

- The National Framework for Air Quality Management (DEA, 2018).
- Institutional planning matters, including:
  - The establishment of a National Air Quality Advisory Committee.
  - The appointment of Air Quality Officers (AQOs) at each level of government.
  - The development, implementation and reporting of Air Quality Management Plans (AQMP) at national, provincial and municipal levels.
- Air quality management measures including:
  - The declaration of Priority Areas where ambient air quality standards are being, or may be, exceeded.
  - The listing of activities that result in atmospheric emissions and which have the potential to impact negatively on the environment and the licensing thereof through an Atmospheric Emissions License (AEL).
  - The declaration of Controlled Emitters.
  - The declaration of Controlled Fuels.

- Procedures to enforce Pollution Prevention Plans or Atmospheric Impact Reporting for the control and inventory of atmospheric pollutants of concern.
- Requirements for addressing dust and offensive odours.

6.1.1.1 LISTED ACTIVITIES AND MINIMUM EMISSIONS STANDARDS

South32 MMT operates a Sinter Plant, triggering listed activity *Category 4: Metallurgical Industry, Sub-category 4.5 Sinter Plants* of Government Notice Regulation 893 of 2013 with associated MES presented in **Table 6-1**.

Table 6-1: Minimum Emission Standards for Sub-category 4.5 – Sinter Plants

Description	Sinter plants for agglomeration of fine ores using a heating process, including sinter cooling where applicable.		
Applications	All installations.		
Substance or mixture of substances			
Common name	**Chemical symbol**	**Plant status**	**mg/Nm³ under normal conditions of 273 Kelvin and 101.3 kPa**
Particulate matter	N/A	New	50
		Existing	100
Sulphur dioxide	SO_2	New	500
		Existing	1,000
Oxides of nitrogen	NO_X expressed as NO_2	New	700
		Existing	1,200

6.1.1.2 SOUTH AFRICAN AMBIENT AIR QUALITY STANDARDS

Ambient air quality standards are defined as "*targets for air quality management which establish the permissible concentration of a particular substance in, or property of, discharges to air, based on what a particular receiving environment can tolerate without significant deterioration*" (DEA, 2000). The aim of these standards is to provide a benchmark for air quality management and governance. South Africa's National Ambient Air Quality Standards (NAAQS) are based primarily on guidance offered by two standards set by the South African National Standards (SANS):

- SANS 69:2004 Framework for implementing National ambient air quality standards.
- SANS 1929:2005 Ambient air quality – Limits for common pollutants.

SANS 69:2004 makes provision for the establishment of air quality objectives for the protection of human health and the environment as a whole. Such air quality objectives include limit values, alert thresholds and target values.

SANS 1929:2005 uses the provisions in SANS 69:2004 to establish air quality objectives for the protection of human health and the environment and stipulates that limit values are initially set to protect human health. The setting of such limit values represents the first step in a process to manage air quality and initiate a process to ultimately achieve acceptable air quality nationally.

The priority pollutants as defined by the NEM:AQA are SO_2, NO_2, PM_{10}, $PM_{2.5}$, benzene, CO, Ozone (O_3) and Lead (Pb). Pollutants assessed in this study are PM_{10} and $PM_{2.5}$ as PM is the only pollutant that South32 MMT is requesting postponement from. The NAAQS presented in **Table 6-2** were promulgated in 2009 and 2012. The NAAQS generally have specific averaging periods, compliance timeframes, permissible frequencies of exceedance and measurement reference methods.

The National Dust Control Regulations (No. R.827) were promulgated on 01 November 2013 in terms of Section 53(o), read with Section 32 of the NEMAQA. The acceptable dust fallout rates, as included in the National Dust Control Regulations, expressed in units of mg/m^2/day over a typical 30-day averaging period are presented in **Table 6-3**: National Dust Control Regulations

The National Dust Control Regulations are presented as dust fallout monitoring results are included in this AIR (see **Section 6.1.4**); however, dust fallout is not included in the dispersion modelling of this AIR.

Table 6-2: National Ambient Air Quality Standards

Pollutant	Averaging Period	Concentration (µg/m^3)	Frequency of Exceedance	Compliance Date
PM_{10}	24-hour	120	4	Immediate – 31 Dec 2014
		75	4	01 Jan 2015
	1 year	50	0	Immediate – 31 Dec 2014
		40	0	01 Jan 2015
$PM_{2.5}$	24-hour	65	4	Immediate – 31 Dec 2015
		40	4	01 Jan 2016 – 31 Dec 2029
		25	4	01 Jan 2030
	1 year	25	0	Immediate – 31 Dec 2015
		20	0	01 Jan 2016 – 31 Dec 2029
		15	0	01 Jan 2030

Table 6-3: National Dust Control Regulations

Restriction Areas	Dust Fallout Rate (D) (mg/m^2/day) 30-Day Average(1)	Permitted Frequency of Exceedances	Reference Method
Residential Area	D < 600	Two within a year, not sequential months	ASTM D1739
Non-Residential Area	600 < D < 1,200(2)	Two within a year, not sequential months	ASTM D1739

This table provides the information as contained in the National Dust Control Regulations. Two aspects to note:

1) The dust fallout rate is referred to only in mg/m^2/day and not normalised to the 30-day average. The rate can only be presented to either and not both. The 30-day average will require an adjustment to the accepted rates.

2) The accepted dust fallout rate at non-residential areas is below 1,200 mg/m^2/day.

6.1.2 HEALTH IMPACTS ASSOCIATED WITH NATIONALLY REGULATED AIR POLLUTANTS

The composition of air pollutant mixtures, pollutant concentrations, duration of exposure and other susceptibility factors (e.g. age, nutritional status and predisposing conditions) can lead to diverse impacts on human health (**Table 6-4**). High risk individuals include the elderly, people with pre-existing heart or lung disease, pregnant women, asthmatics and children.

Table 6-4: NAAQS regulated air pollutants and associated human health impacts

Pollutant	Description	Health effects
Particulate matter (PM_{10} & $PM_{2.5}$)	Particles can be classified by their aerodynamic properties into coarse particles, PM_{10} (particulate matter with an aerodynamic diameter of less than 10 µm) and fine particles, $PM_{2.5}$ (particulate matter with an aerodynamic diameter of less than 2.5 µm) (Harrison and Grieken, 1998). Particulate air pollution affects the respiratory system (WHO, 2000). Particle size is important for health because it controls how far into the respiratory system particles are able to permeate. Fine particles have been found to be more damaging to human health than coarse particles as larger particles are less respirable in that they do not pass from the lungs into the bloodstream (Manahan, 1991).	Increase in lower respiratory symptoms Reduced lung function Inflammation of the lungs Angina Myocardial infraction Bronchitis Mortality

6.1.3 METEOROLOGICAL OVERVIEW

Since meteorological conditions affect how pollutants emitted into the air are directed, diluted and dispersed within the atmosphere, the incorporation of reliable data into an air quality assessment is of the utmost importance. Dispersion comprises vertical and horizontal components of motion. The stability of the atmosphere and the depth of the atmospheric mixing layer control the vertical component. The horizontal dispersion of pollution in the boundary layer is primarily a function of the wind field. The wind speed determines both the distance of downwind transport and the rate of dilution as the plume 'stretches'. Mechanical turbulence is influenced by wind speed in combination with surface roughness.

Parameters that need to be considered in the characterisation of dispersion potential include wind speed, wind direction, atmospheric stability, ambient air temperature and mixing depth. To accurately represent meteorological conditions occurring at South32 MMT, WRF pre-processed meteorological data was purchased from Lakes Environmental Consultants Inc. for the January 2021 – December 2023 period. The data coverage is centred over the South32 MMT Sinter Plant (25.38966°S, 22.99355°E) with a grid cell dimension of 4 km x 4 km resolution at an elevation of 1,107 m.

Additionally, temperature, humidity, pressure, rainfall and wind data for the January 2021 to December 2023 period was sourced from the South African Weather Service (SAWS) Kathu station (27.6700°S, 23.0060°E). The SAWS Kathu station is located approximately 30 km south of South32 MMT and due to the distance, the data should be viewed with caution. Nonetheless, the scarcity of meteorological stations in the region of South32 MMT, requires that that the SAWS Kathu station data is considered to provide a climatic overview of the region. Furthermore, South32 MMT own and operate an onsite rain gauge, which was included in the climatic summary for comparative purposes.

The percentage data recovery for each meteorological variable is provided in **Table 6-5**. It must be noted that the South African National Accreditation System (SANAS, 2012) TR 07-03 standards stipulate a minimum data recovery of 90% for the dataset to be deemed representative of conditions during a specific reporting period. The percentage recovery for all parameters recorded exceeded 90% and the data is thus considered reliable for use in this assessment.

Table 6-5: Percentage data recovery for the January 2021 – December 2023 monitoring period from the SAWS Kathu Station

Data Source	Latitude (°S)	Longitude (°E)	Data Recovery		
			Temperature	Rainfall	Wind
SAWS Kathu	27.6700	23.0060	98%	98%	97%

6.1.3.1 Temperature and Rainfall

Ambient air temperature influences plume buoyancy as the higher the plume temperature is above the ambient air temperature, the higher the plume will rise. Further, the rate of change of atmospheric temperature with height influences vertical stability (i.e. mixing or inversion layers). Rainfall is an effective removal mechanism of atmospheric pollutants.

Figure 6-1 illustrates the average monthly relative humidity, temperature, temperature range (maximum and minimum) from the SAWS Kathu station for the period of 2021 to 2023. Rainfall from both the SAWS Kathu and South32 MMT rain gauge was included in the figure. South32 MMT receives on average 478 mm (South32 MMT) to 544 mm (SAWS Kathu) of rainfall per year, with high rainfall occurring during the summer (December to February) and autumn (March to May) with drier conditions during the winter months (June to August). The highest daily average temperature recorded was 32.5°C (December 2022) while the lowest daily average temperature was 3.1°C (July 2021).

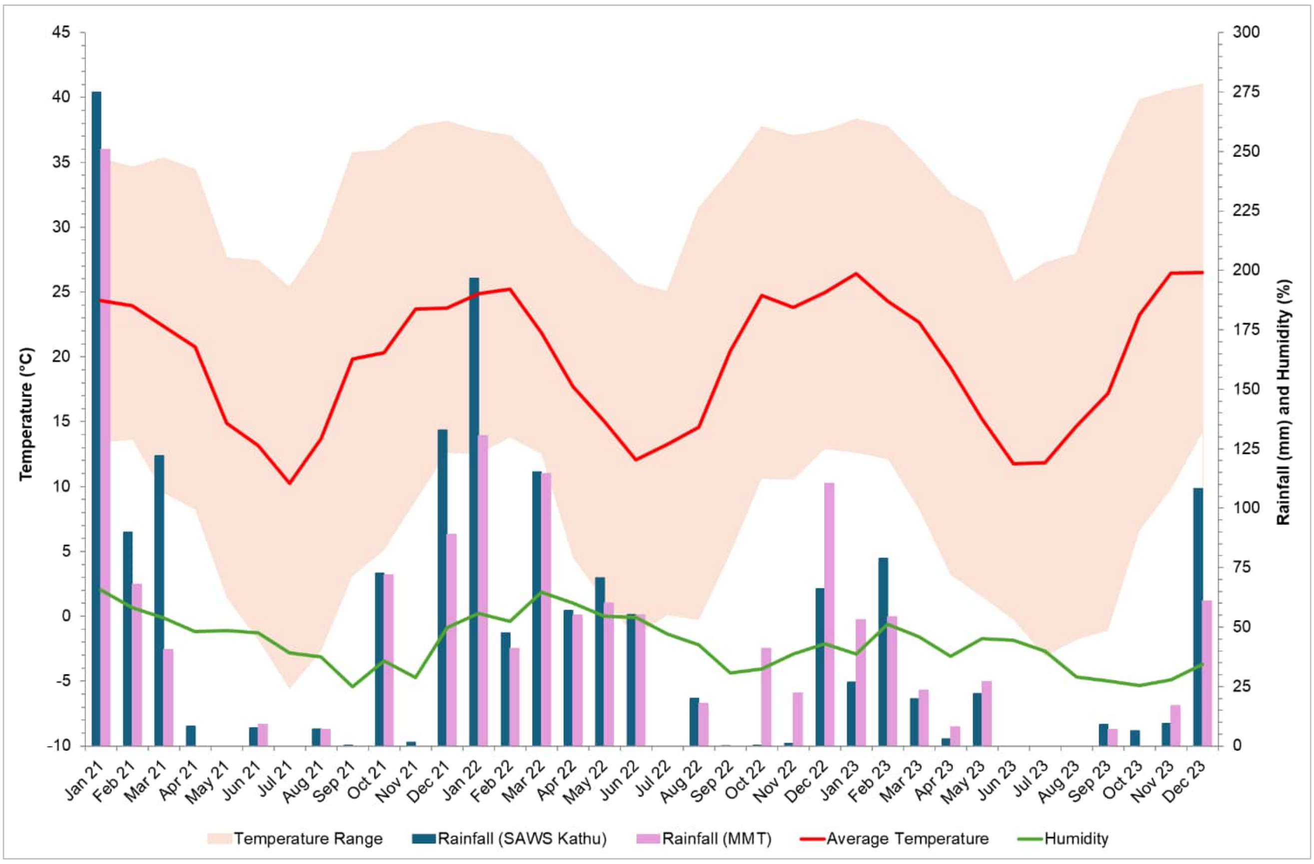


Figure 6-1: Climatic summary from the SAWS Kathu Station (temperature, rainfall and humidity) and MMT (rainfall) for the January 2021 to December 2023 period

6.1.3.2 Wind Field

Wind roses are useful for illustrating the prevailing meteorological conditions of an area, indicating wind speeds and directional frequency distributions. In the following wind roses, the colour of the bar indicates the wind speed while the length of the bar represents the frequency of winds *blowing from* a certain direction (as a percentage).

Period wind rose plots (2021-2023) from the South African Weather Service (SAWS) Kathu station and WRF modelled data are presented in **Figure 6-2**. The data plots for both datasets exhibit different predominant wind directions. In the case of the WRF data, prevailing winds are from the north, northeast, north-northeast and north-northwest, with calm wind conditions (winds < 1 m/s) occurring 3.25% of the time. In the SAWS Kathu dataset, the dominant wind directions are from the south-southeast and north, with a similar occurrence of calm conditions (3.66%) to the WRF dataset. Wind speeds in the WRF dataset are a stronger than those recorded by the SAWS Kathu station. Average recorded wind speeds are, however, similar for both datasets with an average speed of 4.38 m/s for the WRF model data and 3.77 m/s for the SAWS Kathu data.

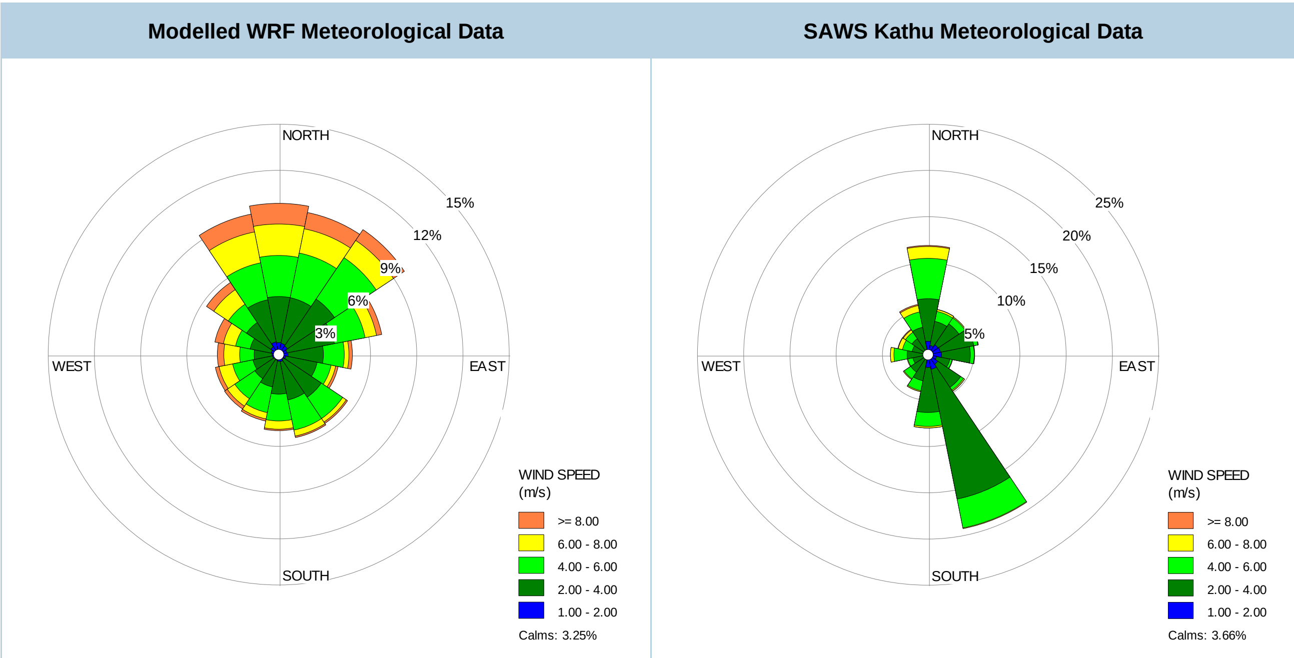


Figure 6-2: Wind rose plots for SAWS Kathu for the period January 2021 to December 2023

Seasonal variations in wind are depicted in **Figure 6-3**. Seasonal winds from the WRF dataset remain fairly consistent throughout the year, with the predominant winds occurring from the north, northeast, north-northeast and north-northwest during all seasons. The WRF dataset does not indicate significant variations in predominant winds, however, calm conditions vary from 1.86% during spring to 4.66% during autumn. The SAWS Kathu dataset indicates a shift from dominant northerly winds during summer to south-south-easterly winds during autumn, winter and spring. Calm conditions from the SAWS Kathu range from 2.26% in spring to 4.57% in autumn.

Diurnal variations in winds are depicted in **Figure 6-4**. During the early morning hours (00:00 – 06:00) winds from the northeast, east-northeast and southeast prevail in the WRF dataset, while winds from the south-southeast prevail in the SAWS Kathu dataset. After sunrise a similar trend occurs in both the WRF and SAWS Kathu datasets, with dominant northerly winds. During the afternoon (12:00 – 18:00), winds from the WRF dataset shift to the north-northwest, while northerly winds prevail from the SAWS Kathu dataset. This is also the period of highest wind speeds and the lowest frequency of calm conditions, evident in both datasets. During the early evening into the night (18:00 – 24:00) winds from the southwest and south-southwest become dominant in the WRF dataset, while the south-south-easterly winds return in the SAWS Kathu dataset.

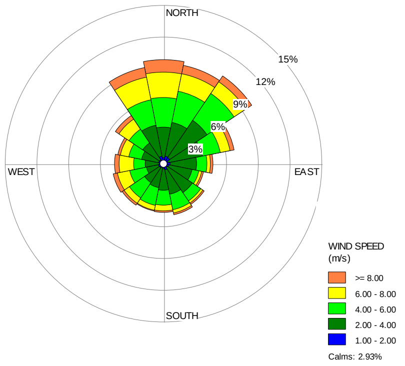
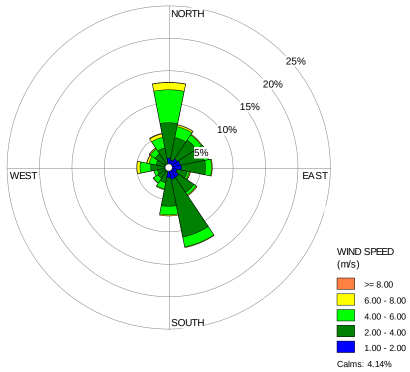
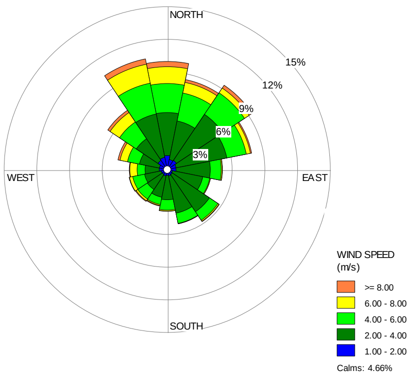
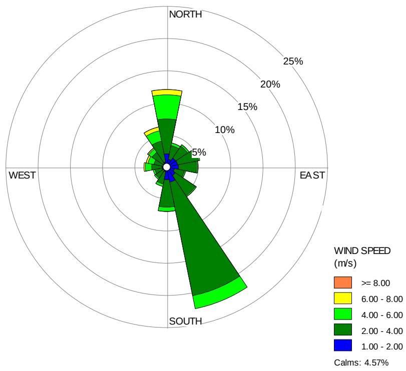
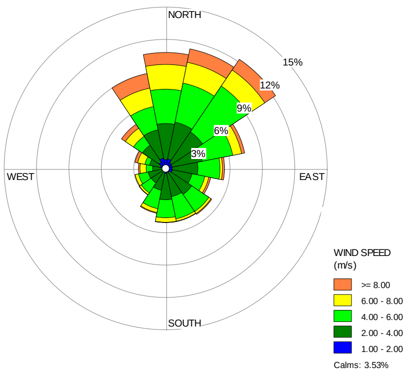
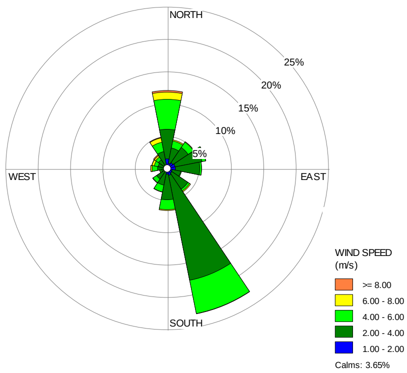
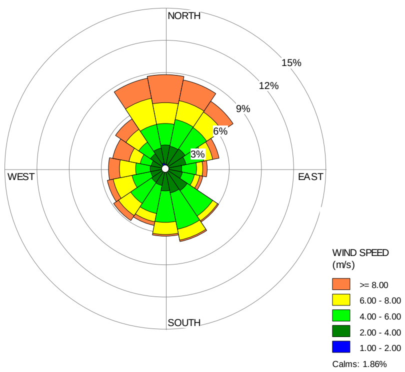
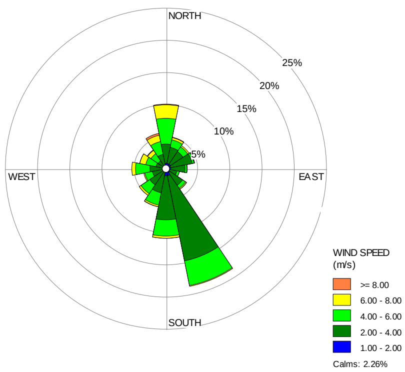
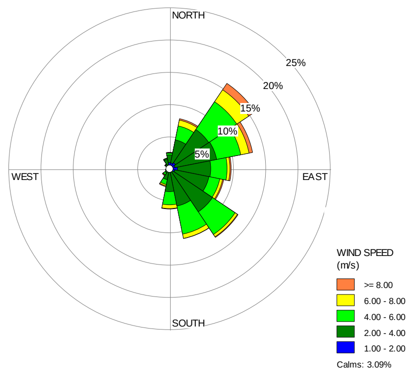
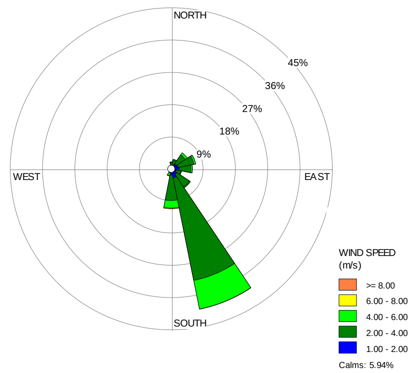
Modelled WRF Meteorological Data	SAWS Kathu Meteorological Data
 *Summer*	 *Summer*
 *Autumn*	 *Autumn*
 *Winter*	 *Winter*
 *Spring*	 *Spring*

Figure 6-3: Seasonal wind rose plots for the period January 2021 to December 2023

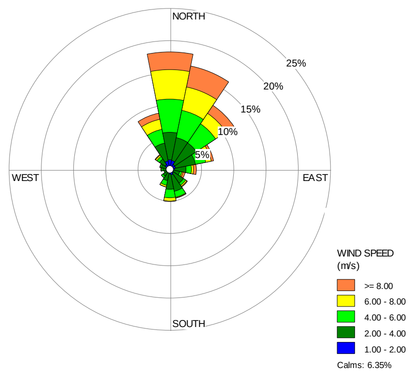
Modelled WRF Meteorological Data	SAWS Kathu Meteorological Data



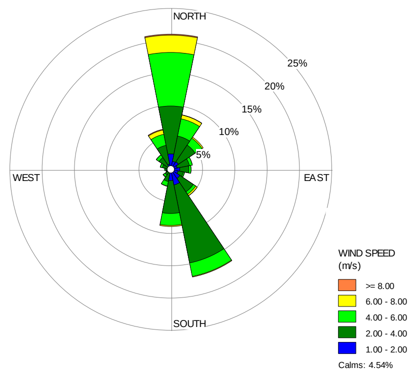
00:00 – 06:00



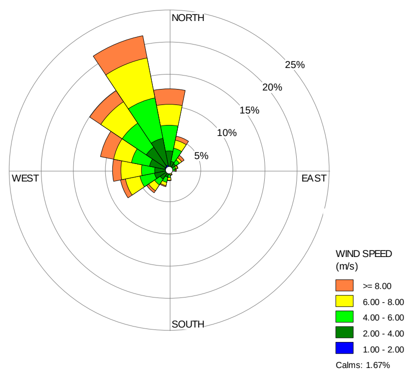
00:00 – 06:00



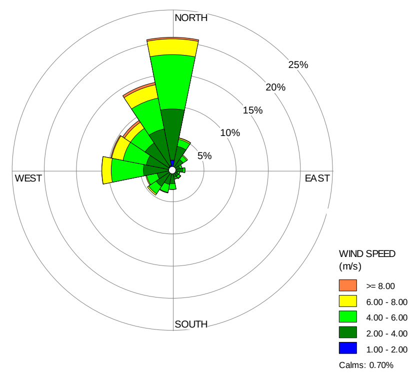
06:00 – 12:00



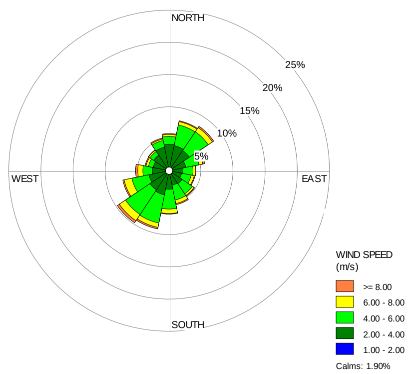
06:00 – 12:00



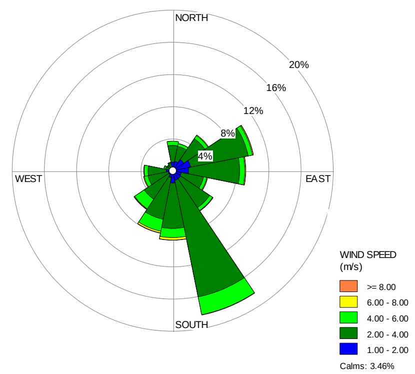
12:00 – 18:00



12:00 – 18:00



18:00 – 24:00



18:00 – 24:00

Figure 6-4: Diurnal wind rose plots for the period January 2021 to December 2023

6.1.4 AMBIENT AIR QUALITY REVIEW

6.1.4.1 EXISTING SOURCES OF EMISSIONS

A qualitative discussion of identified emission sources in the vicinity of the study site is provided below. Key emission sources in the region are mining activities, agricultural activities, domestic fuel burning, vehicle emissions and unpaved roads. These emission sources contribute towards the air quality status quo within the region, with particulates being of particular concern in this regard.

MINING EMISSIONS

Numerous mining operations occur in the region. Mining is identified as the largest source of particulates (PM_{10}, $PM_{2.5}$, TSP) within the region, with smaller contributions from industry and biomass burning (Northern Cape AQMP, 2018). Dust and fine particulate emissions associated with mining operations include wind erosion from waste rock dumps, tailings facilities, open mining pits, blasting emissions, ore processing and refining, sintering operations, unpaved mine access roads and other exposed areas. Factors that influence the rate of wind erosion include surface compaction, moisture content, vegetation, shape of storage pile, particle size distribution, wind speed and rain. Emissions from mining activities are anticipated to be one of the dominant emissions influencing and impacting on the regional air quality (Northern Cape AQMP, 2018).

AGRICULTURAL EMISSIONS

The primary source of emissions from agricultural activities in the region are likely to result from biomass burning of pastures, as part of controlled burning practices. Biomass burning is an incomplete combustion process that produces PM_{10}, CH_4, CO and NO_2. Emissions from agricultural activities are difficult to control due to the seasonality of emissions and the large surface area producing emissions (USEPA, 1995). Most of the agricultural activities in the region appear to be low density commercial farming of goats, sheep, cattle and game farming which is common in the region. Agricultural emissions are not anticipated to significantly influence the air quality in the area due to the low density of the activities. Particulate emissions may increase during the winter period due to seasonal wildfires (USEPA, 1995).

DOMESTIC FUEL BURNING EMISSIONS

Domestic fuel burning of coal emits a large amount of gaseous and particulate pollutants including SO_2, heavy metals, total and respirable particulates, inorganic ash, CO, polycyclic aromatic hydrocarbons (PAH), and benzo(a) pyrene. Pollutants arising due to the combustion of wood include respirable particulates, NO_2, CO, PAH, particulate benzo(a) pyrene and formaldehyde. The main pollutants emitted from the combustion of paraffin are NO_2, particulates, CO and PAH. The density of housing in the region is relatively low with most residential areas being confined to small local towns. In addition to these small residential areas, individual farms/homesteads are scattered throughout the region and comprise formal and informal residential structures. It is thus highly likely that certain households within the communities are likely to use coal, wood and paraffin for space heating and/or cooking purposes. Emissions from these communities and/or the individual residences/homesteads are not anticipated to have a significant impact on the regional air quality due to their low density and dispersed nature (DEA, 2010b).

VEHICLE EMISSIONS

Vehicle tailpipe emissions within the area are considered insignificant due to the low population density of the region. Vehicle emissions are largely associated with the mining and agricultural activities. Atmospheric pollutants emitted from vehicles include hydrocarbons, CO, CO_2, NO_x, SO_2 and particulates. These pollutants are emitted from the tailpipe, from the engine and fuel supply system, and from brake linings, clutch plates and tyres. Hydrocarbon emissions, such as benzene, result from the incomplete combustion of fuel molecules in the engine. CO is a product of incomplete combustion and occurs when carbon in the fuel is only partially oxidized to CO_2. NO_x is formed by the reaction of nitrogen and oxygen under high pressure and temperature conditions in the engine. SO_2 is emitted due to the high sulphur content of the fuel. Particulates such as lead originate from the combustion process as well as from brake and clutch linings wear (Samaras and Sorensen, 1999).

UNPAVED ROADS

Particulate emissions from unpaved roads occur when loose, spilt material on the road surface becomes suspended as vehicles travel across. The force of the wheels of vehicles travelling on unpaved roadways entrains dust and the road surface is exposed to strong air currents in turbulent shear with the surface. The turbulent wake behind the vehicle continues to act on the road surface after the vehicle has passed. The quantity of dust emissions from unpaved roads varies linearly with the volume of traffic USEPA (1995). Vehicle entrained dust emissions from unpaved roads represent a potentially significant source of fugitive dust in the region. Vehicle entrainment of particulates from unpaved access and haul roads are anticipated to be one of the dominant emissions from South32 MMT.

6.1.4.2 LOCAL AIR QUALITY

As part of the National Framework in managing air quality, Government has initiated the National Air Quality Indicator (NAQI) for South Africa. The NAQI has been developed to weigh, balance and present data in such a way as to provide a verifiable and reportable measure of air quality at the national scale. However, there are no monitoring stations in the region of South32 MMT. As such, the local air quality in this section is based on dust fallout monitoring data since 2021 from South32 MMT. South32 MMT have also recently installed two continuous PM units at the Weighbridge and Dump in August 2024. The purpose of these units is to measure PM_{10} and $PM_{2.5}$ concentrations as part of South32 occupational hygiene programme. Station coordinates and data recovery for PM_{10} and $PM_{2.5}$ is provided in **Table 6-6**. Data recovery for PM_{10} and $PM_{2.5}$ at the Weighbridge and Dump for the period August to October 2024 was 59% and 57%, respectively. Due to the data recovery being below 90% as required by the SANAS (2012) TR 07-03, the data is not presented in this report due to the high-uncertainty of the data, the operational status of the units as well as that the units are designed for occupation hygiene monitoring and not for the purpose of monitoring ambient air quality.

Table 6-6: Coordinates and data recovery of the South32 MMT PM Monitors

Monitoring location	Latitude (°E)	Longitude (°S)	Distance from Sinter Plant (km)	Pollutant	Data Recovery (%)
Weighbridge	27.389744	22.991845	0.27	PM_{10}	59%
				$PM_{2.5}$	59%
Dump	27.379700	22.983203	1.63	PM_{10}	57%
				$PM_{2.5}$	57%

DUST FALLOUT

Dust fallout data was obtained for the January 2021 to September 2024 period from South32 MMT. The dust fallout network consists of eight single dust fallout samplers, classified as non-residential. South32 MMT also have directional dust fallout samplers, however, these are excluded as they are not regulated under the National Dust Control Regulations (2013).

One exceedance of the non-residential standard (1,200 mg/m^2/day) was recorded at MMT08 in May 2023, remaining compliant as the National Dust Control Regulations permit two non-sequential exceedances within a twelve-month period. No other monitoring locations have recorded exceedances; thus all monitoring locations remain compliant with the National Dust Control Regulations.

The dust fallout rates are illustrated in **Figure 6-5** and tabulated in **Table 6-7**.

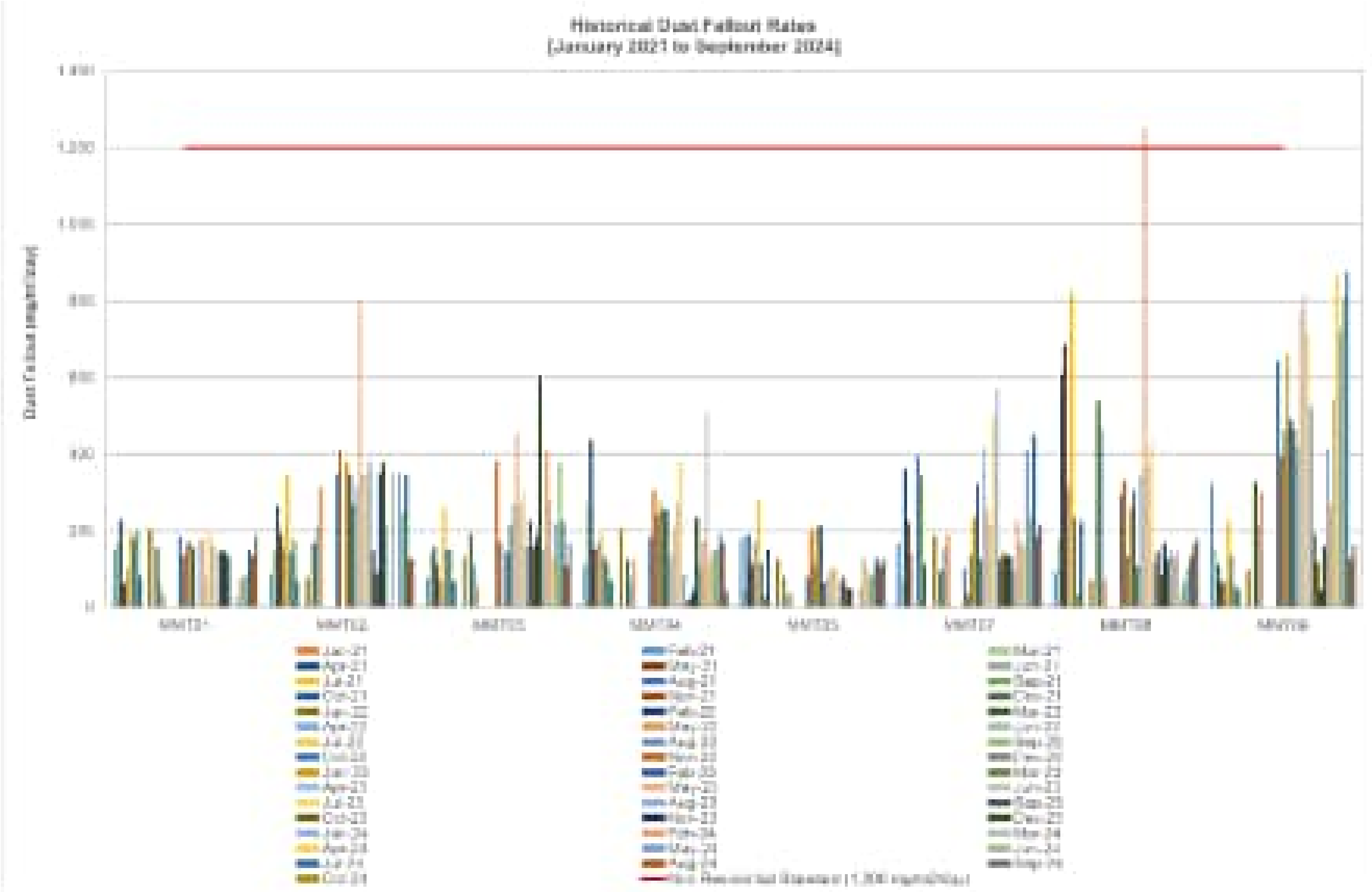


Figure 6-5: Dust fallout rates monitored at MMT for the January 2021 to September 2024 period

Table 6-7: Dust fallout results for January 2021 to September 2024

Sample Location	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21
MMT01	-	150	170	229	64	102	193	180	202	81	-	-
MMT02	-	84	148	265	194	156	342	144	177	69	-	-
MMT03	-	78	142	160	114	73	262	152	151	70	-	-
MMT04	-	112	270	436	153	172	194	133	117	69	-	-
MMT05	-	182	45	188	113	172	283	117	30	151	-	-
MMT07	-	169	71	363	225	143	-	395	343	113	-	-
MMT08	-	97	182	610	688	318	824	234	33	225	-	-
MMT09	-	324	154	111	65	72	227	135	57	46	-	-
Sample Location	**Jan-22**	**Feb-22**	**Mar-22**	**Apr-22**	**May-22**	**Jun-22**	**Jul-22**	**Aug-22**	**Sep-22**	**Oct-22**	**Nov-22**	**Dec-22**
MMT01	206	-	156	64	34	-	-	-	-	185	137	168
MMT02	77	-	168	210	317	-	-	-	-	349	408	-
MMT03	132	-	192	112	57	-	-	-	-	-	385	172
MMT04	206	-	126	74	125	-	-	-	-	185	306	244
MMT05	126	-	80	31	42	-	-	-	-	81	198	110
MMT07	187	-	97	157	189	-	-	-	-	104	35	139
MMT08	73	-	539	465	72	-	-	-	-	296	331	134
MMT09	98	-	329	220	304	-	-	-	-	644	393	465
Notes:	All samplers are classified as Non-Residential. "-" indicates that data was not available. Values in red indicate exceedances of the non-residential standard.											

Sample Location	Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23
MMT01	176	157	-	178	176	76	196	162	-	147	148	140
MMT02	378	347	269	315	803	345	351	381	150	92	351	378
MMT03	-	145	217	272	453	273	305	159	228	160	187	603
MMT04	277	254	256	134	210	275	378	86	16	26	47	236
MMT05	210	215	65	80	101	100	102	64	79	50	50	-
MMT07	234	323	127	421	259	216	497	570	126	145	135	133
MMT08	263	307	109	350	1,251	369	428	118	146	86	169	124
MMT09	661	490	467	417	772	813	716	523	193	118	45	159
Sample Location	**Jan-24**	**Feb-24**	**Mar-24**	**Apr-24**	**May-24**	**Jun-24**	**Jul-24**	**Aug-24**	**Sep-24**	**Oct-24**	**Nov-24**	**Dec-24**
MMT01	130	-	30	78	77	87	151	134	188	N/A	N/A	N/A
MMT02	213	-	352	-	352	252	349	127	127	N/A	N/A	N/A
MMT03	148	406	278	131	220	379	226	108	167	N/A	N/A	N/A
MMT04	107	174	508	122	148	152	189	168	43	N/A	N/A	N/A
MMT05	-	50	132	109	80	90	131	108	126	N/A	N/A	N/A
MMT07	98	228	170	157	409	235	451	187	216	N/A	N/A	N/A
MMT08	148	133	145	34	67	100	131	163	179	N/A	N/A	N/A
MMT09	415	272	546	865	725	812	877	127	164	N/A	N/A	N/A
Notes:	All samplers are classified as Non-Residential. "-" indicates that data was not available. N/A indicates monitoring is ongoing/to be completed. Values in red indicate exceedances of the non-residential standard.											

6.1.5 DISPERSION MODELLING METHODOLOGY

Atmospheric dispersion modelling mathematically simulates the transport and fate of pollutants emitted from a source into the atmosphere. Sophisticated software with algorithms that incorporate source quantification, surface contours and topography, as well as meteorology can reliably predict the downwind concentrations of these pollutants.

As per the *Modelling Regulations*, the level of assessment is dependent on technical factors such as geophysical and meteorological context and the complexity of the emissions inventory. The temporal and spatial resolution and accuracy required from a model must also be taken into account. As such, this assessment is considered to be a Level 2 assessment.

Level 2 assessments should be used for air quality impact assessment in standard/generic licence or amendment processes where:

- The distribution of pollutant concentrations and depositions are required in time and space.
- Pollutant dispersion can be reasonable treated by a straight-line, steady-state, Gaussian plume model with first order chemical transformation. Although more complicated processes may be occurring, a more complicated model that explicitly treats these processes may not be necessary depending on the purposes of the modelling and the zone of interest.
- Emissions are from sources where the greatest impacts are in the order of a few kilometres (less than 50 km), downwind.

For this assessment, the AERMOD dispersion modelling software was utilised. AERMOD is a new generation air dispersion model designed for short-range dispersion of airborne pollutants in steady state plumes that uses hourly sequential meteorological files with pre-processors to generate flow and stability regimes for each hour, that produces output maps of plume spread with key isopleths for visual interpretation and enables, through its statistical output, direct comparisons with the latest National and International ambient air quality standards for compliance testing. AERMOD is the recommended level 2 model prescribed in the Modelling Regulations.

The AERMOD atmospheric dispersion modelling system is an integrated system that includes three modules:

- A steady-state dispersion model designed for short-range (up to 50 km) dispersion of air pollutant emissions from stationary industrial sources.
- A meteorological data pre-processor (AERMET) that accepts surface meteorological data, upper air soundings, and optionally, data from on-site instrument towers. It then calculates atmospheric parameters needed by the dispersion model, such as atmospheric turbulence characteristics, mixing heights, friction velocity, Obukhov length (often referred to as Monin-Obukhov length) and surface heat flux.
- A terrain pre-processor (AERMAP) with the main purpose of providing a physical relationship between terrain features and the behaviour of air pollution plumes. It generates location and height data for each receptor location. It also provides information that allows the dispersion model to simulate the effects of air flowing over hills or splitting to flow around hills.

6.1.5.1 MODELLING SCENARIOS

For the purpose of this study, three dispersion modelling simulations were undertaken as follows:

- Scenario One simulated the current operating conditions whereby the SWS currently exceeds the MES for PM.

- The actual emission rates (mg/Nm^3) obtained from the stack testing reports were used to calculate the emission rates (g/s) for input into this model/assessment.
- The actual emission rates (mg/Nm^3) were, on average, below the MES for stacks PDD1, PDD2, and PDD3, while the emission rate for the SWS (133.44 mg/Nm^3) exceeded the MES (50 mg/Nm^3).

- Scenario Two simulated the future operating conditions where the SWS complies with the MES for PM.
  - The emission rates used for this scenario were the MES rates for all stacks, namely, PDD1, PDD2 and SWS (50 mg/Nm^3), and PDD3 (135 mg/Nm^3).
  - By using the MES for all stacks, it is noted that the emission rates, for Scenario Two are higher than Scenario One for stacks PDD1, PDD2, PDD3. This is due to the average stack testing results for these stacks remaining below the MES.
  - The higher MES emission rates were used as a conservate approach, noting that in some years, the stack testing results exceeded the MES. As such, this scenario takes into consideration that the stacks may have higher emissions in the future, compared to the previous years, yet remaining compliant with the MES.
  - As such this approach, is considered the worst-case approach to remain environmentally conservative in this assessment.

- Scenario Three simulated the postponement operating conditions where the SWS operates with a maximum MES of 200 mg/Nm^3 until such time as the new ESP is operational.
  - The emission rates used for this scenario were the MES rates for stacks PDD1 (50 mg/Nm^3), PDD2 (50 mg/Nm^3), PDD3 (135 mg/Nm^3) and SWS (200 mg/Nm^3).
  - By using the MES for stacks PDD1, PDD2 and PDD3, it is noted that the emission rates, for Scenario Three are higher than Scenario One. This is due to the average stack testing results for these stacks remaining below the MES.
  - The higher MES emission rates were used as a conservate approach, noting that in some years, the stack testing results exceeded the MES. As such, this scenario takes into consideration that the stacks may have higher emissions in the future, compared to the previous years, yet remaining compliant with the MES.
  - As such this approach, is considered the worst-case approach to remain environmentally conservative in this assessment.
  - The proposed MES of 200 mg/Nm^3 for the SWS is also considered a worst-case approach to remain environmentally conservative in this assessment.

6.1.5.2 METEOROLOGICAL INPUT

The meteorological data that was used in the dispersion model was obtained from Lakes Environmental Consultants Inc., in the form of WRF pre-processed meteorological data, for the period January 2021 – December 2023. This is the most complete and representative dataset for the site.

6.1.5.3 TERRAIN INPUT

Terrain influences dispersion of pollutants, especially during periods of stable conditions. The National Aeronautics and Space Administration (NASA) Shuttle Radar Topographic Mission (SRTM) digital elevation model 1-arc data (resolution 30 m x 30 m) was extracted for input into the model to account for terrain influences on dispersion. For the land use categorization, the Global Land Cover Characterization Global Coverage – Version 3 (1 km x 1 km resolution) was used.

6.1.5.4 GRID RESOLUTION

According to the *Modelling Regulations*, the selected size and extent of the model domain is influenced by factors such as source buoyancy, terrain features (i.e. mountains) and the location of contributing sources. Larger domains are recommended for elevated, buoyant sources (e.g. stacks) while smaller domains are considered sufficient for lower release heights, particularly if emissions are at or near ambient temperature. The modelling domain for this study was defined as 30 km x 30 km, centred over the South32 MMT Sinter Plant. The *Modelling Regulations* specify the use of a multi-tier grid and recommend specific tier resolutions. In line with these requirements, the receptor grid resolution was 50 m x 50 m along the mining rights boundary; 100 m x 100 m up to 5,000 m from the centre of the site; 250 m x 250 m up to 10,000 m from the centre of the site; and 1,000 m x 1,000 m thereafter.

6.1.5.5 MODEL INPUT PARAMETERS

Table 6-8 lists the key parameters used in the level 2 dispersion model for the Sinter Plant.

Table 6-8: Key model inputs to be used in the assessment

Parameter		Model Input
Model		
Assessment Level		Level 2
Dispersion Model		AERMOD View 11.0.1
Supporting Models		AERMET and AERMAP
Emissions		
Pollutants modelled		PM_{10} and $PM_{2.5}$
Scenarios		Operational and MES
Chemical transformation		Not Applicable
Exponential decay		Not Applicable
Settings		
Terrain setting		Elevated
Terrain data		SRTM1
Terrain data resolution (m)		Global ~ 30
Land characteristics		Rural
Bowen ratio		4.3
Surface albedo		0.29
Surface roughness		0.30
Grid Receptors		
Modelling domain (km)		30 x 30
Grid resolution	Tier I	100 m
	Tier II	250 m
	Tier III	1,000 m

6.1.5.6 MODEL OUTPUTS

The model outputs that follow (**Section 6.1.6**) show simulated pollutant concentrations experienced at ground level for the Sinter Plant operations. Where applicable, ambient concentrations are compared with the NAAQS to assess impact. For the purposes of this investigation, the following statistical outputs were generated:

- The long-term scenario refers to the period average concentration, which is calculated by averaging all hourly concentrations for the three-year assessment period. The calculation is conducted for each grid point within the modelling domain.
- 99th percentile (P99) concentrations are calculated for comparison with short-term NAAQS as specified in the *Modelling Regulations*.

As defined in the *Modelling Regulations*, ambient air quality standards and guidelines are applied to areas outside the facility fenceline (i.e. beyond the facility boundary). Within the facility boundary, environmental conditions are prescribed by occupational health and safety criteria. As such, tabular model outputs in this assessment are presented for each sensitive receptor, the maximum concentration on the facility boundary and the maximum concentration off-site (i.e. beyond the facility boundary).

6.1.6 DISPERSION MODEL RESULTS

Simulated pollutant concentrations for 24-hour and assessment period (i.e. representing the annual average) averaging periods at each discrete receptor are presented for the current operating conditions in **Table 6-9**, under MES compliance operating conditions in **Table 6-10**, and under postponement operating conditions in **Table 6-11**. Isopleth maps showing pollutant dispersion across the study area are presented in **Figure 6-6** to **Figure 6-17** for the current, MES compliance, and postponement operating conditions. Where applicable, simulated concentrations have been evaluated against their respective NAAQS. Key findings are as follows:

- Scenario One: Current Operating Conditions:
  - PM_{10} emissions do not result in exceedances of the ambient PM_{10} 24-hour (75 µg/m^3) or annual (40 µg/m^3) NAAQS as simulated for the current operations.
    - The current scenario takes into account that the stack emissions from PDD1, PDD2 and PDD3 are below the MES and are thus currently compliant with the MES.
    - The peak concentrations occur onsite; however, remaining well-below the 24-hour and annual NAAQS.
    - Maximum concentrations at all sensitive receptors, 0.51 µg/m^3 and 0.13 µg/m^3 remain well below the 24-hour and annual NAAQS, respectively.
  - $PM_{2.5}$ emissions do not result in exceedances of the ambient $PM_{2.5}$ 24-hour (40 µg/m^3) or annual (20 µg/m^3) NAAQS as simulated for the current operations.
    - The current scenario takes into account that the stack emissions from PDD1, PDD2 and PDD3 are below the MES and are thus currently compliant with the MES.
    - The peak concentrations occur onsite; however, remaining well-below the 24-hour and annual NAAQS.
    - Maximum concentrations at all sensitive receptors, 0.27 µg/m^3 and 0.07 µg/m^3 remain well below the 24-hour and annual NAAQS, respectively.
- Scenario Two: MES Compliance Operating Conditions:
  - PM_{10} emissions do not result in exceedances of the ambient PM_{10} 24-hour (75 µg/m^3) or annual (40 µg/m^3) NAAQS as simulated for the future MES operations.
    - The future MES scenario takes into account that the stack emissions from PDD1, PDD2 and PDD3 are higher than the current emissions; however, remaining compliant with MES.

As mentioned previously, this is to ensure that a worst-case scenario is assessed to remain environmentally conservative.

  - The peak concentrations occur onsite; however, remaining well-below the 24-hour and annual NAAQS.
  - Maximum concentrations at all sensitive receptors, 0.58 µg/m^3 and 0.09 µg/m^3 remain well below the 24-hour and annual NAAQS, respectively.

- $PM_{2.5}$ emissions do not result in exceedances of the ambient $PM_{2.5}$ 24-hour (40 µg/m^3) or annual (20 µg/m^3) NAAQS as simulated for the future MES operations.
  - The future MES scenario takes into account that the stack emissions from PDD1, PDD2 and PDD3 are higher than the current emissions; however, remaining compliant with MES. As mentioned previously, this is to ensure that a worst-case scenario is assessed to remain environmentally conservative.
  - The peak concentrations occur onsite; however, remaining well-below the 24-hour and annual NAAQS.
  - Maximum concentrations at all sensitive receptors, 0.31 µg/m^3 and 0.05 µg/m^3 remain well below the 24-hour and annual NAAQS, respectively.

- Scenario Three: MES Postponement Operating Conditions:
  - PM_{10} emissions do not result in exceedances of the ambient PM_{10} 24-hour (75 µg/m^3) or annual (40 µg/m^3) NAAQS as simulated for the MES postponement operations.
    - The MES postponement scenario takes into account that the stack emissions from PDD1, PDD2 and PDD3 are higher than the current emissions; however, remaining compliant with MES. As mentioned previously, this is to ensure that a worst-case scenario is assessed to remain environmentally conservative.
    - The peak concentrations occur onsite; however, remaining well-below the 24-hour and annual NAAQS.
    - Maximum concentrations at all sensitive receptors, 0.80 µg/m^3 and 0.20 µg/m^3 remain well below the 24-hour and annual NAAQS, respectively.
  - $PM_{2.5}$ emissions do not result in exceedances of the ambient $PM_{2.5}$ 24-hour (40 µg/m^3) or annual (20 µg/m^3) NAAQS as simulated for the MES postponement operations.
    - The MES postponement scenario takes into account that the stack emissions from PDD1, PDD2 and PDD3 are higher than the current emissions; however, remaining compliant with MES. As mentioned previously, this is to ensure that a worst-case scenario is assessed to remain environmentally conservative.
    - The peak concentrations occur onsite; however, remaining well-below the 24-hour and annual NAAQS.
    - Maximum concentrations at all sensitive receptors, 0.43 µg/m^3 and 0.10 µg/m^3 remain well below the 24-hour and annual NAAQS, respectively.
- It is evident from the dispersion modelling results, that despite adopting a worst-case approach to the MES scenarios, the PM_{10} and $PM_{2.5}$ concentrations remain well below the relevant NAAQS as well as peak concentrations remaining within the boundary of South32 MMT.

Table 6-9: Simulated pollutant concentrations at sensitive receptors under current operating conditions (Scenario One)

Pollutant	Predicted Concentrations (µg/m^3)			
	PM_{10}		$PM_{2.5}$	
Averaging Period	24-hour	Period	24-hour	Period
Reference	NAAQS	NAAQS	NAAQS	NAAQS
Standard	75	40	40	20
Boundary Peak	5.48E+00	1.97E+00	2.92E+00	1.05E+00
Sensitive Receptors				
SR1	4.79E-01	7.25E-02	2.55E-01	3.86E-02
SR2	5.14E-01	8.27E-02	2.74E-01	4.41E-02
SR3	2.26E-01	5.88E-02	1.21E-01	3.14E-02
SR4	4.86E-01	1.27E-01	2.59E-01	6.79E-02
SR5	2.99E-01	5.52E-02	1.59E-01	2.95E-02
SR6	1.59E-01	2.58E-02	8.49E-02	1.38E-02
SR7	2.55E-01	3.36E-02	1.36E-01	1.79E-02
SR8	2.42E-01	3.43E-02	1.29E-01	1.83E-02
SR9	2.13E-01	2.63E-02	1.13E-01	1.40E-02
SR10	2.15E-01	2.65E-02	1.15E-01	1.41E-02
SR11	3.36E-01	4.53E-02	1.79E-01	2.41E-02
SR12	2.49E-01	2.84E-02	1.33E-01	1.51E-02
SR13	2.78E-01	3.39E-02	1.48E-01	1.81E-02
SR14	4.14E-01	4.72E-02	2.21E-01	2.52E-02
SR15	3.03E-01	2.97E-02	1.61E-01	1.58E-02
SR16	2.82E-01	2.89E-02	1.51E-01	1.54E-02
SR17	3.01E-01	3.01E-02	1.60E-01	1.60E-02
SR18	4.89E-01	8.31E-02	2.61E-01	4.43E-02
SR19	2.18E-01	5.72E-02	1.16E-01	3.05E-02
Notes:	Red: exceeds applicable reference threshold. Current emission rates extracted from stack testing reports; PDD1, PDD2 and PDD3 emission rates are lower than the MES; SWS emission rate is above the MES.			

Table 6-10: Simulated pollutant concentrations at sensitive receptors under MES compliance operating conditions (Scenario Two)

Pollutant	Predicted Concentrations (µg/m³)			
	PM_{10}		$PM_{2.5}$	
Averaging Period	24-hour	Period	24-hour	Period
Reference	NAAQS	NAAQS	NAAQS	NAAQS
Standard	75	40	40	20
Boundary Peak	5.70E+00	2.34E+00	3.04E+00	1.25E+00
Sensitive Receptors				
SR1	5.58E-01	7.49E-02	2.98E-01	3.99E-02
SR2	5.78E-01	8.04E-02	3.08E-01	4.29E-02
SR3	2.16E-01	4.78E-02	1.15E-01	2.55E-02
SR4	4.42E-01	9.17E-02	2.36E-01	4.89E-02
SR5	2.67E-01	4.14E-02	1.42E-01	2.21E-02
SR6	1.63E-01	2.06E-02	8.71E-02	1.10E-02
SR7	2.12E-01	2.70E-02	1.13E-01	1.44E-02
SR8	2.11E-01	2.75E-02	1.13E-01	1.47E-02
SR9	1.95E-01	2.25E-02	1.04E-01	1.20E-02
SR10	2.00E-01	2.25E-02	1.07E-01	1.20E-02
SR11	3.74E-01	4.51E-02	1.99E-01	2.41E-02
SR12	2.34E-01	2.48E-02	1.25E-01	1.32E-02
SR13	3.43E-01	3.35E-02	1.83E-01	1.79E-02
SR14	4.68E-01	4.57E-02	2.49E-01	2.43E-02
SR15	3.62E-01	2.84E-02	1.93E-01	1.52E-02
SR16	3.09E-01	2.72E-02	1.65E-01	1.45E-02
SR17	3.26E-01	2.84E-02	1.74E-01	1.52E-02
SR18	5.65E-01	8.22E-02	3.02E-01	4.39E-02
SR19	2.29E-01	4.56E-02	1.22E-01	2.43E-02
Notes:	Red: exceeds applicable reference threshold. MES compliance conditions assume the emission rates for PDD1, PDD2 and PDD3 are equal to the MES (i.e. slightly higher than current emissions rates); SWS emission rate is equal to the MES (i.e. lower than the current emission rates).			

Table 6-11: Simulated pollutant concentrations at sensitive receptors under MES postponement operating conditions (Scenario Three)

Pollutant	Predicted Concentrations (µg/m³)			
	PM_{10}		$PM_{2.5}$	
Averaging Period	24-hour	Period	24-hour	Period
Reference	NAAQS	NAAQS	NAAQS	NAAQS
Standard	75	40	40	20
Boundary Peak	8.32E+00	3.09E+00	4.44E+00	1.65E+00
Sensitive Receptors				
SR1	7.63E-01	1.13E-01	4.07E-01	6.01E-02
SR2	8.00E-01	1.28E-01	4.26E-01	6.85E-02
SR3	3.52E-01	9.08E-02	1.88E-01	4.84E-02
SR4	7.47E-01	1.96E-01	3.99E-01	1.04E-01
SR5	4.57E-01	8.49E-02	2.44E-01	4.53E-02
SR6	2.60E-01	3.97E-02	1.39E-01	2.12E-02
SR7	4.01E-01	5.18E-02	2.14E-01	2.77E-02
SR8	3.72E-01	5.29E-02	1.98E-01	2.82E-02
SR9	3.37E-01	4.06E-02	1.80E-01	2.17E-02
SR10	3.41E-01	4.10E-02	1.82E-01	2.19E-02
SR11	5.27E-01	7.04E-02	2.81E-01	3.75E-02
SR12	3.83E-01	4.39E-02	2.04E-01	2.34E-02
SR13	4.39E-01	5.27E-02	2.34E-01	2.81E-02
SR14	6.32E-01	7.35E-02	3.37E-01	3.92E-02
SR15	4.65E-01	4.61E-02	2.48E-01	2.46E-02
SR16	4.50E-01	4.49E-02	2.40E-01	2.40E-02
SR17	4.74E-01	4.67E-02	2.53E-01	2.49E-02
SR18	7.72E-01	1.29E-01	4.12E-01	6.88E-02
SR19	3.44E-01	8.81E-02	1.83E-01	4.70E-02
Notes:	Red: exceeds applicable reference threshold. MES postponement conditions assume the emission rates for PDD1, PDD2 and PDD3 are equal to the MES (i.e. slightly higher than current emissions rates); SWS emission rate is 200 mg/Nm³ (i.e. above current emission rates).			

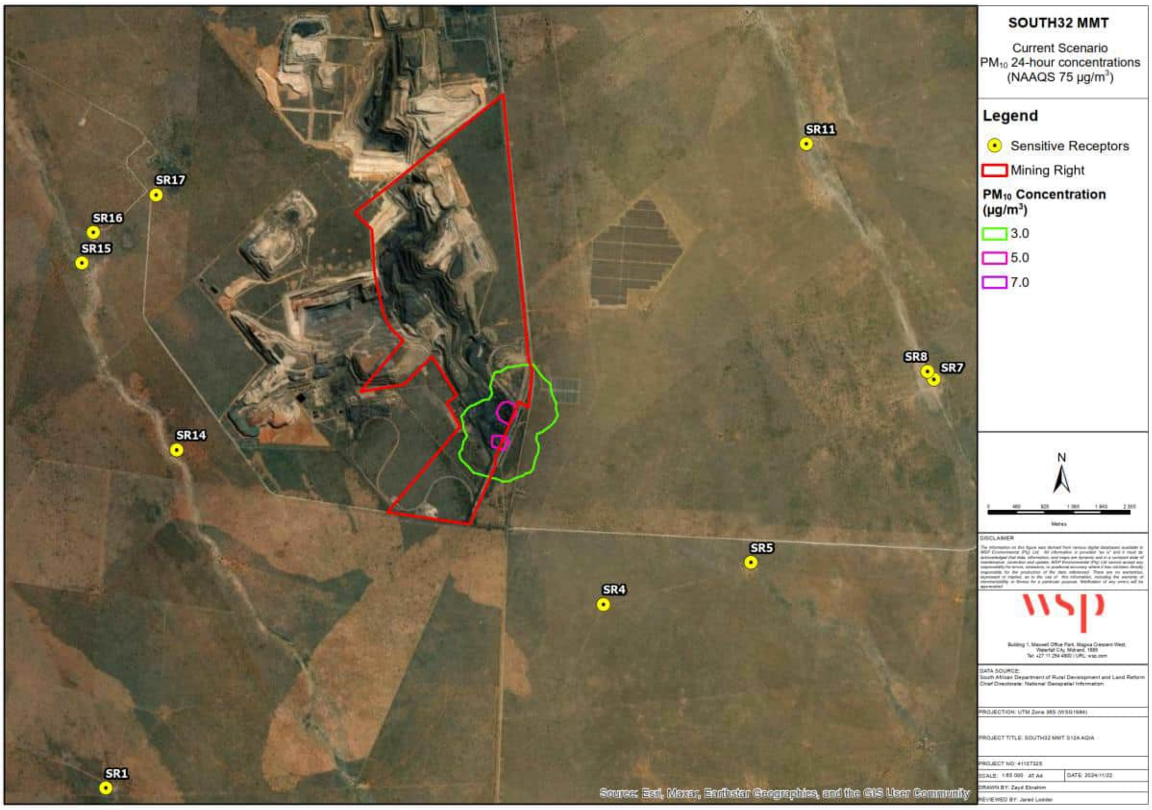


Figure 6-6: P99 24-hour average PM_{10} concentrations (Current Operations)

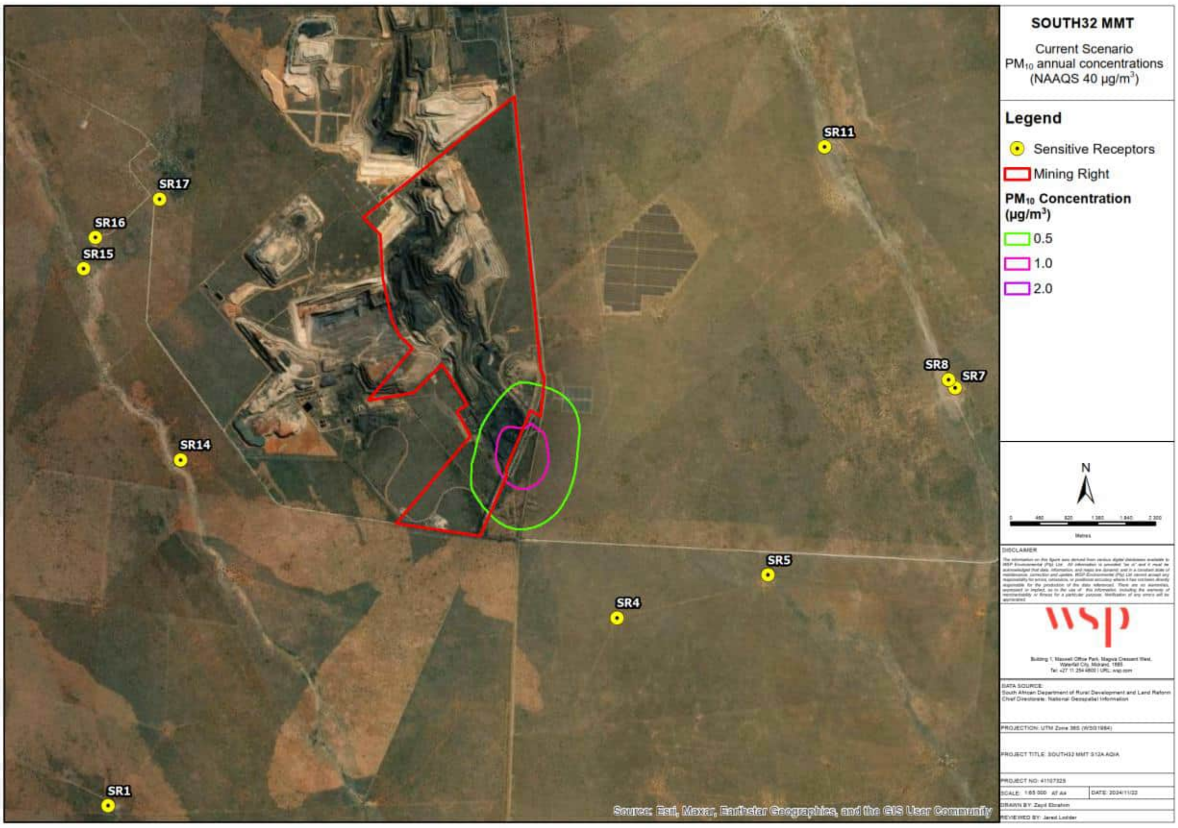


Figure 6-7: Period average PM_{10} concentrations (Current Operations)

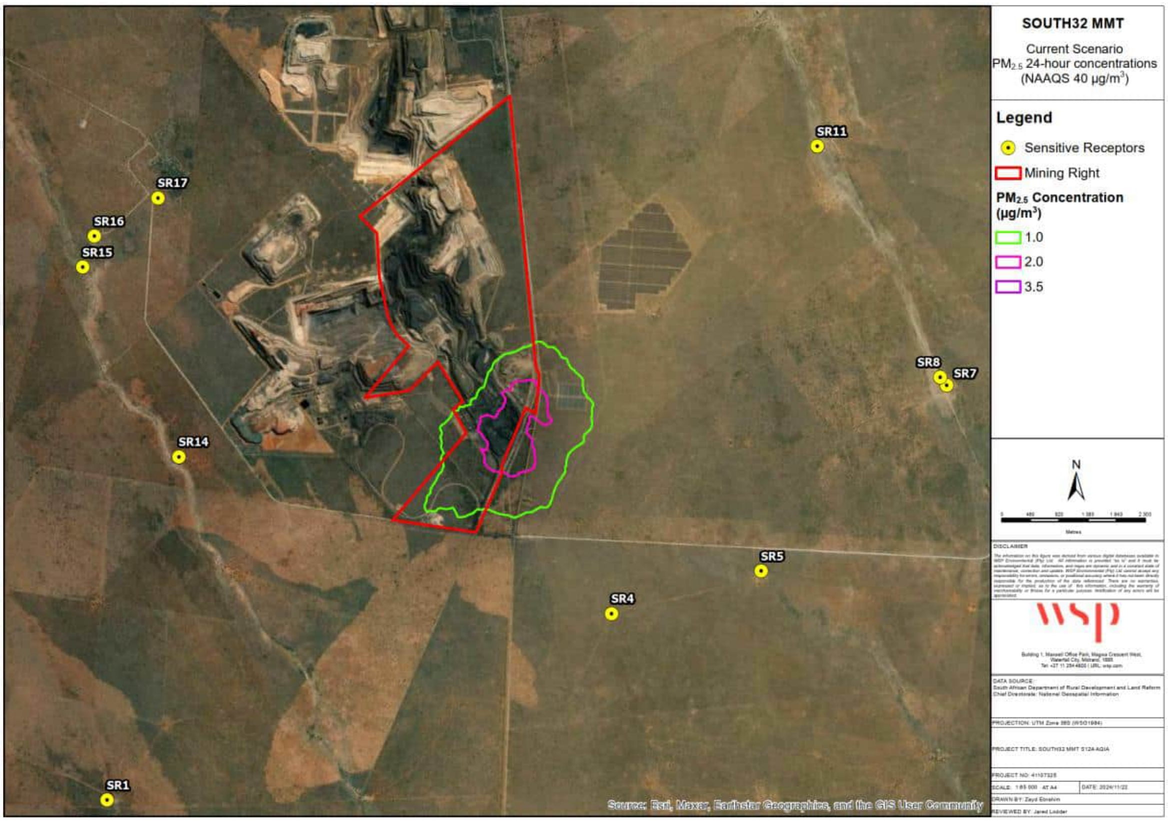


Figure 6-8: P99 24-hour average $PM_{2.5}$ concentrations (Current Operations)

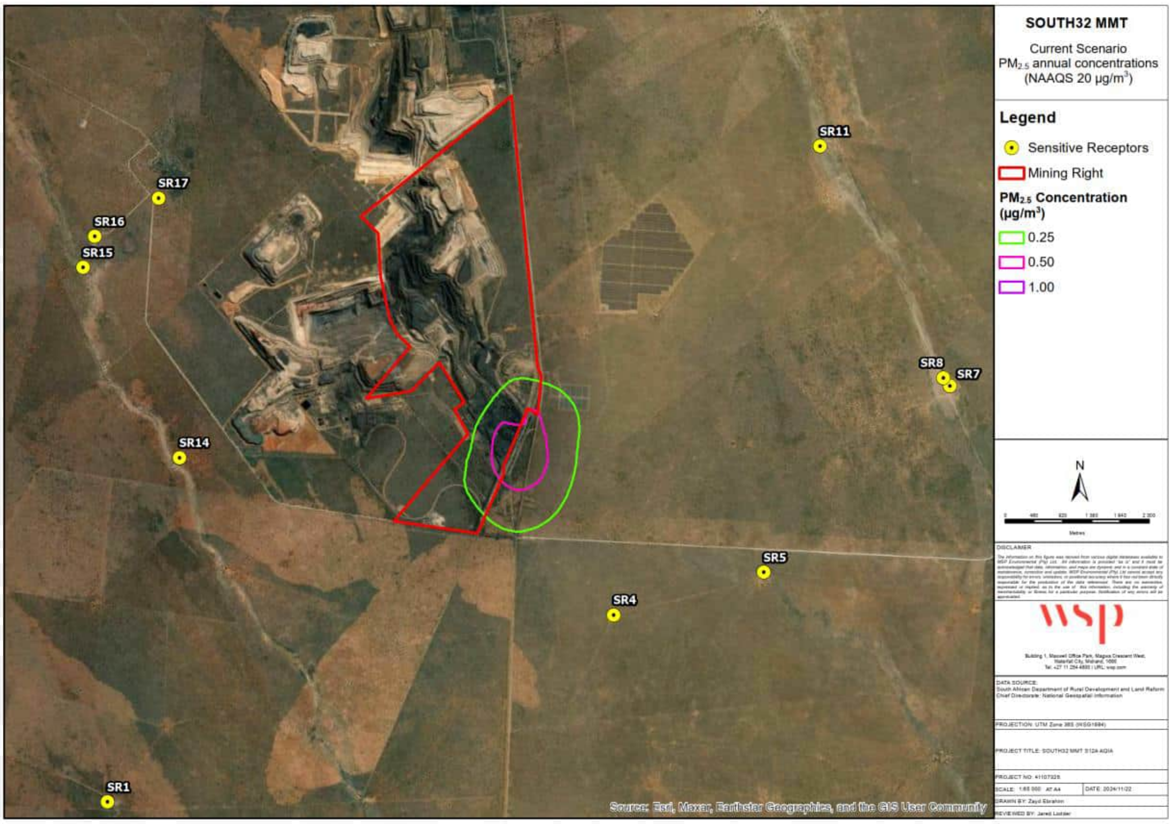


Figure 6-9: Period average $PM_{2.5}$ concentrations (Current Operations)

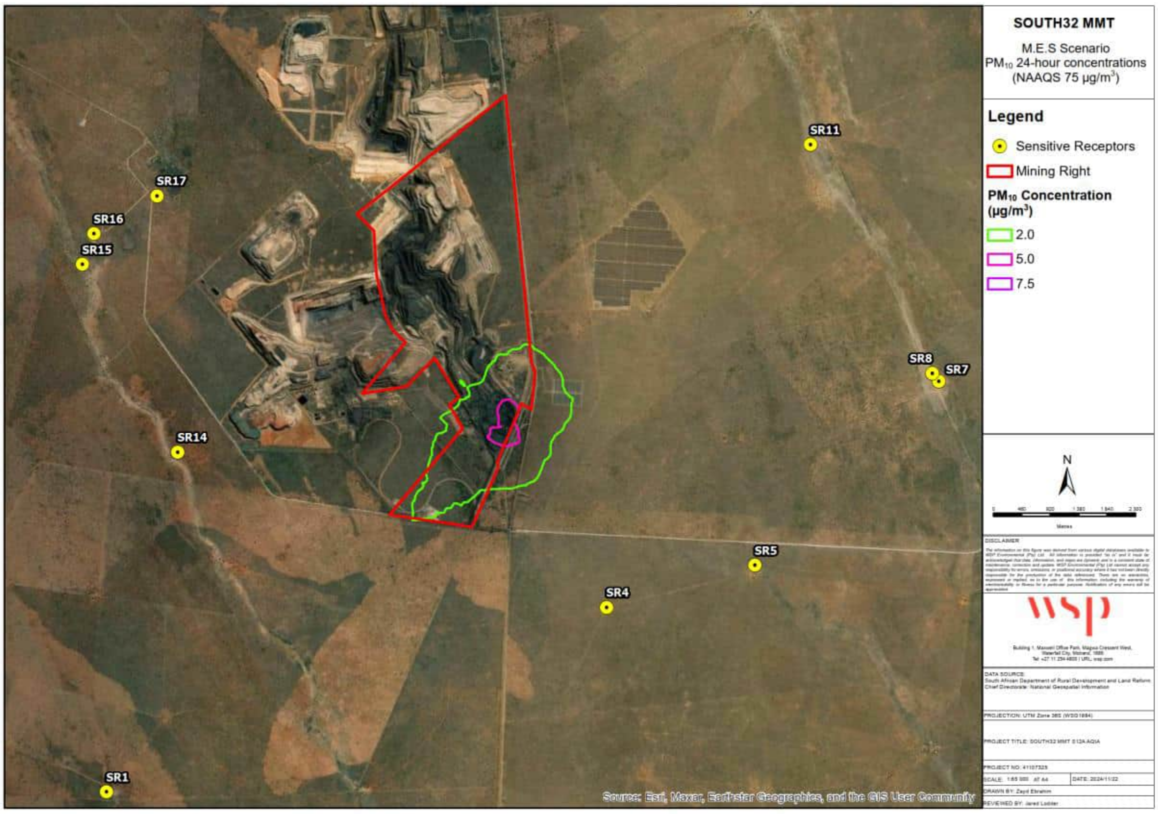


Figure 6-10: P99 24-hour average PM_{10} concentrations (MES Compliance)

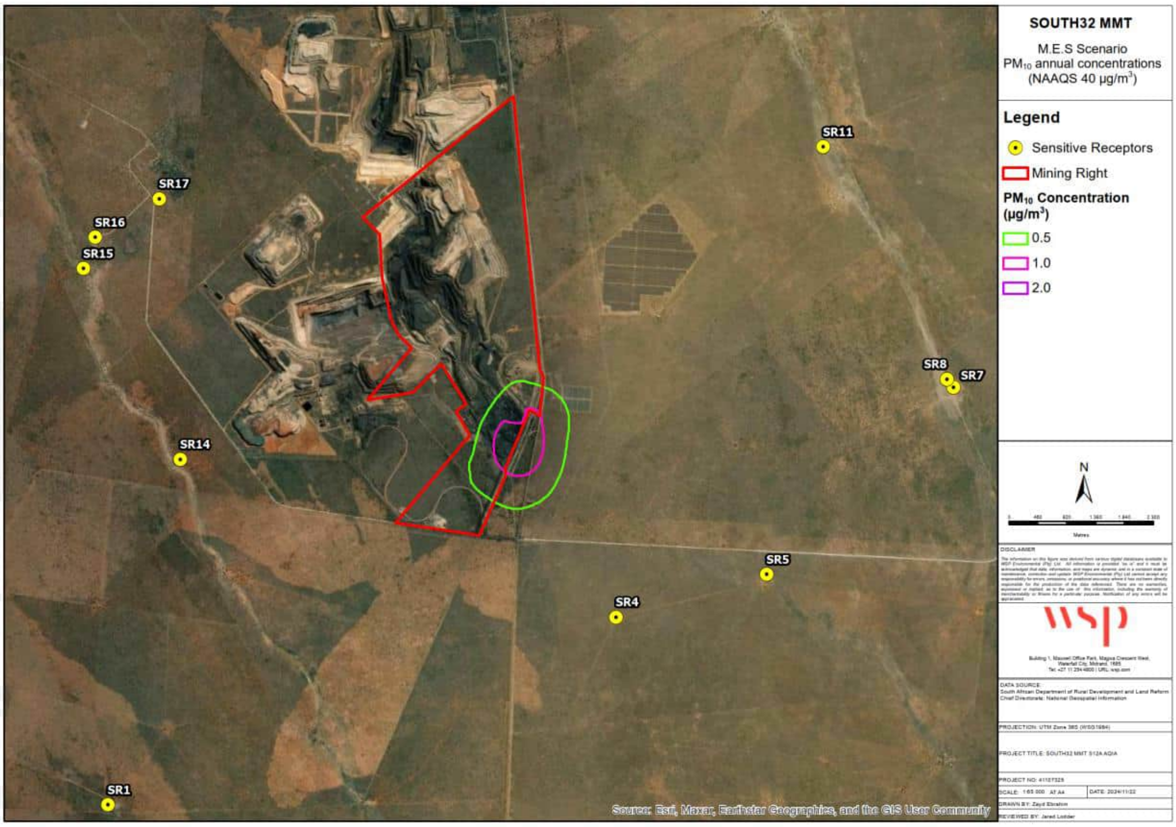


Figure 6-11: Period average PM_{10} concentrations (MES Compliance)

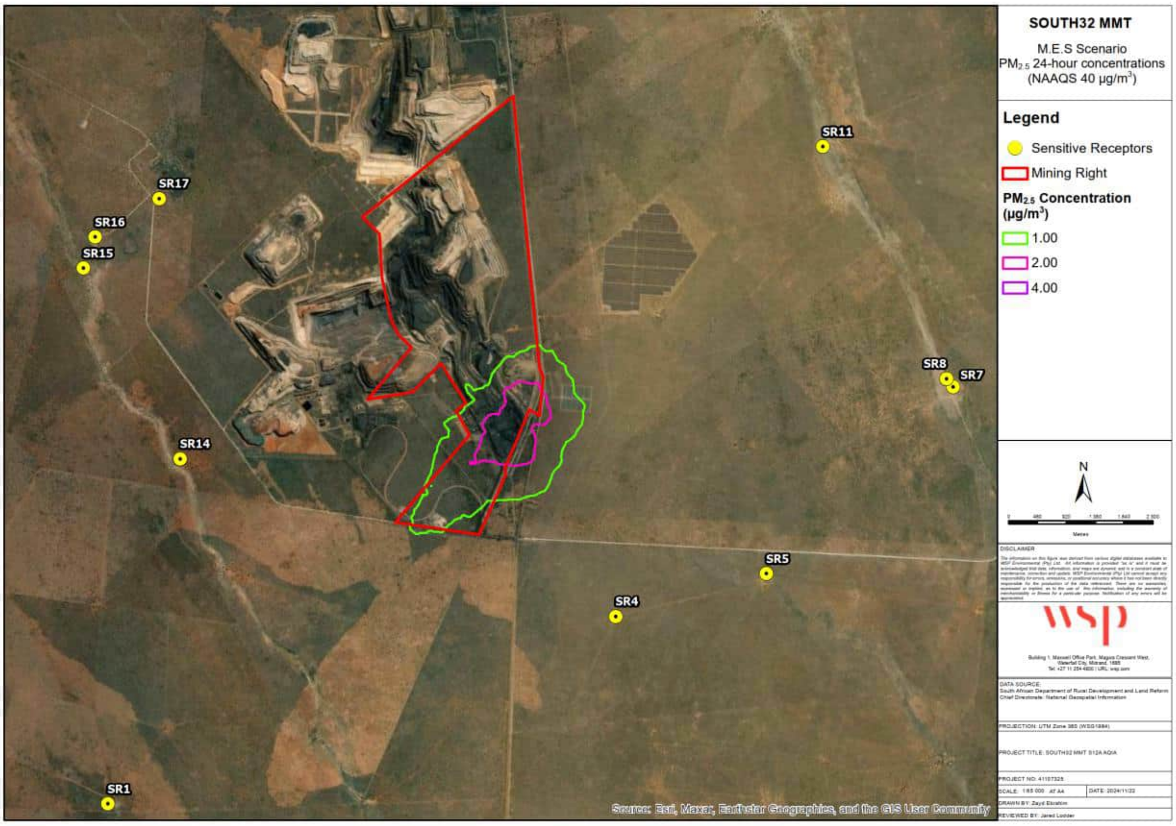


Figure 6-12: P99 24-hour average $PM_{2.5}$ concentrations (MES Compliance)

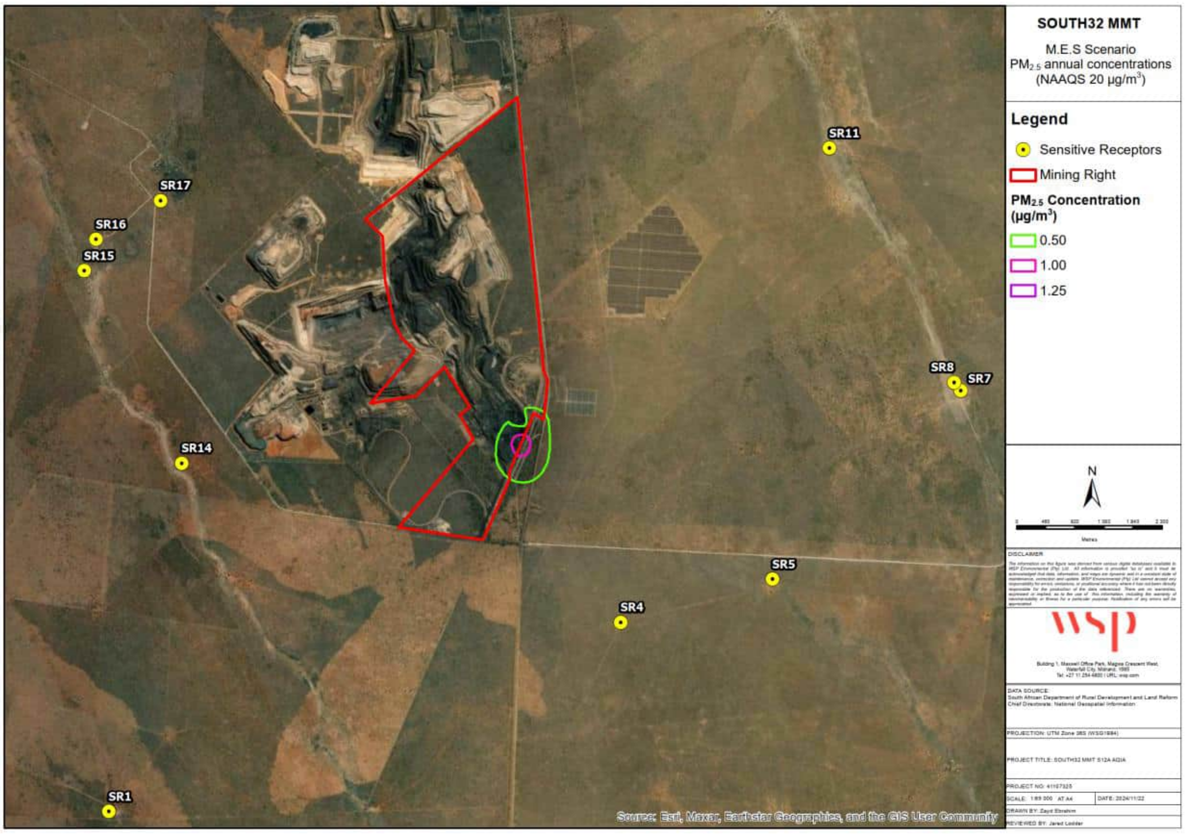


Figure 6-13: Period average $PM_{2.5}$ concentrations (MES Compliance)

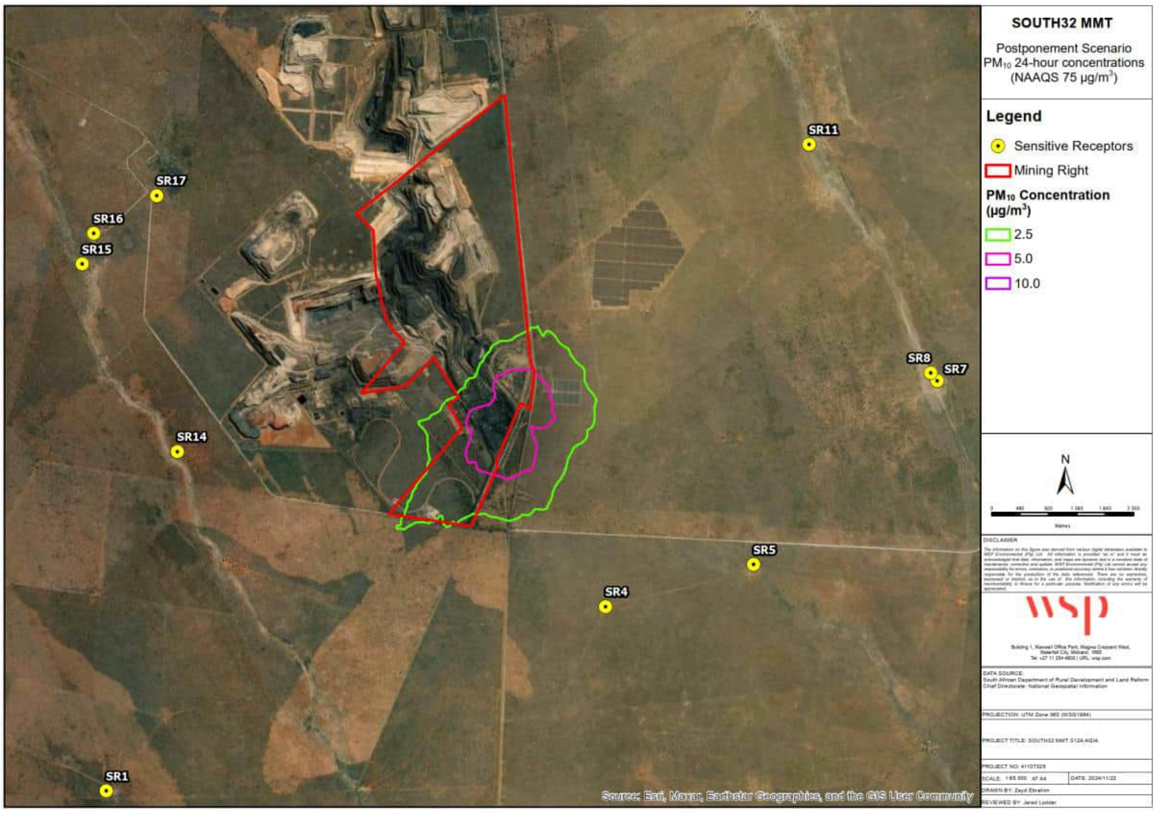


Figure 6-14: P99 24-hour average PM_{10} concentrations (Postponement Operations)

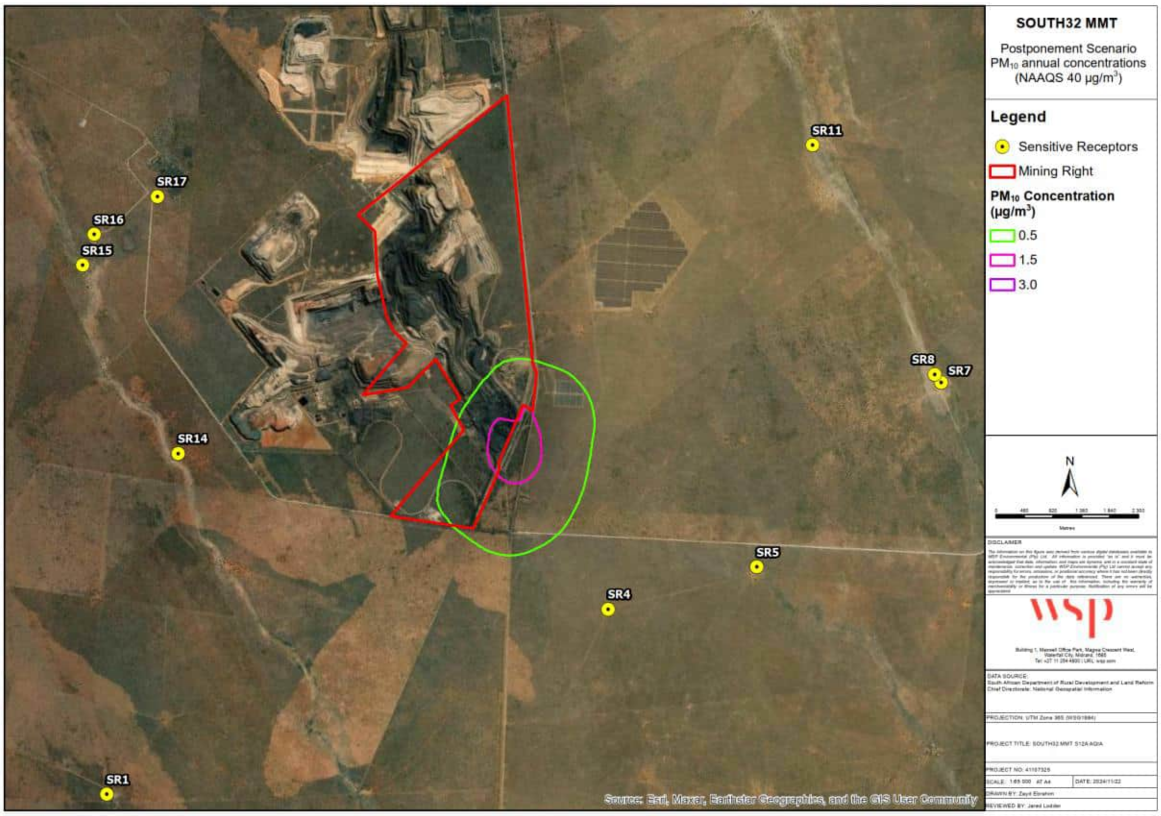


Figure 6-15: Period average PM_{10} concentrations (Postponement Operations)

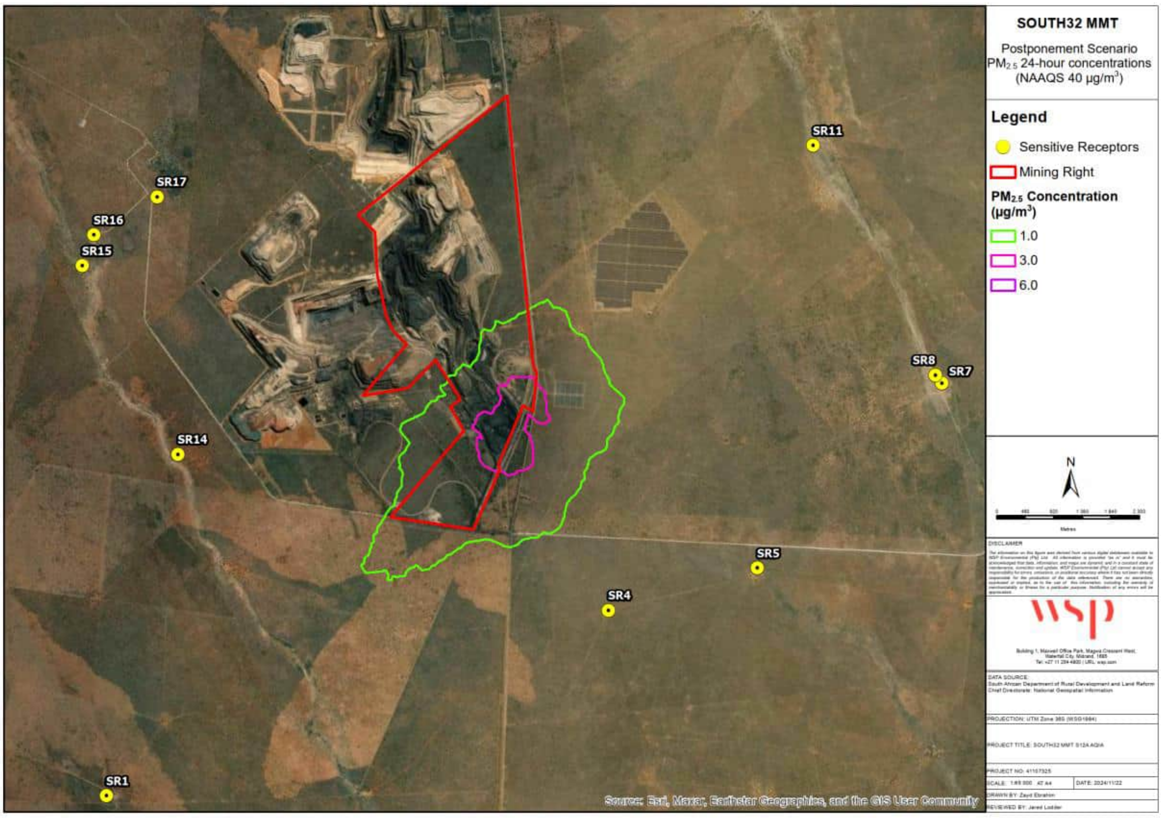


Figure 6-16: P99 24-hour average $PM_{2.5}$ concentrations (Postponement Operations)

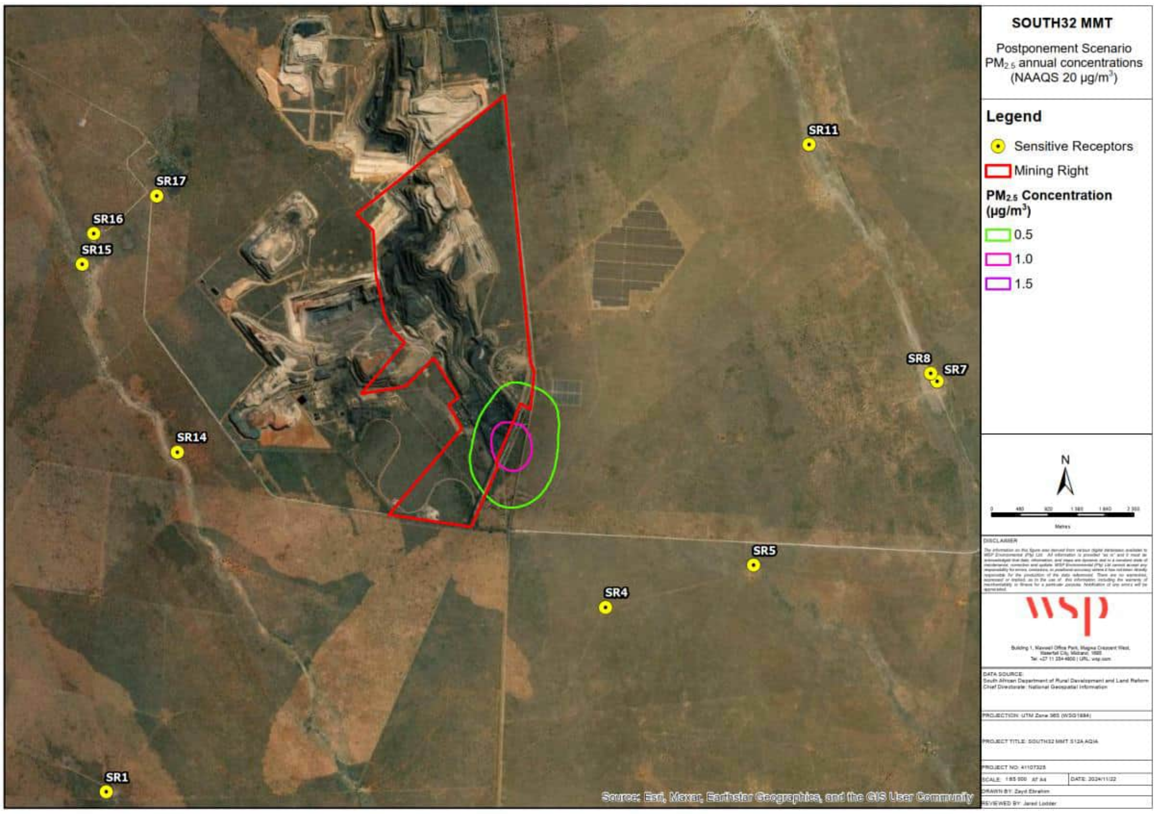


Figure 6-17: Period average $PM_{2.5}$ concentrations (Postponement Operations)

6.1.7 CUMULATIVE ASSESSMENT

The National Framework for Air Quality Management in South Africa calls for air quality assessment in terms of cumulative impacts rather than the contributions from an individual facility. Compliance with the NAAQS is to be determined by taking into account all local and regional contributions to background concentrations. For each averaging time, the sum of the model predicted concentration (C_P) and the background concentration (C_B) must be compared with the NAAQS. The background concentrations C_B must be the sum of contributions from non-modelled local sources and regional background air quality. If the sum of background and predicted concentrations ($C_B + C_P$) is more than the NAAQS, the design of the facility must be reviewed (including pollution control equipment) to ensure compliance with NAAQS. Compliance assessments must provide room for future permits to new emissions sources, while maintaining overall compliance with NAAQS. For the different facility locations and averaging times, the comparisons with NAAQS must be based on recommendations in **Table 6-12.**

Table 6-12: Summary of recommended procedures for assessing compliance with NAAQS

Facility Location	Annual NAAQS	Short-term NAAQS (24 hours or less)
Isolated facility not influenced by other sources, C_B insignificant*.	Highest C_P must be less than the NAAQS, no exceedances allowed.	99th percentile concentrations must be less than the NAAQS. Wherever one year is modelled, the highest concentrations shall be considered.
Facilities influenced by background sources e.g. in urban areas and priority areas.	Sum of the highest C_P and background concentrations must be less that the NAAQS, no exceedances allowed.	Sum of the 99th percentile concentrations and background CB must be less than the NAAQS. Wherever one year is modelled, the highest concentrations shall be considered.

Since the Sinter Plant is operational, existing background concentrations were not used to assess the cumulative impact of the Sinter Plant as inclusion of any baseline data would essentially double account for emissions from the facility (in the background measurements and the inputted emission rates). Additionally, due to the lack of ambient PM monitoring data (monitoring only commenced in August 2024), the contribution of the Sinter Plant to the overall monitored concentrations could not be assessed here.

6.2 ANALYSIS OF EMISSIONS' IMPACT ON THE ENVIRONMENT

The following sections analyse the potential impacts associated with air pollution on the surrounding environment.

6.2.1 EFFECTS ON VEGETATION

Air pollution in South Africa was first identified as a potential threat to vegetation in 1988 (Tyson *et al*., 1988). The commercial forests of the eastern escarpment were highlighted as a threatened resource due to their proximity to the heavily industrialised Highveld. Marshal *et al.* (1998) also identified concerns around the potential impacts on crop yields on the Highveld. Air pollutants that could impact on vegetation include PM, SO_2, O_3, NO_x and hydrogen fluoride (HF).

The effects of pollution on plants include mottled foliage, 'burning' at leaf tips or margins, twig dieback, stunted growth, premature leaf drop, delayed maturity, abortion or early drop of blossoms, and reduced yield or quality. In general, the visible injury to plants is of three types: (1) collapse of leaf tissue with the development of necrotic patterns, (2) yellowing or other colour changes, and (3) alterations in growth or premature loss of foliage (Sikora and Chappelka, 2004). Factors that govern the extent of damage and the region where air pollution is a problem are (1) type and concentration of pollutants, (2) distance from the source, (3) length of exposure, and (4) meteorological conditions. Other important factors are city size and location, land topography, soil moisture and nutrient supply, maturity of plant tissues, time of year, and species and variety of plants. A soil moisture deficit or extremes of temperature, humidity, and light often alter a plant's response to an air pollutant (Sikora and Chappelka, 2004).

6.2.2 EFFECTS ON ANIMALS

Air pollution is a recognized health hazard to domestic animals and wildlife. Industrial air pollutants effect both wild birds and mammals, causing notable decreases in local populations (Newman, 1979). The major effects include direct mortality, debilitating injury and disease, stress, anaemia, and bioaccumulation (Newman, 1979). Certain air pollutants are also known to cause variation in the distribution of certain wildlife species (Schreiber, and Newman, 1988). Animals are typically exposed to air pollution through a) inhalation of gases or small particles, b) ingestion of particles suspended in food or water, or c) absorption of gases through the skin (Burdo, 2018). Soft-bodied invertebrates (such as earthworms), or animals with thin, moist skin (such as amphibians) are the most susceptible to absorption of pollutants. Individual responses to pollutants are dependent on the type of pollutant involved, the duration and time of exposure, and the concentration taken up by the animal (Wong and Candolin, 2015). The individual's age, sex, health, and reproductive condition also determines its response. There is much variability observed between animal classes, species, and even genotypes, in terms of the level of tolerance to a specific pollutant (Wong and Candolin, 2015).

6.3 ASSUMPTIONS AND LIMITATIONS

Various assumptions were made in the compilation of this AIR. When possible, an environmentally conservative approach was taken to ensure emission rate calculations and model predictions represent a worst-case scenario. The assumptions and limitations underlying the study methodology are as follows:

- Unless otherwise stated, operational information for the Sinter Plant was provided by South32 MMT. Any errors, limitations or assumptions inherent in these datasets extend to this study.
- Stack information (diameter, flow rates, velocity and temperature) for each of the four stacks were obtained from the prior three Levego Environmental Services Test Reports (LES0763M 22/R2147-A1; LES0913M 23/R2307; and LES1072M 23/R2467) dated 25 March 2022, 06 February 2023, and 27 March 2024, respectively.
- The stack information extracted from the Levego reports were averaged to determine the current operational conditions for each of the four stacks.
- PM_{10} emissions rates were assumed to be 60% of the total PM rate, based on a literature review applicable to Sinter Plants (USEPA, 1986; and Zhao *et al*, 2017).
- $PM_{2.5}$ emissions rates were assumed to be 32% of the total PM rate, based on a literature review applicable to Sinter Plants (USEPA, 1986; and Zhao *et al*, 2017).
- The MES compliance scenarios emission rates were determined based on each stack meeting the MES for PM, irrespective of the current operational emissions rates. As such, stacks that have emission rates below the MES were simulated with a higher rate (MES equivalent), to determine the worst-case scenario, thus remaining environmentally conservative.

7 COMPLAINTS

There have been no air quality related complaints received in the last two years, as confirmed by South32 MMT.

8 CURRENT OR PLANNED AIR QUALITY MANAGEMENT INTERVENTIONS

South32 MMT have commissioned a study to investigate strategic monitoring locations for continuous particulate matter monitors. This study will focus on ambient air quality and include recommendations of the type of monitors that can be used.

No further interventions over-and-above the ESP installation for the Sinter Waste Stack, which is the purpose and objective of this AIR, are planned.

9 COMPLIANCE AND ENFORCEMENT

There have been no air quality compliance and enforcement actions undertaken against the facility in the last five years as confirmed by South32 MMT.

10 ADDITIONAL INFORMATION

There is no additional information to supply in relation to this AIR.

FORMAL DECLARATIONS

ANNEXURE A: DECLARATION OF ACCURACY OF INFORMATION

DECLARATION OF ACCURACY OF INFORMATION - APPLICANT

Name of Enterprise: South32 Mamatwan Hotazel Manganese Mines

Declaration of accuracy of information provided:

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

I, __Wonder Sigwebela____(duly authorised), declare that the information provided in this atmospheric impact report is, to the best of my knowledge, in all respects factually true and correct. I am aware that the supply of false or misleading information to an air quality officer is a criminal offence in terms of section 51(1)(g) of this Act.

Signed at Mamatwan ______________________on this __27th __ day of __November 2024___

SIGNATURE

Environmental Superintendent

CAPACITY OF SIGNATORY

ANNEXURE B: DECLARATION OF INDEPENDENCE OF PRACTITIONER

DECLARATION OF INDEPENDENCE - PRACTITIONER

Name of Practitioner: Jared Lodder

Declaration of independence and accuracy of information provided:

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

I, Jared Lodder, declare that I am independent of the applicant. I have the necessary expertise to conduct the assessments required for the report and will perform the work relating the application in an objective manner, even if this results in views and findings that are not favourable to the applicant. I will disclose to the applicant and the air quality officer all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the air quality officer, The information provided in this atmospheric impact report is, to the best of my knowledge, in all respects factually true and correct. I am aware that the supply of false or misleading information to an air quality officer is a criminal offence in terms of section 51(1) (g) of this Act.

Signed at Midrand on this 27th day of November 2024.

Lodder, Jared
(ZAJL04997)
2024.11.27
13:37:40 +02'00'

SIGNATURE

Principal Consultant at WSP

CAPACITY OF SIGNATORY

REFERENCE LIST

- Australian Government (2021): Lead. Available online at: https://www.dcceew.gov.au/environment/protection/chemicals-management/lead.
- Burdo, H., (2018): The Effects of Air Pollution on Animals. Available online at: https://bizfluent.com/about-5137668-effects-air-pollution-animals.html
- Department of Environmental Affairs (DEA) (2000): Integrated Pollution and Waste Management Policy for South Africa. Government Notice No. 2270 in Government Gazette No. 20978.
- DEA (2009): National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004), National Ambient Air Quality Standards, Government Notice No. 1210 in Government Gazette No. 32816.
- DEA (2010): List of Activities which result in Atmospheric Emissions which have or may have a significant detrimental effect on the environment, including health, social conditions, economic conditions, ecological conditions or cultural heritage. Government Notice No.248 in Government Gazette No. 33064.
- DEA (2010b): Air Quality Management Plan for the Highveld Priority Area, Report compiled by Umoya Nilu and Environmental Science Associates, Report no.: uMN003-10. Available online at: http://www.highveldair.co.za/docs/DEAT_HPA_08Apr2010-042308.pdf
- DEA (2013): List of Activities which result in atmospheric emissions. Government Notice No. 893 of Government Gazette 36974.
- DEA (2014). Regulations Regarding Air Dispersion Modelling Government Notice No. 533 of Government Gazette No. 37804.
- DEA (2018): The 2017 National Framework for Air Quality Management in the Republic of South Africa (No.R.1144 of 2018) Government Gazette, 26 October 2018 (No. 41996).
- Harrison, R.M. and R.E. van Grieken (1998): Atmospheric Aerosols. John Wiley: Great Britain.
- Kampa, M. and Castanas, E. (2007): Human health effects of air pollution, Environmental Pollution 151 (2008) 362-367, Elsevier.
- Levego Environmental Services (Levego) (2022): Stack Emission Measurement Survey (Compliance) for South32 Hotazel Manganese Mines (Pty) Ltd Mamatwan. Report LES0763M 22/R2147-A1. 25 March 2022.
- Levego (2023): Stack Emission Measurement Survey (Compliance) for South32 Hotazel Manganese Mines (Pty) Ltd Mamatwan. Report LES0913M 23/R2307. 06 February 2023.
- Levego (2024): Stack Emission Measurement Survey (Compliance) for South32 Hotazel Manganese Mines (Pty) Ltd Mamatwan. Report LES1072M 23/R2467. 27 March 2024.
- Manahan, E. (1991): Environmental Chemistry.
- Maroni, M., Seifert, B., Lindvall, T., (1995): Indoor air quality – a comprehensive reference book, Elsevier, Amsterdam.
- Newman, J. R. (1979). Effects of industrial air pollution on wildlife. Biological conservation, 15(3), 181-190.
- Northern Cape Department of Environment and Nature, DENC.,2018: Air Quality Management Plan for the Northern Cape, uMoya-NILU Consulting (Pty) Ltd., report number uMN016-18, Final, 6 March 2018
- Republic of South Africa (2005): National Environmental Management: Air Quality Act (No. R. 39 of 2004) Government Gazette, 24 February 2005 (No. 27318).

- Samaras, Z. and Sorenson, S. (1999): Chapter 5 – Mobile Sources in Urban Air Pollution – European Aspects. Pp. 63-91. J. Fenger, O. Hertel and F. Palmgren (eds). Kluwer Academic Publishers.
- Tyson, P. D., Kruger, F. J., and Louw, C. W. (1988). Atmospheric pollution and its implications in the Eastern Transvaal Highveld. National Scientific Programmes Unit: CSIR.
- Sikora EJ, Chappelka AH. 2004. Air Pollution Damage to Plants. Alabama Cooperative Extension System. Available online at: www.aces.edu.
- United States Environmental Protection Agency (USEPA) (1986): AP-42 Compilation of Air Pollutant Emissions Factors from Stationary Sources. Iron and Steel Production. Chapter 12.5.
- USEPA (1995): Compilation of air pollutant emission factors, AP-42, Fifth Edition Volume 1: Chapter 13: Miscellaneous Sources - Introduction to Fugitive Dust Sources, U.S Environmental Protection Agency, Research Triangle Park, N.C.
- USEPA (2012): Health effects of Hazardous Air Pollutants - Benzene. Available online at: www.epa.gov/airtoxics.
- USEPA (ND): Environmental issues of concern for urban communities: Resources, accessed 06 May 2023. https://www.epa.gov/newenglandhc/environmental-issues-concerns-urban-communities
- World Health Organisation (WHO) (2000): Ambient Air Quality Guidelines for Europe. Available online at: http://www.euro.who.int/__data/assets/pdf_file/0005/74732/E71922.pdf. Subsequently updated in:
- WHO (2005): WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide. Available online at: http://apps.who.int/iris/bitstream/handle/10665/69477/WHO_SDE_PHE_OEH_06.02_eng.pdf;jsessionid=1120BCE96A81BF3406B2D468337E283D?sequence=1
- WHO (2021): WHO Global Air Quality Guidelines. Available online at: https://iris.who.int/bitstream/handle/10665/345329/9789240034228-eng.pdf?sequence=1.
- Wong, B.B.M. and Candolin, U. (2015): Behavioral Responses to Changing Environments, Behavioral Ecology, 26 (3), 665–673. Available online at: https://doi.org/10.1093/beheco/aru
- Zhao, L., Sun, W., Li, X., Ye, Z., Huang, J., Zhang, Z., and Cai, J. (2017): Assessment of particulate emissions from a sinter plant in steelmaking works in China. Environ Monit Assess 189: 368.

Appendix A

STACK EMISSION TEST REPORTS

LEVEGO
Environmental Services

REPORT 22/R2147 – A1

STACK EMISSION MEASUREMENT SURVEY (COMPLIANCE)

FOR

SOUTH 32
HOTAZEL MANGANESE MINES (PTY) LTD
MAMATWAN

SAMPLING PERIOD: FEBRUARY - MARCH 2022

E&OE

LEVEGO ENVIRONMENTAL SERVICES (PTY) LTD Reg No 2017/188749/07. a LEVEGO affiliated company
Directors: G B Woollatt, D L Posthumus, C M Malinda. Tel: (011) 608-4148. Fax: (011) 608-2621. www.levego.co.za
Building R6, Pinelands Site, Ardeer Rd, Modderfontein, 1645. P O Box 422, Modderfontein 1645

Building R6, Pinelands Site, Ardeer Rd, Modderfontein, 1645. P O Box 422, Modderfontein 1645

Your Reference: Order no. 4542277877

Our Reference: **LES0763M** Quotation 22/QF3133/hy

Enquiries: H. M. Yingwani
Cell: 083 402 4436
E-mail: hlayiseka@levego.co.za

Date: 25 March 2022

SOUTH32 HOTAZEL MANGANESE MINES (PTY) LTD
MAMATWAN MINE
PO BOX 506
HOTAZEL
SOUTH AFRICA
6000

Attention: Mr Sisa Teka

Dear Sir,

REPORT No: 22/R2147 –A1 – STACK EMISSION MEASUREMENT SURVEY, SOUTH 32 HOTAZEL MANGANESE MINES (PTY) LTD MAMATWAN

Please find attached our final amended report for the stack emission measurement survey performed on the various stacks described in this report at 32 Hotazel Manganese Mines (Pty) Ltd, Mamatwan. Please note this report is an amendment to and replaces report 22/R2147.

We thank you for this opportunity to be of service, and trust that the attached meets your approval.

If you have any queries, please do not hesitate to contact us at the number provided above.

Yours sincerely,

H. M. Yingwani
Project manager
On behalf of
Levego Environmental Services (Pty) Ltd

TABLE OF CONTENTS

List of abbreviations, acronyms, and symbols (where applicable)	
µg	microgram
ASTM	American Society for Testing and Materials
BDL	below detection limit
DCS	distributed control system
DGM	dry gas meter
ESP	electrostatic precipitator
ISO	International Organisation for Standardisation
kg/Nm^3	kilogram per normalised cubic metre (at NTP)
kPa	kilopascal
LECO	Laboratory Equipment Corporation
LOD	limit of detection
m	metre
m^2	square metre
m^3/s	cubic metre per second
mA	milliampere
mb	millibar
mg/m^3	milligram per cubic metre
mg/Nm^3	milligram per normalised cubic metre (at NTP)
mm	millimetre
N/A	not applicable
N/M	not measured
ng	nanogram
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Technology
Nm^3	normalised cubic metre (at NTP)
NTP	normalised temperature and pressure (273 K and 1013.25 mb)
O_2 ref %	oxygen reference percentage
PLC	programmable logic controller
PM	particulate matter
SCADA	supervisory control and data acquisition
SEM	scanning electron microscope
US EPA	United States Environmental Protection Agency

1. INTRODUCTION

Levego Environmental Services was contracted to carry out a stack emission measurement survey to determine the source emissions from the stacks installed at the South 32 Hotazel Manganese Mines (Pty) Ltd plant.

The following was understood prior to the commencement of the work; the South 32 Hotazel Manganese Mines (Pty) Ltd staff would ensure that all plant operations were to their satisfaction, including the correct operation of all relevant pollution abatement equipment.

1.1 Scope of work

The table below outlines the scope of work that Levego Environmental Services completed during the stack emission measurement survey.

Table 1: Scope of measurements

Release point	De-dust 1 Stack	De-dust 2 Stack	De-dust 3 Stack	Waste Gas Stack
Particulate matter	✓	✓	✓	✓
Water vapour	✓	✓	✓	✓
Oxygen	✓	✓	✓	✓
Carbon dioxide	✓	✓	✓	✓
Volumetric flow rate	✓	✓	✓	✓
Nitrogen oxides	✓	✓	✓	✓
Carbon monoxide	✓	✓	✓	✓
Sulphur dioxide	✓	✓	✓	✓

2. SUMMARY OF TEST PROGRAM: METHOD STATEMENTS AND DEVIATIONS

2.1 Velocity, volume, pressure and temperature

Preliminary measurements, for calculation of the required nozzle size for isokinetic sampling, were determined using sampling and testing procedures as described in ISO 9096:2017(E) "Stationary Source Emissions – Manual Determination of Mass Concentration of Particulate Matter".

Velocity measurements are performed utilising a pitot tube and an inclined manometer. Volume flows are calculated from the average velocity and duct area. Pressure and temperature are measured directly utilising a barometer / manometer combination, and thermocouple, respectively.

2.2 Particulate matter

Particulate matter measurements were determined using sampling and testing procedures as described in ISO 9096:2017(E). "Stationary Source Emissions – Manual Determination of Mass Concentration of Particulate Matter".

High-purity pre-weighed quartz thimbles (30 mm diameter × 100 mm long) were used to collect the particulate matter in the flue gas. The quartz filters are capable of withstanding temperatures of up to 800°C without filter media mass loss, and retain 99.9% of particles >0.3 μm.

2.3 Water vapour

Water vapour (H_2O) measurements were determined using sampling and testing procedures as described in US EPA Method 4 "Determination of Moisture Content in Stack Gases".

A gas sample is extracted isokinetically from the stack. H_2O is removed from the sample stream and determined gravimetrically.

2.4 Nitrogen oxides

Nitrogen oxides (NO_x) measurements were determined using sampling and testing procedures as described in US EPA Method 7E "Determination of Nitrogen Oxides Emissions from Stationary Sources (Instrumental Analyser Procedure)".

A sample of the effluent gas is continuously sampled and conveyed to the analyser for measuring the concentration of NO_x, which is the sum of NO and NO_2.

2.5 Oxygen and carbon dioxide

Oxygen (O_2) and carbon dioxide (CO_2) measurements were determined using sampling and testing procedures as described in US EPA Method 3A "Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyser Procedure)".

A sample of the effluent gas is continuously sampled and conveyed to the analyser for measuring the concentration of O_2 and CO_2.

2.6 Carbon monoxide

Carbon monoxide (CO) measurements were determined using sampling and testing procedures as described in US EPA Method 10 "Determination of Carbon Monoxide Emissions from Stationary Sources (Instrumental Analyser Procedure)".

A sample of the effluent gas is continuously sampled and conveyed to the analyser for measuring the concentration of CO.

2.7 Sulphur dioxide

Sulphur dioxide (SO_2) measurements were determined using sampling and testing procedures as described in US EPA Method 6 "Determination of Sulphur Dioxide Emissions from Stationary Sources".

A gas sample is extracted from the sampling point in the stack. The SO_2 and sulphur trioxide (SO_3), including those fractions in any sulphur acid mist, are separated. The SO_2 fraction is measured, *via* concentration of sulphate anion (SO_4^{2-}), by the barium-thorin titration method.

2.8 Key personnel

The project manager on this project was Hlayiseka Yingwani.

Team 1 consisted of Sizwe Lubuzo (team leader) and Lucky Mkalipi (sampling assistant).

3. MEASUREMENT AND SAMPLING LOCATIONS

3.1 General requirements for sampling locations

ISO 9096:2017(E) requires that the following criteria must be met:

a) the angle of gas flow is less than 15° with regard to the duct axis;

b) no local negative flow is present;

c) the minimum velocity is higher than the detection limit of the method used for the flow rate measurement (for pitot tubes, a differential pressure larger than 5 Pa);

d) the ratio of the highest to the lowest local gas velocities is less than 3:1.

If the above requirements are not met the uncertainty of measurement will be higher than that specified by ISO 9096:2017(E) and the sampling location will not be in compliance.

The above requirements are generally fulfilled in sections of duct with at least five hydraulic diameters of straight duct upstream of the sampling plane, and two hydraulic diameters downstream of the sampling plane (five hydraulic diameters from the top of a stack).

3.2 De-dust 1 Stack

The sampling position was located on the vertical circular stack. The table below details the sampling port specifications.

Table 2: De-dust 1 Stack Compliance with ISO 9096:2017 general requirements

Height above ground level	~10 metres
Stack diameter	1.75 metres
Distance from sampling ports to downstream stack exit	~20 metres
Distance from sampling ports to upstream disturbance	~2 metres
Number of sampling ports	2
90° angle	Yes
Sampling port size	90 mm
ISO 9096:2017(E) a)	Yes
ISO 9096:2017(E) b)	Yes
ISO 9096:2017(E) c	Yes
ISO 9096:2017(E) d)	Yes

The sampling position does not fulfil the recommendations for the required diameters, but meets a), b), c) and d) of the general requirements. The sampling location is in compliance with the requirements of ISO 9096:2017(E)

The sampling position was deemed to be the most practical position to perform measurements within the requirements of ISO 9096:2017(E), and the limitations of the plant design.

3.3 De-dust 2 Stack

The sampling position was located on the vertical circular stack. The table below details the sampling port specifications.

Table 3: De-dust 2 Stack Compliance with ISO 9096:2017 general requirements

Height above ground level	~12 metres
Stack diameter	1.86 metres
Distance from sampling ports to downstream stack exit	~9 metres
Distance from sampling ports to upstream disturbance	~7 metres
Number of sampling ports	2
90° angle	Yes
Sampling port size	90 mm
ISO 9096:2017(E) a)	Yes
ISO 9096:2017(E) b)	Yes
ISO 9096:2017(E) c)	Yes
ISO 9096:2017(E) d)	Yes

The sampling position does not fulfil the recommendations for the required diameters, but meets a), b), c) and d) of the general requirements. The sampling location is in compliance with the requirements of ISO 9096:2017(E)

The sampling position was deemed to be the most practical position to perform measurements within the requirements of ISO 9096:2017(E) and the limitations of the plant design.

3.4 De-dust 3 Stack

The sampling position was located on the vertical circular stack. The table below details the sampling port specifications.

Table 4: De-dust 3 Stack Compliance with ISO 9096:2017 general requirements

Height above ground level	~12 metres
Stack diameter	1.90 metres
Distance from sampling ports to downstream stack exit	~20 metres
Distance from sampling ports to upstream disturbance	~7 metres
Number of sampling ports	2
90° angle	Yes
Sampling port size	90 mm
ISO 9096:2017(E) a)	Yes
ISO 9096:2017(E) b)	Yes
ISO 9096:2017(E) c)	Yes
ISO 9096:2017(E) d)	Yes

The sampling position fulfils the recommendations for the required diameters, and meets a), b), c) and d) of the general requirements. The sampling location is in compliance with the requirements of ISO 9096:2017(E).

The sampling position was deemed to be the most practical position to perform measurements within the requirements of ISO 9096:2017(E), and the limitations of the plant design.

3.5 Waste Gas Stack

The sampling position was located on the vertical circular stack. The table below details the sampling port specifications.

Table 5: Waste Gas Stack Compliance with ISO 9096:2017 general requirements

Height above ground level	~13 metres
Stack diameter	3.29 metres
Distance from sampling ports to downstream stack exit	~30 metres
Distance from sampling ports to upstream disturbance	~2 metres
Number of sampling ports	2 (Only one was used)
90° angle	Yes
Sampling port size	80 mm
ISO 9096:2003 a)	Could not be confirmed
ISO 9096:2003 b)	Could not be confirmed
ISO 9096:2003 c)	Could not be confirmed
ISO 9096:2003 d)	Could not be confirmed

The sampling position does not fulfil the recommendations as per the required diameters. It could not be established if the sampling location meets a), b), c) and d) of the general requirements. Only one sampling port was used for sampling, because there is an analyser on the second port.

The sampling position was deemed to be the most practical position to perform measurements within the requirements of ISO 9096:2017(E), and the limitations of the plant design.

4. QUALITY ASSURANCE AND QUALITY CONTROL

4.1 Sample identification

All filters and solutions are labelled using pre-printed adhesive labels. Their identification codes are recorded on site observation sheets prior to the start of each measurement.

If additional samples are taken they are labelled on site at the completion of each measurement. Pre-printed adhesive labels are also used for this purpose.

4.2 Chain of custody

A chain of custody form accompanies the samples as the samples proceed from one measurement site to another.

4.3 Facility accreditation

The relevant accreditation numbers of the service provider undertaking each item of work is shown below.

Table 6: Scope of accreditation

Test parameter	Sampling	Analysis
Volumetric flow rate	ISO 17025:2017 Levego Environmental Services	ISO 17025:2017 Levego Environmental Services
Particulate matter	ISO 17025:2017 Levego Environmental Services	ISO 17025:2017 Levego Environmental Services
Water vapour	ISO 17025:2017 Levego Environmental Services	ISO 17025:2017 Levego Environmental Services
Nitrogen oxides	ISO 17025:2017 Levego Environmental Services	ISO 17025:2017 Levego Environmental Services
Oxygen	ISO 17025:2017 Levego Environmental Services	ISO 17025:2017 Levego Environmental Services
Carbon dioxide	ISO 17025:2017 Levego Environmental Services	ISO 17025:2017 Levego Environmental Services
Carbon monoxide	ISO 17025:2017 Levego Environmental Services	ISO 17025:2017 Levego Environmental Services
Sulphur dioxide	ISO 17025:2017 Levego Environmental Services	ISO 17025:2017 Levego Environmental Services

Table 7: Facility accreditation number

Facility	Accreditation number
Levego Environmental Services	SANAS Testing Laboratory T0846

4.4 Sampling equipment

Team 1 used the following sampling equipment:

- Apex Model XC-572 source sampling train (Console Serial Number: 1011090)
- Dry gas meter: (Serial Number: 1902092)
- Barometer: (Serial Number: DB17)
- Pitot tube: (Serial Number: ST-1)
- Nozzle(s): (Set Number (s): NS5-2/3/7)
- Flue-gas analyser: Seitron Chemist 600 (Serial Number: 1076)

Calibration records are included in the attachment section of this report.

5. RESULTS AND DISCUSSION

5.1 General

Testing only commenced after confirmation was received from the South 32 Hotazel Manganese Mines (Pty) Ltd staff that the plant was stable and operating under normal conditions.

In this report, an analyte concentration that was measured to be below the limit of detection for a particular laboratory test method is reported at the limit of detection, unless otherwise indicated. For calculation of a pollutant concentration, the analyte amount is calculated and is then divided by the gas volume sampled.

5.2 Results

The result summaries are attached as Appendix A to Appendix D.

5.2.1 Measurement Uncertainty

The measurement uncertainties are shown in Appendices E to H. The tables show the averages over three tests of the measured results, the uncertainties in measurement units, and uncertainties as a proportion (%) of the measured values.

5.3 Discussion

5.3.1 De-dust 1, 2 and 3 stacks

Please note there was visible dust on the stack exit, during sampling.

With regards to the measured CO, CO_2 and NO_x results were below the limits of detection and have been reported at the limit of detection.

5.4 Compliance

As set out in the Atmospheric Emission Licence (AEL), supplied by South 32 Mamatwan Hotazel Manganese Mines, license number: NC/AEL/JTG/MAM01/2012, the emission limits are set as presented in the following table and compared with measured values.

Table 8: Compliance table

Substance or mixture of substances		Date to be achieved by:	Emission limit	De-dust 1 Stack test average	De-dust 2 Stack test average	De-dust 3 Stack test average	Waste Gas Stack test average
Common name	**Chemical symbol**		**mg/Nm³, 273 K, dry, 101.3 kPa**				
Particulate matter	N/A	01/04/2020	50	34.11	**85.06***	N/A	**114.84***
			135	N/A	N/A	13.76	N/A
Nitrogen oxides	NOx	01/04/2020	700	<u>*0.82*</u>	<u>*0.82*</u>	<u>*0.82*</u>	322.37
Sulphur dioxide	SO_2	01/04/2020	500	<u>*0.57*</u>	<u>*0.67*</u>	*4.94*	**658.17***

<u>*Note: Italic underlined values are below the LOD of the method of analysis.*</u>

***Average concentration exceeds the permissible emission limit.**

N/A: Not Applicable

Italic = Results include a result, or results, reported at the laboratory test methods' LOQ

6. APPENDICES

Appendix A - Test Results: De-dust 1 Stack – PM, O_2, CO_2, CO, NO_x and SO_2
Appendix B - Test Results: De-dust 2 Stack – PM, O_2, CO_2, CO, NO_x and SO_2
Appendix C - Test Results: De-dust 3 Stack – PM, O_2, CO_2, CO, NO_x and SO_2
Appendix D - Test Results: Waste Gas Stack – PM, O_2, CO_2, CO, NO_x and SO_2

Appendix E: Uncertainties Reporting Summaries – De-dust 1 Stack
Appendix F: Uncertainties Reporting Summaries – De-dust 2 Stack
Appendix G: Uncertainties Reporting Summaries – De-dust 3 Stack
Appendix H: Uncertainties Reporting Summaries – Waste Gas Stack

7. ATTACHMENTS

- Proof of delivery
- Test sheets
- Chain of custody sheets and laboratory analysis sheets
- Calibration and verification certificates

We would like to take this opportunity to thank the South 32 Hotazel Manganese Mines (Pty) Ltd personnel that assisted us in the survey. We consider the measurement survey to be successful, and an accurate reflection of the plant conditions at the time of measurement.

Yours sincerely,

L. Tsetlho

Report Writer
Levego Environmental Services

H. M. Yingwani

Approved by (Technical Signatory)
Levego Environmental Services

APPENDICES

Appendix A - Test Results: De-dust 1 Stack – PM, O_2, CO_2, CO, NO_x and SO_2

TEST RESULTS
South 32 Hotazel Manganese Mines (Pty) Ltd
De-dust 1 Stack
LES0763M

	DATE	28-Feb-22	28-Feb-22	28-Feb-22	
	TEST START	11:05	12:30	13:55	
	TEST STOP	12:12	13:37	15:03	
PARAMETER	TEST	1	2	3	Averages
O_2	% (dry)	20.90	20.90	20.90	20.90
CO	ppm (dry)	*2.00*	*2.00*	*2.00*	*2.00*
CO_2	% (dry)	*0.70*	*0.70*	*0.70*	*0.70*
N_2 (by difference)	% (dry)	78.40	78.40	78.40	78.40
Dry Gas Density	kg/Nm³	1.29	1.29	1.29	1.29
Barometric Pressure	mb	894.00	894.00	894.00	894.00
Static Pressure	mb	-0.20	-0.20	-0.20	-0.20
Absolute Pressure	mb	893.80	893.80	893.80	893.80
Moisture Content	%	1.91	1.21	1.12	1.42
Gas Temperature	°C	59.00	59.23	60.23	59.49
Wet Gas Density	kg/Nm³	1.28	1.29	1.29	1.29
Duct Size	m	1.75	1.75	1.75	
Duct Area	m²	2.41	2.41	2.41	
Gas Density	kg/m³	0.93	0.93	0.93	0.93
Velocity Head	mb	0.04	0.04	0.04	0.04
Sample Time	sec	3,600.00	3,600.00	3,600.00	
Gas Velocity	m/s	2.99	2.98	2.99	2.99
Gas Volume Flow (actual)	m³/s (actual)	7.18	7.18	7.19	7.18
Gas Volume Flow NTP (wet)	Nm³/s (wet)	5.21	5.20	5.19	5.20
Gas Volume Flow NTP (dry)	Nm³/s (dry)	5.11	5.14	5.13	5.13
Gas Volume Flow NTP (dry, 10% O_2)	Nm³/s (dry, O_2)	0.05	0.05	0.05	0.05
Gas Volume Flow (actual)	m³/h (actual)	25,857.64	25,832.24	25,866.72	25,852.20
Gas Volume Flow NTP (wet)	Nm³/h (wet)	18,757.78	18,726.34	18,695.09	18,726.40
Gas Volume Flow NTP (dry)	Nm³/h (dry)	18,399.14	18,499.25	18,484.94	18,461.11
Gas Volume Flow NTP (dry)	Nm³/h (dry, O_2)	167.26	168.17	168.04	167.83
Nozzle Diameter	mm	12.66	12.66	12.66	
Sampled Volume (dry)	m³	1.37	1.38	1.38	
Sampled Volume NTP (dry)	Nm³	1.00	1.00	1.00	
PM Collected	mg	64.22	16.22	21.59	
PM Concentration (dry)	mg/m³ (dry)	46.79	11.72	15.67	24.73
PM Concentration NTP (dry)	mg/Nm³ (dry)	64.50	16.17	21.68	34.11
Sampled Volume (wet)	m³ (wet)	1.40	1.40	1.39	
Sampled Volume NTP (wet)	Nm³ (wet)	1.02	1.02	1.01	
PM Concentration (wet)	mg/m³ (wet)	45.89	11.58	15.49	24.32
PM Concentration NTP (wet)	mg/Nm³ (wet)	63.26	15.97	21.44	33.56
PM Emission Rate	mg/s	329.63	83.07	111.32	174.68
PM Emission Rate	kg/h	1.19	0.30	0.40	0.63
SO_2 Collected	mg	0.57	0.57	0.57	
SO_2 Concentration (dry)	mg/m³ (dry)	0.41	0.41	0.41	0.41
SO_2 Concentration NTP (dry)	mg/Nm³ (dry)	0.57	0.56	0.57	0.57
SO_2 Concentration (wet)	mg/m³ (wet)	0.41	0.40	0.41	0.41
SO_2 Concentration NTP (wet)	mg/Nm³ (wet)	0.56	0.56	0.56	0.56
SO_2 Emission Rate	mg/s	2.91	2.90	2.92	2.91
SO_2 Emission Rate	kg/h	0.01	0.01	0.01	0.01
NOx Concentration NTP (dry)	mg/Nm³ (dry)	*0.82*	*0.82*	*0.82*	*0.82*
NOx Emission Rate	mg/s	*4.20*	*4.22*	*4.22*	*4.21*
NOx Emission Rate	kg/h	*0.02*	*0.02*	*0.02*	*0.02*
CO Concentration NTP (dry)	mg/Nm³ (dry)	*2.50*	*2.50*	*2.50*	*2.50*
CO Emission Rate	mg/s	*12.77*	*12.84*	*12.83*	*12.82*
CO Emission Rate	kg/h	*0.05*	*0.05*	*0.05*	*0.05*

Isokinetic Rate	%	103	104	103

Italic, underlined = Values are below the detection limit, but the laboratory test method's limit of quantification (LOQ) is reported.

Appendix B - Test Results: De-dust 2 Stack – PM, O_2, CO_2, CO, NO_x and SO_2

TEST RESULTS
South 32 Hotazel Manganese Mines (Pty) Ltd
De-dust 2 Stack
LES0763M

	DATE	26-Feb-22	26-Feb-22	26-Feb-22	
	TEST START	09:45	11:10	12:32	
	TEST STOP	10:53	12:17	13:40	
PARAMETER	TEST	1	2	3	Averages
O_2	% (dry)	20.90	20.90	20.90	20.90
CO	ppm (dry)	*2.00*	*2.00*	*2.00*	*2.00*
CO_2	% (dry)	*0.70*	*0.70*	*0.70*	*0.70*
N_2 (by difference)	% (dry)	78.40	78.40	78.40	78.40
Dry Gas Density	kg/Nm³	1.29	1.29	1.29	1.29
Barometric Pressure	mb	894.00	894.00	894.00	894.00
Static Pressure	mb	-0.43	-0.43	-0.43	-0.43
Absolute Pressure	mb	893.57	893.57	893.57	893.57
Moisture Content	%	2.33	1.51	1.64	1.83
Gas Temperature	°C	58.38	61.62	64.31	61.44
Wet Gas Density	kg/Nm³	1.28	1.29	1.28	1.28
Duct Size	m	1.86	1.86	1.86	
Duct Area	m²	2.72	2.72	2.72	
Gas Density	kg/m³	0.93	0.93	0.92	0.92
Velocity Head	mb	0.48	0.49	0.48	0.48
Sample Time	sec	3,600.00	3,600.00	3,600.00	
Gas Velocity	m/s	10.13	10.28	10.24	10.22
Gas Volume Flow (actual)	m³/s (actual)	27.53	27.92	27.83	27.76
Gas Volume Flow NTP (wet)	Nm³/s (wet)	20.00	20.09	19.86	19.99
Gas Volume Flow NTP (dry)	Nm³/s (dry)	19.53	19.79	19.54	19.62
Gas Volume Flow NTP (dry, 10% O_2)	Nm³/s (dry, O_2)	0.18	0.18	0.18	0.18
Gas Volume Flow (actual)	m³/h (actual)	99,090.33	100,521.07	100,177.19	99,929.53
Gas Volume Flow NTP (wet)	Nm³/h (wet)	71,997.07	72,331.75	71,509.21	71,946.01
Gas Volume Flow NTP (dry)	Nm³/h (dry)	70,317.34	71,240.53	70,335.40	70,631.09
Gas Volume Flow NTP (dry)	Nm³/h (dry, O_2)	639.25	647.64	639.41	642.10
Nozzle Diameter	mm	6.42	6.42	6.42	
Sampled Volume (dry)	m³	1.16	1.17	1.17	
Sampled Volume NTP (dry)	Nm³	0.84	0.84	0.83	
PM Collected	mg	76.39	67.67	70.57	
PM Concentration (dry)	mg/m³ (dry)	65.78	57.64	60.33	61.25
PM Concentration NTP (dry)	mg/Nm³ (dry)	90.54	80.11	84.52	85.06
Sampled Volume (wet)	m³ (wet)	1.19	1.19	1.19	
Sampled Volume NTP (wet)	Nm³ (wet)	0.86	0.86	0.85	
PM Concentration (wet)	mg/m³ (wet)	64.25	56.78	59.34	60.12
PM Concentration NTP (wet)	mg/Nm³ (wet)	88.43	78.90	83.13	83.49
PM Emission Rate	mg/s	1,768.44	1,585.30	1,651.33	1,668.36
PM Emission Rate	kg/h	6.37	5.71	5.94	6.01
SO_2 Collected	mg	0.57	0.57	0.57	
SO_2 Concentration (dry)	mg/m³ (dry)	0.49	0.48	0.48	0.49
SO_2 Concentration NTP (dry)	mg/Nm³ (dry)	0.67	0.67	0.68	0.67
SO_2 Concentration (wet)	mg/m³ (wet)	0.48	0.48	0.48	0.48
SO_2 Concentration NTP (wet)	mg/Nm³ (wet)	0.66	0.66	0.67	0.66
SO_2 Emission Rate	mg/s	13.12	13.28	13.26	13.22
SO_2 Emission Rate	kg/h	0.05	0.05	0.05	0.05
NOx Concentration NTP (dry)	mg/Nm³ (dry)	*0.82*	*0.82*	*0.82*	*0.82*
NOx Emission Rate	mg/s	*16.04*	*16.25*	*16.04*	*16.11*
NOx Emission Rate	kg/h	*0.06*	*0.06*	*0.06*	*0.06*
CO Concentration NTP (dry)	mg/Nm³ (dry)	*2.50*	*2.50*	*2.50*	*2.50*
CO Emission Rate	mg/s	*48.82*	*49.46*	*48.83*	*49.04*
CO Emission Rate	kg/h	*0.18*	*0.18*	*0.18*	*0.18*

Isokinetic Rate	%	101	100	100

Italic, underlined = Values are below the detection limit, but the laboratory test method's limit of quantification (LOQ) is reported.

Appendix C - Test Results: De-dust 3 Stack – PM, O_2, CO_2, CO, NO_x and SO_2

TEST RESULTS
South 32 Hotazel Manganese Mines (Pty) Ltd
De-dust 3 Stack
LES0763M

	DATE	25-Feb-22	25-Feb-22	25-Feb-22	
	TEST START	12:01	13:26	14:46	
	TEST STOP	13:09	14:34	15:53	
PARAMETER	TEST	1	2	3	Averages
O_2	% (dry)	20.90	20.90	20.90	20.90
CO	ppm (dry)	*2.00*	*2.00*	*2.00*	*2.00*
CO_2	% (dry)	*0.70*	*0.70*	*0.70*	*0.70*
N_2 (by difference)	% (dry)	78.40	78.40	78.40	78.40
Dry Gas Density	kg/Nm³	1.29	1.29	1.29	1.29
Barometric Pressure	mb	891.00	891.00	891.00	891.00
Static Pressure	mb	-1.08	-1.08	-1.08	-1.08
Absolute Pressure	mb	889.92	889.92	889.92	889.92
Moisture Content	%	2.14	1.17	1.10	1.47
Gas Temperature	°C	49.15	50.23	51.46	50.28
Wet Gas Density	kg/Nm³	1.28	1.29	1.29	1.29
Duct Size	m	1.90	1.90	1.90	
Duct Area	m^2	2.84	2.84	2.84	
Gas Density	kg/m³	0.95	0.95	0.95	0.95
Velocity Head	mb	1.82	1.79	1.79	1.80
Sample Time	sec	3,600.00	3,600.00	3,600.00	
Gas Velocity	m/s	19.55	19.35	19.38	19.43
Gas Volume Flow (actual)	m³/s (actual)	55.44	54.86	54.95	55.08
Gas Volume Flow NTP (wet)	Nm³/s (wet)	41.27	40.70	40.61	40.86
Gas Volume Flow NTP (dry)	Nm³/s (dry)	40.38	40.22	40.16	40.26
Gas Volume Flow NTP (dry, 10% O_2)	Nm³/s (dry, O_2)	0.37	0.37	0.37	0.37
Gas Volume Flow (actual)	m³/h (actual)	199,578.71	197,494.41	197,827.20	198,300.11
Gas Volume Flow NTP (wet)	Nm³/h (wet)	148,554.19	146,513.21	146,203.65	147,090.35
Gas Volume Flow NTP (dry)	Nm³/h (dry)	145,378.63	144,803.70	144,590.61	144,924.31
Gas Volume Flow NTP (dry)	Nm³/h (dry, O_2)	1,321.62	1,316.40	1,314.46	1,317.49
Nozzle Diameter	mm	4.63	4.63	4.63	
Sampled Volume (dry)	m³	1.19	1.19	1.21	
Sampled Volume NTP (dry)	Nm³	0.88	0.89	0.89	
PM Collected	mg	11.90	11.50	13.21	
PM Concentration (dry)	mg/m³ (dry)	10.04	9.64	10.94	10.21
PM Concentration NTP (dry)	mg/Nm³ (dry)	13.49	12.99	14.81	13.76
Sampled Volume (wet)	m³ (wet)	1.21	1.21	1.22	
Sampled Volume NTP (wet)	Nm³ (wet)	0.90	0.90	0.90	
PM Concentration (wet)	mg/m³ (wet)	9.83	9.53	10.82	10.06
PM Concentration NTP (wet)	mg/Nm³ (wet)	13.20	12.84	14.64	13.56
PM Emission Rate	mg/s	544.73	522.56	594.71	554.00
PM Emission Rate	kg/h	1.96	1.88	2.14	1.99
SO_2 Collected	mg	11.96	0.57	0.57	
SO_2 Concentration (dry)	mg/m³ (dry)	10.09	0.48	0.47	3.68
SO_2 Concentration NTP (dry)	mg/Nm³ (dry)	13.56	0.64	0.64	4.94
SO_2 Concentration (wet)	mg/m³ (wet)	9.88	0.47	0.46	3.60
SO_2 Concentration NTP (wet)	mg/Nm³ (wet)	13.27	0.63	0.63	4.84
SO_2 Emission Rate	mg/s	547.50	25.76	25.52	199.59
SO_2 Emission Rate	kg/h	1.97	0.09	0.09	0.72
NOx Concentration NTP (dry)	mg/Nm³ (dry)	*0.82*	*0.82*	*0.82*	*0.82*
NOx Emission Rate	mg/s	*33.15*	*33.02*	*32.97*	*33.05*
NOx Emission Rate	kg/h	*0.12*	*0.12*	*0.12*	*0.12*
CO Concentration NTP (dry)	mg/Nm³ (dry)	*2.50*	*2.50*	*2.50*	*2.50*
CO Emission Rate	mg/s	*100.93*	*100.53*	*100.38*	*100.62*
CO Emission Rate	kg/h	*0.36*	*0.36*	*0.36*	*0.36*
Isokinetic Rate	%	102	103	104	

Italic, underlined = Values are below the detection limit, but the laboratory test method's limit of quantification (LOQ) is reported.
Italic = Results include a result, or results, reported at the laboratory test methods's LOQ

Appendix D - Test Results: Waste Gas Stack – PM, O_2, CO_2, CO, NO_x and SO_2

TEST RESULTS South 32 Hotazel Manganese Mines (Pty) Ltd Waste Gas Stack LES0763M					
	DATE	02-Mar-22	02-Mar-22	02-Mar-22	
	TEST START	11:20	12:48	14:13	
	TEST STOP	12:24	13:52	15:17	
PARAMETER	TEST	1	2	3	Averages
O_2	% (dry)	17.61	16.99	17.54	17.38
CO	ppm (dry)	6,589.31	5,392.94	5,272.50	5,751.58
CO_2	% (dry)	4.27	4.37	4.31	4.32
N_2 (by difference)	% (dry)	77.42	78.05	77.59	77.69
Dry Gas Density	kg/Nm³	1.31	1.31	1.31	1.31
Barometric Pressure	mb	892.00	892.00	892.00	892.00
Static Pressure	mb	-3.53	-3.53	-3.53	-3.53
Absolute Pressure	mb	888.47	888.47	888.47	888.47
Moisture Content	%	3.48	2.45	2.79	2.91
Gas Temperature	°C	164.00	166.19	168.31	166.17
Wet Gas Density	kg/Nm³	1.30	1.30	1.30	1.30
Duct Size	m	3.29	3.29	3.29	
Duct Area	m²	8.50	8.50	8.50	
Gas Density	kg/m³	0.71	0.71	0.70	0.71
Velocity Head	mb	3.11	3.10	3.11	3.11
Sample Time	sec	3,840.00	3,840.00	3,840.00	
Gas Velocity	m/s	29.61	29.59	29.72	29.64
Gas Volume Flow (actual)	m³/s (actual)	251.75	251.56	252.65	251.99
Gas Volume Flow NTP (wet)	Nm³/s (wet)	137.93	137.14	137.07	137.38
Gas Volume Flow NTP (dry)	Nm³/s (dry)	133.13	133.78	133.24	133.38
Gas Volume Flow NTP (dry, 10% O_2)	Nm³/s (dry, O_2)	41.07	48.72	41.94	43.91
Gas Volume Flow (actual)	m³/h (actual)	906,307.33	905,617.74	909,522.73	907,149.27
Gas Volume Flow NTP (wet)	Nm³/h (wet)	496,560.51	493,712.15	493,454.26	494,575.64
Gas Volume Flow NTP (dry)	Nm³/h (dry)	479,278.83	481,610.52	479,663.28	480,184.21
Gas Volume Flow NTP (dry)	Nm³/h (dry, O_2)	147,868.41	175,404.74	150,984.92	158,086.02
Nozzle Diameter	mm	4.63	4.63	4.63	
Sampled Volume (dry)	m³	1.77	1.80	1.82	
Sampled Volume NTP (dry)	Nm³	0.97	0.98	0.99	
PM Collected	mg	140.36	60.60	136.86	
PM Concentration (dry)	mg/m³ (dry)	79.16	33.60	75.08	62.61
PM Concentration NTP (dry)	mg/Nm³ (dry)	144.49	61.64	138.38	114.84
Sampled Volume (wet)	m³ (wet)	1.84	1.85	1.88	
Sampled Volume NTP (wet)	Nm³ (wet)	1.01	1.01	1.02	
PM Concentration (wet)	mg/m³ (wet)	76.41	32.78	72.98	60.72
PM Concentration NTP (wet)	mg/Nm³ (wet)	139.46	60.13	134.51	111.37
PM Emission Rate	mg/s	19,236.11	8,246.26	18,437.43	15,306.60
PM Emission Rate	kg/h	69.25	29.69	66.37	55.10
SO_2 Collected	mg	646.97	744.86	544.82	
SO_2 Concentration (dry)	mg/m³ (dry)	364.90	413.04	298.86	358.93
SO_2 Concentration NTP (dry)	mg/Nm³ (dry)	666.00	757.65	550.86	658.17
SO_2 Concentration (wet)	mg/m³ (wet)	352.20	402.92	290.51	348.54
SO_2 Concentration NTP (wet)	mg/Nm³ (wet)	642.82	739.08	535.46	639.12
SO_2 Emission Rate	mg/s	88,666.00	101,358.70	73,396.18	87,806.96
SO_2 Emission Rate	kg/h	319.20	364.89	264.23	316.11
NOx Concentration NTP (dry)	mg/Nm³ (dry)	321.48	313.65	331.99	322.37
NOx Emission Rate	mg/s	42,798.96	41,960.32	44,234.86	42,998.05
NOx Emission Rate	kg/h	154.08	151.06	159.25	154.79
CO Concentration NTP (dry)	mg/Nm³ (dry)	8,234.45	6,739.38	6,588.87	7,187.57
CO Emission Rate	mg/s	1,096,277.07	901,598.80	877,899.97	958,591.95
CO Emission Rate	kg/h	3,946.60	3,245.76	3,160.44	3,450.93

Isokinetic Rate	%	96	97	98

Appendix E: Uncertainties Reporting Summaries – De-dust 1 Stack

AEL Reporting Summaries South 32 Hotazel Manganese Mines (Pty) Ltd De-dust 1 Stack LES0763M				
Substance or mixture of substances		**Concentrations**		
		Average	**Uncertainty (95% confidence, k=2)**	
Common name	Chemical symbol	mg/Nm³ (dry)	mg/Nm³ (dry)	%
Particulate matter	N/A	34.11	± 1.21	± 3.55
Carbon dioxide	CO_2	<u>*13,744*</u>	<u>*± 261*</u>	<u>*± 1.90*</u>
Carbon monoxide	CO	<u>*2.50*</u>	<u>*± 0.05*</u>	<u>*± 1.97*</u>
Nitrogen oxides	NOx expressed as NO_2	<u>*0.82*</u>	<u>*± 0.02*</u>	<u>*± 2.04*</u>
Sulphur dioxide (wet chemical)	SO_2	<u>*0.57*</u>	<u>*± 0.10*</u>	<u>*± 17.96*</u>

Limit of Quantification (LOQ):

- Where the results are below the laboratory test method's LOQ, they are calculated and reported at the LOQ
- Where the average includes a result from a value below the LOQ, it is shown as *italics*.
- Where the average is of all the results from values below the LOQ, it is shown as <u>*underlined italics*</u>.

Appendix F: Uncertainties Reporting Summaries – De-dust 2 Stack

AEL Reporting Summaries South 32 Hotazel Manganese Mines (Pty) Ltd De-dust 2 Stack LES0763M				
Substance or mixture of substances		**Concentrations**		
		Average	**Uncertainty (95% confidence, k=2)**	
Common name	Chemical symbol	mg/Nm³ (dry)	mg/Nm³ (dry)	%
Particulate matter	N/A	85.06	± 2.85	± 3.4
Carbon dioxide	CO_2	<u>*13,744*</u>	<u>*± 261*</u>	<u>*± 1.9*</u>
Carbon monoxide	CO	<u>*2.50*</u>	<u>*± 0.05*</u>	<u>*± 2.0*</u>
Nitrogen oxides	NOx expressed as NO_2	<u>*0.82*</u>	<u>*± 0.02*</u>	<u>*± 2.0*</u>
Sulphur dioxide (wet chemical)	SO_2	<u>*0.67*</u>	<u>*± 0.12*</u>	<u>*± 18.0*</u>

Limit of Quantification (LOQ):

- Where the results are below the laboratory test method's LOQ, they are calculated and reported at the LOQ
- Where the average includes a result from a value below the LOQ, it is shown as *italics*.
- Where the average is of all the results from values below the LOQ, it is shown as <u>*underlined italics*</u>.

Appendix G: Uncertainties Reporting Summaries – De-dust 3 Stack

AEL Reporting Summaries South 32 Hotazel Manganese Mines (Pty) Ltd De-dust 3 Stack LES0763M				
Substance or mixture of substances		**Concentrations**		
		Average	**Uncertainty (95% confidence, k=2)**	
Common name	Chemical symbol	mg/Nm³ (dry)	mg/Nm³ (dry)	%
Particulate matter	N/A	13.76	± 0.58	± 4.2
Carbon dioxide	CO_2	*13,744*	*± 261*	*± 1.9*
Carbon monoxide	CO	*2.50*	*± 0.05*	*± 2.0*
Nitrogen oxides	NOx expressed as NO_2	*0.82*	*± 0.02*	*± 2.0*
Sulphur dioxide (wet chemical)	SO_2	*4.94*	*± 0.23*	*± 13.1*

Limit of Quantification (LOQ):

- Where the results are below the laboratory test method's LOQ, they are calculated and reported at the LOQ
- Where the average includes a result from a value below the LOQ, it is shown as *italics*.
- Where the average is of all the results from values below the LOQ, it is shown as *underlined italics*.

Appendix H: Uncertainties Reporting Summaries – Waste Gas Stack

AEL Reporting Summaries South 32 Hotazel Manganese Mines (Pty) Ltd Waste Gas Stack LES0763M				
Substance or mixture of substances		**Concentrations**		
		Average	**Uncertainty (95% confidence, k=2)**	
Common name	Chemical symbol	mg/Nm³ (dry)	mg/Nm³ (dry)	%
Particulate matter	N/A	114.84	± 3.85	± 3.4
Carbon dioxide	CO_2	84,756	± 6443	± 7.6
Carbon monoxide	CO	7,187.57	± 159.34	± 2.2
Nitrogen oxides	NOx expressed as NO_2	322.37	± 6.59	± 2.0
Sulphur dioxide (wet chemical)	SO_2	658.17	± 22.02	± 3.3

Limit of Quantification (LOQ):

- Where the results are below the laboratory test method's LOQ, they are calculated and reported at the LOQ
- Where the average includes a result from a value below the LOQ, it is shown as *italics*.
- Where the average is of all the results from values below the LOQ, it is shown as <u>*underlined italics*</u>.

ATTACHMENTS

LEVEGO
Environmental Services

REPORT 23/R2307

STACK EMISSION MEASUREMENT SURVEY (COMPLIANCE)

FOR

SOUTH 32
HOTAZEL MANGANESE MINES (PTY) LTD
MAMATWAN

SAMPLING PERIOD: NOVEMBER 2022 – JANUARY 2023

E&OE

LEVEGO ENVIRONMENTAL SERVICES (PTY) LTD Reg No 2017/188749/07. a LEVEGO affiliated company
Directors: G B Woollatt, D L Posthumus, C M Malinda. Tel: (011) 608-4148. Fax: (011) 608-2621. www.levego.co.za
Building R6, Pinelands Site, Ardeer Rd, Modderfontein, 1645. P O Box 422, Modderfontein 1645

Building R6, Pinelands Site, Ardeer Rd, Modderfontein, 1645. P O Box 422, Modderfontein 1645

Your Reference:	Order no. 4542492488
Our Reference:	**LES0913M** Quotation 22/QF3452/hy
Enquiries:	H. M. Yingwani Cell: 083 402 4436 E-mail: hlayiseka@levego.co.za
Date:	06 February 2023

SOUTH32 HOTAZEL MANGANESE MINES (PTY) LTD
MAMATWAN MINE
PO BOX 506
HOTAZEL
SOUTH AFRICA
6000

Attention: Mr Sisa Teka

Dear Sir,

REPORT No: 23/R2307 – STACK EMISSION MEASUREMENT SURVEY, SOUTH 32 HOTAZEL MANGANESE MINES (PTY) LTD MAMATWAN

Please find attached our final report for the stack emission measurement survey performed on the various stacks described in this report at 32 Hotazel Manganese Mines (Pty) Ltd, Mamatwan.

We thank you for this opportunity to be of service, and trust that the attached meets your approval.

If you have any queries, please do not hesitate to contact us at the number provided above.

Yours sincerely,

H. M. Yingwani
Project manager
On behalf of
Levego Environmental Services (Pty) Ltd

TABLE OF CONTENTS

List of abbreviations, acronyms, and symbols (where applicable)	
µg	microgram
ASTM	American Society for Testing and Materials
BDL	below detection limit
DCS	distributed control system
DGM	dry gas meter
ESP	electrostatic precipitator
ISO	International Organisation for Standardisation
kg/Nm^3	kilogram per normalised cubic metre (at NTP)
kPa	kilopascal
LECO	Laboratory Equipment Corporation
LOD	limit of detection
m	metre
m^2	square metre
m^3/s	cubic metre per second
mA	milliampere
mb	millibar
mg/m^3	milligram per cubic metre
mg/Nm^3	milligram per normalised cubic metre (at NTP)
mm	millimetre
N/A	not applicable
N/M	not measured
ng	nanogram
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Technology
Nm^3	normalised cubic metre (at NTP)
NTP	normalised temperature and pressure (273 K and 1013.25 mb)
O_2 ref %	oxygen reference percentage
PLC	programmable logic controller
PM	particulate matter
SCADA	supervisory control and data acquisition
SEM	scanning electron microscope
US EPA	United States Environmental Protection Agency

1. INTRODUCTION

Levego Environmental Services was contracted to carry out a stack emission measurement survey to determine the source emissions from the stacks installed at the South 32 Hotazel Manganese Mines (Pty) Ltd plant.

The following was understood prior to the commencement of the work; the South 32 Hotazel Manganese Mines (Pty) Ltd staff would ensure that all plant operations were to their satisfaction, including the correct operation of all relevant pollution abatement equipment.

1.1 Scope of work

The table below outlines the scope of work that Levego Environmental Services completed during the stack emission measurement survey.

Table 1: Scope of measurements

Release point	De-dust 1 Stack	De-dust 2 Stack	De-dust 3 Stack	Waste Gas Stack
Particulate matter	✓	✓	✓	✓
Water vapour	✓	✓	✓	✓
Oxygen	✓	✓	✓	✓
Carbon dioxide	✓	✓	✓	✓
Volumetric flow rate	✓	✓	✓	✓
Nitrogen oxides	✓	✓	✓	✓
Carbon monoxide	✓	✓	✓	✓
Sulphur dioxide	✓	✓	✓	✓

2. SUMMARY OF TEST PROGRAM: METHOD STATEMENTS AND DEVIATIONS

2.1 Velocity, volume, pressure and temperature

Preliminary measurements, for calculation of the required nozzle size for isokinetic sampling, were determined using sampling and testing procedures as described in ISO 9096:2017(E) "Stationary Source Emissions – Manual Determination of Mass Concentration of Particulate Matter".

Velocity measurements are performed utilising a pitot tube and an inclined manometer. Volume flows are calculated from the average velocity and duct area. Pressure and temperature are measured directly utilising a barometer / manometer combination, and thermocouple, respectively.

2.2 Particulate matter

Particulate matter measurements were determined using sampling and testing procedures as described in ISO 9096:2017(E). "Stationary Source Emissions – Manual Determination of Mass Concentration of Particulate Matter".

High-purity pre-weighed quartz thimbles (30 mm diameter × 100 mm long) were used to collect the particulate matter in the flue gas. The quartz filters are capable of withstanding temperatures of up to 800°C without filter media mass loss, and retain 99.9% of particles >0.3 μm.

2.3 Water vapour

Water vapour (H_2O) measurements were determined using sampling and testing procedures as described in US EPA Method 4 "Determination of Moisture Content in Stack Gases".

A gas sample is extracted isokinetically from the stack. H_2O is removed from the sample stream and determined gravimetrically.

2.4 Nitrogen oxides

Nitrogen oxides (NO_x) measurements were determined using sampling and testing procedures as described in US EPA Method 7E "Determination of Nitrogen Oxides Emissions from Stationary Sources (Instrumental Analyser Procedure)".

A sample of the effluent gas is continuously sampled and conveyed to the analyser for measuring the concentration of NO_x, which is the sum of NO and NO_2.

2.5 Oxygen and carbon dioxide

Oxygen (O_2) and carbon dioxide (CO_2) measurements were determined using sampling and testing procedures as described in US EPA Method 3A "Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyser Procedure)".

A sample of the effluent gas is continuously sampled and conveyed to the analyser for measuring the concentration of O_2 and CO_2.

2.6 Carbon monoxide

Carbon monoxide (CO) measurements were determined using sampling and testing procedures as described in US EPA Method 10 "Determination of Carbon Monoxide Emissions from Stationary Sources (Instrumental Analyser Procedure)".

A sample of the effluent gas is continuously sampled and conveyed to the analyser for measuring the concentration of CO.

2.7 Sulphur dioxide

Sulphur dioxide (SO_2) measurements were determined using sampling and testing procedures as described in US EPA Method 6 "Determination of Sulphur Dioxide Emissions from Stationary Sources".

A gas sample is extracted from the sampling point in the stack. The SO_2 and sulphur trioxide (SO_3), including those fractions in any sulphur acid mist, are separated. The SO_2 fraction is measured, *via* concentration of sulphate anion (SO_4^{2-}), by the barium-thorin titration method.

2.8 Key personnel

The project manager on this project was Hlayiseka Yingwani.

Team 1 consisted of Sizwe Lubuzo (team leader) and Lucky Mkalipi (sampling assistant).

3. MEASUREMENT AND SAMPLING LOCATIONS

3.1 General requirements for sampling locations

ISO 9096:2017(E) requires that the following criteria must be met:

a) the angle of gas flow is less than 15° with regard to the duct axis;

b) no local negative flow is present;

c) the minimum velocity is higher than the detection limit of the method used for the flow rate measurement (for pitot tubes, a differential pressure larger than 5 Pa);

d) the ratio of the highest to the lowest local gas velocities is less than 3:1.

If the above requirements are not met the uncertainty of measurement will be higher than that specified by ISO 9096:2017(E) and the sampling location will not be in compliance.

The above requirements are generally fulfilled in sections of duct with at least five hydraulic diameters of straight duct upstream of the sampling plane, and two hydraulic diameters downstream of the sampling plane (five hydraulic diameters from the top of a stack).

3.2 De-dust 1 Stack

The sampling position was located on the vertical circular stack. The table below details the sampling port specifications.

Table 2: De-dust 1 Stack, Compliance with ISO 9096:2017 general requirements

Height above ground level	~10 metres
Stack diameter	1.75 metres
Distance from sampling ports to downstream stack exit	~18 metres
Distance from sampling ports to upstream disturbance	~2.5 metres
Number of sampling ports	2
90° angle	Yes
Sampling port size	85 mm
ISO 9096:2017(E) a)	Yes
ISO 9096:2017(E) b)	Yes
ISO 9096:2017(E) c	Yes
ISO 9096:2017(E) d)	Yes

The sampling position does not fulfil the recommendations for the required diameters, but meets a), b), c) and d) of the general requirements. The sampling location is in compliance with the requirements of ISO 9096:2017(E)

The sampling position was deemed to be the most practical position to perform measurements within the requirements of ISO 9096:2017(E), and the limitations of the plant design.

3.3 De-dust 2 Stack

The sampling position was located on the vertical circular stack. The table below details the sampling port specifications.

Table 3: De-dust 2 Stack, Compliance with ISO 9096:2017 general requirements

Height above ground level	~12 metres
Stack diameter	1.86 metres
Distance from sampling ports to downstream stack exit	~8 metres
Distance from sampling ports to upstream disturbance	~8 metres
Number of sampling ports	2
90° angle	Yes
Sampling port size	85 mm
ISO 9096:2017(E) a)	Yes
ISO 9096:2017(E) b)	Yes
ISO 9096:2017(E) c)	Yes
ISO 9096:2017(E) d)	Yes

The sampling position does not fulfil the recommendations for the required diameters, but meets a), b), c) and d) of the general requirements. The sampling location is in compliance with the requirements of ISO 9096:2017(E)

The sampling position was deemed to be the most practical position to perform measurements within the requirements of ISO 9096:2017(E) and the limitations of the plant design.

3.4 De-dust 3 Stack

The sampling position was located on the vertical circular stack. The table below details the sampling port specifications.

Table 4: De-dust 3 Stack, Compliance with ISO 9096:2017 general requirements

Height above ground level	~15 metres
Stack diameter	1.90 metres
Distance from sampling ports to downstream stack exit	~15 metres
Distance from sampling ports to upstream disturbance	~7 metres
Number of sampling ports	2
90° angle	Yes
Sampling port size	80 mm
ISO 9096:2017(E) a)	Yes
ISO 9096:2017(E) b)	Yes
ISO 9096:2017(E) c)	Yes
ISO 9096:2017(E) d)	Yes

The sampling position fulfils the recommendations for the required diameters, and meets a), b), c) and d) of the general requirements. The sampling location is in compliance with the requirements of ISO 9096:2017(E).

The sampling position was deemed to be the most practical position to perform measurements within the requirements of ISO 9096:2017(E), and the limitations of the plant design.

3.5 Waste Gas Stack

The sampling position was located on the vertical circular stack. The table below details the sampling port specifications.

Table 5: Waste Gas Stack, Compliance with ISO 9096:2017 general requirements

Height above ground level	~16 metres
Stack diameter	3.29 metres
Distance from sampling ports to downstream stack exit	~20 metres
Distance from sampling ports to upstream disturbance	~2 metres
Number of sampling ports	2 (Only one was used)
90° angle	Yes
Sampling port size	80 mm
ISO 9096:2003 a)	Could not be confirmed
ISO 9096:2003 b)	Could not be confirmed
ISO 9096:2003 c)	Could not be confirmed
ISO 9096:2003 d)	Could not be confirmed

The sampling position does not fulfil the recommendations as per the required diameters. It could not be established if the sampling location meets a), b), c) and d) of the general requirements. Only one sampling port was used for sampling, because there is an analyser on the second port.

The sampling position was deemed to be the most practical position to perform measurements within the requirements of ISO 9096:2017(E), and the limitations of the plant design.

4. QUALITY ASSURANCE AND QUALITY CONTROL

4.1 Sample identification

All filters and solutions are labelled using pre-printed adhesive labels. Their identification codes are recorded on site observation sheets prior to the start of each measurement.

If additional samples are taken they are labelled on site at the completion of each measurement. Pre-printed adhesive labels are also used for this purpose.

4.2 Chain of custody

A chain of custody form accompanies the samples as the samples proceed from one measurement site to another.

4.3 Facility accreditation

The relevant accreditation numbers of the service provider undertaking each item of work is shown below.

Table 6: Scope of accreditation

Test parameter	Sampling	Analysis
Volumetric flow rate	ISO 17025:2017 Levego Environmental Services	ISO 17025:2017 Levego Environmental Services
Particulate matter	ISO 17025:2017 Levego Environmental Services	ISO 17025:2017 Levego Environmental Services
Water vapour	ISO 17025:2017 Levego Environmental Services	ISO 17025:2017 Levego Environmental Services
Nitrogen oxides	ISO 17025:2017 Levego Environmental Services	ISO 17025:2017 Levego Environmental Services
Oxygen	ISO 17025:2017 Levego Environmental Services	ISO 17025:2017 Levego Environmental Services
Carbon dioxide	ISO 17025:2017 Levego Environmental Services	ISO 17025:2017 Levego Environmental Services
Carbon monoxide	ISO 17025:2017 Levego Environmental Services	ISO 17025:2017 Levego Environmental Services
Sulphur dioxide	ISO 17025:2017 Levego Environmental Services	ISO 17025:2017 Levego Environmental Services

Table 7: Facility accreditation number

Facility	Accreditation number
Levego Environmental Services	SANAS Testing Laboratory T0846

4.4 Sampling equipment

Team 1 used the following sampling equipment:

- Apex Model XC-572 source sampling train (Console Serial Number: 911058 and 0809061)
- Dry gas meter: (Serial Number: 5711 and 1900835)
- Barometer: (Serial Number: DB17)
- Pitot tube: (Serial Number: ST-A3390 and ST-A3399)
- Nozzle(s): (Set Number (s): NS1-3 and NS2-2)
- Flue-gas analyser: Seitron Chemist 600 (Serial Number: 1076)

Calibration records are included in the attachment section of this report.

5. RESULTS AND DISCUSSION

5.1 General

Testing only commenced after confirmation was received from the South 32 Hotazel Manganese Mines (Pty) Ltd staff that the plant was stable and operating under normal conditions.

In this report:

- An analyte concentration that was measured to be below the limit of detection for a particular laboratory test method is reported at the limit of detection, unless otherwise indicated. For calculation of a pollutant concentration, the analyte amount is calculated and is then divided by the gas volume sampled.
- Where averages are reported, these are the arithmetic mean, without any other statistical analyses applied.

$$A = \frac{1}{n}\sum_{i=1}^{n} a_i$$

Where:

A = average (arithmetic mean)
n = number of data sets (generally three for this report)
a_i = data set values

5.2 Results

The result summaries are attached as Appendix A to Appendix D.

5.2.1 Measurement Uncertainty

The measurement uncertainties are shown in Appendices E to H. The tables show the averages over three tests of the measured results, the uncertainties in measurement units, and uncertainties as a proportion (%) of the measured values.

With regards to the measured CO, CO_2 and NO_x results were below the limits of detection and have been reported at the limit of detection.

5.3 Discussion

5.3.1 De-dust 1 stack

The plant is stable but De-dust 3 had technical problems which causes the dust to flow heavily from time to time.

5.4 Compliance

As set out in the Atmospheric Emission Licence (AEL), supplied by South 32 Mamatwan Hotazel Manganese Mines, license number: NC/AEL/JTG/MAM01/2012, the emission limits are set as presented in the following table and compared with measured values.

Table 8: Compliance table

Substance or mixture of substances		**Date to be achieved by:**	**Emission limit**	**De-dust 1 Stack test average**	**De-dust 2 Stack test average**	**De-dust 3 Stack test average**	**Waste Gas Stack test average**
Common name	**Chemical symbol**		**mg/Nm³, 273 K, dry, 101.3 kPa**				
Particulate matter	N/A	01/04/2020	50	**71.59***	17.28	-	**168.36***
			135	-	-	**156.96***	N/A
Sulphur dioxide	SO_2	01/04/2020	500	_0.59_	_0.63_	_0.63_	**578.11***
Nitrogen oxides	NOx	01/04/2020	700	_0.82_	_0.82_	_0.82_	368.21

Note: Italic underlined values are below the LOD of the method of analysis.
***Average concentration exceeds the permissible emission limit.**

6. APPENDICES

Appendix A - Test Results: De-dust 1 Stack – PM, O_2, CO_2, CO, NO_x and SO_2
Appendix B - Test Results: De-dust 2 Stack – PM, O_2, CO_2, CO, NO_x and SO_2
Appendix C - Test Results: De-dust 3 Stack – PM, O_2, CO_2, CO, NO_x and SO_2
Appendix D - Test Results: Waste Gas Stack – PM, O_2, CO_2, CO, NO_x and SO_2

Appendix E: Uncertainties Reporting Summaries – De-dust 1 Stack
Appendix F: Uncertainties Reporting Summaries – De-dust 2 Stack
Appendix G: Uncertainties Reporting Summaries – De-dust 3 Stack
Appendix H: Uncertainties Reporting Summaries – Waste Gas Stack

7. ATTACHMENTS

- Proof of delivery
- Test sheets
- Chain of custody sheets and laboratory analysis sheets
- Calibration and verification certificates

We would like to take this opportunity to thank the South 32 Hotazel Manganese Mines (Pty) Ltd personnel that assisted us in the survey. We consider the measurement survey to be successful, and an accurate reflection of the plant conditions at the time of measurement.

Yours sincerely,

L. Tsetlho

Report Writer
Levego Environmental Services

H. M. Yingwani

Approved by (Technical Signatory)
Levego Environmental Services

APPENDICES

Appendix A - Test Results: De-dust 1 Stack – PM, O_2, CO_2, CO, NO_x and SO_2

TEST RESULTS
South 32 Hotazel Manganese Mines (Pty) Ltd
De-dust 1 Stack
LES0913M

	DATE	27-Nov-20	27-Nov-20	27-Nov-20	
	TEST START	09:10	10:30	11:53	
	TEST STOP	10:18	11:38	13:00	
	TEST	1	2	3	
PARAMETER	PLANT CONDITIONS	The plant declared stable	The plant declared stable	The plant declared stable	Averages
O_2	% (dry)	20.90	20.90	20.90	20.90
CO	ppm (dry)	*2.00*	*2.00*	*2.00*	*2.00*
CO_2	% (dry)	*0.70*	*0.70*	*0.70*	*0.70*
N_2 (by difference)	% (dry)	78.40	78.40	78.40	78.40
Dry Gas Density	kg/Nm³	1.29	1.29	1.29	1.29
Barometric Pressure	mb	890.00	890.00	890.00	890.00
Static Pressure	mb	-0.39	-0.39	-0.39	-0.39
Absolute Pressure	mb	889.61	889.61	889.61	889.61
Moisture Content	%	1.35	1.09	1.04	1.16
Gas Temperature	°C	42.46	46.00	50.85	46.44
Wet Gas Density	kg/Nm³	1.29	1.29	1.29	1.29
Duct Size	m	1.75	1.75	1.75	
Duct Area	m²	2.41	2.41	2.41	
Gas Density	kg/m³	0.98	0.97	0.95	0.97
Velocity Head	mb	0.54	0.51	0.49	0.51
Sample Time	sec	3,900.00	3,900.00	3,900.00	
Gas Velocity	m/s	10.47	10.26	10.09	10.27
Gas Volume Flow (actual)	m³/s (actual)	25.17	24.69	24.27	24.71
Gas Volume Flow NTP (wet)	Nm³/s (wet)	19.13	18.55	17.97	18.55
Gas Volume Flow NTP (dry)	Nm³/s (dry)	18.87	18.35	17.78	18.33
Gas Volume Flow (actual)	m³/h (actual)	90,626.18	88,882.64	87,379.64	88,962.82
Gas Volume Flow NTP (wet)	Nm³/h (wet)	68,862.69	66,789.04	64,677.54	66,776.42
Gas Volume Flow NTP (dry)	Nm³/h (dry)	67,934.33	66,057.88	64,002.11	65,998.11
Nozzle Diameter	mm	6.42	6.42	6.42	
Sampled Volume (dry)	m³	1.29	1.27	1.26	
Sampled Volume NTP (dry)	Nm³	0.98	0.96	0.93	
PM Collected	mg	56.20	78.24	70.53	
PM Concentration (dry)	mg/m³ (dry)	43.43	61.54	56.06	53.67
PM Concentration NTP (dry)	mg/Nm³ (dry)	57.16	81.89	75.73	71.59
Sampled Volume (wet)	m³ (wet)	1.31	1.29	1.27	
Sampled Volume NTP (wet)	Nm³ (wet)	1.00	0.97	0.94	
PM Concentration (wet)	mg/m³ (wet)	42.85	60.86	55.47	53.06
PM Concentration NTP (wet)	mg/Nm³ (wet)	56.39	81.00	74.94	70.78
PM Emission Rate	mg/s	1,078.61	1,502.69	1,346.40	1,309.23
PM Emission Rate	kg/h	3.88	5.41	4.85	4.71
SO_2 Collected	mg	*0.57*	*0.57*	*0.57*	
SO_2 Concentration (dry)	mg/m³ (dry)	*0.44*	*0.45*	*0.45*	*0.44*
SO_2 Concentration NTP (dry)	mg/Nm³ (dry)	*0.58*	*0.59*	*0.61*	*0.59*
SO_2 Concentration (wet)	mg/m³ (wet)	*0.43*	*0.44*	*0.45*	*0.44*
SO_2 Concentration NTP (wet)	mg/Nm³ (wet)	*0.57*	*0.59*	*0.60*	*0.59*
SO_2 Emission Rate	mg/s	*10.88*	*10.89*	*10.82*	*10.86*
SO_2 Emission Rate	kg/h	*0.04*	*0.04*	*0.04*	*0.04*
NOx Concentration NTP (dry)	mg/Nm³ (dry)	*0.82*	*0.82*	*0.82*	*0.82*
NOx Emission Rate	mg/s	*15.49*	*15.06*	*14.60*	*15.05*
NOx Emission Rate	kg/h	*0.06*	*0.05*	*0.05*	*0.05*
CO Concentration NTP (dry)	mg/Nm³ (dry)	*2.50*	*2.50*	*2.50*	*2.50*
CO Emission Rate	mg/s	*47.16*	*45.86*	*44.43*	*45.82*
CO Emission Rate	kg/h	*0.17*	*0.17*	*0.16*	*0.16*

Isokinetic Rate	%	99	99	100

Italic, underlined = Values are below the detection limit, but the laboratory test method's limit of quantification (LOQ) is reported.

Appendix B - Test Results: De-dust 2 Stack – PM, O_2, CO_2, CO, NO_x and SO_2

TEST RESULTS
South 32 Hotazel Manganese Mines (Pty) Ltd
De-dust 2 Stack
LES0913M

	DATE	28-Nov-22	28-Nov-22	28-Nov-22	
	TEST START	09:17	10:43	12:04	
	TEST STOP	10:25	11:50	13:12	
	TEST	1	2	3	
PARAMETER	PLANT CONDITIONS	Declared stable	Declared stable	Declared stable	Averages
O_2	% (dry)	20.90	20.90	20.90	20.90
CO	ppm (dry)	*2.00*	*2.00*	*2.00*	*2.00*
CO_2	% (dry)	*0.70*	*0.70*	*0.70*	*0.70*
N_2 (by difference)	% (dry)	78.40	78.40	78.40	78.40
Dry Gas Density	kg/Nm³	1.29	1.29	1.29	1.29
Barometric Pressure	mb	897.70	897.70	897.70	897.70
Static Pressure	mb	-0.39	-0.39	-0.39	-0.39
Absolute Pressure	mb	897.31	897.31	897.31	897.31
Moisture Content	%	2.06	1.75	1.72	1.84
Gas Temperature	°C	68.62	67.92	72.62	69.72
Wet Gas Density	kg/Nm³	1.28	1.28	1.28	1.28
Duct Size	m	1.86	1.86	1.86	
Duct Area	m^2	2.72	2.72	2.72	
Gas Density	kg/m³	0.91	0.91	0.90	0.91
Velocity Head	mb	0.49	0.49	0.48	0.49
Sample Time	sec	3,900.00	3,900.00	3,900.00	
Gas Velocity	m/s	10.36	10.37	10.34	10.36
Gas Volume Flow (actual)	m³/s (actual)	28.16	28.17	28.08	28.14
Gas Volume Flow NTP (wet)	Nm³/s (wet)	19.93	19.98	19.65	19.85
Gas Volume Flow NTP (dry)	Nm³/s (dry)	19.52	19.63	19.31	19.49
Gas Volume Flow (actual)	m³/h (actual)	101,363.31	101,419.71	101,103.07	101,295.36
Gas Volume Flow NTP (wet)	Nm³/h (wet)	71,742.86	71,928.49	70,730.84	71,467.40
Gas Volume Flow NTP (dry)	Nm³/h (dry)	70,264.95	70,669.00	69,515.68	70,149.88
Nozzle Diameter	mm	6.42	6.42	6.42	
Sampled Volume (dry)	m³	1.28	1.29	1.28	
Sampled Volume NTP (dry)	Nm³	0.91	0.91	0.90	
PM Collected	mg	20.67	13.21	13.06	
PM Concentration (dry)	mg/m³ (dry)	16.17	10.24	10.19	12.20
PM Concentration NTP (dry)	mg/Nm³ (dry)	22.84	14.45	14.56	17.28
Sampled Volume (wet)	m³ (wet)	1.31	1.31	1.30	
Sampled Volume NTP (wet)	Nm³ (wet)	0.92	0.93	0.91	
PM Concentration (wet)	mg/m³ (wet)	15.83	10.07	10.01	11.97
PM Concentration NTP (wet)	mg/Nm³ (wet)	22.37	14.19	14.31	16.96
PM Emission Rate	mg/s	445.79	283.57	281.21	336.86
PM Emission Rate	kg/h	1.60	1.02	1.01	1.21
SO_2 Collected	mg	*0.57*	*0.57*	*0.57*	
SO_2 Concentration (dry)	mg/m³ (dry)	*0.44*	*0.44*	*0.44*	*0.44*
SO_2 Concentration NTP (dry)	mg/Nm³ (dry)	*0.63*	*0.62*	*0.63*	*0.63*
SO_2 Concentration (wet)	mg/m³ (wet)	*0.43*	*0.43*	*0.43*	*0.43*
SO_2 Concentration NTP (wet)	mg/Nm³ (wet)	*0.61*	*0.61*	*0.62*	*0.61*
SO_2 Emission Rate	mg/s	*12.23*	*12.17*	*12.21*	*12.20*
SO_2 Emission Rate	kg/h	*0.04*	*0.04*	*0.04*	*0.04*
NOx Concentration NTP (dry)	mg/Nm³ (dry)	*0.82*	*0.82*	*0.82*	*0.82*
NOx Emission Rate	mg/s	*16.02*	*16.12*	*15.85*	*16.00*
NOx Emission Rate	kg/h	*0.06*	*0.06*	*0.06*	*0.06*
CO Concentration NTP (dry)	mg/Nm³ (dry)	*2.50*	*2.50*	*2.50*	*2.50*
CO Emission Rate	mg/s	*48.78*	*49.06*	*48.26*	*48.70*
CO Emission Rate	kg/h	*0.18*	*0.18*	*0.17*	*0.18*

Isokinetic Rate	%	100	100	100

Italic, underlined = Values are below the detection limit, but the laboratory test method's limit of quantification (LOQ) is reported.

Appendix C - Test Results: De-dust 3 Stack – PM, O_2, CO_2, CO, NO_x and SO_2

TEST RESULTS
South 32 Hotazel Manganese Mines (Pty) Ltd
De-dust 3 Stack
LES0913M

	DATE	17-Jan-23	17-Jan-23	17-Jan-23	
	TEST START	12:15	13:50	15:11	
	TEST STOP	13:22	14:58	16:18	
	TEST	1	2	3	
PARAMETER	PLANT CONDITIONS	The plant is stable but DD3 has technical problems	The plant is stable but DD3 has technical problems	The plant is stable but DD3 has technical problems	Averages
O_2	% (dry)	20.90	20.90	20.90	20.90
CO	ppm (dry)	*2.00*	*2.00*	*2.00*	*2.00*
CO_2	% (dry)	*0.70*	*0.70*	*0.70*	*0.70*
N_2 (by difference)	% (dry)	78.40	78.40	78.40	78.40
Dry Gas Density	kg/Nm³	1.29	1.29	1.29	1.29
Barometric Pressure	mb	894.00	894.00	894.00	894.00
Static Pressure	mb	-0.98	-0.98	-0.98	-0.98
Absolute Pressure	mb	893.02	893.02	893.02	893.02
Moisture Content	%	2.04	1.48	1.03	1.52
Gas Temperature	°C	48.38	48.92	48.54	48.62
Wet Gas Density	kg/Nm³	1.28	1.29	1.29	1.29
Duct Size	m	1.90	1.90	1.90	
Duct Area	m²	2.84	2.84	2.84	
Gas Density	kg/m³	0.96	0.96	0.96	0.96
Velocity Head	mb	1.81	1.79	1.80	1.80
Sample Time	sec	3,900.00	3,900.00	3,900.00	
Gas Velocity	m/s	19.41	19.28	19.31	19.33
Gas Volume Flow (actual)	m³/s (actual)	55.02	54.67	54.75	54.81
Gas Volume Flow NTP (wet)	Nm³/s (wet)	41.19	40.86	40.97	41.01
Gas Volume Flow NTP (dry)	Nm³/s (dry)	40.35	40.26	40.55	40.39
Gas Volume Flow (actual)	m³/h (actual)	198,069.96	196,804.97	197,107.45	197,327.46
Gas Volume Flow NTP (wet)	Nm³/h (wet)	148,298.36	147,104.88	147,507.13	147,636.79
Gas Volume Flow NTP (dry)	Nm³/h (dry)	145,269.93	144,925.46	145,994.84	145,396.74
Nozzle Diameter	mm	4.41	4.41	4.41	
Sampled Volume (dry)	m³	1.20	1.17	1.20	
Sampled Volume NTP (dry)	Nm³	0.90	0.88	0.90	
PM Collected	mg	94.07	113.11	213.93	
PM Concentration (dry)	mg/m³ (dry)	78.16	96.41	177.73	117.43
PM Concentration NTP (dry)	mg/Nm³ (dry)	104.39	128.98	237.50	156.96
Sampled Volume (wet)	m³ (wet)	1.23	1.19	1.22	
Sampled Volume NTP (wet)	Nm³ (wet)	0.92	0.89	0.91	
PM Concentration (wet)	mg/m³ (wet)	76.56	94.98	175.91	115.82
PM Concentration NTP (wet)	mg/Nm³ (wet)	102.26	127.07	235.06	154.80
PM Emission Rate	mg/s	4,212.31	5,192.46	9,631.44	6,345.41
PM Emission Rate	kg/h	15.16	18.69	34.67	22.84
SO_2 Collected	mg	*0.57*	*0.57*	*0.57*	
SO_2 Concentration (dry)	mg/m³ (dry)	*0.47*	*0.48*	*0.47*	*0.48*
SO_2 Concentration NTP (dry)	mg/Nm³ (dry)	*0.63*	*0.65*	*0.63*	*0.63*
SO_2 Concentration (wet)	mg/m³ (wet)	*0.46*	*0.48*	*0.47*	*0.47*
SO_2 Concentration NTP (wet)	mg/Nm³ (wet)	*0.62*	*0.64*	*0.62*	*0.63*
SO_2 Emission Rate	mg/s	*25.38*	*26.02*	*25.52*	*25.64*
SO_2 Emission Rate	kg/h	*0.09*	*0.09*	*0.09*	*0.09*
NOx Concentration NTP (dry)	mg/Nm³ (dry)	*0.82*	*0.82*	*0.82*	*0.82*
NOx Emission Rate	mg/s	*33.13*	*33.05*	*33.30*	*33.16*
NOx Emission Rate	kg/h	*0.12*	*0.12*	*0.12*	*0.12*
CO Concentration NTP (dry)	mg/Nm³ (dry)	*2.50*	*2.50*	*2.50*	*2.50*
CO Emission Rate	mg/s	*100.86*	*100.62*	*101.36*	*100.94*
CO Emission Rate	kg/h	*0.36*	*0.36*	*0.36*	*0.36*

Isokinetic Rate	%	106	104	106

Italic, underlined = Values are below the detection limit, but the laboratory test method's limit of quantification (LOQ) is reported.

Appendix D - Test Results: Waste Gas Stack – PM, O_2, CO_2, CO, NO_x and SO_2

TEST RESULTS
South 32 Hotazel Manganese Mines (Pty) Ltd
Waste Gas Stack
LES0913M

	DATE	26-Nov-22	26-Nov-22	26-Nov-22	
	TEST START	09:46	11:16	12:36	
	TEST STOP	10:50	12:20	13:40	
	TEST	1	2	3	
PARAMETER	PLANT CONDITIONS	The palnt declared stable	The palnt declared stable	The palnt declared stable	Averages
O_2	% (dry)	17.66	17.44	17.26	17.45
CO	ppm (dry)	25,764.13	32,115.63	24,516.44	27,465.40
CO_2	% (dry)	3.47	3.69	3.78	3.64
N_2 (by difference)	% (dry)	76.26	75.62	76.48	76.12
Dry Gas Density	kg/Nm³	1.31	1.31	1.31	1.31
Barometric Pressure	mb	891.00	891.00	891.00	891.00
Static Pressure	mb	-3.53	-3.53	-3.53	-3.53
Absolute Pressure	mb	887.47	887.47	887.47	887.47
Moisture Content	%	2.69	2.43	3.06	2.73
Gas Temperature	°C	148.56	153.69	148.00	150.08
Wet Gas Density	kg/Nm³	1.29	1.30	1.29	1.29
Duct Size	m	3.29	3.29	3.29	
Duct Area	m²	8.50	8.50	8.50	
Gas Density	kg/m³	0.73	0.73	0.73	0.73
Velocity Head	mb	2.67	2.74	2.71	2.71
Sample Time	sec	3,840.00	3,840.00	3,840.00	
Gas Velocity	m/s	26.97	27.46	27.18	27.21
Gas Volume Flow (actual)	m³/s (actual)	229.31	233.48	231.08	231.29
Gas Volume Flow NTP (wet)	Nm³/s (wet)	130.09	130.86	131.27	130.74
Gas Volume Flow NTP (dry)	Nm³/s (dry)	126.59	127.68	127.25	127.17
Gas Volume Flow (actual)	m³/h (actual)	825,528.95	840,515.96	831,878.26	832,641.06
Gas Volume Flow NTP (wet)	Nm³/h (wet)	468,332.09	471,109.08	472,564.45	470,668.54
Gas Volume Flow NTP (dry)	Nm³/h (dry)	455,725.92	459,639.24	458,086.01	457,817.06
Nozzle Diameter	mm	4.70	4.70	4.70	
Sampled Volume (dry)	m³	1.67	1.72	1.71	
Sampled Volume NTP (dry)	Nm³	0.95	0.96	0.97	
PM Collected	mg	167.34	159.58	158.63	
PM Concentration (dry)	mg/m³ (dry)	100.09	92.90	92.54	95.18
PM Concentration NTP (dry)	mg/Nm³ (dry)	176.42	165.75	162.90	168.36
Sampled Volume (wet)	m³ (wet)	1.72	1.76	1.77	
Sampled Volume NTP (wet)	Nm³ (wet)	0.97	0.99	1.00	
PM Concentration (wet)	mg/m³ (wet)	97.39	90.64	89.70	92.58
PM Concentration NTP (wet)	mg/Nm³ (wet)	171.68	161.71	157.91	163.77
PM Emission Rate	mg/s	22,333.69	21,162.09	20,728.49	21,408.09
PM Emission Rate	kg/h	80.40	76.18	74.62	77.07
SO_2 Collected	mg	711.99	489.63	462.68	
SO_2 Concentration (dry)	mg/m³ (dry)	425.85	285.04	269.91	326.94
SO_2 Concentration NTP (dry)	mg/Nm³ (dry)	750.65	508.55	475.14	578.11
SO_2 Concentration (wet)	mg/m³ (wet)	414.39	278.10	261.64	318.04
SO_2 Concentration NTP (wet)	mg/Nm³ (wet)	730.44	496.17	460.58	562.40
SO_2 Emission Rate	mg/s	95,024.68	64,931.02	60,459.62	73,471.77
SO_2 Emission Rate	kg/h	342.09	233.75	217.65	264.50
NOx Concentration NTP (dry)	mg/Nm³ (dry)	354.32	376.12	374.20	368.21
NOx Emission Rate	mg/s	44,852.98	48,022.52	47,615.39	46,830.30
NOx Emission Rate	kg/h	161.47	172.88	171.42	168.59
CO Concentration NTP (dry)	mg/Nm³ (dry)	32,196.59	40,133.85	30,637.40	34,322.61
CO Emission Rate	mg/s	4,075,783.50	5,124,192.72	3,898,489.53	4,366,155.25
CO Emission Rate	kg/h	14,672.82	18,447.09	14,034.56	15,718.16
Isokinetic Rate	%	96	96	98	

Italic, underlined = Values are below the detection limit, but the laboratory test method's limit of quantification (LOQ) is reported.

Appendix E: Uncertainties Reporting Summaries – De-dust 1 Stack

AEL Reporting Summaries South 32 Hotazel Manganese Mines (Pty) Ltd De-dust 1 Stack LES0913M				
Substance or mixture of substances		**Concentrations**		
		Average	**Uncertainty (95% confidence, k=2)**	
Common name	Chemical symbol	mg/Nm³ (dry)	mg/Nm³ (dry)	%
Particulate matter	N/A	71.59	± 2.45	± 3.4
Carbon dioxide	CO_2	*13,744*	*± 261*	*± 1.9*
Carbon monoxide	CO	*2.50*	*± 0.05*	*± 2.0*
Nitrogen oxides	NOx expressed as NO_2	*0.82*	*± 0.02*	*± 2.0*
Sulphur dioxide (wet chemical)	SO_2	*0.59*	*± 0.11*	*± 18.0*

Limit of Quantification (LOQ):
- Where the results are below the laboratory test method's LOQ, they are calculated and reported at the LOQ
- Where the average includes a result from a value below the LOQ, it is shown as *italics*.
- Where the average is of all the results from values below the LOQ, it is shown as *underlined italics*.

Appendix F: Uncertainties Reporting Summaries – De-dust 2 Stack

AEL Reporting Summaries South 32 Hotazel Manganese Mines (Pty) Ltd De-dust 2 Stack LES0913M				
Substance or mixture of substances		**Concentrations**		
		Average	**Uncertainty (95% confidence, k=2)**	
Common name	Chemical symbol	mg/Nm³ (dry)	mg/Nm³ (dry)	%
Particulate matter	N/A	17.28	± 0.68	± 3.9
Carbon dioxide	CO_2	*13,744*	*± 261*	*± 1.9*
Carbon monoxide	CO	*2.50*	*± 0.05*	*± 2.0*
Nitrogen oxides	NOx expressed as NO_2	*0.82*	*± 0.02*	*± 2.0*
Sulphur dioxide (wet chemical)	SO_2	*0.63*	*± 0.11*	*± 18.0*

Limit of Quantification (LOQ):
- Where the results are below the laboratory test method's LOQ, they are calculated and reported at the LOQ
- Where the average includes a result from a value below the LOQ, it is shown as *italics*.
- Where the average is of all the results from values below the LOQ, it is shown as *underlined italics*.

Appendix G: Uncertainties Reporting Summaries – De-dust 3 Stack

AEL Reporting Summaries South 32 Hotazel Manganese Mines (Pty) Ltd De-dust 3 Stack LES0913M				
Substance or mixture of substances		Concentrations		
		Average	Uncertainty (95% confidence, k=2)	
Common name	Chemical symbol	mg/Nm³ (dry)	mg/Nm³ (dry)	%
Particulate matter	N/A	156.96	± 5.27	± 3.4
Carbon dioxide	CO_2	*13,744*	*± 261*	*± 1.9*
Carbon monoxide	CO	*2.50*	*± 0.05*	*± 2.0*
Nitrogen oxides	NOx expressed as NO_2	*0.82*	*± 0.02*	*± 2.0*
Sulphur dioxide (wet chemical)	SO_2	*0.63*	*± 0.11*	*± 18.0*

Limit of Quantification (LOQ):

- Where the results are below the laboratory test method's LOQ, they are calculated and reported at the LOQ
- Where the average includes a result from a value below the LOQ, it is shown as *italics*.
- Where the average is of all the results from values below the LOQ, it is shown as *underlined italics*.

Appendix H: Uncertainties Reporting Summaries – Waste Gas Stack

AEL Reporting Summaries South 32 Hotazel Manganese Mines (Pty) Ltd Waste Gas Stack LES0913M				
Substance or mixture of substances		Concentrations		
		Average	Uncertainty (95% confidence, k=2)	
Common name	Chemical symbol	mg/Nm³ (dry)	mg/Nm³ (dry)	%
Particulate matter	N/A	168.36	± 5.67	± 3.4
Carbon dioxide	CO_2	71,544	± 4630	± 6.5
Carbon monoxide	CO	34,322.61	± 1787.96	± 5.2
Nitrogen oxides	NOx expressed as NO_2	368.21	± 7.53	± 2.0
Sulphur dioxide (wet chemical)	SO_2	578.11	± 19.42	± 3.4

Limit of Quantification (LOQ):

- Where the results are below the laboratory test method's LOQ, they are calculated and reported at the LOQ
- Where the average includes a result from a value below the LOQ, it is shown as *italics*.
- Where the average is of all the results from values below the LOQ, it is shown as *underlined italics*.

ATTACHMENTS

Report Sheet for Work Done / Down Time

Project Number	[illegible]		
Client (Company)	Socati 32	Client Contact Number	
Client Plant (Site)	[illegible]	Team Leader	Sizwe

Date	Work Carried Out / Reason For Down Time	Start Time	End Time	No of Hrs Worked / Hrs Down Time	Client Rep Name	Levego Rep Name	Client Signature	Levego Signature
27/11/2022	Set-up and [illegible] Dedust 1	07:20	13:30		Siso	Sizwe		[signature]
28/11/2022	Set-up and Three [illegible] Dedust 2	07:20	15:00		Siso	Sizwe		[signature]
29/11/2022	Dedust 3 had technical problems [illegible] drive back to JHB	07:00	14:00		Siso	Sizwe		[signature]
11/12/2022	Driving from JHB to [illegible]	13:00	20:00		Siso	Sizwe		[signature]
12/12/2022	Access and the plant was not running	07:30	11:00		Siso	Sizwe		[signature]
13/12/2022	Driving back to JHB, due to the technical problems being not resolved.	~~08:30~~ 06:30	13:30		Siso	Sizwe		[signature]

LEVEGO Environmental Services	LES-A-F-017	Page:	1 of 1
	REPORT SHEET FOR WORK DONE / DOWN TIME	Revision Status :	E01
		Effective date	2010-04-11

Report Sheet for Work Done / Down Time

Project Number	LES 0913M		
Client (Company)	Sasol 32	Client Contact Number	
Client Plant (Site)	Mmabatho	Team Leader	Sizwe

Date	Work Carried Out / Reason For Down Time	Start Time	End Time	No of Hrs Worked / Hrs Down Time	Client Rep Name	Levego Rep Name	Client Signature	Levego Signature
22/11/2012	Driving to Kriel	16:00	11:00		Siso	Sizwe		
23/11/2012	Access	09:00	13:30		Siso	Sizwe		
24/11/2012	Paperwork after Ok for in at 11:00 due to the delay the of the [illegible] the the plant was not running	08:00	13:30		Siso	Sizwe		
25/11/2012	Set-up of DDL and the plant stopped and run one train we waited but it come back very late	08:45	16:00		Siso	Sizwe		
26/11/2012	Set-up and three M6 test at the waste Gas Stack	07:30	15:00		Siso	Sizwe		

LEVEGO Environmental Services	LES-A-F-017	Page:	1 of 1
	REPORT SHEET FOR WORK DONE / DOWN TIME	Revision Status :	E01
		Effective date	2010-04-11

Report Sheet for Work Done / Down Time

Project Number	LES0913M		
Client (Company)	South 32	Client Contact Number	
Client Plant (Site)	Mpumalanga	Team Leader	Sizwe

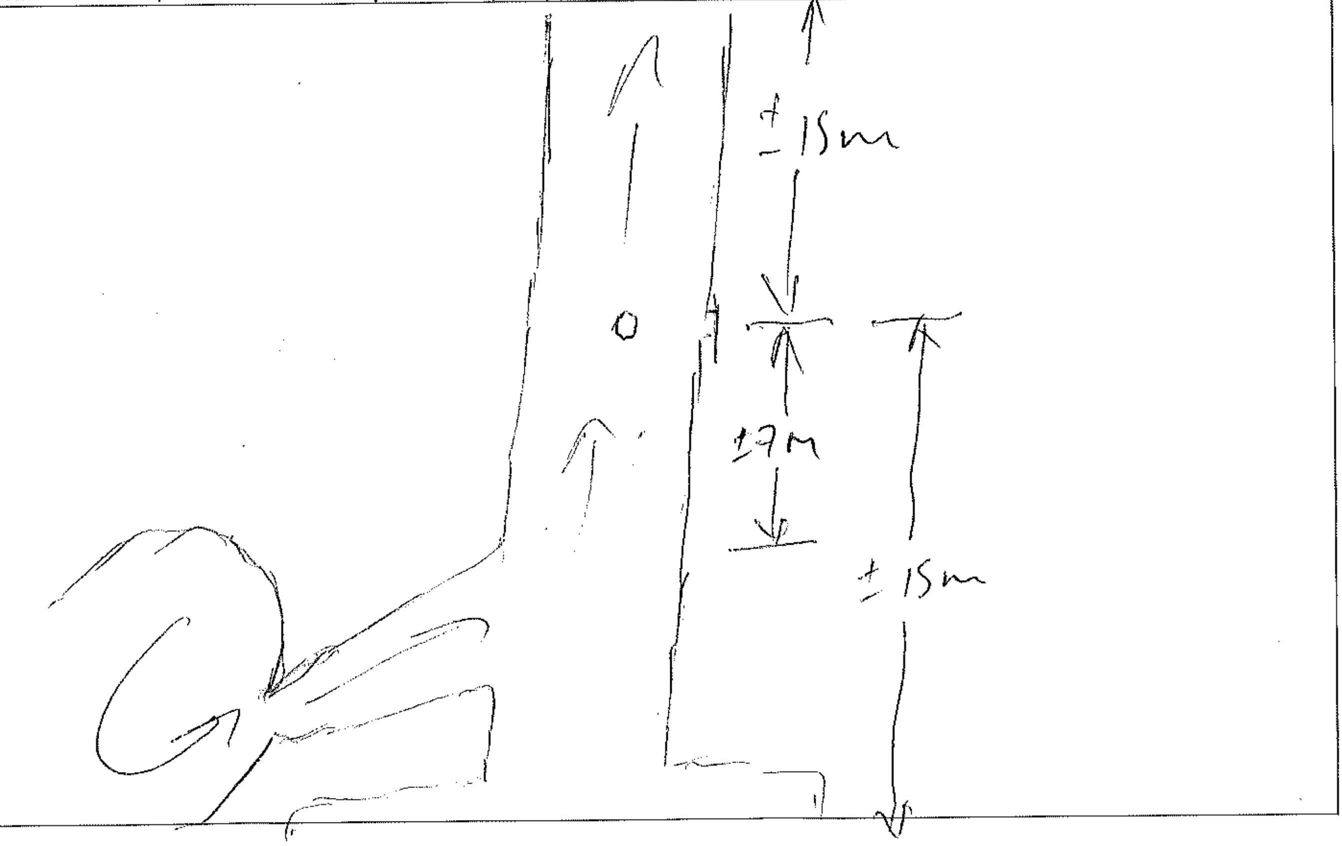
Date	Work Carried Out / Reason For Down Time	Start Time	End Time	No of Hrs Worked / Hrs Down Time	Client Rep Name	Levego Rep Name	Client Signature	Levego Signature
15/01/2023	Driving from JHB to kathu	15:00	22:00		Siso	Sizwe		
16/01/2023	Permit to work and access	08:00	12:30		Siso	Sizwe		
17/01/2023	Paperwork, setup [illegible] and three M6 tests, got stopped by the ATW	07:45	18:45		Siso	Sizwe		
18/01/2023	Driving from kathu to JHB	08:00	15:00		Siso	Sizwe		

Company:	South 32
Site:	Mamatwan
Project No.	LES0913M

Location:	Dedust 3
Date:	2023/01/17
Technician:	S12V[illegible]

1. Sketch (refer to Site Observation Examples LES-A-F-097)

Draw the Stack/Duct sampling location, showing the orientation of sampling ports. Mark the ports (i.e. P1, P2, etc.) For typical examples, refer to LES-A-F-097 Site Observation Examples, Figures 1 to 5.
Indicate North, or other cardinal points, as per typical example in LES-A-F-097, Figure 5.



2. Occurrence Report

Deviations, abnormalities or problems experienced; (Any related to method, procedure or process operating conditions)

The plant is stable but dedust 3 has got technical problems which cause the dust to flow frequently from time to time. The client is aware of that and gave the procedure with the survey. Also the sound of the flow would go up and the velocity would go down for about five to 10 seconds then back to its normal velocity.

Company:	South 32	Location:	Dedust 3
Site:	Meyerton	Date:	2023/01/17
Project No.	LES0913M	Technician:	Sizwe

3. Stack/Duct Information (refer to Site Observation Examples LES-A-F-097)

How were dimensions and details obtained?			Measured ✓	Estimated	Historical
Material	Steel ✓	Brick	Glass reinforced polymer (GRP)	Other (specify)	Refer Figure
Support structure	Free standing ✓	Steel frame	Multi-flue within windshield (provide sketch)	Other (specify)	
Duct/stack orientation	Vertical ✓	Horizontal	Angle to horizontal (δ) degrees	Angle to vertical (β) degrees	3
Shape	Circular ✓	Rectangular	Square	Other (specify)	
Flow direction of angled duct		Up (u) ±15	Down (d) ±17		3

SAMPLING PORT – DIMENSIONS					
Height above ground level				h ±15 m	1
Straight duct downstream from sampling plane (ports), or to stack exit				a ±15 m	1 & 3
Is downstream disturbance open (stack exit), or closed (balance of plant)?					1 & 3
Straight duct upstream from sampling plane (ports)				b ±7 m	1 & 3
Port diameter (d)	80 mm	Rectangular port dimensions		100/120 mm	1 & 4
Boss length (ℓ)	0 mm	Wall + insulation thickness (t)		5 mm	1 & 4

CIRCULAR DUCT/STACK – DIMENSIONS			
Circumference (outer)	m		
Outside diameter (OD)	1,9 m	diameter = circumference ÷ π	
Wall + insulation thickness	t 5 mm		1
Inside diameter (ID)	D 1,9 m	ID = OD – (2×t÷1000)	1
Number of ports	2		
Angle between port centre lines	α 90 degrees		1
Port centre lines to Inlet centre line	φ degrees	ψ degrees	2

RECTANGULAR/SQUARE DUCT/STACK – DIMENSIONS				
Depth outside	L_o m			4
Wall + insulation thickness	t mm			4
Inside depth	L m	$L = L_o – (2×t÷1000)$		4
Width outside	W_o m			4
Wall + insulation thickness	t mm			4
Inside width	W m	$W = W_o – (2×t÷1000)$		4
Equivalent diameter	D_e m	(2×L×W)÷(L+W)		
Number of ports & Location		On side dimensioned L or W?		4
Angle of flow with regard to duct axis =	degrees	Angle of flow <15° with regard to duct axis, for each point?	Yes	No
Negative flows present?			Yes	No

PROCESS INFORMATION				
Source of pollutant	Boiler furnace	Kiln	Crusher, or mill	Other (specify below)
Pollution control equipment	ESP	Fabric filter	Scrubber	Other (specify below)

Comments:

Project No.	LES0713M
Company	South 32
Site	Mozal Nam
Location	D-Stack 3

Date	2023/07/17
Technician 1	Grace
Technician 2	Luck-1
Technician 3	

Duct/Stack Dimensions & Information

Round		
Diameter	1,9	m
Rectangular		
Depth (L)	N/A	m
Width (W)		m

Barometer

Barometer Number	DB 17

Flue Gas Analyser

Analyser Model	Setron
Analyser Serial Number	1076

Pitot Tube

Pitot Tube Number	ST-A338
Pitot Tube Coefficient	0,84

Probe

Probe Number	B5
Probe Length	9ft
Liner Material	SS

Sampling Points – Method

	✓
ISO 9096 – General Rule (centre point)	✓
ISO 9096 – Tangential Rule (no centre point)	
ISO 9096 – Rectangular	
US EPA Method 1 – Circular	
US EPA Method 1 – Rectangular	
Other (specify below)	

Sampling Points – Details

Number of Ports Used	2
Points per Traverse	7
Total Number of Points	13
Time per Point (minutes)	5
Sampling Time Total (mins)	65

Console Details

Console Number	080706
DGM Meter Number	1508835
DGM Calibration Factor (y)	0,997
ΔH@ (0.75 scfm)	49,529 mm H_2O

This document consists of 9 pages
Page 1 = information common to the tests
Pages 2 & 3 = velocity traverse measurements
Pages 4 & 5 = 1st test measurements
Pages 6 & 7 = 2nd test measurements
Pages 8 & 9 = 3rd test measurements

LEAK TEST REQUIREMENTS

Pitot Tube

Pressure, or vacuum ≥ ±180 mm H_2O Time ≥ 1 minute

Sampling Train

Vacuum ≥ −15 inch Hg Time ≥ 1 minute

SAMPLING TIME REQUIREMENTS – LEVEGO PROCEDURE

1. Sampling time: ≥ 2 minutes per point
2. Total sampling time: ≥1 hour
3. The sampling time at each point shall be the same. The number of minutes sampled at each point shall be an integer, or an integer plus one-half minute.

Example 1: 13 points	60 ÷ 13 = 4.62 minutes per point, which is less than the maximum of 5 minutes per point, but it is not an integer, or an integer plus one-half minute.
	Sampling time = 5 minutes per point.
	Total sampling time = 65 minutes

4. Record velocity head (Δp) and update orifice flow (ΔH) at least every 5 min. Update temperatures and vacuum readings at the same time.

Example 2: 8 points	60 ÷ 8 = 7.5 minutes per point, which exceeds the maximum of 5 minutes per point.
	7.5 ÷ 2 = 3.75 minutes per point, which is not an integer, or an integer plus one-half minute.
	Sampling time = 8 minutes per point, with an update every 4 minutes.
	Total sampling time = 64 minutes

Technician's Signature: ....

Acceptance Signature: ....

Project No.	LES0913M
Location	Default 3

Date:	2023/01/17
Test Number	1
Test Method	M6

Flue Gas Analysis (for K-factor calculations) – Measured (M), or Estimated (E)? – Mark the relevant ones.

O_2	M or E?	M	% v/v dry
CO_2	M or E?	M	% v/v dry
CO	M or E?	M	% v/v dry

H_2	M or E?		% v/v dry
CH_4	M or E?		% v/v dry
H_2O (moist)	M or E?	M	% v/v

Test Equipment

Nozzle Number	NS 2-2	
Nozzle Diameter	4,41	mm

Test Details

K-factor (Δp to ΔH Iso)	0,987	
Barometric Press	884	mb
Static (duct) pressure	-10	mm H_2O

Leak Tests

Pitot Tube	Impact side	Wake side
Leak? (Pass, or not)	o/c	o/c
At Pressure/Vacuum	200 mm H_2O	200 mm H_2O
Sampling Train	Start	End
DGM – Prior	* 994	* 994
At Vacuum of	-19 inch Hg	-19 inch Hg
DGM – Post	* 618	* 618
At Vacuum of	-19 inch Hg	-19 inch Hg

* Last three digits on DGM

Site Calculations

H_2O (moisture)	2,04	% v/v
Isokinetic	106,09	%

Test & Sample Details

Filter Number	LEV22-Q-1772
Probe Wash Number	09136E
Chain of Custody	09860

Port (Traverse Line)	Traverse Point No.	Sampling Time	Clock Time	DGM Reading	Velocity Head	Desired Orifice	Actual Orifice	Stack Temp	Probe Temp	Filter Temp	DGM Outlet	Impinger Exit	Pump Vacuum	Isokinetic
				V_m	Δp	ΔH	ΔH	t_s	t_p	t_f	t_{mo}	t_i		
		min	hh:mm	m^3	mm H_2O	mm H_2O	mm H_2O	°C	°C	°C	°C	°C	inch Hg	%
1	1	5	12:15	0592,2020	20	19,7	20	49	—	—	32	24	-1	
1	2	10			20,6	20,2	20	48	—	—	32	19	-1	
1	3	15			20	19,7	20	48	—	—	32	16	-1	
1	4	20			21	20,6	21	48	—	—	34	16	-1	
1	5	25			20,4	20,1	20	48	—	—	34	15	-1	
1	6	30			24	20.6	21	49	—	—	35	15	-1	
1	7	35			22	21,6	22	49	—	—	35	15	-1	
2	8	40			32	31,5	32	49	—	—	35	18	-1	
2	9	45			36	35.4	36	49	—	—	35	16	-1	
2	10	50			38	37,4	38	49	—	—	35	15	-1	
2	11	55			34	33,4	34	48	—	—	35	15	-1	
2	12	60			30	29,5	30	48	—	—	35	15	-1	
2	13	65	13:22	0593,8512	30	29,5	30	49	—	—	35	14	-1	

PTO for continuation of table

Technician's Signature: ***Acceptance Signature:***

Project No.	LES0913
Location	Debult 1

Date:	2023/01/17
Test Number	2
Test Method	M5

Flue Gas Analysis (for K-factor calculations) – Measured (M), or Estimated (E)? – Mark the relevant ones.

O_2	M or E?	M	% v/v dry
CO_2	M or E?	M	% v/v dry
CO	M or E?	M	% v/v dry

H_2	M or E?		% v/v dry
CH_4	M or E?		% v/v dry
H_2O (moist)	M or E?	M	% v/v

Test Equipment

Nozzle Number	NS2-2	
Nozzle Diameter	4,41	mm

Test Details

K-factor (Δp to ΔH Iso)	0,967	
Barometric Press	894	mb
Static (duct) pressure	-10	mm H_2O

Leak Tests

Pitot Tube	Impact side	Wake side
Leak? (Pass, or not)	ok	ok
At Pressure/Vacuum	20 mm H_2O	20 mm H_2O
Sampling Train	**Start**	**End**
DGM – Prior	* 196	* 196
At Vacuum of	-19 inch Hg	-19 inch Hg
DGM – Post	* 610	* 610
At Vacuum of	-19 inch Hg	-19 inch Hg

* Last three digits on DGM

Site Calculations

H_2O (moisture)	1,48	% v/v
Isokinetic	103,48	%

Test & Sample Details

Filter Number	LEV22-P-1773
Probe Wash Number	091356
Chain of Custody	09860

Port (Traverse Line)	Traverse Point No.	Sampling Time	Clock Time	DGM Reading	Velocity Head	Desired Orifice	Actual Orifice	Stack Temp	Probe Temp	Filter Temp	DGM Outlet	Impinger Exit	Pump Vacuum	Isokinetic
				V_m	Δp	ΔH	ΔH	t_s	t_p	t_f	t_{mo}	t_i		
		min	hh:mm	m³	mm H_2O	mm H_2O	mm H_2O	°C	°C	°C	°C	°C	inch Hg	%
1	1	5	12:50	593,4232	19,1	19	19	48	—	-	35	25	-1	
1	2	10			20	19,3	19,5	49	—	—	36	19	-1	
1	3	15			19,6	19	19	49	—	—	36	13	-1	
1	4	20			20,6	19,9	20	49	—	-	36	15	-1	
1	5	25			20	19,3	19,5	49	—	—	37	14	-1	
1	6	30			21	20,3	20	49	—	—	37	14	-1	
1	7	35			22	21.3	21	49	—	—	37	14	-1	
2	8	40			32	30,9	32	48	—	—	37	18	-1	
2	9	45			36	34.8	34	49	—	—	37	14	-1	
2	10	50			36	34.8	34	49	—	—	37	15	-1	
2	11	55			34	32,9	32	49	—	—	37	18	-1	
2	12	60			30	29,0	30	50	—	—	37	16	-1	
2	13	65	14:58	594,8506	30	29,0	30	49	—	—	37	16	-1	

PTO for continuation of table

Technician's Signature: ....

Acceptance Signature: ....

Project No.	LES0913M
Location	Dedust 3

Date:	2023/01/17
Test Number	3
Test Method	M6

Flue Gas Analysis (for K-factor calculations) – Measured (M), or Estimated (E)? – Mark the relevant ones.

O_2	M or E?	M	% v/v dry
CO_2	M or E?	M	% v/v dry
CO	M or E?	M	% v/v dry

H_2	M or E?		% v/v dry
CH_4	M or E?		% v/v dry
H_2O (moist)	M or E?	M	% v/v

Test Equipment

Nozzle Number	NS2-2	
Nozzle Diameter	4,41	mm

Test Details

K-factor (Δp to ΔH Iso)	0,969	
Barometric Press	894	mb
Static (duct) pressure	-10	mm H_2O

Leak Tests

Pitot Tube	Impact side	Wake side
Leak? (Pass, or not)	OK	OK
At Pressure/Vacuum	200 mm H_2O	200 mm H_2O
Sampling Train	Start	End
DGM – Prior	* 780	* 780
At Vacuum of	-19 inch Hg	-19 inch Hg
DGM – Post	* 510	* 510
At Vacuum of	-19 inch Hg	-19 inch Hg

* Last three digits on DGM

Site Calculations

H_2O (moisture)	1,03	% v/v
Isokinetic	105,51	%

Test & Sample Details

Filter Number	LEV22-Q-1782
Probe Wash Number	07,346
Chain of Custody	19860

Port (Traverse Line)	Traverse Point No.	Sampling Time	Clock Time	DGM Reading V_m	Velocity Head Δp	Desired Orifice ΔH	Actual Orifice ΔH	Stack Temp t_s	Probe Temp t_p	Filter Temp t_f	DGM Outlet t_{mo}	Impinger Exit t_i	Pump Vacuum	Isokinetic
		min	hh:mm	m^3	mm H_2O	mm H_2O	mm H_2O	°C	°C	°C	°C	°C	inch Hg	%
1	1	5	15:11	594,5816	19,6	19,0	19	48	—	—	35	25	-1	
1	2	10			20	19,3	19,5	48	—	—	35	18	-1	
1	3	15			19,8	19,1	19	48	—	—	35	16	-1	
1	4	20			19,6	19,0	19	48	—	—	36	14	-1	
1	5	25			20	19,3	19,5	48	—	—	36	14	-1	
1	6	30			22	21,3	21	49	—	—	37	14	-1	
1	7	35			22	21,3	21	49	—	—	37	13	-1	
2	8	40			32	30,9	32	48	—	—	37	17	-1	
2	9	45			36	34,8	34	48	—	—	37	14	-1	
2	10	50			36	34,8	34	49	—	—	37	13	-1	
2	11	55			34	32,9	34	49	—	—	38	13	-1	
2	12	60			32	30,9	32	49	—	—	38	13	-1	
2	13	67	16:18	595,7356	30	29,0	30	49	—	—	37	13	-1	

PTO for continuation of table

Technician's Signature: ____________ *Acceptance Signature:* ____________

	LES-L-F-054	Page	1 of 1
LEVEGO Environmental Services	FLUE GAS ANALYSER MEASUREMENT SHEET	Revision	E02
		Effective date	2017-04-11
		Management System Manual	

PROJECT NUMBER	L650913M	DATE	2023/01/17
CLIENT (COMPANY)	South 32	OPERATOR	Sizwe
CLIENT PLANT (SITE)	Meyerton	SPECIALIST/ASSISTANT	Lucky
SAMPLING LOCATION (STACK)	Dedust 3	TEST NUMBER	1-3
NUMBER OF PORTS USED	2	POINTS ACROSS	13
ANALYSER SERIAL No.	1076	ANALYSER MODEL	Sitron

	hh:mm Time	% O_2	% CO_2	ppm CO	% CH_4	ppm NO_x	ppm NO	ppm NO_2	ppm SO_2	% H_2	SAMPLE ID
1		20,9	0	0		0	0	0			
2		20,9	0	0		0	0	0			
3		20,9	0	0		0	0	0			
4		20,9	0	0		0	0	0			T1
5		20,9	0	0		0	0	0			
6		20,9	0	0		0	0	0			
7		20,9	0	0		0	0	0			
8		20,9	0	0		0	0	0			
9		20,9	0	0		0	0	0			
10		20,9	0	0		0	0	0			
11		20,9	0	0		0	0	0			
12		20,9	0	0		0	0	0			
13		20,9	0	0		0	0	0			
14		20,9	0	0		0	0	0			
15		20,9	0	0		0	0	0			T2
16		20,9	0	0		0	0	0			
17		20,9	0	0		0	0	0			
18		20,9	0	0		0	0	0			
19		20,9	0	0		0	0	0			
20		20,9	0	0		0	0	0			
21		20,9	0	0		0	0	0			
22		20,9	0	0		0	0	0			
23		20,9	0	0		0	0	0			
24		20,9	0	0		0	0	0			
25		20,9	0	0		0	0	0			T3
26		20,9	0	0		0	0	0			
27		20,9	0	0		0	0	0			
28		20,9	0	0		0	0	0			
29		20,9	0	0		0	0	0			
30		20,9	0	0		0	0	0			
31											
32											
33											
34											
35											
36											
37											
38											
39											
40											

Operator

Partner / Manager

LEVEGO Environmental Services	LES-A-F-011	Page:	1 of 1
	MOISTURE WEIGHTS - (METHOD 5, 6, 13B & 17 (ISOKINETIC))	Revision Status :	E03
		Effective date	2017-04-12

Balance ID:	Bal 26	Site / Plant Name:	Southz 3L (MMT)
Date (dd/mm/yyyy):	17 / 01 / 2023	Stack Name:	Dedust 3
Job File Number:	LES 0913 M	Project Manager:	Alexis Kay
Method:	M6	Team Leader:	Sizwa

Test Number:	Impinger No.	Pre-weight	Post-weight	Material / Solution:
		Test 1		
	1	234,3	222,9	Water / 10% H_2O_2
	2			Water / 10% H_2O_2
	3			Empty
	4	846,6	868,1	Silica Gel
PW1 / NW2 / Acetone		22,6	97,3	
		Test 2		
	1	234,4	230	Water / 10% H_2O_2
	2			Water / 10% H_2O_2
	3			Empty
	4	868,1	883,1	Silica Gel
PW1 / NW2 / Acetone		21,6	101,6	
		Test 3		
	1	234,6	229,6	Water / 10% H_2O_2
	2			Water / 10% H_2O_2
	3			Empty
	4	883,1	875,6	Silica Gel
PW1 / NW2 / Acetone		21,6	98,6	
		Test 4 / Blank		
	1			Water / 10% H_2O_2
	2			Water / 10% H_2O_2
	3			Empty
	4			Silica Gel
PW[1] / NW[2] / Acetone		21.6	110,6	

Notes:

1 - Probe Wash, 2 - Nozzle Wash

Signature Team Leader:

Signature Project Manager:

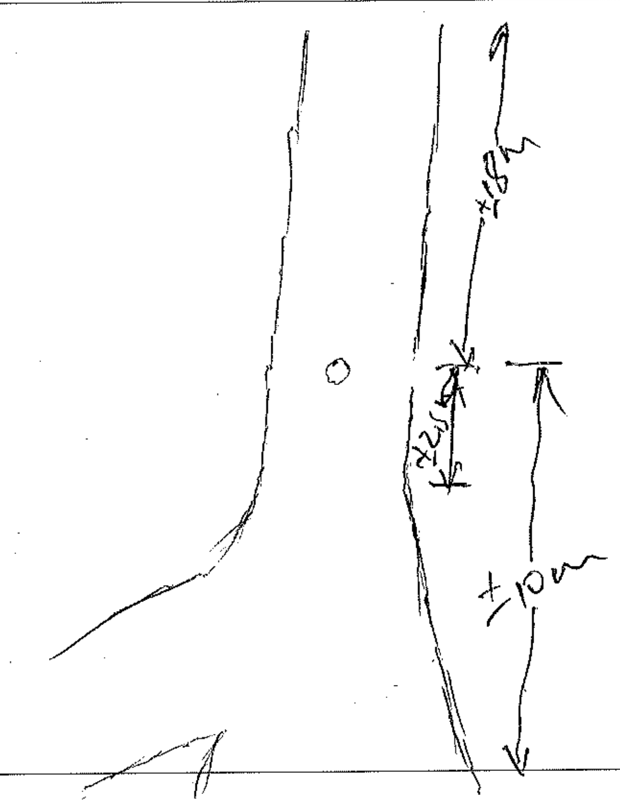
	LES-A-F-010	Page:	1 of 2
LEVEGO Environmental Services	SITE OBSERVATION SHEET ISO 9096	Revision Status :	E07
		Effective date	2019-07-25

Company:	South 32
Site:	Meyerton
Project No.	LG0913M

Location:	Dedust 1
Date:	2022/11/22
Technician:	Sizwe

1. Sketch (refer to Site Observation Examples LES-A-F-097)

Draw the Stack/Duct sampling location, showing the orientation of sampling ports. Mark the ports (i.e. P1, P2, etc.)
For typical examples, refer to LES-A-F-097 Site Observation Examples, Figures 1 to 5.
Indicate North, or other cardinal points, as per typical example in LES-A-F-097, Figure 5.



2. Occurrence Report

Deviations, abnormalities or problems experienced; (Any related to method, procedure or process operating conditions)

LEVEGO Environmental Services	LES-A-F-010	Page:	
	SITE OBSERVATION SHEET ISO 9096	Revision Status :	E07
		Effective date	2019-07-25

Company:	[illegible] 32
Site:	[illegible]
Project No.	[illegible]

Location:	2022/11/27
Date:	[illegible] 1
Technician:	[illegible]

3. Stack/Duct Information (refer to Site Observation Examples LES-A-F-097)

How were dimensions and details obtained?			Measured ✓	Estimated	Historical
Material	Steel ✓	Brick	Glass reinforced polymer (GRP)	Other (specify)	**Refer Figure**
Support structure	Free standing ✓	Steel frame	Multi-flue within windshield (provide sketch)	Other (specify)	
Duct/stack orientation	Vertical ✓	Horizontal	Angle to horizontal (δ) degrees	Angle to vertical (β) degrees	3
Shape	Circular ✓	Rectangular	Square	Other (specify)	
Flow direction of angled duct		Up (u) ±18m	Down (d) ±2,5m		3

SAMPLING PORT – DIMENSIONS				
Height above ground level			h ±10 m	1
Straight duct downstream from sampling plane (ports), or to stack exit			a ±18 m	1 & 3
Is downstream disturbance open (stack exit), or closed (balance of plant)?				1 & 3
Straight duct upstream from sampling plane (ports)			b ±2,5 m	1 & 3
Port diameter (d)	85 mm	**Rectangular port dimensions**	N/A mm	1 & 4
Boss length (ℓ)	0 mm	**Wall + insulation thickness (t)**	5 mm	1 & 4

CIRCULAR DUCT/STACK – DIMENSIONS			
Circumference (outer)	m		
Outside diameter (OD)	m	diameter = circumference ÷ π	
Wall + insulation thickness	t mm		1
Inside diameter (ID)	D 1,75 m	ID = OD – (2×t÷1000)	1
Number of ports	2		
Angle between port centre lines	α 90 degrees		1
Port centre lines to Inlet centre line	φ degrees	ψ degrees	2

RECTANGULAR/SQUARE DUCT/STACK – DIMENSIONS			
Depth outside	L_o m		4
Wall + insulation thickness	t mm		4
Inside depth	L m	L = L_o – (2×t÷1000)	4
Width outside	W_o m		4
Wall + insulation thickness	t mm		4
Inside width	W m	W = W_o – (2×t÷1000)	4
Equivalent diameter	D_e m	(2×L×W)÷(L+W)	
Number of ports & Location		On side dimensioned L or W?	4
Angle of flow with regard to duct axis =	degrees	**Angle of flow <15° with regard to duct axis, for each point?** Yes	No
Negative flows present?		Yes	No

PROCESS INFORMATION				
Source of pollutant	Boiler furnace	Kiln	Crusher, or mill	Other (specify below)
Pollution control equipment	ESP	Fabric filter	Scrubber	Other (specify below)

Comments:

Project No.	LES08BM
Company	South 32
Site	Mengebwen
Location	Dedust 1

Date	2021/11/22
Technician 1	Gizhuto
Technician 2	Lucky
Technician 3	

Duct/Stack Dimensions & Information

Round		
Diameter	1,75	m
Rectangular		
Depth (L)	N/A	m
Width (W)		m

Barometer

Barometer Number	DB 17

Flue Gas Analyser

Analyser Model	Scitron
Analyser Serial Number	1076

Pitot Tube

Pitot Tube Number	ST-A3390
Pitot Tube Coefficient	0,84

Probe

Probe Number	UP
Probe Length	8ft
Liner Material	SS

Sampling Points – Method	✓
ISO 9096 – General Rule (centre point)	✓
ISO 9096 – Tangential Rule (no centre point)	
ISO 9096 – Rectangular	
US EPA Method 1 – Circular	
US EPA Method 1 – Rectangular	
Other (specify below)	

Sampling Points – Details

Number of Ports Used	2
Points per Traverse	7
Total Number of Points	13
Time per Point (minutes)	5
Sampling Time Total (mins)	65

Console Details

Console Number	91058	
DGM Meter Number	5711	
DGM Calibration Factor (y)	0,996	
ΔH@ (0.75 scfm)	48,122	mm H_2O

This document consists of 9 pages
Page 1 = information common to the tests
Pages 2 & 3 = velocity traverse measurements
Pages 4 & 5 = 1st test measurements
Pages 6 & 7 = 2nd test measurements
Pages 8 & 9 = 3rd test measurements

LEAK TEST REQUIREMENTS

Pitot Tube

Pressure, or vacuum ≥ ±180 mm H_2O Time ≥ 1 minute

Sampling Train

Vacuum ≥ −15 inch Hg Time ≥ 1 minute

SAMPLING TIME REQUIREMENTS – LEVEGO PROCEDURE

1. Sampling time: ≥ 2 minutes per point
2. Total sampling time: ≥1 hour
3. The sampling time at each point shall be the same. The number of minutes sampled at each point shall be an integer, or an integer plus one-half minute.

Example 1: 13 points	60 ÷ 13 = 4.62 minutes per point, which is less than the maximum of 5 minutes per point, but it is not an integer, or an integer plus one-half minute.
	Sampling time = 5 minutes per point.
	Total sampling time = 65 minutes

4. Record velocity head (Δp) and update orifice flow (ΔH) at least every 5 min. Update temperatures and vacuum readings at the same time.

Example 2: 8 points	60 ÷ 8 = 7.5 minutes per point, which exceeds the maximum of 5 minutes per point.
	7.5 ÷ 2 = 3.75 minutes per point, which is not an integer, or an integer plus one-half minute.
	Sampling time = 8 ~~minutes~~ per point, with an update every 4 minutes.
	Total sampling time = 64 minutes

Technician's Signature: .... ***Acceptance Signature:*** ....

Project No.	LES0913M
Location	Dedust 1

Date:	2022/11/27
Test Number	1
Test Method	M6

Flue Gas Analysis (for K-factor calculations) – Measured (M), or Estimated (E)? – Mark the relevant ones.

O_2	M or E?	M	% v/v dry
CO_2	M or E?	M	% v/v dry
CO	M or E?	M	% v/v dry
H_2	M or E?		% v/v dry
CH_4	M or E?		% v/v dry
H_2O (moist)	M or E?	M	% v/v

Test Equipment

Nozzle Number	NSI-3	
Nozzle Diameter	6,42	mm

Leak Tests

Pitot Tube	Impact side	Wake side
Leak? (Pass, or not)	OK	OK
At Pressure/Vacuum	180 mm H_2O	180 mm H_2O
Sampling Train	**Start**	**End**
DGM – Prior	* 686	* 686
At Vacuum of	-21 inch Hg	-21 inch Hg
DGM – Post	* 524	* 524
At Vacuum of	-21 inch Hg	-21 inch Hg

* Last three digits on DGM

Test Details

K-factor (Δp to ΔH Iso)	4,51	
Barometric Press	880	mb
Static (duct) pressure	-4	mm H_2O

Site Calculations

H_2O (moisture)	1,35	% v/v
Isokinetic	99,08	%

Test & Sample Details

Filter Number	LEV22-Q-1778
Probe Wash Number	09096
Chain of Custody	09856

Port (Traverse Line)	Traverse Point No.	Sampling Time	Clock Time	DGM Reading	Velocity Head	Desired Orifice	Actual Orifice	Stack Temp	Probe Temp	Filter Temp	DGM Outlet	Impinger Exit	Pump Vacuum	Isokinetic
				V_m	Δp	ΔH	ΔH	t_s	t_p	t_f	t_{mo}	t_i		
		min	hh:mm	m^3	mm H_2O	mm H_2O	mm H_2O	°C	°C	°C	°C	°C	inch Hg	%
1	1	5	09:10	128,4712	7,4	33,4	34	40	—	—	33	23	-1	
1	2	10			7,6	34,3	34	42	—	—	33	18	-1	
1	3	15			7,6	34,1	36	42	—	—	33	14	-1	
1	4	20			8	36,1	36	42	—	—	35	12	-1	
1	5	25			8,2	37,0	38	42	—	—	37	11	-1	
1	6	30			8	36,1	36	42	—	—	37	11	-1	
1	7	35			7,6	34,3	36	41	—	—	37	16	-1	
2	8	40			7,6	34,7	36	43	—	—	37	12	-1	
2	9	45			8	36,1	36	43	—	—	37	11	-1	
2	10	50			7,8	35,2	35	43	—	—	40	12	-1	
2	11	55			7,8	35,2	36	44	—	—	42	12	-1	
2	12	60			7,6	34,3	36	44	—	—	42	11	-1	
2	13	65	10:18	129,7436	7,4	33,4	34	44	—	—	42	11	-1	

PTO for continuation of table

Technician's Signature:

Acceptance Signature:

Project No.	
Location	

Date:	
Test Number	*(continued)*
Test Method	

Table continued

Port (Traverse Line)	Traverse Point No.	Sampling Time	Clock Time	DGM Reading	Velocity Head	Desired Orifice	Actual Orifice	Stack Temp	Probe Temp	Filter Temp	DGM Outlet	Impinger Exit	Pump Vacuum	Isokinetic
				V_m	Δp	ΔH	ΔH	t_s	t_p	t_f	t_{mo}	t_i		
		min	hh:mm	m^3	mm H_2O	mm H_2O	mm H_2O	°C	°C	°C	°C	°C	inch Hg	%

Technician's Signature: ....

Acceptance Signature: ....

Project No.	LES 0910M
Location	Dedust 1

Date:	2022/11/27
Test Number	2
Test Method	M 6

Flue Gas Analysis (for K-factor calculations) – Measured (M), or Estimated (E)? – Mark the relevant ones.

O_2	M or E?	M	% v/v dry
CO_2	M or E?	M	% v/v dry
CO	M or E?	M	% v/v dry

H_2	M or E?		% v/v dry
CH_4	M or E?		% v/v dry
H_2O (moist)	M or E?	m	% v/v

Test Equipment

Nozzle Number	NS 1-3
Nozzle Diameter	6,42 mm

Test Details

K-factor (Δp to ΔH Iso)	4,511
Barometric Press	890 mb
Static (duct) pressure	-24 mm H_2O

Leak Tests

Pitot Tube	Impact side	Wake side
Leak? (Pass, or not)	o/c	o/c
At Pressure/Vacuum	180 mm H_2O	180 mm H_2O
Sampling Train	Start	End
DGM – Prior	* 771	* 786
At Vacuum of	-21 inch Hg	-21 inch Hg
DGM – Post	* 560	* 560
At Vacuum of	-21 inch Hg	-21 inch Hg

* Last three digits on DGM

Site Calculations

H_2O (moisture)	1,09 % v/v
Isokinetic	99,09 %

Test & Sample Details

Filter Number	LEV22-P-1780
Probe Wash Number	090961E
Chain of Custody	09856

Port (Traverse Line)	Traverse Point No.	Sampling Time	Clock Time	DGM Reading	Velocity Head	Desired Orifice	Actual Orifice	Stack Temp	Probe Temp	Filter Temp	DGM Outlet	Impinger Exit	Pump Vacuum	Isokinetic
				V_m	Δp	ΔH	ΔH	t_s	t_p	t_f	t_{mo}	t_i		
		min	hh:mm	m^3	mm H_2O	mm H_2O	mm H_2O	°C	°C	°C	°C	°C	inch Hg	%
1	1	5	10:30	128,7820	7,2	32,5	34	44	—	—	43	21	-1	
1	2	10			7,6	34,3	34	44	—	—	44	17	-1	
1	3	15			7,6	34,3	36	44	—	—	44	13	-1	
1	4	20			8	36.1	36	44	—	—	44	11	-1	
1	5	25			7,6	34,3	34	45	—	—	44	11	-1	
1	6	30			7,2	32,5	34	46	—	—	44	12	-1	
1	7	35			7	31.6	32	47	—	—	44	12	-1	
2	8	40			7,4	33,4	34	46	—	—	44	15	-1	
2	9	45			7,2	32,5	32	47	—	—	44	13	-1	
2	10	50			7,6	34,3	34	47	—	—	44	12	-1	
2	11	55			7,4	33,4	34	48	—	—	44	11	-1	
2	12	60			7	31.6	32	48	—	—	45	13	-1	
2	13	65	11:38	131,0956	7	31.6	32	48	—	—	45	14	-1	

PTO for continuation of table

Technician's Signature:

Acceptance Signature:

Project No.	
Location	

Date:	
Test Number	*(continued)*
Test Method	

Table continued

Port (Traverse Line)	Traverse Point No.	Sampling Time	Clock Time	DGM Reading	Velocity Head	Desired Orifice	Actual Orifice	Stack Temp	Probe Temp	Filter Temp	DGM Outlet	Impinger Exit	Pump Vacuum	Isokinetic
				V_m	Δp	ΔH	ΔH	t_s	t_p	t_f	t_{mo}	t_i		
		min	hh:mm	m^3	mm H_2O	mm H_2O	mm H_2O	°C	°C	°C	°C	°C	inch Hg	%

Technician's Signature: .... ***Acceptance Signature:*** ....

Project No.	LES0913My
Location	Baghouse 1

Date:	2022/11/22
Test Number	3
Test Method	M6

Flue Gas Analysis (for K-factor calculations) – Measured (M), or Estimated (E)? – Mark the relevant ones.

O_2	M or E?	M	% v/v dry
CO_2	M or E?	~	% v/v dry
CO	M or E?	~	% v/v dry

H_2	M or E?		% v/v dry
CH_4	M or E?		% v/v dry
H_2O (moist)	M or E?	M	% v/v

Test Equipment

Nozzle Number	NS 1-3	
Nozzle Diameter	6,42	mm

Test Details

K-factor (Δp to ΔH Iso)	4,51	
Barometric Press	850	mb
Static (duct) pressure	-4	mm H_2O

Leak Tests

Pitot Tube	Impact side	Wake side
Leak? (Pass, or not)	OK	OK
At Pressure/Vacuum	180 mm H_2O	180 mm H_2O
Sampling Train	**Start**	**End**
DGM – Prior	* 688	* 688
At Vacuum of	-21 inch Hg	-21 inch Hg
DGM – Post	* 190	* 190
At Vacuum of	-21 inch Hg	-21 inch Hg

* Last three digits on DGM

Site Calculations

H_2O (moisture)	1,04	% v/v
Isokinetic	98,61	%

Test & Sample Details

Filter Number	LEV22-Q-1770
Probe Wash Number	090058
Chain of Custody	09856

Port (Traverse Line)	Traverse Point No.	Sampling Time	Clock Time	DGM Reading	Velocity Head	Desired Orifice	Actual Orifice	Stack Temp	Probe Temp	Filter Temp	DGM Outlet	Impinger Exit	Pump Vacuum	Isokinetic
				V_m	Δp	ΔH	ΔH	t_s	t_p	t_f	t_{mo}	t_i		
		min	hh:mm	m^3	mm H_2O	mm H_2O	mm H_2O	°C	°C	°C	°C	°C	inch Hg	%
1	1	5	11:53	131,0774	7	31,6	32	50	—	—	46	24	-1	
1	2	10			7,4	33,4	34	50	—	—	46	17	-1	
1	3	15			7,1	32,5	32	50	—	—	46	11	-1	
1	4	20			7	31,6	32	50	—	—	46	10	-1	
1	5	25			7,2	32,5	34	50	—	—	46	10	-1	
1	6	30			7	31,6	32	50	—	—	46	11	-1	
1	7	35			6,8	~~[illegible]~~ 30,7	32	50	—	—	46	11	-1	
2	8	40			7	31,6	32	50	—	—	46	16	-1	
2	9	45			7,2	32,5	32	52	—	—	46	12	-1	
2	10	50			6,8	30,7	32	52	—	—	46	12	-1	
2	11	55			6,8	30,7	32	52	—	—	45	11	-1	
2	12	60			7	31,6	32	53	—	—	45	13	-1	
2	13	65	13:00	132,3096	6,8	30,7	32	52	—	—	47	14	-1	

PTO for continuation of table

Technician's Signature: .... ***Acceptance Signature:*** ....

Project No.	
Location	

Date:	
Test Number	*(continued)*
Test Method	

Table continued

Port (Traverse Line)	Traverse Point No.	Sampling Time	Clock Time	DGM Reading	Velocity Head	Desired Orifice	Actual Orifice	Stack Temp	Probe Temp	Filter Temp	DGM Outlet	Impinger Exit	Pump Vacuum	Isokinetic
				V_m	Δp	ΔH	ΔH	t_s	t_p	t_f	t_{mo}	t_i		
		min	hh:mm	m^3	mm H_2O	mm H_2O	mm H_2O	°C	°C	°C	°C	°C	inch Hg	%

Technician's Signature: .... ***Acceptance Signature:*** ....

	LES-A-F-011	Page:	1 of 1
LEVEGO Environmental Services	MOISTURE WEIGHTS - (METHOD 5, 6, 13B & 17 (ISOKINETIC))	Revision Status :	E03
		Effective date	2017-04-12

Balance ID:	BCf 26	**Site / Plant Name:**	South 32 (MMP)
Date (dd/mm/yyyy):	27 / 11 / 2022	**Stack Name:**	Dunske I
Job File Number:	LES 0913 M	**Project Manager:**	Hlupeko
Method:	M6	**Team Leader:**	Sizwe

Test Number:	**Impinger No.**	**Pre-weight**	**Post-weight**	**Material / Solution:**
		Test 1		
	1	232,7	235,1	Water / 10% H_2O_2
	2			Water / 10% H_2O_2
	3			Empty
	4	796,2	804,6	Silica Gel
PW1 / NW2 / Acetone		21.6	89,2	
		Test 2		
	1	232,4	234,6	Water / 10% H_2O_2
	2			Water / 10% H_2O_2
	3			Empty
	4	800.6	810,9	Silica Gel
PW1 / NW2 / Acetone		21.6	92,1	
		Test 3		
	1	235,6	237,9	Water / 10% H_2O_2
	2			Water / 10% H_2O_2
	3			Empty
	4	810,9	816,5	Silica Gel
PW1 / NW2 / Acetone		21.6	102.1	
		Test 4 / Blank		
	1			Water / 10% H_2O_2
	2			Water / 10% H_2O_2
	3			Empty
	4			Silica Gel
PW[1] / NW[2] / Acetone				
		Notes:		

1 - Probe Wash, 2 - Nozzle Wash

Signature Team Leader: ____________ **Signature Project Manager:** ____________

LEVEGO Environmental Services	LES-L-F-054 FLUE GAS ANALYSER MEASUREMENT SHEET	Page 1 of 1 Revision E02 Effective date 2017-04-11 Management System Manual

PROJECT NUMBER	LES0913M	DATE	2022/11/22
CLIENT (COMPANY)	South 32	OPERATOR	Sizwe
CLIENT PLANT (SITE)	Mpumalanga	SPECIALIST/ASSISTANT	Lucky
SAMPLING LOCATION (STACK)	Dedust 1	TEST NUMBER	1-3
NUMBER OF PORTS USED	2	POINTS ACROSS	13
ANALYSER SERIAL No.	1076	ANALYSER MODEL	Seitron

	hh:mm Time	% O_2	% CO_2	ppm CO	% CH_4	ppm NO_x	ppm NO	ppm NO_2	ppm SO_2	% H_2	SAMPLE ID
1		20,9	0	0		0	0	0			
2		20,9	0	0		0	0	0			
3		20,9	0	0		0	0	0			
4		20,9	0	0		0	0	0			
5		20,9	0	0		0	0	0			
6		20,9	0	0		0	0	0			
7		20,9	0	0		0	0	0			
8		20,9	0	0		0	0	0			T1
9		20,9	0	0		0	0	0			
10		20,9	0	0		0	0	0			
11		20,9	0	0		0	0	0			
12		20,9	0	0		0	0	0			
13		20,9	0	0		0	0	0			
14		20,9	0	0		0	0	0			
15		20,9	0	0		0	0	0			
16		20,9	0	0		0	0	0			
17		20,9	0	0		0	0	0			
18		20,9	0	0		0	0	0			T2
19		20,9	0	0		0	0	0			
20		20,9	0	0		0	0	0			
21		20,9	0	0		0	0	0			
22		20,9	0	0		0	0	0			
23		20,9	0	0		0	0	0			
24		20,9	0	0		0	0	0			
25		20,9	0	0		0	0	0			
26		20,9	0	0		0	0	0			
27		20,9	0	0		0	0	0			T3
28		20,9	0	0		0	0	0			
29		20,9	0	0		0	0	0			
30		20,9	0	0		0	0	0			
31		20,9	0	0		0	0	0			
32		20,9	0	0		0	0	0			
33		20,9	0	0		0	0	0			
34		20,9	0	0		0	0	0			
35		20,9	0	0		0	0	0			
36		20,9	0	0		0	0	0			
37		20,9	0	0		0	0	0			
38		20,9	0	0		0	0	0			
39		20,9	0	0		0	0	0			
40		20,9	0	0		0					

Operator

Partner / Manager

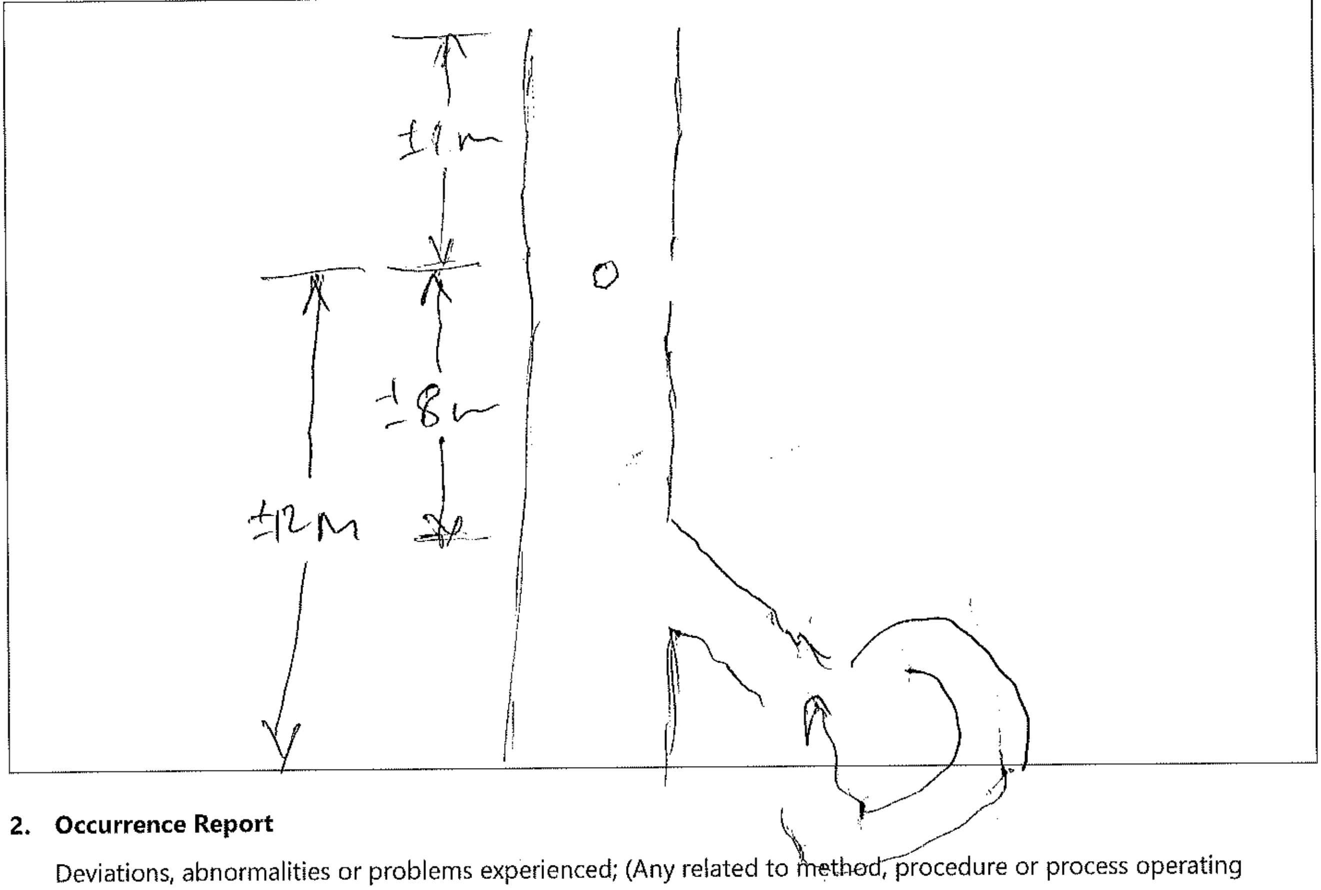
	LES-A-F-010	Page:	1 of 2
LEVEGO Environmental Services	SITE OBSERVATION SHEET ISO 9096	Revision Status :	E07
		Effective date	2019-07-25

Company:	Sonar 32
Site:	Mpumbran
Project No.	LES0413m

Location:	Duduse 2
Date:	2018/11/28
Technician:	[illegible]

1. Sketch (refer to Site Observation Examples LES-A-F-097)

Draw the Stack/Duct sampling location, showing the orientation of sampling ports. Mark the ports (i.e. P1, P2, etc.) For typical examples, refer to LES-A-F-097 Site Observation Examples, Figures 1 to 5.
Indicate North, or other cardinal points, as per typical example in LES-A-F-097, Figure 5.



2. Occurrence Report

Deviations, abnormalities or problems experienced; (Any related to method, procedure or process operating conditions)

Company:	South 32
Site:	[illegible]
Project No.	LEG0913 [illegible]

Location:	[illegible] 2
Date:	2022/11/28
Technician:	[illegible]

3. Stack/Duct Information (refer to Site Observation Examples LES-A-F-097)

How were dimensions and details obtained?	Measured ✓	Estimated	Historical		
Material	Steel ✓	Brick	Glass reinforced polymer (GRP)	Other (specify)	**Refer Figure**
Support structure	Free standing ✓	Steel frame	Multi-flue within windshield (provide sketch)	Other (specify)	
Duct/stack orientation	Vertical ✓	Horizontal	Angle to horizontal (δ) degrees	Angle to vertical (β) degrees	3
Shape	Circular ✓	Rectangular	Square	Other (specify)	
Flow direction of angled duct		Up (u) [illegible]	Down (d) [illegible]		3

SAMPLING PORT – DIMENSIONS				
Height above ground level		h ± 12	m	1
Straight duct downstream from sampling plane (ports), or to stack exit		a ± 5	m	1 & 3
Is downstream disturbance open (stack exit), or closed (balance of plant)?				1 & 3
Straight duct upstream from sampling plane (ports)		b ± 8	m	1 & 3
Port diameter (d) 85 mm	**Rectangular port dimensions**	WxH/NA	mm	1 & 4
Boss length (ℓ) 8 mm	**Wall + insulation thickness (t)**	5	mm	1 & 4

CIRCULAR DUCT/STACK – DIMENSIONS				
Circumference (outer)		m		
Outside diameter (OD)		m	diameter = circumference ÷ π	
Wall + insulation thickness	t 5	mm		1
Inside diameter (ID)	D 1,2	m	ID = OD – (2×t÷1000)	1
Number of ports	2			
Angle between port centre lines	α 90	degrees		1
Port centre lines to Inlet centre line	φ	degrees	ψ degrees	2

RECTANGULAR/SQUARE DUCT/STACK – DIMENSIONS				
Depth outside	L_o	m		4
Wall + insulation thickness	t	mm		4
Inside depth	L	m	$L = L_o - (2\times t\div1000)$	4
Width outside	W_o	m		4
Wall + insulation thickness	t	mm		4
Inside width	W	m	$W = W_o - (2\times t\div1000)$	4
Equivalent diameter	D_e	m	$(2\times L\times W)\div(L+W)$	
Number of ports & Location			On side dimensioned L or W?	4

Angle of flow with regard to duct axis =	degrees	**Angle of flow <15° with regard to duct axis, for each point?**	Yes	No
Negative flows present?			Yes	No

PROCESS INFORMATION				
Source of pollutant	Boiler furnace	Kiln	Crusher, or mill	Other (specify below)
Pollution control equipment	ESP	Fabric filter	Scrubber	Other (specify below)

Comments:

Project No.	LES0813M
Company	South 32
Site	Mozal[illegible]
Location	Dedust 2

Date	2022/11/~~25~~ 28
Technician 1	Sizwe
Technician 2	Lucky
Technician 3	

Duct/Stack Dimensions & Information

Round		
Diameter	1,86	m
Rectangular		
Depth (L)	N/A	m
Width (W)	N/A	m

Barometer

Barometer Number	DB 17

Flue Gas Analyser

Analyser Model	Seltron
Analyser Serial Number	1076

Pitot Tube

Pitot Tube Number	ST-A3190
Pitot Tube Coefficient	0,84

Probe

Probe Number	UP
Probe Length	8ft
Liner Material	SS

Sampling Points – Method	✓
ISO 9096 – General Rule (centre point)	✓
ISO 9096 – Tangential Rule (no centre point)	
ISO 9096 – Rectangular	
US EPA Method 1 – Circular	
US EPA Method 1 – Rectangular	
Other (specify below)	

Sampling Points – Details

Number of Ports Used	2
Points per Traverse	7
Total Number of Points	13
Time per Point (minutes)	5
Sampling Time Total (mins)	65

Console Details

Console Number	91058
DGM Meter Number	5711
DGM Calibration Factor (y)	0,996
ΔH@ (0.75 scfm)	~~49~~,22 mm H_2O

This document consists of 9 pages
Page 1 = information common to the tests
Pages 2 & 3 = velocity traverse measurements
Pages 4 & 5 = 1st test measurements
Pages 6 & 7 = 2nd test measurements
Pages 8 & 9 = 3rd test measurements

LEAK TEST REQUIREMENTS

Pitot Tube

Pressure, or vacuum ≥ ±180 mm H_2O Time ≥ 1 minute

Sampling Train

Vacuum ≥ −15 inch Hg Time ≥ 1 minute

SAMPLING TIME REQUIREMENTS – LEVEGO PROCEDURE

1. Sampling time: ≥ 2 minutes per point
2. Total sampling time: ≥1 hour
3. The sampling time at each point shall be the same. The number of minutes sampled at each point shall be an integer, or an integer plus one-half minute.

Example 1: 13 points	60 ÷ 13 = 4.62 minutes per point, which is less than the maximum of 5 minutes per point, but it is not an integer, or an integer plus one-half minute.
	Sampling time = 5 minutes per point.
	Total sampling time = 65 minutes

4. Record velocity head (Δp) and update orifice flow (ΔH) at least every 5 min. Update temperatures and vacuum readings at the same time.

Example 2: 8 points	60 ÷ 8 = 7.5 minutes per point, which exceeds the maximum of 5 minutes per point.
	7.5 ÷ 2 = 3.75 minutes per point, which is not an integer, or an integer plus one-half minute.
	Sampling time = 8 minutes per point, with an update every 4 minutes.
	Total sampling time = 64 minutes

Technician's Signature: ....

Acceptance Signature: ....

Project No.	LES 0913M
Location	Dedust 2

Date:	2022/11/25
Test Number	1
Test Method	M6

Flue Gas Analysis (for K-factor calculations) – Measured (M), or Estimated (E)? – Mark the relevant ones.

O_2	M or E?	M	% v/v dry
CO_2	M or E?	M	% v/v dry
CO	M or E?	M	% v/v dry

H_2	M or E?		% v/v dry
CH_4	M or E?		% v/v dry
H_2O (moist)	M or E?	M	% v/v

Test Equipment

Nozzle Number	NS 1-3
Nozzle Diameter	6,42 mm

Test Details

K-factor (Δp to ΔH Iso)	4,264
Barometric Press	877,7 mb
Static (duct) pressure	-4 mm H_2O

Leak Tests

Pitot Tube	Impact side	Wake side
Leak? (Pass, or not)	OK	OK
At Pressure/Vacuum	200 mm H_2O	200 mm H_2O
Sampling Train	Start	End
DGM – Prior	* 872	* 872
At Vacuum of	-19 inch Hg	-19 inch Hg
DGM – Post	*	*
At Vacuum of	inch Hg	inch Hg

* Last three digits on DGM

Site Calculations

H_2O (moisture)	% v/v
Isokinetic	%

Test & Sample Details

Filter Number	
Probe Wash Number	
Chain of Custody	

Port (Traverse Line)	Traverse Point No.	Sampling Time	Clock Time	DGM Reading	Velocity Head	Desired Orifice	Actual Orifice	Stack Temp	Probe Temp	Filter Temp	DGM Outlet	Impinger Exit	Pump Vacuum	Isokinetic
				V_m	Δp	ΔH	ΔH	t_s	t_p	t_f	t_{mo}	t_i		
		min	hh:mm	m^3	mm H_2O	mm H_2O	mm H_2O	°C	°C	°C	°C	°C	inch Hg	%
1	1	5	10:20	123,9964	7	29,8	30	67	—	—	28	21	-1	
1	2	10			7,2	30,7	30	69	—	—	28	16	-1	
1	3	15			7,2	30,7	30	70	—	—	30	14	-1	
1	4	20			6,8	29,0	30	71	—	—	30	13	-1	
1	5	25			7	29,8	30	71	—	—	30	13	-1	
1	6	30												
1	7	35												
2	8	40												
2	9	45												
2	10	50												
2	11	55												
2	12	60												
2	13	65												

PTO for continuation of table

Technician's Signature:

Acceptance Signature:

Project No.	1_BO513M
Location	Dedust 2

Date:	2024/11/28
Test Number	7
Test Method	M6

Flue Gas Analysis (for K-factor calculations) – Measured (M), or Estimated (E)? – Mark the relevant ones.

O_2	M or E?	M	% v/v dry
CO_2	M or E?	M	% v/v dry
CO	M or E?	M	% v/v dry

H_2	M or E?		% v/v dry
CH_4	M or E?		% v/v dry
H_2O (moist)	M or E?	M	% v/v

Test Equipment

Nozzle Number	NS1-5
Nozzle Diameter	6,42 mm

Test Details

K-factor (Δp to ΔH Iso)	4264
Barometric Press	847,7 mb
Static (duct) pressure	-4 mm H_2O

Leak Tests

Pitot Tube	Impact side	Wake side
Leak? (Pass, or not)	OK	OK
At Pressure/Vacuum	180 mm H_2O	180 mm H_2O
Sampling Train	**Start**	**End**
DGM – Prior	* 772	* 772
At Vacuum of	-21 inch Hg	-21 inch Hg
DGM – Post	* 324	* 324
At Vacuum of	-21 inch Hg	-21 inch Hg

* Last three digits on DGM

Site Calculations

H_2O (moisture)	2,06 % v/v
Isokinetic	99,60 %

Test & Sample Details

Filter Number	LEV2218-0099
Probe Wash Number	04103
Chain of Custody	09852

Port (Traverse Line)	Traverse Point No.	Sampling Time	Clock Time	DGM Reading	Velocity Head	Desired Orifice	Actual Orifice	Stack Temp	Probe Temp	Filter Temp	DGM Outlet	Impinger Exit	Pump Vacuum	Isokinetic
				V_m	Δp	ΔH	ΔH	t_s	t_p	t_f	t_{mo}	t_i		
		min	hh:mm	m^3	mm H_2O	mm H_2O	mm H_2O	°C	°C	°C	°C	°C	inch Hg	%
1	1	5	09:17	132,3756	7,2	30,7	32	67	—	—	28	21	-1	
1	2	10			7	29,8	30	69	—	—	29	15	-1	
1	3	15			7,2	30,7	32	70	—	—	29	13	-1	
1	4	20			6,8	29,0	30	72	—	—	30	12	-1	
1	5	25			7	29,8	30	70	—	—	30	12	-1	
1	6	30			7,2	30,7	32	69	—	—	32	11	-1	
1	7	35			7,2	30,7	32	69	—	—	32	10	-1	
2	8	40			7	29,8	30	68	—	—	32	13	-1	
2	9	45			7,2	30,7	32	68	—	—	32	11	-1	
2	10	50			6,8	29,0	30	68	—	—	34	11	-1	
2	11	55			7	29,8	30	68	—	—	35	12	-1	
2	12	60			7,2	30,7	32	68	—	—	36	11	-1	
2	13	65	10:25	133,5212	6,8	29,0	30	68	—	—	36	11	-1	

PTO for continuation of table

Technician's Signature: ....

Acceptance Signature: ....

Project No.	
Location	

Date:	
Test Number	*(continued)*
Test Method	

Table continued

Port (Traverse Line)	Traverse Point No.	Sampling Time	Clock Time	DGM Reading	Velocity Head	Desired Orifice	Actual Orifice	Stack Temp	Probe Temp	Filter Temp	DGM Outlet	Impinger Exit	Pump Vacuum	Isokinetic
				V_m	Δp	ΔH	ΔH	t_s	t_p	t_f	t_{mo}	t_i		
		min	hh:mm	m^3	mm H_2O	mm H_2O	mm H_2O	°C	°C	°C	°C	°C	inch Hg	%

Technician's Signature: .... ***Acceptance Signature:*** ....

Project No.	LES 0913 ms
Location	Aeduse 2

Date:	2022/11/28
Test Number	2
Test Method	M6

Flue Gas Analysis (for K-factor calculations) – Measured (M), or Estimated (E)? – Mark the relevant ones.

O_2	M or E?	M	% v/v dry
CO_2	M or E?	M	% v/v dry
CO	M or E?	M	% v/v dry

H_2	M or E?		% v/v dry
CH_4	M or E?		% v/v dry
H_2O (moist)	M or E?	M	% v/v

Test Equipment

Nozzle Number	NS 1-3	
Nozzle Diameter	6,42	mm

Test Details

K-factor (Δp to ΔH Iso)	4,264	
Barometric Press	847,7	mb
Static (duct) pressure	-4	mm H_2O

Leak Tests

Pitot Tube	Impact side	Wake side
Leak? (Pass, or not)	OK	OK
At Pressure/Vacuum	150 mm H_2O	80 mm H_2O
Sampling Train	**Start**	**End**
DGM – Prior	* 910	* 910
At Vacuum of	-21 inch Hg	-21 inch Hg
DGM – Post	* 918	* 918
At Vacuum of	-21 inch Hg	-21 inch Hg

* Last three digits on DGM

Site Calculations

H_2O (moisture)	1,75	% v/v
Isokinetic	100,07	%

Test & Sample Details

Filter Number	LEV22-Q-1779
Probe Wash Number	09,026
Chain of Custody	09852

Port (Traverse Line)	Traverse Point No.	Sampling Time	Clock Time	DGM Reading	Velocity Head	Desired Orifice	Actual Orifice	Stack Temp	Probe Temp	Filter Temp	DGM Outlet	Impinger Exit	Pump Vacuum	Isokinetic
				V_m	Δp	ΔH	ΔH	t_s	t_p	t_f	t_{mo}	t_i		
		min	hh:mm	m^3	mm H_2O	mm H_2O	mm H_2O	°C	°C	°C	°C	°C	inch Hg	%
1	1	5	10:47	133,6736	7,2	30,7	32	68	—	—	36	23	-1	
1	2	10			7,2	30,7	32	68	—	—	35	15	-1	
1	3	15			7,4	31,6	32	67	—	—	35	13	-1	
1	4	20			7	29,8	30	67	—	—	35	12	-1	
1	5	25			7,4	31,6	32	67	—	—	35	11	-1	
1	6	30			7	29,8	30	67	—	—	37	11	-1	
1	7	35			7	29,8	30	66	—	—	36	15	-1	
2	8	40			7,2	30,7	32	67	—	—	36	12	-1	
2	9	45			7	29,8	30	68	—	—	36	11	-1	
2	10	50			6,8	29,0	30	68	—	—	37	11	-1	
2	11	55			7	29,8	30	69	—	—	37	10	-1	
2	12	60			7	29,8	30	70	—	—	37	11	-1	
2	13	65	11:50	134,8626	6,8	29,0	30	70	—	—	37	11	-1	

PTO for continuation of table

Technician's Signature: ____________ ***Acceptance Signature:*** ____________

Project No.	
Location	

Date:	
Test Number	*(continued)*
Test Method	

Table continued

Port (Traverse Line)	Traverse Point No.	Sampling Time	Clock Time	DGM Reading	Velocity Head	Desired Orifice	Actual Orifice	Stack Temp	Probe Temp	Filter Temp	DGM Outlet	Impinger Exit	Pump Vacuum	Isokinetic
				V_m	Δp	ΔH	ΔH	t_s	t_p	t_f	t_{mo}	t_i		
		min	hh:mm	m^3	mm H_2O	mm H_2O	mm H_2O	°C	°C	°C	°C	°C	inch Hg	%

Technician's Signature: .... ***Acceptance Signature:*** ....

Project No.	LES0913M	**Date:**	2022/11/28
Location	Dedusel2	**Test Number**	3
		Test Method	M6

Flue Gas Analysis (for K-factor calculations) – Measured (M), or Estimated (E)? – Mark the relevant ones.

O_2	M or E?	M	% v/v dry	H_2	M or E?		% v/v dry
CO_2	M or E?	M	% v/v dry	CH_4	M or E?		% v/v dry
CO	M or E?		% v/v dry	H_2O (moist)	M or E?	M	% v/v

Test Equipment

Nozzle Number	N8-3	
Nozzle Diameter	6,42	mm

Test Details

K-factor (Δp to ΔH Iso)	4,264	
Barometric Press	887,1	mb
Static (duct) pressure	-4	mm H_2O

Leak Tests

Pitot Tube	Impact side	Wake side
Leak? (Pass, or not)	OK	O/C
At Pressure/Vacuum	180 mm H_2O	180 mm H_2O
Sampling Train	**Start**	**End**
DGM – Prior	* 880	* 880
At Vacuum of	-21 inch Hg	-21 inch Hg
DGM – Post	* ~~880~~ 560	* ~~880~~ 560
At Vacuum of	-21 inch Hg	-21 inch Hg

* Last three digits on DGM

28/11/2022

Site Calculations

H_2O (moisture)	1,72	% v/v
Isokinetic	99,76	%

Test & Sample Details

Filter Number	~~LEV18~~ LEV22-Q-1776
Probe Wash Number	09101E
Chain of Custody	09857

Port (Traverse Line)	Traverse Point No.	Sampling Time	Clock Time	DGM Reading	Velocity Head	Desired Orifice	Actual Orifice	Stack Temp	Probe Temp	Filter Temp	DGM Outlet	Impinger Exit	Pump Vacuum	Isokinetic
				V_m	Δp	ΔH	ΔH	t_s	t_p	t_f	t_{mo}	t_i		
		min	hh:mm	m^3	mm H_2O	mm H_2O	mm H_2O	°C	°C	°C	°C	°C	inch Hg	%
1	1	5	12:04	134,8906	7	29,0	30	66	–	–	35	22	-1	
1	2	10			7,2	29,8	30	68	–	–	35	16	-1	
1	3	15			7	29,0	30	71	–	–	38	15	-1	
1	4	20			7,4	31,6	32	72	–	–	37	14	-1	
1	5	25			7	29,8	30	72	–	–	37	14	-1	
1	6	30			6,8	29,0	30	72	–	–	39	13	-1	
1	7	35			6,8	29,0	30	72	–	–	39	13	-1	
2	8	40			6,6	28,1	30	73	–	–	37	15	-1	
2	9	45			6,8	29,0	30	75	–	–	39	15	-1	
2	10	50			6,8	29,0	30	75	–	–	39	14	-1	
2	11	55			7	29,8	30	75	–	–	39	14	-1	
2	12	60			6,8	29,0	30	76	–	–	39	15	-1	
2	13	65	13:12	136,0456	7	29,8	30	77	–	–	39	17	-1	

PTO for continuation of table

Technician's Signature:

Acceptance Signature:

Project No.	
Location	

Date:	
Test Number	*(continued)*
Test Method	

Table continued

Port (Traverse Line)	Traverse Point No.	Sampling Time	Clock Time	DGM Reading	Velocity Head	Desired Orifice	Actual Orifice	Stack Temp	Probe Temp	Filter Temp	DGM Outlet	Impinger Exit	Pump Vacuum	Isokinetic
				V_m	Δp	ΔH	ΔH	t_s	t_p	t_f	t_{mo}	t_i		
		min	hh:mm	m^3	mm H_2O	mm H_2O	mm H_2O	°C	°C	°C	°C	°C	inch Hg	%

Technician's Signature: .... ***Acceptance Signature:*** ....

Balance ID:	Bel 26	**Site / Plant Name:**	Dedusters
Date (dd/mm/yyyy):	28 / 11 / 2022	**Stack Name:**	Scan 82
Job File Number:	LES 0913 M	**Project Manager:**	Heyisecke
Method:	M6	**Team Leader:**	Sizwe

Test Number:	Impinger No.	Pre-weight	Post-weight	Material / Solution:
Test 1				
	1	232,1	235,6	Water / 10% H_2O_2
	2			Water / 10% H_2O_2
	3			Empty
	4	890,6	903,8	Silica Gel
PW1 / NW2 / Acetone		26,5	85,1	
Test 2				
	1	233,1	234,9	Water / 10% H_2O_2
	2			Water / 10% H_2O_2
	3			Empty
	4	903,8	915,1	Silica Gel
PW1 / NW2 / Acetone		26,6	96,8	
Test 3				
	1	232,9	234	Water / 10% H_2O_2
	2			Water / 10% H_2O_2
	3			Empty
	4	915,1	926,6	Silica Gel
PW1 / NW2 / Acetone		26,6	98,2	
Test 4 / Blank				
	1			Water / 10% H_2O_2
	2			Water / 10% H_2O_2
	3			Empty
	4			Silica Gel
PW[1] / NW[2] / Acetone				
Notes:				

1 - Probe Wash, 2 - Nozzle Wash

Signature Team Leader:

Signature Project Manager:

LEVEGO Environmental Services	LES-L-F-054 FLUE GAS ANALYSER MEASUREMENT SHEET	Page: 1 of 1 Revision: E02 Effective date: 2017-04-11 Management System Manual

PROJECT NUMBER	LES0913m	DATE	2022/11/28
CLIENT (COMPANY)	South 32	OPERATOR	Sizwe
CLIENT PLANT (SITE)	Mpumalanga	SPECIALIST/ASSISTANT	Lucky
SAMPLING LOCATION (STACK)	Dedust 2	TEST NUMBER	1-3
NUMBER OF PORTS USED	2	POINTS ACROSS	13
ANALYSER SERIAL No.	1076	ANALYSER MODEL	Sitron

	hh:mm Time	% O_2	% CO_2	ppm CO	% CH_4	ppm NO_x	ppm NO	ppm NO_2	ppm SO_2	% H_2	SAMPLE ID
1		20,9	0	0		0	0	0			
2		20,9	0	0		0	0	0			
3		20,9	0	0		0	0	0			
4		20,9	0	0		0	0	0			
5		20,9	0	0		0	0	0			T1
6		20,9	0	0		0	0	0			
7		20,9	0	0		0	0	0			
8		20,9	0	0		0	0	0			
9		20,9	0	0		0	0	0			
10		20,9	0	0		0	0	0			
11		20,9	0	0		0	0	0			
12		20,9	0	0		0	0	0			
13		20,9	0	0		0	0	0			
14		20,9	0	0		0	0	0			
15		20,9	0	0		0	0	0			
16		20,9	0	0		0	0	0			
17		20,9	0	0		0	0	0			T2
18		20,9	0	0		0	0	0			
19		20,9	0	0		0	0	0			
20		20,9	0	0		0	0	0			
21		20,9	0	0		0	0	0			
22		20,9	0	0		0	0	0			
23		20,9	0	0		0	0	0			
24		20,9	0	0		0	0	0			
25		20,9	0	0		0	0	0			
26		20,9	0	0		0	0	0			T3
27		20,9	0	0		0	0	0			
28		20,9	0	0		0	0	0			
29		20,9	0	0		0	0	0			
30		20,9		0		0	0	0			
31											
32											
33											
34											
35											
36											
37											
38											
39											
40											

Operator

Partner/Manager

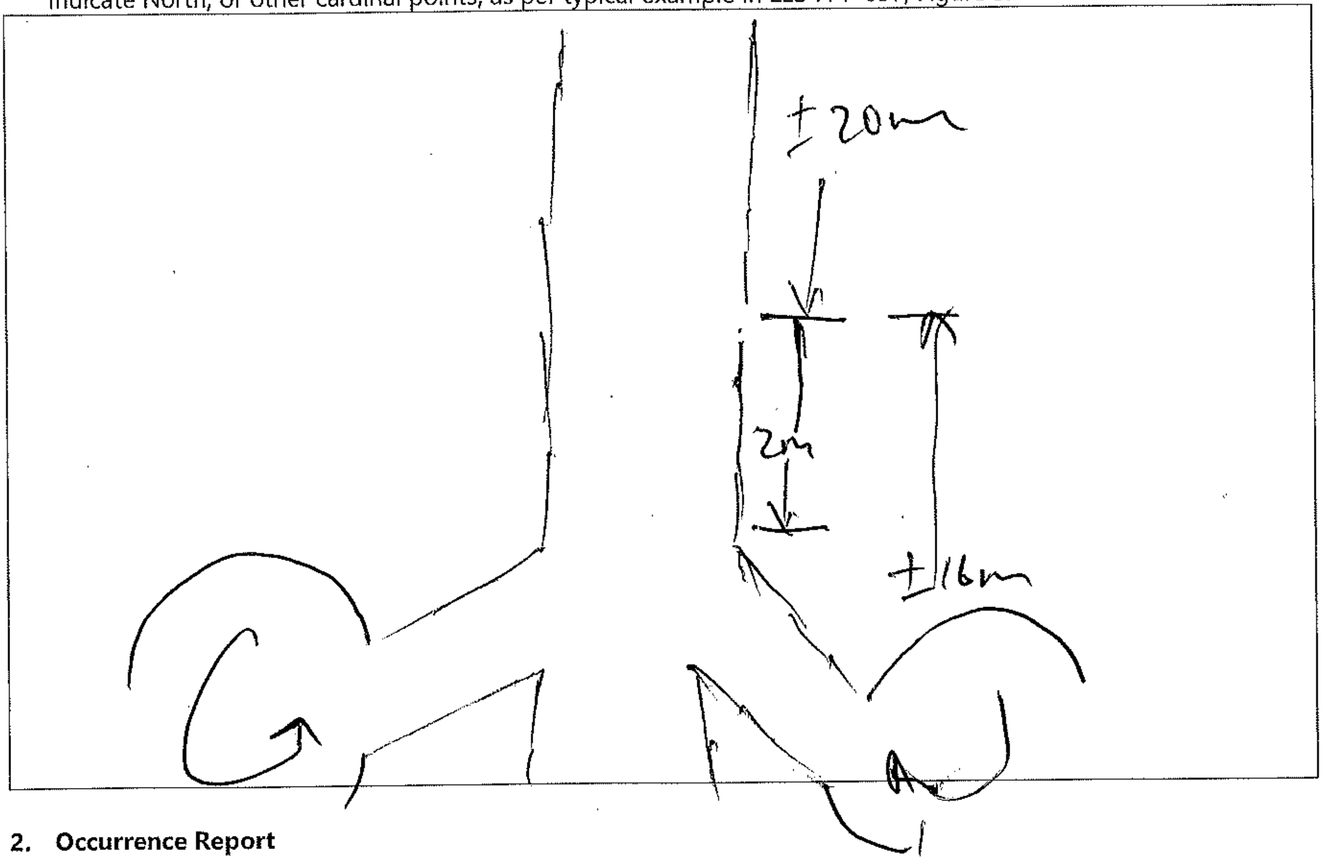
LEVEGO Environmental Services	LES-A-F-010	Page:	1 of 2
	SITE OBSERVATION SHEET ISO 9096	Revision Status :	E07
		Effective date	2019-07-25

Company:	South 32
Site:	Mamatwan
Project No.	LES0913M

Location:	Waste Gas Stack
Date:	2021/11/26
Technician:	Sizwe

1. Sketch (refer to Site Observation Examples LES-A-F-097)

Draw the Stack/Duct sampling location, showing the orientation of sampling ports. Mark the ports (i.e. P1, P2, etc.) For typical examples, refer to LES-A-F-097 Site Observation Examples, Figures 1 to 5.
Indicate North, or other cardinal points, as per typical example in LES-A-F-097, Figure 5.



2. Occurrence Report

Deviations, abnormalities or problems experienced; (Any related to method, procedure or process operating conditions)

Only one sampling port could be utilized due to the analyzer fitted on the other one at P0.
The velocity was bit lower compared to the previous survey, but the operator declared the plant on normall operating conditions

Company:	South 32	Location:	Wasto Gas Storage
Site:	Mamatwa	Date:	2024/11/26
Project No.	LES0813	Technician:	Sizwe

3. Stack/Duct Information (refer to Site Observation Examples LES-A-F-097)

How were dimensions and details obtained?			Measured	Estimated	Historical ✓
Material	Steel	Brick	Glass reinforced polymer (GRP)	Other (specify) Concrete	**Refer Figure**
Support structure	Free standing ✓	Steel frame	Multi-flue within windshield (provide sketch)	Other (specify)	
Duct/stack orientation	Vertical ✓	Horizontal	Angle to horizontal (δ) degrees	Angle to vertical (β) degrees	3
Shape	Circular ✓	Rectangular	Square	Other (specify)	
Flow direction of angled duct		Up (u) ± 20	Down (d) ± 2m		3

SAMPLING PORT – DIMENSIONS

Height above ground level		h ± 16	m	1
Straight duct downstream from sampling plane (ports), or to stack exit		a ± 20	m	1 & 3
Is downstream disturbance open (stack exit), or closed (balance of plant)?				1 & 3
Straight duct upstream from sampling plane (ports)		b ± 2	m	1 & 3
Port diameter (d)	80 mm	Rectangular port dimensions	N/A mm	1 & 4
Boss length (ℓ)	200 mm	Wall + insulation thickness (t)	200 mm	1 & 4

CIRCULAR DUCT/STACK – DIMENSIONS

Circumference (outer)	m		
Outside diameter (OD)	m	diameter = circumference ÷ π	
Wall + insulation thickness	t 200 mm		1
Inside diameter (ID)	D 3,14 m	ID = OD – (2×t÷1000)	1
Number of ports	One		
Angle between port centre lines	α N/A degrees		1
Port centre lines to Inlet centre line	φ degrees	ψ degrees	2

RECTANGULAR/SQUARE DUCT/STACK – DIMENSIONS

Depth outside	L_o m		4
Wall + insulation thickness	t mm		4
Inside depth	L m	$L = L_o - (2 \times t \div 1000)$	4
Width outside	W_o m		4
Wall + insulation thickness	t mm		4
Inside width	W m	$W = W_o - (2 \times t \div 1000)$	4
Equivalent diameter	D_e m	$(2 \times L \times W) \div (L+W)$	
Number of ports & Location		On side dimensioned L or W?	4
Angle of flow with regard to duct axis =	degrees	Angle of flow <15° with regard to duct axis, for each point?	Yes / No
Negative flows present?			Yes / No

PROCESS INFORMATION

Source of pollutant	Boiler furnace	Kiln	Crusher, or mill	Other (specify below)
Pollution control equipment	ESP	Fabric filter	Scrubber	Other (specify below)

Comments: Waste Gas Storage

LEVEGO Environmental Services	LES-A-F-009	Page:	1 of 9
	ISOKINETIC MEASUREMENT SHEET	Revision Status :	E09
		Effective date	2018-10-22

Project No.	LES 0813M
Company	South 32
Site	Mamphuma
Location	Waste Gas Stack

Date	2024/11/26
Technician 1	Sizwe
Technician 2	Luki
Technician 3	

Duct/Stack Dimensions & Information

Round		
Diameter	3,28	m
Rectangular		
Depth (L)	N/A	m
Width (W)		m

Barometer

Barometer Number	DB 17

Flue Gas Analyser

Analyser Model	Seitron
Analyser Serial Number	1076

Pitot Tube

Pitot Tube Number	S-A3380
Pitot Tube Coefficient	0,84

Probe

Probe Number	UP
Probe Length	8ft
Liner Material	SS

Sampling Points – Method

	✓
ISO 9096 – General Rule (centre point)	
ISO 9096 – Tangential Rule (no centre point)	✓
ISO 9096 – Rectangular	
US EPA Method 1 – Circular	
US EPA Method 1 – Rectangular	
Other (specify below)	

Sampling Points – Details

Number of Ports Used	1
Points per Traverse	8 x 2
Total Number of Points	16
Time per Point (minutes)	4
Sampling Time Total (mins)	64

Console Details

Console Number	811088
DGM Meter Number	3711
DGM Calibration Factor (γ)	0,986
ΔH@ (0.75 scfm)	48,122 mm H_2O

This document consists of 9 pages
Page 1 = information common to the tests
Pages 2 & 3 = velocity traverse measurements
Pages 4 & 5 = 1st test measurements
Pages 6 & 7 = 2nd test measurements
Pages 8 & 9 = 3rd test measurements

LEAK TEST REQUIREMENTS

Pitot Tube

Pressure, or vacuum ≥ ±180 mm H_2O Time ≥ 1 minute

Sampling Train

Vacuum ≥ −15 inch Hg Time ≥ 1 minute

SAMPLING TIME REQUIREMENTS – LEVEGO PROCEDURE

1. Sampling time: ≥ 2 minutes per point
2. Total sampling time: ≥1 hour
3. The sampling time at each point shall be the same. The number of minutes sampled at each point shall be an integer, or an integer plus one-half minute.

Example 1: 13 points	60 ÷ 13 = 4.62 minutes per point, which is less than the maximum of 5 minutes per point, but it is not an integer, or an integer plus one-half minute.
	Sampling time = 5 minutes per point.
	Total sampling time = 65 minutes

4. Record velocity head (Δp) and update orifice flow (ΔH) at least every 5 min. Update temperatures and vacuum readings at the same time.

Example 2: 8 points	60 ÷ 8 = 7.5 minutes per point, which exceeds the maximum of 5 minutes per point.
	7.5 ÷ 2 = 3.75 minutes per point, which is not an integer, or an integer plus one-half minute.
	Sampling time = 8 minutes per point, with an update every 4 minutes.
	Total sampling time = 64 minutes

Technician's Signature .... *Acceptance Signature:* ....

Project No.	LES0913M
Location	Waste Gas Stack

Date:	2022/11/26
Test Number	1
Test Method	M6

Flue Gas Analysis (for K-factor calculations) – Measured (M), or Estimated (E)? – Mark the relevant ones.

O_2	M or E?	M	% v/v dry
CO_2	M or E?	M	% v/v dry
CO	M or E?	M	% v/v dry
H_2	M or E?		% v/v dry
CH_4	M or E?		% v/v dry
H_2O (moist)	M or E?	M	% v/v

Test Equipment

Nozzle Number	NS1-2
Nozzle Diameter	4.7 mm

Leak Tests

Pitot Tube	Impact side	Wake side
Leak? (Pass, or not)	OK	OK
At Pressure/Vacuum	180 mm H_2O	180 mm H_2O

Sampling Train	Start	End
DGM – Prior	* 976	* 976
At Vacuum of	-22 inch Hg	-22 inch Hg
DGM – Post	* 226	* 226
At Vacuum of	-22 inch Hg	-22 inch Hg

* Last three digits on DGM

Test Details

K-factor (Δp to ΔH Iso)	0.934
Barometric Press	881 mb
Static (duct) pressure	-36 mm H_2O

Site Calculations

H_2O (moisture)	2.78 % v/v
Isokinetic	95.64 %

Test & Sample Details

Filter Number	LEV22-Q-1769
Probe Wash Number	09088E
Chain of Custody	09886

Port (Traverse Line)	Traverse Point No.	Sampling Time	Clock Time	DGM Reading	Velocity Head	Desired Orifice	Actual Orifice	Stack Temp	Probe Temp	Filter Temp	DGM Outlet	Impinger Exit	Pump Vacuum	Isokinetic
				V_m	Δp	ΔH	ΔH	t_s	t_p	t_f	t_{mo}	t_i		
		min	hh:mm	m^3	mm H_2O	mm H_2O	mm H_2O	°C	°C	°C	°C	°C	inch Hg	%
1	1	4	09:46	124,5984	40	37.4	38	150	—	—	28	21	-1	
1	2	8			40	37.4	38	150	—	—	28	18	-1	
1	3	12			42	39.2	40	148	—	—	30	15	-1	
1	4	16			42	39.2	40	148	—	—	32	13	-1	
1	5	20			40	37.4	38	148	—	—	32	13	-1	
1	6	24			38	35.5	36	150	—	—	33	13	-1	
1	7	28			38	35.5	36	150	—	—	33	12	-1	
1	8	32			36	33.6	34	151	—	—	33	12	-1	
1	9	36			40	37.4	38	151	—	—	35	13	-1	
1	10	40			38	35.5	36	148	—	—	36	13	-1	
1	11	44			36	33.6	34	147	—	—	36	14	-1	
1	12	48			36	33.6	34	147	—	—	36	13	-1	
1	13	52			38	35.5	36	147	—	—	36	14	-1	

PTO for continuation of table

Technician's Signature:

Acceptance Signature:

LEVEGO Environmental Services	LES-A-F-009	Page:	7 of 9
	ISOKINETIC MEASUREMENT SHEET	Revision Status :	E09
		Effective date	2018-10-22

Project No.	LES0913M
Location	Waste Gas Stack

Date:	2024/11/26
Test Number	1 (continued)
Test Method	M5

Table continued

Port (Traverse Line)	Traverse Point No.	Sampling Time	Clock Time	DGM Reading	Velocity Head	Desired Orifice	Actual Orifice	Stack Temp	Probe Temp	Filter Temp	DGM Outlet	Impinger Exit	Pump Vacuum	Isokinetic
				V_m	Δp	ΔH	ΔH	t_s	t_p	t_f	t_{mo}	t_i		
		min	hh:mm	m^3	mm H_2O	mm H_2O	mm H_2O	°C	°C	°C	°C	°C	inch Hg	%
1	14	56			40	37.4	38	147	—	-	36	14	-1	
1	15	60			38	35.5	36	147	—	-	36	14	-1	
1	16	64	10:50	125,8100	36	33.6	34	147	—	—	36	13	-1	

Technician's Signature: ....

Acceptance Signature: ....

LEVEGO Environmental Services	LES-A-F-009	Page:	
	ISOKINETIC MEASUREMENT SHEET	Revision Status :	E09
		Effective date	2018-10-22

Project No.	LES0913M
Location	Wiesta Gas

Date:	2022/11/26
Test Number	2
Test Method	M6

Flue Gas Analysis (for K-factor calculations) – Measured (M), or Estimated (E)? – Mark the relevant ones.

O_2	M or E?	M	% v/v dry
CO_2	M or E?	M	% v/v dry
CO	M or E?	M	% v/v dry

H_2	M or E?		% v/v dry
CH_4	M or E?		% v/v dry
H_2O (moist)	M or E?	M	% v/v

Test Equipment

Nozzle Number	NJ 1-2
Nozzle Diameter	4,7 mm

Test Details

K-factor (Δp to ΔH Iso)	0,934
Barometric Press	891 mb
Static (duct) pressure	-36 mm H_2O

Leak Tests

Pitot Tube	Impact side	Wake side
Leak? (Pass, or not)	O/K	O/K
At Pressure/Vacuum	180 mm H_2O	180 mm H_2O
Sampling Train	**Start**	**End**
DGM – Prior	* 646	* 646
At Vacuum of	-22 inch Hg	-22 inch Hg
DGM – Post	* 306	* 306
At Vacuum of	-22 inch Hg	-22 inch Hg

* Last three digits on DGM

Site Calculations

H_2O (moisture)	2,50 % v/v
Isokinetic	96,25 %

Test & Sample Details

Filter Number	LEV22-P-M71
Probe Wash Number	090886
Chain of Custody	09856

Port (Traverse Line)	Traverse Point No.	Sampling Time	Clock Time	DGM Reading	Velocity Head	Desired Orifice	Actual Orifice	Stack Temp	Probe Temp	Filter Temp	DGM Outlet	Impinger Exit	Pump Vacuum	Isokinetic
				V_m	Δp	ΔH	ΔH	t_s	t_p	t_f	t_{mo}	t_i		
		min	hh:mm	m^3	mm H_2O	mm H_2O	mm H_2O	°C	°C	°C	°C	°C	inch Hg	%
1	1	4	11:16	15,8670	38	35.5	36	153	—	—	38	22	-1	
1	2	8			38	35.5	36	152	—	—	38	16	-1	
1	3	12			40	37,4	38	152	—	—	38	14	-1	
1	4	16			40	37.4	38	152	—	—	38	13	-1	
1	5	20			38	35.5	36	152	—	—	38	13	-1	
1	6	24			36	35.5	36	153	—	—	38	13	-1	
1	7	28			40	37.4	38	153	—	—	38	12	-1	
1	8	32			42	39,2	40	158	—	—	38	11	-1	
1	9	36			42	39,2	40	158	—	—	38	12	-1	
1	10	40			40	37,4	38	158	—	—	38	13	-1	
1	11	44			40	37,4	38	153	—	—	40	14	-1	
1	12	48			42	39,2	40	153	—	—	42	14	-1	
1	13	52			38	35.5	36	153	—	—	42	14	-1	

PTO for continuation of table

Technician's Signature:

Acceptance Signature:

LEVEGO Environmental Services	LES-A-F-009	Page:	9 of 9
	ISOKINETIC MEASUREMENT SHEET	Revision Status :	E09
		Effective date	2018-10-22

Project No.	LES0913h
Location	Wesga Gul

Date:	2022/11/26
Test Number	2 *(continued)*
Test Method	m6

Table continued

Port (Traverse Line)	Traverse Point No.	Sampling Time	Clock Time	DGM Reading	Velocity Head	Desired Orifice	Actual Orifice	Stack Temp	Probe Temp	Filter Temp	DGM Outlet	Impinger Exit	Pump Vacuum	Isokinetic
				V_m	Δp	ΔH	ΔH	t_s	t_p	t_f	t_{mo}	t_i		
		min	hh:mm	m^3	mm H_2O	mm H_2O	mm H_2O	°C	°C	°C	°C	°C	inch Hg	%
1	14	56		8	38	35.5	36	153	–	–	42	15	-1	
1	15	60	~~12:20~~	~~127,1196~~	40	37.4	38	153	–	–	42	15	-1	
1	16	8F	12:20	127,1196	42	39,2	40	153	–	–	43	15	-1	

Technician's Signature:

Acceptance Signature:

Project No.	LES0813M
Location	Westa Gas

Date:	2022/11/26
Test Number	2
Test Method	M6

Flue Gas Analysis (for K-factor calculations) – Measured (M), or Estimated (E)? – Mark the relevant ones.

O_2	M or E?	NA % v/v dry
CO_2	M or E?	NA % v/v dry
CO	M or E?	NA % v/v dry

H_2	M or E?	% v/v dry
CH_4	M or E?	% v/v dry
H_2O (moist)	M or E?	NA % v/v

Test Equipment

Nozzle Number	NS1-2
Nozzle Diameter	4.70 mm

Test Details

K-factor (Δp to ΔH Iso)	0,934
Barometric Press	851 mb
Static (duct) pressure	-38 mm H_2O

Leak Tests

Pitot Tube	Impact side	Wake side
Leak? (Pass, or not)	OK	O/K
At Pressure/Vacuum	180 mm H_2O	180 mm H_2O
Sampling Train	Start	End
DGM – Prior	* 626	* 626
At Vacuum of	-21 inch Hg	-21 inch Hg
DGM – Post	* 556	* 556
At Vacuum of	-20 inch Hg	-21 inch Hg

* Last three digits on DGM

Site Calculations

H_2O (moisture)	3.12 % v/v
Isokinetic	97,67 %

Test & Sample Details

Filter Number	LEV22F-1772
Probe Wash Number	098876
Chain of Custody	09856

Port (Traverse Line)	Traverse Point No.	Sampling Time	Clock Time	DGM Reading	Velocity Head	Desired Orifice	Actual Orifice	Stack Temp	Probe Temp	Filter Temp	DGM Outlet	Impinger Exit	Pump Vacuum	Isokinetic
				V_m	Δp	ΔH	ΔH	t_s	t_p	t_f	t_{mo}	t_i		
		min	hh:mm	m^3	mm H_2O	mm H_2O	mm H_2O	°C	°C	°C	°C	°C	inch Hg	%
1	1	4	12:38	127,1650	42	39,2	40	146	–	–	43	26	-1	
1	2	8			42	39,2	40	150	–	–	43	19	-1	
1	3	12			40	37,4	38	149	–	–	43	16	-1	
1	4	16			38	35.5	36	150	–	–	43	15	-1	
1	5	20			38	35.5	36	150	–	–	43	14	-1	
1	6	24			40	37,4	38	150	–	–	43	14	-1	
1	7	28			38	35.5	36	149	–	–	43	13	-1	
1	8	32			40	37.4	38	149	–	–	43	13	-1	
1	9	36			42	39,2	40	148	–	–	43	13	-1	
1	10	40			40	37.4	38	147	–	–	43	15	-1	
1	11	44			38	35.5	36	146	–	–	43	16	-1	
1	12	48			38	35.5	36	146	–	–	43	16	-1	
1	13	52			36	33,6	34	146	–	–	43	16	-1	

PTO for continuation of table

Technician's Signature: .... ***Acceptance Signature:*** ....

LEVEGO Environmental Services	LES-A-F-009	Page:	7 of 9
	ISOKINETIC MEASUREMENT SHEET	Revision Status :	E09
		Effective date	2018-10-22

Project No.	LES09131
Location	West Gas

Date:	2022/11/26
Test Number	3 (continued)
Test Method	M26

Table continued

Port (Traverse Line)	Traverse Point No.	Sampling Time	Clock Time	DGM Reading	Velocity Head	Desired Orifice	Actual Orifice	Stack Temp	Probe Temp	Filter Temp	DGM Outlet	Impinger Exit	Pump Vacuum	Isokinetic
				V_m	Δp	ΔH	ΔH	t_s	t_p	t_f	t_{mo}	t_i		
		min	hh:mm	m^3	mm H_2O	mm H_2O	mm H_2O	°C	°C	°C	°C	°C	inch Hg	%
1	14	56			38	35.5	36	147	—	—	43	15	-1	
1	15	60			4.0	37.4	38	147	—	—	43	16	-1	
2	16	64	13:40	128.4464	38	35.5	36	147	-	—	43	17	-1	

Technician's Signature:

Acceptance Signature:

Balance ID:	Bal 26	**Site / Plant Name:**	South 32 (MMT)
Date (dd/mm/yyyy):	26 / 11 / 2022	**Stack Name:**	Waste Gas
Job File Number:	LES 0913 M	**Project Manager:**	Hoyisa
Method:	M6	**Team Leader:**	Steve

Test Number:	Impinger No.	Pre-weight	Post-weight	Material / Solution:
		Test 1		
	1	233,8	240	Water / 10% H_2O_2
	2			Water / 10% H_2O_2
	3			Empty
	4	787.0	802.1	Silica Gel
PW1 / NW2 / Acetone		21.6	88.6	
		Test 2		
	1	234.3	242.1	Water / 10% H_2O_2
	2			Water / 10% H_2O_2
	3			Empty
	4	802.6	814.6	Silica Gel
PW1 / NW2 / Acetone		21.6	50.6	
		Test 3		
	1	235.6	248.5	Water / 10% H_2O_2
	2			Water / 10% H_2O_2
	3			Empty
	4	814.6	826,4	Silica Gel
PW1 / NW2 / Acetone		21.6	96.1	
		Test 4 / Blank		
	1			Water / 10% H_2O_2
	2			Water / 10% H_2O_2
	3			Empty
	4			Silica Gel
PW[1] / NW[2] / Acetone		21.6	96.1	
		Notes:		

1 - Probe Wash, 2 - Nozzle Wash

Signature Team Leader:

Signature Project Manager:

LEVEGO Environmental Services	LES-L-F-054 FLUE GAS ANALYSER MEASUREMENT SHEET	Page: 1 of 1 Revision: E02 Effective date: 2017-04-11 Management System Manual

PROJECT NUMBER	LES0813M	DATE	2024/11/26
CLIENT (COMPANY)	Sarta 32	OPERATOR	Sizwe
CLIENT PLANT (SITE)	Mpumalanga	SPECIALIST/ASSISTANT	Lucky
SAMPLING LOCATION (STACK)	Waste Gas	TEST NUMBER	1-2
NUMBER OF PORTS USED	1	POINTS ACROSS	16
ANALYSER SERIAL No.	1076	ANALYSER MODEL	Sartron

	hh:mm Time	% O_2	% CO_2	ppm CO	% CH_4	ppm NO_x	ppm NO	ppm NO_2	ppm SO_2	% H_2	SAMPLE ID
1		18.1	3.0	55600		177	175	2			
2		17.8	3.6	54600		181	178	3			
3		17.6	3.6	53100		175	175	3			
4		17.6	3.5	50600		181	178	3			
5		17.5	3.6	50700		180	176	4			
6		17.6	3.4	71600		180	176	4			
7		17.4	3.8	4360		180	176	4			
8		17.5	3.5	4560		178	175	4			
9		17.6	3.5	5610		180	177	3			
10		17.6	3.5	5160		179	176	3			
11		17.5	3.6	4360		179	176	3			
12		17.8	3.2	3535		178	176	3			
13		18.0	3.2	4100		178	175	3			
14		17.8	3.3	4280		177	174	3			
15		17.6	3.4	4600		178	174	4			
16		17.5	3.3	4600		178	175	4			
17											
18											
19											
20											
21		17.6	3.8	66580		185	181	4			
22		17.6	3.7	65800		186	182	4			
23		17.4	4.0	66880		187	182	3			
24		17.3	4.0	56800		181	178	2			
25		17.3	4.1	58800		181	179	2			
26		17.2	4.1	51900		187	180	3			
27		17.4	3.9	8860		184	181	3			
28		17.6	3.6	8210		184	181	5			
29		17.5	3.6	7620		182	178	3			
30		17.3	3.5	7480		182	179	3			
31		17.3	3.5	7420		184	180	4			
32		17.8	3.5	7430		184	180	4			
33		17.5	3.5	45600		185	181	4			
34		17.6	3.2	45100		184	180	4			
35		17.6	3.3	3600		182	179	3			
36		17.5	3.4	4800		182	178	3			
37											
38											
39											
40											

Operator

Partner / Manager

LEVEGO Environmental Services	LES-L-F-054 FLUE GAS ANALYSER MEASUREMENT SHEET	Page: 1 of 1 Revision: E02 Effective date: 2017-04-11 Management System Manual

PROJECT NUMBER	LSO913M	DATE	2022/11/26
CLIENT (COMPANY)	South 32	OPERATOR	Sizwe
CLIENT PLANT (SITE)	Mamatwan	SPECIALIST/ASSISTANT	Lucky
SAMPLING LOCATION (STACK)	Waste Gas	TEST NUMBER	3
NUMBER OF PORTS USED	1	POINTS ACROSS	16
ANALYSER SERIAL No.	1076	ANALYSER MODEL	Skitron

	hh:mm Time	% O_2	% CO_2	ppm CO	% CH_4	ppm NO_x	ppm NO	ppm NO_2	ppm SO_2	% H_2	SAMPLE ID
1		17.6	3.2	66260		180	176	4			
2		17.2	3.6	52610		181	177	4			
3		17.1	3.8	52900		180	177	3			
4		17.0	4	51966		178	176	3			
5		17.2	3.5	52300		182	178	4			
6		17.2	3.9	51996		182	178	4			
7		17.0	4.1	5560		182	178	4			
8		17.3	3.8	7480		182	179	4			
9		17.4	3.6	9490		183	179	4			
10		17.3	3.8	6896		185	181	4			
11		17.4	3.7	6892		184	181	3			
12		17.5	3.7	5586		184	181	3			
13		17.3	3.5	4347		185	180	3			
14		17.3	3.6	3956		183	180	3			
15		17.2	3.9	3981		182	179	3			
16		17.1	4.1	3687		184	180	4			
17											
18											
19											
20											
21											
22											
23											
24											
25											
26											
27											
28											
29											
30											
31											
32											
33											
34											
35											
36											
37											
38											
39											
40											

Operator

Partner / Manager

CHAIN OF CUSTODY AND ANALYTICAL REQUEST

LEVEGO
Environmental Services

No: 09860

FROM: : Levego Environmental Services (Pty) Ltd	LAB SENT TO:	LES	
Building R6, Pinelands Site, Ardeer Rd	Contact Person	Mosima	
PO Box 422, Modderfontein, 1645	Contact Number	011 608 4148	
Tel: +27 11 608 4148	Date Sent to Lab	2023/01/19	
Fax: +27 11 608 2621	Date Requested Back	ASAP	
Contact Person: Sizwe	Page Number	1 of 1	
Email Address: Sizwe@levego.co.za			

Purchase Order No: Levego Job No: LEV0913m   Client Name: South 32 (Mm7)

SAMPLE ID	TEST NO.	STACK DESCRIPTION	METHOD USED & ANALYSIS REQUIRED	SAMPLE CONTENT	COLLECTION DATE	SPECIAL INSTRUCTIONS	DATE RESULTS RECEIVED
08131E	1	Dedust 3	(M6) SW	10% HNO2	2023/01/17		
08130E	2						
08129E	3						
08128E	Blank						
08136E	1	Dedust 3	(US EPA 06) Evaporate	Acetone Ethnol	2023/01/17		
08135E	2						
08134E	3						
08133E	Blank						
LEV22-Q-1772	1	Dedust 3	(US EPA 06) Post weight	Filter	2023/01/17		
LEV22-Q-1773	2						
LEV22-Q-1782	3						
LEV22-Q-1464	Blank						

Sampler's Name:	Sizwe	Signature:			
Samples Relinquished by:	Sizwe	Signature:		Time & Date:	2023/01/19 08:00
Samples Approved by:	Hayweleu	Signature:		Time & Date:	2023/01/19 09:20
Samples Received by:	Mosima	Signature:	P.	Time & Date:	2023-01-19 @ 09:20
Samples Relinquished by:		Signature:		Time & Date:	
Samples Received by:		Signature:		Time & Date:	

Physical: Building R6, Pinelands Site
Ardeer Rd, Modderfontein, 1645
Postal: P O Box 422, Modderfontein
1645*Tel:* 011 608 4148
Fax: 011 608 2621
E-mail: harvey@levego.co.za
www.levego.co.za

LEVEGO
Environmental Services

LEVEGO ENVIRONMENTAL SERVICES

Laboratory Test Report

Laboratory Test Report Number	LEV-LTR23-011
Date of Report	2023/01/25
Client	Levego Environmental Services Building R6 Pinelands Site Modderfontein 1645
Client Contact	Hlayiseka Yingwani
Client Contact Number	073 383 8663
Client e-mail	Hlayiseka@levego.co.za
Client Reference Number	LES0913M COC09860
Analysis Required	Particulate matter and Sulphur Dioxide
Location of Analysis	Levego Environmental Services Laboratory, Modderfontein, South Africa

This laboratory test report relates only to the specific samples received by the laboratory, identified herein. The laboratory does not accept responsibility from any matters arising from the further use of these results.

Levego laboratory does not accept responsibility for any errors that may have arisen from the sampling and transportation of the samples by external parties.

This laboratory test report may not be reproduced, except in full, unless written approval is obtained from the laboratory manager prior to publication.

Technical Signatory

Name: Mosima Chidi

Signature :

Laboratory Manager

Name : Harvey Butcher

Signature :

sanas
T0846

1. DESCRIPTION OF TEST METHODS

1.1 LEV-M-001: Determination of sulphur dioxide emissions from stationary sources.

This method is based on USEPA Method 6 and applies to the measurement of sulphur dioxide (SO_2) (CAS number 7449-09-5) emissions from stationary sources. A gas sample is extracted from the sampling point in the stack. The SO_2 and sulphur trioxide (SO_3), including those fractions in any sulphur acid mist, are separated. The SO_2 fraction is measured, via concentration of sulphate anion (SO_4^{2-}), by the barium-thorin titration method.

1.2 LEV-M-002: Determination of particulate matter emissions from stationary sources.

This method is based on USEPA Method 5, USEPA Method 17, BS EN 13284-1:2002 and ISO 9096:2003(E), and applies to the determination of particulate matter (PM) (CAS number not assigned) emissions from stationary sources. Particulate matter is withdrawn iso-kinetically from the source and collected on a filter. The particulate matter, which includes particles, of any shape, structure or density, dispersed in the gas phase under the sampling conditions, is determined gravimetrically after the removal of uncombined water. This method is restricted to particulate matter collected in the sampling system, on and before a filter, under specified temperature conditions.

The particulate matter rinsing liquids were dried at 160 °C. The particulate matter filters were dried at 160 °C.

2. REMARKS

2.1 No deviations from laboratory test methods.

Table 1 - Samples

Test item description	Test item condition	Count
Acetone: water rinsing liquids	Received in polyethelene bottles at room temperature	4
Hydrogen peroxide solutions	Received in polyethelene bottles at room temperature	4
30x100mm Quartz Filter Thimbles	Received in securitainers, at room temperature	4

Table 2 - Particulate matter (rinsing liquid) results (Method LEV-M-002) - Measurement Uncertainty - ± 0.16 mg

Note: <* = Result below LOQ

Laboratory Identity Number	Client Identity Number	Type	LOQ	Date Received	Date of analysis	Particulate Matter (rinse) Lev-M-002		
						Particulate Matter (mg)	Post-Weight Average (g)	Pre-Weight Average (g)
24192	09136E	Rinse	0.05	2023/01/19	2023/01/25	4.37	36.03916	36.03479
24193	09135E	Rinse	0.05	2023/01/19	2023/01/25	4.22	37.16368	37.15946
24194	09134E	Rinse	0.05	2023/01/19	2023/01/25	5.38	36.08422	36.07884
24195	09133E	Rinse	0.05	2023/01/19	2023/01/25	0.09	36.94551	36.94542

Table 3 - Particulate matter (Quartz filter) results (Method LEV-M-002)

Measurement Uncertainty : -

30 * 100 mm Quartz Filter Thimbles ± 0.56 mg
47 mm Quartz Filters ± 0.28 mg
82.6 mm Quartz Filters ± 0.39 mg

Note: <* = Result below LOQ

Laboratory Identity Number	Client Identity Number	Type	LOQ	Date Received	Date of Analysis	Particulate Matter (Filter)		
						Particulate Matter (mg)	Post-Weight Average (g)	Pre-Weight Average (g)
23587	LEV22-Q-1772	30mmx100mm	0.05	2023/01/19	2023/01/24	89.81	3.02141	2.93160
23588	LEV22-Q-1773	30mmx100mm	0.05	2023/01/19	2023/01/24	109.00	3.00761	2.89861
23597	LEV22-Q-1782	30mmx100mm	0.05	2023/01/19	2023/01/24	208.66	3.12153	2.91287
22640	LEV22-Q-1464	30mmx100mm	0.05	2023/01/19	2023/01/24	0.11	2.94662	2.94651

Table 4 - Sulphur dioxide results (Method LEV-M-001)

Measurement Uncertainty : -

± 0.10 $mg\ell^{-1}$ (5ml burette)
± 0.12 $mg\ell^{-1}$ (10ml burette)
± 0.53 $mg\ell^{-1}$ (50ml burette)

Note: <* = Result below LOQ

Laboratory Identity Number	Client Identity Number	Type	LOQ $mg\ell^{-1}$	Date Received	Date of Analysis	Volume	Sulphur Dioxide LEV-M-001
							Sulphate(SO_4^{2-}) (mg/l)
24188	09131E	SO2, 5 ml	1.70	2023-01-19	2023-01-25	500.00	<*
24189	09130E	SO2, 5 ml	1.70	2023-01-19	2023-01-25	500.00	<*
24190	09129E	SO2, 5 ml	1.70	2023-01-19	2023-01-25	500.00	<*
24191	09128E	SO2, 5 ml	1.70	2023-01-19	2023-01-25	500.00	<*

T0846

CHAIN OF CUSTODY AND ANALYTICAL REQUEST

LEVEGO
Environmental Services

No: 09856

FROM: : Levego Environmental Services (Pty) Ltd	LAB SENT TO:	WES
Building R6, Pinelands Site, Ardeer Rd	Contact Person	Mosima
PO Box 422, Modderfontein, 1645	Contact Number	011 608 4148
Tel: +27 11 608 4148	Date Sent to Lab	2022/12/02
Fax: +27 11 608 2621	Date Requested Back	ASAP
Contact Person: Sizwe	Page Number	1 of 2
Email Address: Sizwe@levego.co.za		

Purchase Order No: Levego Job No: LEG0913m Client Name: South 32 (MMT)

SAMPLE ID	TEST NO.	STACK DESCRIPTION	METHOD USED & ANALYSIS REQUIRED	SAMPLE CONTENT	COLLECTION DATE	SPECIAL INSTRUCTIONS	DATE RESULTS RECEIVED
09093E	1	Wet End	CM6 SO2	10% H2O2	2022/11/26		
09092E	2						
09091E	3						
09090E	Blank						
09089E	1	Wet End	(ISO 9096) Evaporate	Acetone & H2O	2022/11/26		
09088E	2						
09087E	3						
09086E	Blank						
LEV22-Q-1769	✓1	Wet End	(ISO 9096) Post weight	Filter	2022/11/26		
LEV22-Q-1771	✓2						
LEV22-Q-1777	✓3						
LEV22-Q-0039	Blank						
09100E	1	Dedust 1	CM6 SO2	10% H2O2	2022/11/27	Please use the same blank as 09090E	
09099E	2						
09098E	3						
09097E	1	Dedust 1	(ISO 9096) Evaporate	Acetone & H2O	2022/11/27	Please use the same blank 09086E	
09096E	2						
09095E	3						
LEV22-Q-1778	✓1	Dedust 1	(ISO 9096) Post weight	Filter	2022/11/27		
LEV22-Q-1780	✓2						
LEV22-Q-1770	✓3						

Sampler's Name:	Sizwe	Signature:			
Samples Relinquished by:	Sizwe	Signature:		Time & Date:	2022/12/02 08:20
Samples Approved by:	Hlengisecca	Signature:	P.P	Time & Date:	2022-12-06 11:02
Samples Received by:		Signature:		Time & Date:	
Samples Relinquished by:		Signature:		Time & Date:	
Samples Received by:		Signature:		Time & Date:	

CHAIN OF CUSTODY AND ANALYTICAL REQUEST

LEVEGO
Environmental Services

No: 09857

FROM: : Levego Environmental Services (Pty) Ltd	LAB SENT TO:		VES
Building R6, Pinelands Site, Ardeer Rd	Contact Person		Mosimo
PO Box 422, Modderfontein, 1645	Contact Number		011 608 4148
Tel: +27 11 608 4148	Date Sent to Lab		2022/12/02
Fax: +27 11 608 2621	Date Requested Back		ASAP
Contact Person: Sizwe	Page Number		2 of 2
Email Address: Sizwe@levego.co.za			

Purchase Order No: Levego Job No: VES0913 m Client Name: Sower 32 (MM1771)

SAMPLE ID	TEST NO.	STACK DESCRIPTION	METHOD USED & ANALYSIS REQUIRED	SAMPLE CONTENT	COLLECTION DATE	SPECIAL INSTRUCTIONS	DATE RESULTS RECEIVED
LEV22Q-1784	Blank	Dedust 1	(ISO9096) Post weigh	Filter	2022/11/27		
09106E	1				2022/11/28	Please use the	
09105E	2	Dedust 2	EN6 SO2	10% H2O2		same blank 09090E	
09104E	3						
~~09106E~~	1				2022/11/28	09,103E	
~~09105E~~	2	Dedust 2	(ISO9096) Evaporate	Acetone ...		09,102E	
~~09104E~~	3					09,101E 2022/11/28	
LEV22Q-0099	1		(ISO9096)		2022/11/28	Please use the	
LEV22Q-1779	2	Dedust 2	Post weigh	Filter		same blank	
LEV22Q-1776	3					09086E	
LEV22Q-1774	Blank		(ISO9096) Post weigh				

Sampler's Name:	Sizwe	Signature:	[signature]		
Samples Relinquished by:	Sizwe	Signature:	[signature]	Time & Date:	2022/12/02 08:20
Samples Approved by:	Hlayiseka	Signature:	[signature]	Time & Date:	2022/12/02 11:00
Samples Received by:		Signature:		Time & Date:	
Samples Relinquished by:		Signature:		Time & Date:	
Samples Received by:		Signature:		Time & Date:	

LEVEGO
Environmental Services

Physical: Building R6, Pinelands Site
Ardeer Rd, Modderfontein, 1645
Postal: P O Box 422, Modderfontein
1645Tel: 011 608 4148
Fax: 011 608 2621
E-mail: harvey@levego.co.za
www.levego.co.za

LEVEGO ENVIRONMENTAL SERVICES
Laboratory Test Report

Laboratory Test Report Number	LEV-LTR22-260
Date of Report	2022/12/12
Client	Levego Environmental Services Building R6 Pinelands Site Modderfontein 1645
Client Contact	Hlayiseka Yingwani
Client Contact Number	073 383 8663
Client e-mail	Hlayiseka@levego.co.za
Client Reference Number	LES0913M COC09856/7
Analysis Required	Particulate matter and Sulphur Dioxide
Location of Analysis	Levego Environmental Services Laboratory, Modderfontein, South Africa

This laboratory test report relates only to the specific samples received by the laboratory, identified herein. The laboratory does not accept responsibility from any matters arising from the further use of these results.

Levego laboratory does not accept responsibility for any errors that may have arisen from the sampling and transportation of the samples by external parties.

This laboratory test report may not be reproduced, except in full, unless written approval is obtained from the laboratory manager prior to publication.

Technical Signatory	Laboratory Manager
Name: Mosima Chidi	Name : Harvey Butcher
Signature :	Signature :

sanas
T0846

1. DESCRIPTION OF TEST METHODS

1.1 LEV-M-001: Determination of sulphur dioxide emissions from stationary sources.

This method is based on USEPA Method 6 and applies to the measurement of sulphur dioxide (SO_2) (CAS number 7449-09-5) emissions from stationary sources. A gas sample is extracted from the sampling point in the stack. The SO_2 and sulphur trioxide (SO_3), including those fractions in any sulphur acid mist, are separated. The SO_2 fraction is measured, via concentration of sulphate anion (SO_4^{2-}) , by the barium-thorin titration method.

1.2 LEV-M-002: Determination of particulate matter emissions from stationary sources.

This method is based on USEPA Method 5, USEPA Method 17, BS EN 13284-1:2002 and ISO 9096:2003(E), and applies to the determination of particulate matter (PM) (CAS number not assigned) emissions from stationary sources. Particulate matter is withdrawn iso-kinetically from the source and collected on a filter. The particulate matter, which includes particles, of any shape, structure or density, dispersed in the gas phase under the sampling conditions, is determined gravimetrically after the removal of uncombined water. This method is restricted to particulate matter collected in the sampling system, on and before a filter, under specified temperature conditions.

The particulate matter rinsing liquids were dried at 160 °C. The particulate matter filters were dried at 160 °C.

2. REMARKS

2.1 No deviations from laboratory test methods.

Table 1 - Samples

Test item description	Test item condition	Count
Acetone: water rinsing liquids	Received in polyethelene bottles at room temperature	10
Hydrogen peroxide solutions	Received in polyethelene bottles at room temperature	10
30x100mm Quartz Filter Thimbles	Received in securitainers, at room temperature	12

Table 2 - Particulate matter (rinsing liquid) results (Method LEV-M-002) - Measurement Uncertainty - ± 0.16 mg

Note: <* = Result below LOQ

Laboratory Identity Number	Client Identity Number	Type	LOQ	Date Received	Date of analysis	Particulate Matter (rinse) Lev-M-002		
						Particulate Matter (mg)	Post-Weight Average (g)	Pre-Weight Average (g)
23877	09089E	Rinse	0.05	2022/12/02	2022/12/08	4.63	36.24316	36.23853
23878	09088E	Rinse	0.05	2022/12/02	2022/12/08	3.51	35.95502	35.95151
23879	09087E	Rinse	0.05	2022/12/02	2022/12/08	9.27	36.95423	36.94496
23880	09086E	Rinse	0.05	2022/12/02	2022/12/08	0.05	36.02778	36.02773
23881	09097E	Rinse	0.05	2022/12/02	2022/12/08	4.22	36.03928	36.03506
23882	09096E	Rinse	0.05	2022/12/02	2022/12/08	7.07	35.64970	35.64262
23883	09095E	Rinse	0.05	2022/12/02	2022/12/08	0.47	35.76791	35.76744
23884	09103E	Rinse	0.05	2022/12/02	2022/12/08	3.60	36.11837	36.11477
23885	09102E	Rinse	0.05	2022/12/02	2022/12/08	2.85	38.29722	38.29437
23886	09101E	Rinse	0.05	2022/12/02	2022/12/08	3.56	36.02887	36.02531

Table 3 - Particulate matter (Quartz filter) results (Method LEV-M-002)

Measurement Uncertainty : -
30 * 100 mm Quartz Filter Thimbles ± 0.56 mg
47 mm Quartz Filters ± 0.28 mg
82.6 mm Quartz Filters ± 0.39 mg

Note: <* = Result below LOQ

Laboratory Identity Number	Client Identity Number	Type	LOQ	Date Received	Date of Analysis	Particulate Matter (Filter)		
						Particulate Matter (mg)	Post-Weight Average (g)	Pre-Weight Average (g)
23584	LEV22-Q-1769	30mmx100mm	0.05	2022/12/02	2022/12/07	162.79	3.06906	2.90627
23586	LEV22-Q-1771	30mmx100mm	0.05	2022/12/02	2022/12/07	156.16	3.07698	2.92083
23592	LEV22-Q-1777	30mmx100mm	0.05	2022/12/02	2022/12/07	149.44	3.07260	2.92316
18810	LEV22-Q-0039	30mmx100mm	0.05	2022/12/02	2022/12/07	0.08	2.91469	2.91461
23593	LEV22-Q-1778	30mmx100mm	0.05	2022/12/02	2022/12/07	52.07	2.96426	2.91219
23595	LEV22-Q-1780	30mmx100mm	0.05	2022/12/02	2022/12/07	71.25	3.00952	2.93827
23585	LEV22-Q-1770	30mmx100mm	0.05	2022/12/02	2022/12/07	70.15	2.97285	2.90270
23599	LEV22-Q-1784	30mmx100mm	0.05	2022/12/02	2022/12/07	0.08	2.93992	2.93983
18972	LEV22-Q-0099	30mmx100mm	0.05	2022/12/02	2022/12/07	17.17	2.90934	2.89217
23594	LEV22-Q-1779	30mmx100mm	0.05	2022/12/02	2022/12/07	10.46	2.98248	2.97202
23591	LEV22-Q-1776	30mmx100mm	0.05	2022/12/02	2022/12/07	9.60	2.88601	2.87641
23589	LEV22-Q-1774	30mmx100mm	0.05	2022/12/02	2022/12/07	0.10	2.89341	2.89331

Table 4 - Sulphur dioxide results (Method LEV-M-001)

Measurement Uncertainty : -

± 0.10 $mg\ell^{-1}$ (5ml burette)
± 0.12 $mg\ell^{-1}$ (10ml burette)
± 0.53 $mg\ell^{-1}$ (50ml burette)

Note: <* = Result below LOQ

Laboratory Identity Number	Client Identity Number	Type	LOQ $mg\ell^{-1}$	Date Received	Date of Analysis	Volume	Sulphur Dioxide
							LEV-M-001
							Sulphate(SO_4^{2-}) (mg/l)
23867	09093E	SO2, 5 ml	1.70	2022-12-02	2022-12-09	500.00	2 135.29
23868	09092E	SO2, 5 ml	1.70	2022-12-02	2022-12-09	500.00	1 468.43
23869	09091E	SO2, 5 ml	1.70	2022-12-02	2022-12-09	500.00	1 387.60
23870	09090E	SO2, 5 ml	1.70	2022-12-02	2022-12-09	500.00	<*
23871	09100E	SO2, 5 ml	1.70	2022-12-02	2022-12-09	500.00	<*
23872	09099E	SO2, 5 ml	1.70	2022-12-02	2022-12-09	500.00	<*
23873	09098E	SO2, 5 ml	1.70	2022-12-02	2022-12-09	500.00	<*
23874	09106E	SO2, 5 ml	1.70	2022-12-02	2022-12-09	500.00	<*
23875	09105E	SO2, 5 ml	1.70	2022-12-02	2022-12-09	500.00	<*
23876	09104E	SO2, 5 ml	1.70	2022-12-02	2022-12-09	500.00	<*

DJN Metgauge cc
P.O Box 6646
Westgate
1734
Tel: (011) 768 3325
(011) 768 4270
Fax: (011) 768 3653
Email: info@metgauge.co.za

METGAUGE

Calibration Laboratory
Since 1987

Medgate Centre, Shop No.8, Kingfisher Street, Horizon, Roodepoort

sanas Calibration Laboratory Lab 010

Calibration Certificate

Certificate No: P03716

Cal. Date: 27 July 2022
Due Date: Customer Req.

Customer: Levego Environmental Services
P.O.Box 422
Modderfontein
1645

Description: 0-150mm Digital Caliper
Serial: 11004211
Manufacturer: Ultra
Uncertainty Of Measurement: See Overleaf
Reference Publication: B.S 887: 2008
Calibration Procedure No: P-010-008-02
Environment: **Temperature** 20º C ± 1º C **Humidity** 40 To 60%
Traceable Standard Used: Steel Reference Set Gauge Blocks
Serial No. 71839 Cert. No. 2086

Equipment Used:
Vernier Gauge Blocks Serial No. MG 10

Error In Units Of mm
Temperature 20º C ± 1ºC

Calibration Points		Permissible Error	Actual Error
Parallelism			
Internal Jaw		0.010mm	0.008
External Jaw		0.008mm	0.006
External Measuring			
Scale Error	**0.00**	± 0.020mm	0.000
	10.00	± 0.020mm	0.000
	20.00	± 0.020mm	0.000
	41.20	± 0.020mm	-0.010
	51.20	± 0.020mm	-0.010
	81.50	± 0.020mm	-0.010
	101.20	± 0.020mm	-0.010
	121.80	± 0.020mm	-0.010
	150.00	± 0.020mm	-0.010
Internal Measuring			
Jaw at 20mm		± 0.020mm	-0.020
Depth Measuring		± 0.020mm	0.010

Note: Permissible error taken from B.S 887: 2008

Uncertainty of Measurement: ± 0.015mm

27 July 2022
Date

Calibrated By
P.M.Mncube

Technical Signatory
D. Bruwer

CALIBRATE
@PJB
Metrology Laboratory

sanas
Calibration Laboratory
DC Low Frequency . 118
Pressure . 218
Temperature . 318
Force . 818
Humidity . 1518
Conforms with ISO 17025:2017

ilac-MRA

calibration certificate

certificate number	**C29442**
calibrated for	LEVEGO ENVIRONMENTAL SERVICES PTY LTD BUILDING R6 PINELANDS SITE ARDEER ROAD MODDERFONTEIN 1645
section / location	STORES
instrument	DIGITAL TEMPERATURE AND HUMIDITY METER
serial number	090716
model	PERCEPTION 11
manufacturer	DAVIS
date of calibration	2022/11/24
date for recalibration	2023/11/24
date of issue	2022/11/30
environment	22.0 °C and 47.0 %rh

The South African National Accreditation System (SANAS) is a member of the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement (MRA). This arrangement allows for mutual recognition of technical test and calibration data by member accreditation bodies worldwide. For more information on the arrangement, please consult www.ilac.org.

Calibrations performed by this laboratory are in terms of standards which are traceable to the national measuring standards and conforms to the ISO.IEC 17025 requirements. The calibration procedures are performed in terms of approved company quality standards.

This certificate is a true record of the measurements made and values reflected on this certificate are correct at the time of calibration and only applies to the readings of the UUT identified on this certificate. Subsequently the accuracy will depend on such factors as the care executed in handling and use of the device, and the frequency of use.
Recalibration should be undertaken after a period which is chosen to ensure that the instrument's accuracy remains within the desired limits, or as agreed with the customer, or as required by South African Civil Aviation Regulations.

This Certification may not be reproduced other than in full, exception with prior approval of the issuing laboratory.

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor K = 2 providing level of confidence of approximately 95.45 %, the uncertainty of measurement has been estimated in accordence with the principles defined in the GUM, Guide to Uncertainty of Measurement, ISO Geneva, Switzerland, 1993.

Legal liability shall be limited to the cost of the recalibration and or certification, and the applicant hereby idemnifies PJB Contracting CC against any, consequential or other loss.

Calibrate@pjb will maintain a professional standard in its performance of calibration activities. We will not be liable for any claims whatsoever airising out of the use, implementation or inability to use any of the results generated on our certificates.

A calibration sticker has been affixed to the instrument bearing calibration date, serial number, due date * and certificate number.

calibrated by Kennedy Smuts
metrologist

Kennedy Smuts
technical signatory

po box 9314 edleen 1625 5 platberg avenue van riebeeck park kempton park 1619
phone +27 11 972 3798 fax 086 674 9980 lab@pjb.co.za www.pjb.co.za
pjb contracting cc t/a calibrate@pjb CK1993/11192/23 member pj burmeister

CALIBRATE @PJB
Metrology Laboratory

sanas Calibration Laboratory
DC Low Frequency . 118
Pressure . 218
Temperature . 318
Force . 818
Humidity . 1518
Conforms with ISO 17025:2017

Calibration Certificate

Certificate Number C29442

Calibrated for LEVEGO ENVIRONMENTAL SERVICES PTY LTD

Instrument DIGITAL TEMPERATURE AND HUMIDITY METER

calibrate@pjb calibration procedure
P/1/002 (Issue 17.0)
P/1/007 (Issue 12.0)
P/1/008 (Issue 13.0)

calibrated@pjb standards and laboratory equipment used

Instrument	Model	Serial No	Certificate	Calibration Due Date
[45] THERMOMETER, CHUB-E4	1529	A56912	119531-1	2024/04/14
[46] PLATINUM RESISTANCE THERMOMETER	18004-A-120-6-B-1	743455	1198531-1	2024/04/14
[91] ABSOLUTE PRESSURE GAUGE	DPI705	70561580	2102P9684-1	2023/02/26
[96] TEMPERATURE & HUMIDITY DATA LOGGER	U14-001	10237101	A108851	2023/10/04
[159] HYGROTHERMOMETER AND PROBE	HP32-S-SET WITH HC2-A	5181494	C25926	2024/09/20
[156] HYGROTHERMOMETER AND PROBE	HP32	'6/ PROBE 20‹	c22811	2023/05/20
[170] DIGITAL HAND HELD AND PROBE	HC2A-S	20312200	C22812	2023/06/14

Results

Standard Input %rh	Before %rh	UUT After Reading %rh	Corr	Remark
36.20	-	33	3	AT 22.09°C
53.12	-	51	2	AT 29.92°C
67.89	-	66	2	AT 22.75°C

Uncertainty +/- 3.0 %rh

Standard Input °C	Before °C	UUT After Reading °C	Corr	Remark
10.23	-	10.4	-0.2	
22.75	-	22.9	-0.2	
29.92	-	29.9	0.0	

Uncertainty +/- 1.5 °C

Standard Input mbar	Before mbar	UUT After Reading mbar	Corr	Remark
835.3	-	832.5	2.8	

Uncertainty +/- 1.0 %

Conversion Factor : 1 mbar = .1 kPa

Kennedy Smuts
Calibrated Signatory

Kennedy Smuts
Technical Signatory

CALIBRATE
@PJB
Metrology Laboratory

Calibration Certificate

sanas
Calibration Laboratory
DC Low Frequency . 118
Pressure . 218
Temperature . 318
Force . 818
Humidity . 1518
Conforms with ISO 17025:2017

Certificate Number C29442

Calibrated for LEVEGO ENVIRONMENTAL SERVICES PTY LTD

Instrument DIGITAL TEMPERATURE AND HUMIDITY METER

Remarks

UNIT CLEANED AND CALIBRATED
FITTED NEW BATTERY(/IES)
(REPORTED VALUES MAY BE ROUNDED OFF WHERE APPLICABLE)
UNIT CALIBRATED IN THE PRESSURE LABORATORY OF CALIBRATE@PJB, 5 PLATBERG AVENUE, VAN RIEBEECK PARK, KEMPTON PARK
UNIT CALIBRATED IN THE TEMPERATURE LABORATORY OF CALIBRATE@PJB, 5 PLATBERG AVENUE, VAN RIEBEECK PARK, KEMPTON PARK

Kennedy Smuts
Calibrated Signatory

* End of document *

Kennedy Smuts
Technical Signatory

This certificate was issued using COS V1.0

@CALIBRATE
@PJB
Metrology Laboratory

sanas
Calibration Laboratory
DC Low Frequency , 118
Pressure , 218
Temperature , 318
Force , 818
Humidity , 1518
Conforms with ISO 17025:2017

ilac-MRA

calibration certificate

certificate number	C26342
calibrated for	LEVEGO ENVIRONMENTAL SERVICES PVT LTD BUILDING R6 PINELANDS SITE ARDEER ROAD MODDERFONTEIN 1645
section / location	STORES
instrument	THERMOCOUPLE CALIBRATOR
serial number	108390
model	520
manufacturer	PIE
date of calibration	2022/07/26
date for recalibration	2023/07/26
date of issue	2022/07/27
environment	20.7 °C and 49.0 %rh

The South African National Accreditation System (SANAS) is a member of the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement (MRA). This arrangement allows for mutual recognition of technical test and calibration data by member accreditation bodies worldwide. For more information on the arrangement, please consult www.ilac.org.

Calibrations performed by this laboratory are in terms of standards which are traceable to the national measuring standards and conforms to the ISO,IEC 17025 requirements. The calibration procedures are performed in terms of approved company quality standards.

This certificate is a true record of the measurements made and values reflected on this certificate are correct at the time of calibration and only applies to the readings reported. Subsequently the accuracy will depend on such factors as the care executed in handling and use of the device, and the frequency of use.
Recalibration should be undertaken after a period which is chosen to ensure that the instrument's accuracy remains within the desired limits, or as agreed with the customer, or as required by South African Civil Aviation Regulations.

This Certification may not be reproduced other than in full, exception with prior approval of the issuing laboratory.

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor K = 2 providing level of confidence of approximately 95.45 % , the uncertainty of measurement has been estimated in accordance with the principles defined in the GUM, Guide to Uncertainty of Measurement, ISO Geneva, Switzerland, 1993.

Legal liability shall be limited to the cost of the recalibration and or certification, and the applicant hereby idemnifies PJB Contracting CC against any, consequential or other loss.

Calibrate@pjb will maintain a professional standard in its performance of calibration activities. We will not be liable for any claims whatsoever airising out of the use, implementation or inability to use any of the results generated on our certificates.

A calibration sticker has been affixed to the instrument bearing calibration date, serial number, due date and certificate number.

calibrated by Kennedy Smuts
metrologist

Kennedy Smuts
technical signatory

po box 9314 edleen 1625 5 platberg avenue van riebeeck park kempton park 1619
phone +27 11 972 3798 fax 086 674 9980 lab@pjb.co.za www.pjb.co.za
pjb contracting cc t/a calibrate@pjb CK1993/11192/23 member pj burmeister

CALIBRATE @PJB
Metrology Laboratory

ilac-MRA

sanas
Calibration Laboratory
DC Low Frequency . 118
Pressure . 218
Temperature . 318
Force . 818
Humidity . 1518
Conforms with ISO 17025:2017

Calibration Certificate

Certificate Number C26342

Calibrated for LEVEGO ENVIRONMENTAL SERVICES PVT LTD

Instrument THERMOCOUPLE CALIBRATOR

calibrate@pjb calibration procedure
P/1/015 (issue 4.0)

calibrated@pjb standards and laboratory equipment used

Instrument	Model	Serial No	Certificate	Calibration Due Date
[40] FLUKE 5500A CALIBRATOR	FLUKE	8695015	114985-1	2023/03/01
[97] TEMPERATURE & HUMIDITY DATA LOGGER	HOBO	10237102	A108849	2023/10/04

Results

Standard Input °C	Before °C	UUT After Reading °C	Corr	Remark
-19.51	-	-20	0.49	ELECTRICAL SIMULATION
-9.53	-	-10	0	TYPE K (ITS-90)
0.49	-	0	0	
10.47	-	10	0	
20.48	-	20	0	
50.44	-	50	0	
100.46	-	100	0	
500.52	-	500	1	
1000.65	-	1000	1	

Uncertainty +/- 1.0 °C

Remarks
UNIT CLEANED AND CALIBRATED
(REPORTED VALUES MAY BE ROUNDED OFF WHERE APPLICABLE)
UNIT CALIBRATED IN THE AC/DC LABORATORY OF CALIBRATE@PJB, 5 PLATBERG AVENUE, VAN RIEBEECK PARK, KEMPTON PARK

Kennedy Smuts
Calibrated Signatory

* End of document *

Kennedy Smuts
Technical Signatory

This certificate was issued using COS V1.0

Environmental Supply Company, Inc.

Quality Source Sampling Systems & Accessories

15 POINT SECONDARY REFERENCE METER CALIBRATION

Date: July 30, 2021 **DGM Model:** SK25EX

Customer: Levego **DGM S/N:** 00006673

Reference Prover: #3050 **Tape:** #01131693

Pb: 29.65 in Hg

Flow Rate (lpm) Q	Volume: Prover (liters) V_w	Volume: DGM (liters) V_{ds}	Temperature: Prover (F) t_w	Temperature: DGM (F) t_{ds}	Pressure: Prover (in H_2O) P_w	Pressure: DGM (in H_2O) P_m	Time (min) Θ	Meter Coefficient Y_{ds}	Average Meter Coefficient Y_{ds}
32.9	150.282	151.480	74.3	74.3	1.25	1.02	4.47	0.993	
32.9	150.282	151.616	74.4	74.5	1.25	1.02	4.47	0.992	
33.0	150.282	151.614	74.1	74.5	1.25	1.02	4.47	0.993	0.992
26.8	150.282	151.196	74.1	74.6	1.25	1.08	5.50	0.995	
26.8	150.282	151.284	74.2	74.8	1.25	1.08	5.50	0.995	
26.8	150.282	151.233	74.0	74.7	1.25	1.08	5.50	0.996	0.995
21.5	150.282	150.486	74.0	74.8	1.26	1.14	6.83	1.001	
21.5	150.282	150.503	74.0	74.8	1.26	1.14	6.83	1.000	
21.5	150.282	150.538	74.0	74.9	1.26	1.14	6.83	1.000	1.000
17.3	150.282	150.136	74.1	74.9	1.26	1.17	8.52	1.003	
17.3	150.282	150.183	74.0	74.9	1.26	1.17	8.52	1.002	
17.3	150.282	150.142	74.0	74.9	1.26	1.17	8.52	1.003	1.003
9.5	150.282	148.837	73.9	74.9	1.26	1.22	15.55	1.012	
9.5	150.282	148.860	73.9	74.9	1.26	1.22	15.55	1.012	
9.5	150.282	148.829	73.9	74.9	1.26	1.22	15.55	1.012	1.012

ScF 1.9420 **AVERAGE Y_{ds}** 1.000

$$Y_{ds} = \frac{V_w(t_{ds} + t_{std})}{V_{ds}(t_w + t_{std})} * \frac{P_{bar}}{\left(P_{bar} + P_m/13.6\right)} \qquad Q = 17.64 \frac{P_{bar}}{(t_w + t_{std})} \frac{V_w}{\Phi}$$

Dry gas meter Serial Number 6673 was calibrated in accordance with the Code of Federal Regulations, Title 40, Part 60, Appendix A, Method 5 Section 16.1.1

Signature

708 E. Club Blvd., Durham, North Carolina 27704 www.environsupply.com 919-956-9688 FAX: 919-682-0333

U EPA METHOD 5 - SOURCE SAMPLING CONSOLE CALIBRATION

USING A SECONDARY REFERENCE METER

5-POINT (METRIC UNITS)

Meter Console Information	
Console Model Number	572
Console Serial Number	809061
DGM Model Number	AP 25
DGM Serial Number	1900835

Calibration Meter Information (Secondary Meter)		
Calibration Meter Serial #	SK25EX-00006673	
Calibration Meter Gamma	unitless	1.000

Calibration Conditions		
Barometric Pressure	mb	846
	mm Hg	635
Date		03-Aug-22
Calibration Technician		Stanford

Factors		
Std Temp [1]	K	293.15
Std Press	mm Hg	760
K_1	K/mm Hg	0.3857

[1] US EPA Method 5 uses Standard Absolute Temperature (293.15 K) for K^1, DGM calibration factor (Y), and ΔH@ calculations

Calibration Data

Run Time	Metering Console							Calibration Meter			
Elapsed	DGM Orifice ΔH	Volume Initial	Volume Final	Outlet Temp Initial	Outlet Temp Final	Vacuum (*for information*) Absolute (positve) value		Volume Initial	Volume Final	Outlet Temp Initial	Outlet Temp Final
Θ	P_m	V_{mi}	V_{mf}	t_{mi}	t_{mf}			V_{wi}	V_{wf}	t_{wi}	t_{wf}
min	mm H_2O	m^3	m^3	°C	°C	inch Hg	mm Hg	litre	litre	°C	°C
5.0	120.0	392.0302	392.2132	22	23	13.7	348	0.000	184.276	21	22
6.0	80.0	392.2132	392.3946	23	23	13.6	345	184.276	366.235	22	22
7.0	50.0	392.3946	392.5592	23	24	13.5	343	366.235	530.967	22	23
10.0	25.0	392.5592	392.7252	24	24	13.4	340	530.967	696.449	23	23
15.0	13.0	392.7252	392.9052	24	25	13.3	338	696.449	875.465	23	24

Results

Standardized Data				Dry Gas Meter					
Dry Gas Meter		Calibration Meter (Secondary)		Calibration Factor			Flowrate	ΔH @	
				Value	Variation	Variation	Std & Corr	0.0212 m^3_{std}/min	Variation
$V_{m(std)}$	$Q_{m(std)}$	$V_{w(std)}$	$Q_{w(std)}$	Y	ΔY	ΔY	$Q_{m(std)(corr)}$	ΔH@	ΔΔH@
m^3	m^3/min	m^3	m^3/min	0.95 to 1.05	Max-Min ≤ 0.030	< ± 2% of avg	m^3/min	mm H_2O	< ± 5.1 mm of avg
0.154	0.031	0.153	0.031	0.997	-0.001	-0.1%	0.031	49.157	-0.172
0.151	0.025	0.151	0.025	0.997	0.000	0.0%	0.025	48.040	-1.288
0.137	0.020	0.136	0.019	0.998	0.001	0.1%	0.019	49.603	0.275
0.137	0.014	0.137	0.014	0.997	0.000	0.0%	0.014	49.954	0.625
0.148	0.010	0.148	0.010	0.996	-0.001	-0.1%	0.010	49.889	0.560
			Y Average	**0.997**	**0.002**	Max minus Min		49.329	ΔH@ Average

The calibration factor, Y, at each of the flow rates, should not differ by more than ±2 percent from the average, as specified in 16.2.3.4 of US EPA Method 5. (Refer to sheet "References to EPA M5")

ΔH@ = orifice pressure differential that equates to 0.75cfm (0.0212 m^3/min) at standard temperature and pressure. Acceptable tolerance of individual values from the average is ±0.2 inches (±5.1mm) H_2O.

The above Orifice set was calibrated in accordance with USEPA Methods, CFR 40 Part 60, Appendix A, Method 5, item 7.2.2

Verified by: Stanford

Date: 2022-08-03

Signature:

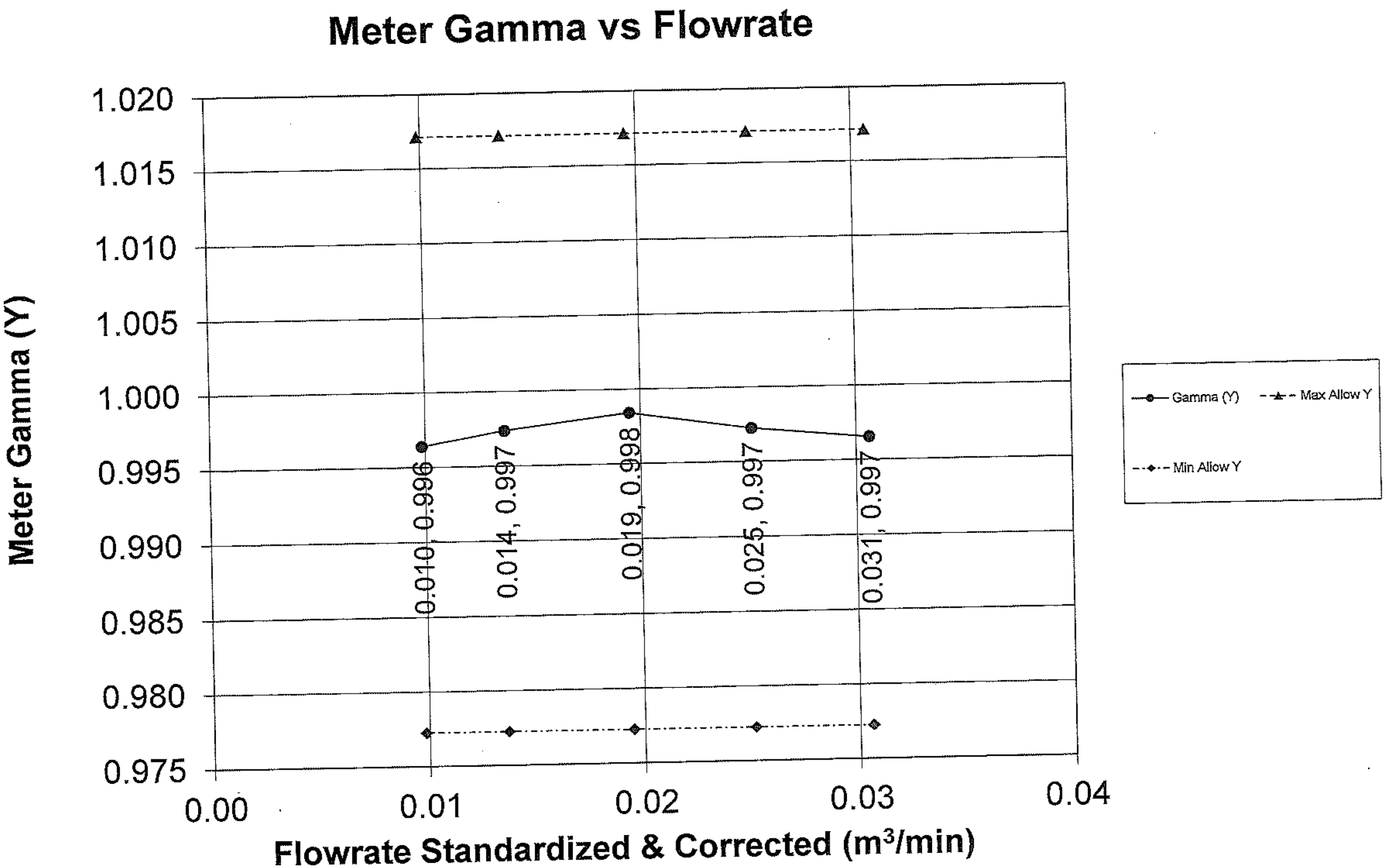
Checked by: HHOFVG?

Date: 2022/08/03

Signature:

Calibration Date: 2022-8-3

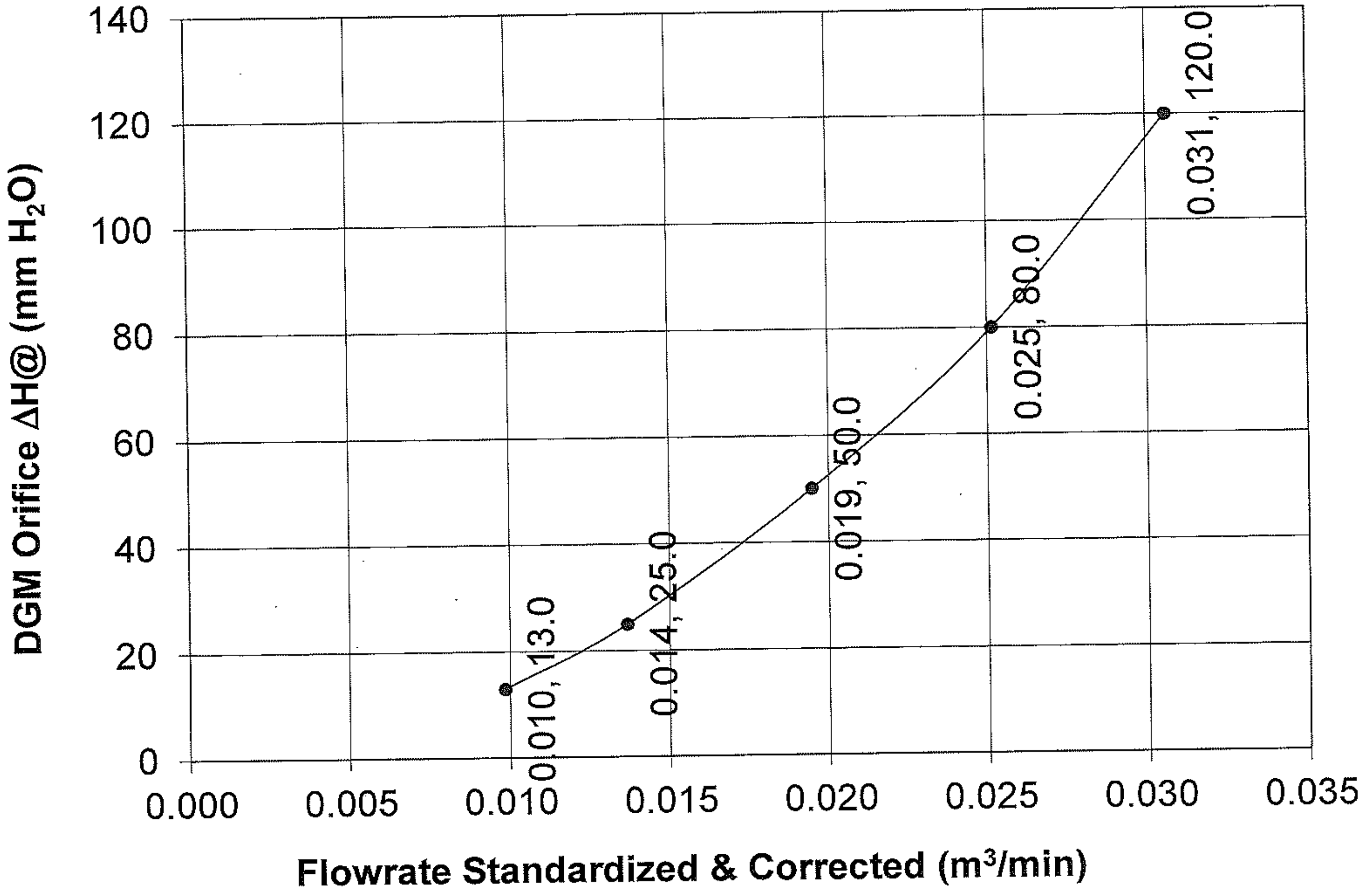
Calibration Technician: Stanford



Console Serial: 809061

Console Model: 572

Meter Pressure vs Flowrate



Console Serial: 809061

Console Model: 572

Digital Thermometer Verification Form

Name of Measurement Technician	Stanford		
Calibration Simulator Reference Name and S/N	Thermocouple Calibrator. 108390		
Source Sampler Console No.	809061		
Main Thermometer S/N	19E30132		
Calibration Date:	2022-07-26	**Calibration Certificate No.**	**C26342**

*Delete the dates that were not filled in, this will ensure that the red text will not be printed.

Date	**Parameters Measured**	**Ambient Temp °C**	**Reference Set Simulator Temp °C (T1)**	**Source Sampler Console Display Temp °C (T2)**	***Absolute Temp Difference %**
2022-12-14	Aux	22	**20**	20	0
			100	100	0
			250	249	0.4
2022-12-14	Stack	22	**20**	20	0
			100	99	1
			250	250	0
2022-12-14	Probe	22	**20**	20	0
			100	100	0
			250	249	0.4
2022-12-14	Filter	22	**20**	20	0
			100	100	0
			250	250	0
2022-12-14	Exit	22	**20**	20	0
			100	99	1
			250	249	0.4
n/a	n/a	n/a	**20**	n/a	n/a
			100	n/a	n/a
			250	n/a	n/a

* Formula for Calculating the Absolute Temperature difference (temperatures in K).

$$\%Diff = |T_1 - T_2| \div T_1 * 100$$

Notify managing member if absolute temperature difference is not within 1.5% (as per Apex Method 5)

Verified by:	Stanford	Sign:		Date	2022-12-14
Checked by:	Harvey	Sign:		Date	2022/12/14

Authorisation	**Position**	**Name**	**Date**
Compiled by:	Technical Manager	Harvey Butcher	2021-12-02
Reviewed by:	Equipment Technician	Stanford Kanyai	2021-12-02
Approved by:	Technical Manager	Harvey Butcher	2021-12-02

Digital Barometer Verification Form

Serial No /ID:	DB 17
Verification Technician:	Stanford
Calibration Date Hygrograph:	2022-11-24
Certificate Number:	C29442

Date	Time	Pressure (mb)		Within ±3mb Yes or No	Verified by	Checked by
		Perception II	Barometer			
14/12/22	10:27am	842	845	Yes	Stanford	HButcher
02/02/23	9:31am	844	847	Yes	Stanford	HButcher

Authorisation	**Position**	**Name**	**Date**
Compiled by:	Technical Manager	Harvey Butcher	2021-12-02
Reviewed by:	Equipment Technician	Stanford Kanyai	2021-12-02
Approved by:	Technical Manager	Harvey Butcher	2021-12-02

Verification of S-Type Pitot tube

S-Type pitot tube number:	ST-A3389
Date	2022-12-14

Parameter	Value	Allowable Range
Assembly Level	Yes	Yes/No
Ports Damaged	No	Yes/No
α_1	2.2	$-10° < \alpha_1 < 10°$
α_2	2.0	$-10° < \alpha_2 < 10°$
β_1	1.4	$-5° < \beta_1 < 5°$
β_2	0.8	$-5° < \beta_2 < 5°$
γ	0.4	= (90° - measured value)
P_A	9.88	
P_B	9.82	
θ	0.2	= (90° - measured value)
Z=A tan γ round to 2 decimals	0.02	$Z \leq 0.32$cm
W=A tan θ round to 2 decimals	0.01	$W \leq 0.08$cm
Dt	0.95	0.48 to 0.95cm
A	2.17	For 3/8" OD -2.00 to 2.86
A	n/a	For 1/4" OD 1.33 to 1.91

Certification:

I certify that the Pitot tube number ST-A3389 meets or exceeds all Specifications, Criteria and/or applicable design features and is hereby assigned a Pitot tube certification factor of 0.84.

***If Pitot tube does not meet the criteria above it should not be used and reported to the Quality Manager/ Managing member.**

Verified by:	Stanford	Sign:		Date	2022-12-14
Checked by:	HARVEY	Sign:		Date	2022/12/14

Authorisation	**Position**	**Name**	**Date**
Compiled by:	Technical Manager	Harvey Butcher	2021-12-02
Reviewed by:	Operations Director	Deon Posthumus	2021-12-02
Approved by:	Technical Manager	Harvey Butcher	2021-12-02

LEVEGO
Environmental Services

NOZZLE DIAMETER VERIFICATION RECORD

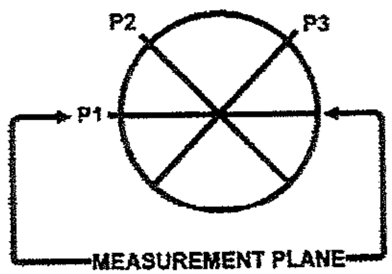
Vernier name:	Ultra
Vernier s/n:	11004211
Vernier calibration certficate No:	P03716
Vernier uncertainty:	0.015 mm
Verification uncertainty:	0.010225
Circumferance tolerance:	0.100 mm

*Measurement uncertainty calculation

Date	Nozzle number	Average diameter / mm	uncertainty / mm	Measured values / mm			Hi to Lo	Allowable tolerance (max) / mm ≤ 0.100 mm	**Visible deformation / damage?
				Meas 1	Meas 2	Meas 3	Δ Dia / mm	Pass / Fail	
2022/12/14	NS2-1	2.85	0.04	2.85	2.83	2.86	0.03	Pass	Fit for Use
2022/12/14	NS2-2	4.41	0.07	4.43	4.42	4.37	0.06	Pass	Fit for use
2022/12/14	NS2-3	6.15	0.09	6.18	6.15	6.13	0.05	Pass	Fit for use
2022/12/14	NS2-4A	7.80	0.12	7.79	7.82	7.80	0.03	Pass	Fit for use
2022/12/14	NS2-5	9.63	0.14	9.64	9.62	9.62	0.02	Pass	Fit for use
2022/12/14	NS2-6	10.93	0.16	10.93	10.92	10.95	0.03	Pass	Fit for Use
2022/12/14	NS2-7	12.68	0.19	12.65	12.70	12.68	0.05	Pass	Fit for Use

Where:
Meas 1, Meas 2, Meas 3 = Measure the inside diameter of the nozzle by taking three reading approxamately 45-60° appart from one another and record.
H i-Lo Δ D = maximum difference between any two diameters, must be less than or equal to 0.1 mm
Average Diameter = average of Meas 1, Meas 2 and Meas 3

**If nozzle is damaged or deformed report to management.



Stanford	[signature]	2022-12-14
Verified by:	Signature:	Date:
[signature]	[signature]	2022/12/14
Checked by:	Signature:	Date:

LEVEGO Environmental Services	Portable Flue Gas Analyser Verification	Page:	1 of 1
		Revision:	E00
		Effective date:	2019/11/13
		Management System	

Project No.	LES0913M
Company	South 32 Hotazel Manganese Mines (Pty) L
Site	0
Location	De-dust 1 Stack

Analyser	
Name and Model	Seitron
Serial Number	1076

Calibration Gas Certificate Numbers							
	CO_2 (%)	CO (ppm)	O_2 (%)	NO_2 (ppm)	NO (ppm)	SO_2 (ppm)	Zero/N_2 (ppm)
Certificate	9762MM	9762MM	9762MM		CHEM/APG-0260		
Concentration	18.06	308.90	18.36		500.00		

Date & Time	Components		Pre-Measurements		Post-Measurements		Pre-System Bias		Post-System Bias		Deviations/Drifts		Pass	
			Zero	Span	Zero	Span	Zero	Span	Zero	Span	Zero	Span	EPA	EN
	CO_2	1	0	18.03	0	18.02	0.00	0.17	0.00	0.22	0.00	0.06	**0.06**	**0.06**
		2	0	18.03	0	18.02	0.00	0.17	0.00	0.22	0.00	0.06	**0.06**	**0.06**
		3	0	18.02	0	18.01	0.00	0.22	0.00	0.28	0.00	0.06	**0.06**	**0.06**
		4	0	18.02	0	18	0.00	0.22	0.00	0.33	0.00	0.11	**0.11**	**0.11**
	CO	1	0	309	0	307	0.00	-0.03	0.00	0.62	0.00	0.65	**0.65**	**0.65**
		2	0	310	0	307	0.00	-0.36	0.00	0.62	0.00	0.97	**0.97**	**0.97**
		3	0	307	0	306	0.00	0.62	0.00	0.94	0.00	0.32	**0.32**	**0.32**
		4	0	307	0	305	0.00	0.62	0.00	1.26	0.00	0.65	**0.65**	**0.65**
	O_2	1	0	18.36	0	18.37	0.00	0.00	0.00	-0.05	0.00	0.05	**0.05**	**0.05**
		2	0	18.36	0	18.36	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**
		3	0	18.35	0	18.36	0.00	0.05	0.00	0.00	0.00	0.05	**0.05**	**0.05**
		4	0	18.36	0	18.35	0.00	0.00	0.00	0.05	0.00	0.05	**0.05**	**0.05**
	NO_2	1											**0.00**	**0.00**
		2											**0.00**	**0.00**
		3											**0.00**	**0.00**
		4											**0.00**	**0.00**
	NO	1	0	499	0	500	0.00	0.20	0.00	0.00	0.00	0.20	**0.20**	**0.20**
		2	0	498	0	501	0.00	0.40	0.00	-0.20	0.00	0.60	**0.60**	**0.60**
		3	0	498	0	500	0.00	0.40	0.00	0.00	0.00	0.40	**0.40**	**0.40**
		4	0	499	0	499	0.00	0.20	0.00	0.20	0.00	0.00	**0.00**	**0.00**
	SO_2	1											**0.00**	**0.00**
		2											**0.00**	**0.00**
		3											**0.00**	**0.00**
		4											**0.00**	**0.00**

Project Manager (PM) to be informed immediately of any run failing any of the above checks			
KEY	**Green**	Yellow	Red
	No adjustment of logged data required	Adjust of logged data required	Sampling to be repeated

Equipment Verification Technician: **Name:** ________ **Signature:** ________ **Date:** ________

DTR:	LES0913M-DD1-M6-JOHN(V2).xlsx

LEVEGO Environmental Services	Portable Flue Gas Analyser Verification	Page:	1 of 1
		Revision:	E00
		Effective date:	2019/11/13
		Management System	

Project No.	LES0913M
Company	South 32 Hotazel Manganese Mines (Pty) L
Site	0
Location	De-dust 2 Stack

Analyser	
Name and Model	Seitron
Serial Number	1076

Calibration Gas Certificate Numbers							
	CO_2 (%)	CO (ppm)	O_2 (%)	NO_2 (ppm)	NO (ppm)	SO_2 (ppm)	Zero/N_2 (ppm)
Certificate	9762MM	9762MM	9762MM		CHEM/APG-0260		
Concentration	18.06	308.90	18.36		500.00		

Date & Time	Components		Pre-Measurements		Post-Measurements		Pre-System Bias		Post-System Bias		Deviations/Drifts		Pass	
			Zero	Span	Zero	Span	Zero	Span	Zero	Span	Zero	Span	EPA	EN
	CO_2	1	0	18.05	0	18.03	0.00	0.06	0.00	0.17	0.00	0.11	**0.11**	**0.11**
		2	0	18.05	0	18.03	0.00	0.06	0.00	0.17	0.00	0.11	**0.11**	**0.11**
		3	0	18.04	0	18.02	0.00	0.11	0.00	0.22	0.00	0.11	**0.11**	**0.11**
		4	0	18.05	0	18.01	0.00	0.06	0.00	0.28	0.00	0.22	**0.22**	**0.22**
	CO	1	0	309	0	308	0.00	-0.03	0.00	0.29	0.00	0.32	**0.32**	**0.32**
		2	0	308	0	306	0.00	0.29	0.00	0.94	0.00	0.65	**0.65**	**0.65**
		3	0	307	0	306	0.00	0.62	0.00	0.94	0.00	0.32	**0.32**	**0.32**
		4	0	307	0	307	0.00	0.62	0.00	0.62	0.00	0.00	**0.00**	**0.00**
	O_2	1	0	18.36	0	18.35	0.00	0.00	0.00	0.05	0.00	0.05	**0.05**	**0.05**
		2	0	18.36	0	18.34	0.00	0.00	0.00	0.11	0.00	0.11	**0.11**	**0.11**
		3	0	18.35	0	18.34	0.00	0.05	0.00	0.11	0.00	0.05	**0.05**	**0.05**
		4	0	18.36	0	18.33	0.00	0.00	0.00	0.16	0.00	0.16	**0.16**	**0.16**
	NO_2	1											**0.00**	**0.00**
		2											**0.00**	**0.00**
		3											**0.00**	**0.00**
		4											**0.00**	**0.00**
	NO	1	0	498	0	497	0.00	0.40	0.00	0.60	0.00	0.20	**0.20**	**0.20**
		2	0	498	0	497	0.00	0.40	0.00	0.60	0.00	0.20	**0.20**	**0.20**
		3	0	499	0	496	0.00	0.20	0.00	0.80	0.00	0.60	**0.60**	**0.60**
		4	0	498	0	496	0.00	0.40	0.00	0.80	0.00	0.40	**0.40**	**0.40**
	SO_2	1											**0.00**	**0.00**
		2											**0.00**	**0.00**
		3											**0.00**	**0.00**
		4											**0.00**	**0.00**

Project Manager (PM) to be informed immediately of any run failing any of the above checks

KEY	Green	Yellow	Red
	No adjustment of logged data required	Adjust of logged data required	Sampling to be repeated

Equipment Verification Technician: **Name:** ____________ **Signature:** ____________ **Date:** ____________

DTR:	LES0913M-DD2-M6-JOHN(V2).xlsx

LEVEGO Environmental Services	Portable Flue Gas Analyser Verification	Page:	1 of 1
		Revision:	E00
		Effective date:	2019/11/13
		Management System	

Project No.	LES0913M
Company	South 32 Hotazel Manganese Mines (Pty) L
Site	0
Location	Waste Gas Stack

Analyser	
Name and Model	Seitron
Serial Number	1076

Calibration Gas Certificate Numbers	CO_2 (%)	CO (ppm)	O_2 (%)	NO_2 (ppm)	NO (ppm)	SO_2 (ppm)	Zero/N_2 (ppm)
Certificate	9762MM	9762MM	9762MM		CHEM/APG-0260		
Concentration	18.06	308.90	18.36		500.00		

Date & Time	Components		Pre-Measurements Zero	Pre-Measurements Span	Post-Measurements Zero	Post-Measurements Span	Pre-System Bias Zero	Pre-System Bias Span	Post-System Bias Zero	Post-System Bias Span	Deviations/Drifts Zero	Deviations/Drifts Span	Pass EPA	Pass EN
	CO_2	1	0	18.05	0	18.04	0.00	0.06	0.00	0.11	0.00	0.06	**0.06**	**0.06**
		2	0	18.05	0	18.02	0.00	0.06	0.00	0.22	0.00	0.17	**0.17**	**0.17**
		3	0	18.03	0	18.02	0.00	0.17	0.00	0.22	0.00	0.06	**0.06**	**0.06**
		4	0	18.01	0	18.01	0.00	0.28	0.00	0.28	0.00	0.00	**0.00**	**0.00**
	CO	1	0	308	0	307	0.00	0.29	0.00	0.62	0.00	0.32	**0.32**	**0.32**
		2	0	308	0	307	0.00	0.29	0.00	0.62	0.00	0.32	**0.32**	**0.32**
		3	0	307	0	306	0.00	0.62	0.00	0.94	0.00	0.32	**0.32**	**0.32**
		4	0	306	0	307	0.00	0.94	0.00	0.62	0.00	0.32	**0.32**	**0.32**
	O_2	1	0	18.36	0	18.37	0.00	0.00	0.00	-0.05	0.00	0.05	**0.05**	**0.05**
		2	0	18.36	0	18.36	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**
		3	0	18.35	0	18.36	0.00	0.05	0.00	0.00	0.00	0.05	**0.05**	**0.05**
		4	0	18.36	0	18.35	0.00	0.00	0.00	0.05	0.00	0.05	**0.05**	**0.05**
	NO_2	1											**0.00**	**0.00**
		2											**0.00**	**0.00**
		3											**0.00**	**0.00**
		4											**0.00**	**0.00**
	NO	1	0	500	0	498	0.00	0.00	0.00	0.40	0.00	0.40	**0.40**	**0.40**
		2	0	501	0	498	0.00	-0.20	0.00	0.40	0.00	0.60	**0.60**	**0.60**
		3	0	501	0	499	0.00	-0.20	0.00	0.20	0.00	0.40	**0.40**	**0.40**
		4	0	500	0	499	0.00	0.00	0.00	0.20	0.00	0.20	**0.20**	**0.20**
	SO_2	1											**0.00**	**0.00**
		2											**0.00**	**0.00**
		3											**0.00**	**0.00**
		4											**0.00**	**0.00**

Project Manager (PM) to be informed immediately of any run failing any of the above checks

KEY	Green	Yellow	Red
	No adjustment of logged data required	Adjust of logged data required	Sampling to be repeated

Equipment Verification Technician: **Name:** ______ **Signature:** ______ **Date:** ______

DTR:	LES0913M-Waste-Gas-M6-JOHN(V2).xlsx

LEVEGO
Environmental Services

REPORT 23/R2467

STACK EMISSION MEASUREMENT SURVEY (COMPLIANCE)

FOR

SOUTH 32
HOTAZEL MANGANESE MINES (PTY) LTD
MAMATWAN

SAMPLING PERIOD: DECEMBER 2023 – FEBRUARY 2024

E&OE

LEVEGO ENVIRONMENTAL SERVICES (PTY) LTD Reg No 2017/188749/07. A LEVEGO affiliated company
Directors: G B Woollatt, D L Posthumus, Tel: (011) 608-4148 Fax: (011) 608-2621 Web: www.levego.co.za
Building R6, Pinelands Site, Ardeer Rd, Modderfontein, 1645. P O Box 422, Modderfontein 1645

Building R6, Pinelands Site, Ardeer Rd, Modderfontein, 1645. P O Box 422, Modderfontein 1645

Your Reference: Order no. **4542738978**

Our Reference: **LES1072M** Quotation 23/QF3942/hy

Enquiries: H. M. Yingwani
Cell: 083 402 4436
E-mail: hlayiseka@levego.co.za

Date: 27 March 2024

SOUTH 32 HOTAZEL MANGANESE MINES (PTY) LTD
MAMATWAN MINE
PO BOX 506
HOTAZEL
SOUTH AFRICA

Attention: Ms Jo'lene Booysen

Dear Madam,

REPORT No: 23/R2467 – STACK EMISSION MEASUREMENT SURVEY, SOUTH 32 HOTAZEL MANGANESE MINES (PTY) LTD MAMATWAN

Please find attached our final report for the stack emission measurement survey performed on the various stacks described in this report at South 32 Hotazel Manganese Mines (Pty) Ltd, Mamatwan.

We thank you for this opportunity to be of service, and trust that the attached meets your approval.

If you have any queries, please do not hesitate to contact us at the number provided above.

Yours sincerely,

H. M. Yingwani
Project manager
On behalf of
Levego Environmental Services (Pty) Ltd

TABLE OF CONTENTS

List of abbreviations, acronyms, and symbols (where applicable)	
µg	microgram
ASTM	American Society for Testing and Materials
BDL	below detection limit
DCS	distributed control system
DGM	dry gas meter
ESP	electrostatic precipitator
ISO	International Organisation for Standardisation
kg/Nm^3	kilogram per normalised cubic metre (at NTP)
kPa	kilopascal
LECO	Laboratory Equipment Corporation
LOD	limit of detection
m	metre
m^2	square metre
m^3/s	cubic metre per second
mA	milliampere
mb	millibar
mg/m^3	milligram per cubic metre
mg/Nm^3	milligram per normalised cubic metre (at NTP)
mm	millimetre
N/A	not applicable
N/M	not measured
ng	nanogram
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Technology
Nm^3	normalised cubic metre (at NTP)
NTP	normalised temperature and pressure (273 K and 1013.25 mb)
O_2 ref %	oxygen reference percentage
PLC	programmable logic controller
PM	particulate matter
SCADA	supervisory control and data acquisition
SEM	scanning electron microscope
TOC	total organic carbon
US EPA	United States Environmental Protection Agency
VOC	volatile organic compound

1. INTRODUCTION

Levego Environmental Services was contracted to carry out a stack emission measurement survey to determine the source emissions from the stack installed at the South 32 Hotazel Manganese Mines (Pty) Ltd plant.

The following was understood prior to the commencement of the work; the South 32 Hotazel Manganese Mines (Pty) Ltd staff would ensure that all plant operations were to their satisfaction, including the correct operation of all relevant pollution abatement equipment.

1.1 Scope of work

The table below outlines the scope of work that Levego Environmental Services completed during the stack emission measurement survey.

Table 1: Scope of measurements

Release point	De-dust 1 Stack	De-dust 2 Stack	De-dust 3 Stack	Main Stack
Particulate matter	✓	✓	✓	✓
Water vapour	✓	✓	✓	✓
Oxygen	✓	✓	✓	✓
Carbon dioxide	✓	✓	✓	✓
Volumetric flow rate	✓	✓	✓	✓
Nitrogen oxides	✓	✓	✓	✓
Carbon monoxide	✓	✓	✓	✓
Sulphur dioxide	✓	✓	✓	✓

2. SUMMARY OF TEST PROGRAM: METHOD STATEMENTS AND DEVIATIONS

2.1 Velocity, volume, pressure and temperature

Preliminary measurements, for calculation of the required nozzle size for isokinetic sampling, were determined using sampling and testing procedures as described in ISO 9096:2017(E) "Stationary Source Emissions – Manual Determination of Mass Concentration of Particulate Matter".

Velocity measurements are performed utilising a pitot tube and an inclined manometer. Volume flows are calculated from the average velocity and duct area. Pressure and temperature are measured directly utilising a barometer / manometer combination, and thermocouple, respectively.

2.2 Particulate matter

Particulate matter measurements were determined using sampling and testing procedures as described in ISO 9096:2017(E). "Stationary Source Emissions – Manual Determination of Mass Concentration of Particulate Matter".

High-purity pre-weighed quartz thimbles (30 mm diameter × 100 mm long) and quartz disc filters (47 mm diameter) were used to collect the particulate matter in the flue gas. The quartz filters are capable of withstanding temperatures of up to 800°C without filter media mass loss, and retain 99.9% of particles >0.3 μm.

2.3 Water vapour

Water vapour (H_2O) measurements were determined using sampling and testing procedures as described in US EPA Method 4 "Determination of Moisture Content in Stack Gases".

A gas sample is extracted isokinetically from the stack. H_2O is removed from the sample stream and determined gravimetrically.

2.4 Nitrogen oxides

Nitrogen oxides (NO_x) measurements were determined using sampling and testing procedures as described in US EPA Method 7E "Determination of Nitrogen Oxides Emissions from Stationary Sources (Instrumental Analyser Procedure)".

A sample of the effluent gas is continuously sampled and conveyed to the analyser for measuring the concentration of NO_x, which is the sum of NO and NO_2.

2.5 Oxygen and carbon dioxide

Oxygen (O_2) and carbon dioxide (CO_2) measurements were determined using sampling and testing procedures as described in US EPA Method 3A "Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyser Procedure)".

A sample of the effluent gas is continuously sampled and conveyed to the analyser for measuring the concentration of O_2 and CO_2.

2.6 Carbon monoxide

Carbon monoxide (CO) measurements were determined using sampling and testing procedures as described in US EPA Method 10 "Determination of Carbon Monoxide Emissions from Stationary Sources (Instrumental Analyser Procedure)".

A sample of the effluent gas is continuously sampled and conveyed to the analyser for measuring the concentration of CO.

2.7 Sulphur dioxide (US EPA Method 6)

Sulphur dioxide (SO_2) measurements were determined using sampling and testing procedures as described in US EPA Method 6 "Determination of Sulphur Dioxide Emissions from Stationary Sources".

A gas sample is extracted from the sampling point in the stack. The SO_2 and sulphur trioxide (SO_3), including those fractions in any sulphur acid mist, are separated. The SO_2 fraction is measured, *via* concentration of sulphate anion (SO_4^{2-}), by the barium-thorin titration method.

2.8 Sulphur dioxide (US EPA Method 6C)

Sulphur dioxide (SO_2) measurements were determined using sampling and testing procedures as described in US EPA Method 6C "Determination of Sulphur Dioxide Emissions from Stationary Sources (Instrumental Analyser Procedure)".

The effluent gas is continuously sampled and then conveyed to an analyser that measures the concentration of SO_2.

2.9 Key personnel

The project manager on this project was Hlayiseka Yingwani.

Team 1 consisted of Rolphy Vuma (team leader), Tinyiko Chauke and Lesiba Masemola (sampling assistants).

3. MEASUREMENT AND SAMPLING LOCATIONS

3.1 General requirements for sampling locations

ISO 9096:2017(E) requires that the following criteria must be met:

a) the angle of gas flow is less than 15° with regard to the duct axis;

b) no local negative flow is present;

c) the minimum velocity is higher than the detection limit of the method used for the flow rate measurement (for pitot tubes, a differential pressure larger than 5 Pa);

d) the ratio of the highest to the lowest local gas velocities is less than 3:1.

If the above requirements are not met the uncertainty of measurement will be higher than that specified by ISO 9096:2017(E) and the sampling location will not be in compliance.

The above requirements are generally fulfilled in sections of duct with at least five hydraulic diameters of straight duct upstream of the sampling plane, and two hydraulic diameters downstream of the sampling plane (five hydraulic diameters from the top of a stack).

3.2 De-dust 1 Stack

The sampling position was located on the vertical circular stack. The table below details the sampling port specifications.

Table 2: De-dust 1 Stack, Compliance with ISO 9096:2017 general requirements

Height above ground level	~10 metres
Stack diameter	1.75 metres
Distance from sampling ports to downstream stack exit	~12 metres
Distance from sampling ports to upstream disturbance	~5 metres
Number of sampling ports	2
90° angle	Yes
Sampling port size	80 mm
ISO 9096:2017(E) a)	Yes
ISO 9096:2017(E) b)	Yes
ISO 9096:2017(E) c)	Yes
ISO 9096:2017(E) d)	Yes

The sampling position does not fulfil the recommendations for the required diameters, but meets a), b), c) and d) of the general requirements. The sampling location is in compliance with the requirements of ISO 9096:2017(E).

The sampling position was deemed to be the most practical position to perform measurements within the requirements of ISO 9096:2017(E), and the limitations of the plant design.

3.3 De-dust 2 Stack

The sampling position was located on the vertical circular stack. The table below details the sampling port specifications.

Table 3: De-dust 2 Stack, Compliance with ISO 9096:2017 general requirements

Height above ground level	~10 metres
Stack diameter	1.86 metres
Distance from sampling ports to downstream stack exit	~10 metres
Distance from sampling ports to upstream disturbance	~5 metres
Number of sampling ports	2
90° angle	Yes
Sampling port size	80 mm
ISO 9096:2017(E) a)	Yes
ISO 9096:2017(E) b)	Yes
ISO 9096:2017(E) c)	Yes
ISO 9096:2017(E) d)	Yes

The sampling position does not fulfil the recommendations for the required diameters, but meets a), b), c) and d) of the general requirements. The sampling location is in compliance with the requirements of ISO 9096:2017(E).

The sampling position was deemed to be the most practical position to perform measurements within the requirements of ISO 9096:2017(E), and the limitations of the plant design.

3.4 De-dust 3 Stack

The sampling position was located on the vertical circular stack. The table below details the sampling port specifications.

Table 4: De-dust 3 Stack, Compliance with ISO 9096:2017 general requirements

Height above ground level	~12 metres
Stack diameter	1,90 metres
Distance from sampling ports to downstream stack exit	~10 metres
Distance from sampling ports to upstream disturbance	~8 metres
Number of sampling ports	2
90° angle	Yes
Sampling port size	90 mm
ISO 9096:2017(E) a)	Yes
ISO 9096:2017(E) b)	Yes
ISO 9096:2017(E) c)	Yes
ISO 9096:2017(E) d)	Yes

The sampling position does not fulfil the recommendations for the required diameters, but meets a), b), c) and d) of the general requirements. The sampling location is in compliance with the requirements of ISO 9096:2017(E).

The sampling position was deemed to be the most practical position to perform measurements within the requirements of ISO 9096:2017(E), and the limitations of the plant design.

3.5 Main Stack

The sampling position was located on the vertical circular stack. The table below details the sampling port specifications.

Table 5: Main Stack, Compliance with ISO 9096:2017 general requirements

Height above ground level	~12 metres
Stack diameter	3.20 metres
Distance from sampling ports to downstream stack exit	~20 metres
Distance from sampling ports to upstream disturbance	~3 metres
Number of sampling ports	2
90° angle	Yes
Sampling port size	85 mm
ISO 9096:2017(E) a)	Yes
ISO 9096:2017(E) b)	Yes
ISO 9096:2017(E) c)	Yes
ISO 9096:2017(E) d)	Yes

The sampling position does not fulfil the recommendations for the required diameters, but meets a), b), c) and d) of the general requirements. The sampling location is in compliance with the requirements of ISO 9096:2017(E).

The sampling position was deemed to be the most practical position to perform measurements within the requirements of ISO 9096:2017(E), and the limitations of the plant design.

4. QUALITY ASSURANCE AND QUALITY CONTROL

4.1 Sample identification

All filters and solutions are labelled using pre-printed adhesive labels. Their identification codes are recorded on site observation sheets prior to the start of each measurement.

If additional samples are taken they are labelled on site at the completion of each measurement. Pre-printed adhesive labels are also used for this purpose.

4.2 Chain of custody

A chain of custody form accompanies the samples as the samples proceed from one measurement site to another.

4.3 Facility accreditation

The relevant accreditation numbers of the service provider undertaking each item of work is shown below.

Table 6: Scope of accreditation

Test parameter	Sampling	Analysis
Volumetric flow rate	ISO 17025:2017 Levego Environmental Services	ISO 17025:2017 Levego Environmental Services
Particulate matter	ISO 17025:2017 Levego Environmental Services	ISO 17025:2017 Levego Environmental Services
Water vapour	ISO 17025:2017 Levego Environmental Services	ISO 17025:2017 Levego Environmental Services
Nitrogen oxides	ISO 17025:2017 Levego Environmental Services	ISO 17025:2017 Levego Environmental Services
Oxygen	ISO 17025:2017 Levego Environmental Services	ISO 17025:2017 Levego Environmental Services
Carbon dioxide	ISO 17025:2017 Levego Environmental Services	ISO 17025:2017 Levego Environmental Services
Carbon monoxide	ISO 17025:2017 Levego Environmental Services	ISO 17025:2017 Levego Environmental Services
Sulphur dioxide	ISO 17025:2017 Levego Environmental Services	ISO 17025:2017 Levego Environmental Services

Table 7: Facility accreditation number

Facility	Accreditation number
Levego Environmental Services	SANAS Testing Laboratory T0846

4.4 Sampling equipment

Team 1 used the following sampling equipment:

- Apex Model XC-572 source sampling train (Console Serial Number: 91157 and 809061)
- Dry gas meter: (Serial Number: 00006429 and 1900835)
- Barometer: (Serial Number: DB18)
- Pitot tube: (Serial Number: ST-25 and ST-48)
- Nozzle(s): (Set Number (s): NS10-2 / NS10-3 / NS10-4 / NSE1-2)
- Flue-gas analyser: Seitron Chemist 902 (Serial Number: 1088)

Calibration records are included in the attachment section of this report.

5. RESULTS AND DISCUSSION

5.1 General

Testing only commenced after confirmation was received from the South 32 Hotazel Manganese Mines (Pty) Ltd staff that the plant was stable and operating under normal conditions.

In this report:

- An analyte concentration that was measured to be below the limit of detection for a particular laboratory test method is reported at the limit of detection, unless otherwise indicated. For calculation of a pollutant concentration, the analyte amount is calculated and is then divided by the gas volume sampled.
- Where averages are reported, these are the arithmetic mean, without any other statistical analyses applied.

$$A = \frac{1}{n}\sum_{i=1}^{n} a_i$$

Where:

A = average (arithmetic mean)
n = number of data sets (generally three for this report)
a_i = data set values

5.2 Results

The result summaries are attached as Appendix A to Appendix D.

5.2.1 Measurement Uncertainty

The measurement uncertainties are shown in Appendices E to H. The tables show the averages over three tests of the measured results, the uncertainties in measurement units, and uncertainties as a proportion (%) of the measured values.

5.3 Discussion

5.3.1 Gases

For the gases analysed with an instrumental analyser and not detected (NO_x, CO and SO_2), the results are reported at the detection limit of the instrument.

5.4 Compliance

As set out in the Atmospheric Emission Licence (AEL), supplied by South 32 Mamatwan Hotazel Manganese Mines, license number: NC/AEL/JTG/MAM01/2012, the emission limits are set as presented in the following table and compared with measured values.

Table 8: Compliance table

Substance or mixture of substances		Date to be achieved by:	Emission limit	De-dust 1 Stack test average	De-dust 2 Stack test average	De-dust 3 Stack test average	Main Stack test average
Common name	**Chemical symbol**		**mg/Nm³, 273 K, dry, 101.3 kPa**				
Particulate matter	N/A	01/04/2020	50	30.95	11.22	N/A	**117.13***
			135	N/A	N/A	45.34	N/A
Sulphur dioxide	SO_2	01/04/2020	500	*28.58*	*28.58*	*28.58*	307.10
Nitrogen oxides	NOx	01/04/2020	700	*6.16*	*6.16*	*6.16*	262.73

Note: Italic underlined values are below the LOD of the method of analysis.
***Average concentration exceeds the permissible emission limit.**

6. APPENDICES

Appendix A.1 - Test Results: De-dust 1 Stack - PM, O_2, CO_2, and Test Parameters
Appendix A.2 - Test Results: De-dust 1 Stack - CO, NO_x and SO_2

Appendix B.1 - Test Results: De-dust 2 Stack - PM, O_2, CO_2, and Test Parameters
Appendix B.2 - Test Results: De-dust 2 Stack - CO, NO_x and SO_2

Appendix C.1 - Test Results: De-dust 3 Stack - PM, O_2, CO_2, and Test Parameters
Appendix C.2 - Test Results: De-dust 3 Stack - CO, NO_x and SO_2

Appendix D.1 - Test Results: Main Stack - PM, O_2, CO_2, and Test Parameters
Appendix D.2 - Test Results: Main Stack - CO, NO_x and SO_2

Appendix E - Uncertainties Reporting Summaries – De-dust 1 Stack
Appendix F - Uncertainties Reporting Summaries – De-dust 2 Stack
Appendix G - Uncertainties Reporting Summaries – De-dust 3 Stack
Appendix H - Uncertainties Reporting Summaries – Main Stack

7. ATTACHMENTS

- Proof of delivery
- Test sheets
- Chain of custody sheets and laboratory analysis sheets
- Calibration and verification certificates

We would like to take this opportunity to thank the South 32 Hotazel Manganese Mines (Pty) Ltd personnel that assisted us in the survey. We consider the measurement survey to be successful, and an accurate reflection of the plant conditions at the time of measurement.

Yours sincerely,

PP

M. J. SEKO

Report Writer
Levego Environmental Services

H. M. Yingwani

Approved by (Technical Signatory)
Levego Environmental Services

APPENDICES

Appendix A.1 - Test Results: De-dust 1 Stack – PM, O_2, CO_2, and Test Parameters

TEST RESULTS
SOUTH 32 HOTAZEL MANGANESE MINES (PTY) LTD MAMATWAN
DE-DUST 1 STACK
LES1072M

	DATE	17-Nov-23	17-Nov-23	17-Nov-23	
	TEST START	12:05	13:21	14:40	
	TEST STOP	13:14	14:27	15:45	
	TEST	1	2	3	
PARAMETER	PLANT CONDITIONS	STABLE	STABLE	STABLE	Averages
O_2	% (dry)	20.44	20.47	20.47	20.46
CO	ppm (dry)	*2.00*	*2.00*	*2.00*	*2.00*
CO_2	% (dry)	*0.70*	*0.70*	*0.70*	*0.70*
Dry Gas Density	kg/Nm³	1.29	1.29	1.29	1.29
Barometric Pressure	mb	887.20	887.20	887.20	887.20
Static Pressure	mb	0.59	0.59	0.59	0.59
Absolute Pressure	mb	887.79	887.79	887.79	887.79
Moisture Concentration	%	1.36	1.57	1.71	1.55
Gas Temperature	°C	60.00	60.58	61.00	60.53
Wet Gas Density	kg/Nm³	1.29	1.28	1.28	1.28
Duct Size	m	1.75	1.75	1.75	
Duct Area	m²	2.41	2.41	2.41	
Gas Density	kg/m³	0.92	0.92	0.92	0.92
Dynamic Pressure	mb	0.29	0.29	0.28	0.29
Sample Time	sec	3,600	3,600	3,600	
Gas Velocity	m/s	7.87	7.89	7.87	7.88
Gas Volume Flow (actual)	m³/s (actual)	18.93	18.99	18.93	18.95
Gas Volume Flow NTP (wet)	Nm³/s (wet)	13.60	13.62	13.56	13.59
Gas Volume Flow NTP (dry)	Nm³/s (dry)	13.41	13.40	13.33	13.38
Gas Volume Flow (actual)	m³/h (actual)	68,138	68,359	68,149	68,215
Gas Volume Flow NTP (wet)	Nm³/h (wet)	48,949	49,022	48,810	48,927
Gas Volume Flow NTP (dry)	Nm³/h (dry)	48,284	48,250	47,977	48,170
Nozzle Diameter	mm	7.63	7.63	7.63	
Sampled Volume (dry)	m³	1.29	1.28	1.29	
Sampled Volume NTP (dry)	Nm³	0.93	0.92	0.92	
PM Collected	mg	23.78	34.83	27.13	
PM Concentration (dry)	mg/m³ (dry)	18.37	27.20	21.01	22.19
PM Concentration NTP (dry)	mg/Nm³ (dry)	25.57	37.93	29.34	30.95
Sampled Volume (wet)	m³ (wet)	1.31	1.30	1.31	
Sampled Volume NTP (wet)	Nm³ (wet)	0.94	0.93	0.94	
PM Concentration (wet)	mg/m³ (wet)	18.12	26.78	20.66	21.85
PM Concentration NTP (wet)	mg/Nm³ (wet)	25.22	37.34	28.84	30.47
PM Emission Rate	mg/s	342.91	508.43	391.02	414.12
PM Emission Rate	kg/h	1.23	1.83	1.41	1.49

Isokinetic Rate	%	101	100	101

Appendix A.2 - Test Results: De-dust 1 Stack – CO, NO_x and SO_2

TEST RESULTS SOUTH 32 HOTAZEL MANGANESE MINES (PTY) LTD MAMATWAN DE-DUST 1 STACK LES1072M					
	DATE	17-Nov-23	17-Nov-23	17-Nov-23	
	TEST START	12:05	13:21	14:40	
	TEST STOP	13:14	14:27	15:45	
	TEST	1	2	3	
PARAMETER	PLANT CONDITIONS	STABLE	STABLE	STABLE	Averages
SO_2 Instrumental Analyser Results					
SO_2 Concentration NTP (dry)	mg/Nm³ (dry)	*28.58*	*28.58*	*28.58*	*28.58*
SO_2 Emission Rate	mg/s	*383.33*	*383.06*	*380.90*	*382.43*
SO_2 Emission Rate	kg/h	*1.38*	*1.38*	*1.37*	*1.38*
NOx Concentration NTP (dry)	mg/Nm³ (dry)	*6.16*	*6.16*	*6.16*	*6.16*
NOx Emission Rate	mg/s	*82.59*	*82.53*	*82.06*	*82.39*
NOx Emission Rate	kg/h	*0.30*	*0.30*	*0.30*	*0.30*
CO Concentration NTP (dry)	mg/Nm³ (dry)	*2.50*	*2.50*	*2.50*	*2.50*
CO Emission Rate	mg/s	*33.52*	*33.50*	*33.31*	*33.44*
CO Emission Rate	kg/h	*0.12*	*0.12*	*0.12*	*0.12*

Isokinetic Rate	%	101	100	101

Italic, underlined values are below the detection limit.

Appendix B.1 - Test Results: De-dust 2 Stack – PM, O_2, CO_2, and Test Parameters

TEST RESULTS SOUTH 32 HOTAZEL MANGANESE MINES (PTY) LTD MAMATWAN DE-DUST 2 STACK LES1072M					
	DATE	08-Dec-23	08-Dec-23	08-Dec-23	
	TEST START	12:49	14:31	15:50	
	TEST STOP	13:55	15:36	16:55	
	TEST	1	2	3	
PARAMETER	PLANT CONDITIONS	Stable	Stable	Stable	Averages
O_2	% (dry)	20.55	20.49	20.49	20.51
CO	ppm (dry)	*2.00*	*2.00*	*2.00*	*2.00*
CO_2	% (dry)	*0.70*	*0.70*	*0.70*	*0.70*
Dry Gas Density	kg/Nm³	1.29	1.29	1.29	1.29
Barometric Pressure	mb	887.40	887.40	887.40	887.40
Static Pressure	mb	0.59	0.59	0.59	0.59
Absolute Pressure	mb	887.99	887.99	887.99	887.99
Moisture Concentration	%	1.79	1.68	1.85	1.78
Gas Temperature	°C	70.08	70.33	69.75	70.06
Wet Gas Density	kg/Nm³	1.28	1.28	1.28	1.28
Duct Size	m	1.86	1.86	1.86	
Duct Area	m²	2.72	2.72	2.72	
Gas Density	kg/m³	0.90	0.89	0.90	0.90
Dynamic Pressure	mb	0.47	0.46	0.46	0.46
Sample Time	sec	3,600	3,600	3,600	
Gas Velocity	m/s	10.23	10.18	10.15	10.18
Gas Volume Flow (actual)	m³/s (actual)	27.79	27.65	27.57	27.67
Gas Volume Flow NTP (wet)	Nm³/s (wet)	19.38	19.27	19.25	19.30
Gas Volume Flow NTP (dry)	Nm³/s (dry)	19.03	18.95	18.89	18.96
Gas Volume Flow (actual)	m³/h (actual)	100,033	99,539	99,254	99,608
Gas Volume Flow NTP (wet)	Nm³/h (wet)	69,766	69,371	69,290	69,476
Gas Volume Flow NTP (dry)	Nm³/h (dry)	68,517	68,203	68,007	68,242
Nozzle Diameter	mm	6.48	6.48	6.48	
Sampled Volume (dry)	m³	1.20	1.20	1.18	
Sampled Volume NTP (dry)	Nm³	0.84	0.84	0.82	
PM Collected	mg	8.89	11.92	7.25	
PM Concentration (dry)	mg/m³ (dry)	7.39	9.95	6.14	7.83
PM Concentration NTP (dry)	mg/Nm³ (dry)	10.59	14.28	8.79	11.22
Sampled Volume (wet)	m³ (wet)	1.23	1.22	1.20	
Sampled Volume NTP (wet)	Nm³ (wet)	0.85	0.85	0.84	
PM Concentration (wet)	mg/m³ (wet)	7.26	9.78	6.03	7.69
PM Concentration NTP (wet)	mg/Nm³ (wet)	10.40	14.03	8.63	11.02
PM Emission Rate	mg/s	201.64	270.45	166.11	212.73
PM Emission Rate	kg/h	0.73	0.97	0.60	0.77

Isokinetic Rate	%	101	101	100

Appendix B.2 - Test Results: De-dust 2 Stack – CO, NO_x and SO_2

TEST RESULTS
SOUTH 32 HOTAZEL MANGANESE MINES (PTY) LTD MAMATWAN
DE-DUST 2 STACK
LES1072M

	DATE	08-Dec-23	08-Dec-23	08-Dec-23	
	TEST START	12:49	14:31	15:50	
	TEST STOP	13:55	15:36	16:55	
	TEST	1	2	3	
PARAMETER	PLANT CONDITIONS	Stable	Stable	Stable	Averages
SO_2 Instrumental Analyser Results					
SO_2 Concentration NTP (dry)	mg/Nm³ (dry)	*28.58*	*28.58*	*28.58*	*28.58*
SO_2 Emission Rate	mg/s	*543.96*	*541.47*	*539.92*	*541.78*
SO_2 Emission Rate	kg/h	*1.96*	*1.95*	*1.94*	*1.95*
NOx Concentration NTP (dry)	mg/Nm³ (dry)	*6.16*	*6.16*	*6.16*	*6.16*
NOx Emission Rate	mg/s	*117.19*	*116.66*	*116.32*	*116.72*
NOx Emission Rate	kg/h	*0.42*	*0.42*	*0.42*	*0.42*
CO Concentration NTP (dry)	mg/Nm³ (dry)	*2.50*	*2.50*	*2.50*	*2.50*
CO Emission Rate	mg/s	*47.57*	*47.35*	*47.21*	*47.38*
CO Emission Rate	kg/h	*0.17*	*0.17*	*0.17*	*0.17*

Isokinetic Rate	%	101	101	100

Italic, underlined values are below the detection limit.

Appendix C.1 - Test Results: De-dust 3 Stack – PM, O_2, CO_2, and Test Parameters

TEST RESULTS SOUTH 32 HOTAZEL MANGANESE MINES (PTY) LTD MAMATWAN DE-DUST 3 STACK LES1072M					
	DATE	20-Feb-24	20-Feb-24	20-Feb-24	
	TEST START	12:20	13:40	15:00	
	TEST STOP	13:23	14:42	16:03	
	TEST	1	2	3	
PARAMETER	PLANT CONDITIONS	STABLE	STABLE	STABLE	Averages
O_2	% (dry)	20.72	20.74	20.72	20.73
CO	ppm (dry)	*2.00*	*2.00*	*2.00*	*2.00*
CO_2	% (dry)	*0.70*	*0.70*	*0.70*	*0.70*
Dry Gas Density	kg/Nm³	1.29	1.29	1.29	1.29
Barometric Pressure	mb	899.00	899.00	899.00	899.00
Static Pressure	mb	-1.08	-1.08	-1.08	-1.08
Absolute Pressure	mb	897.92	897.92	897.92	897.92
Moisture Concentration	%	2.05	1.89	2.23	2.06
Gas Temperature	°C	49.83	49.33	50.92	50.03
Wet Gas Density	kg/Nm³	1.28	1.28	1.28	1.28
Duct Size	m	1.90	1.90	1.90	
Duct Area	m²	2.84	2.84	2.84	
Gas Density	kg/m³	0.96	0.96	0.96	0.96
Dynamic Pressure	mb	1.74	1.70	1.72	1.72
Sample Time	sec	3,600	3,600	3,600	
Gas Velocity	m/s	19.00	18.81	18.97	18.93
Gas Volume Flow (actual)	m³/s (actual)	53.87	53.34	53.80	53.67
Gas Volume Flow NTP (wet)	Nm³/s (wet)	40.38	40.04	40.18	40.20
Gas Volume Flow NTP (dry)	Nm³/s (dry)	39.55	39.28	39.29	39.37
Gas Volume Flow (actual)	m³/h (actual)	193,948	192,018	193,667	193,211
Gas Volume Flow NTP (wet)	Nm³/h (wet)	145,354	144,131	144,658	144,715
Gas Volume Flow NTP (dry)	Nm³/h (dry)	142,370	141,400	141,440	141,736
Nozzle Diameter	mm	4.52	4.52	4.52	
Sampled Volume (dry)	m³	1.07	1.06	1.07	
Sampled Volume NTP (dry)	Nm³	0.80	0.79	0.80	
PM Collected	mg	39.61	36.79	32.05	
PM Concentration (dry)	mg/m³ (dry)	37.05	34.86	29.99	33.97
PM Concentration NTP (dry)	mg/Nm³ (dry)	49.44	46.44	40.15	45.34
Sampled Volume (wet)	m³ (wet)	1.09	1.08	1.09	
Sampled Volume NTP (wet)	Nm³ (wet)	0.82	0.81	0.82	
PM Concentration (wet)	mg/m³ (wet)	36.29	34.19	29.32	33.27
PM Concentration NTP (wet)	mg/Nm³ (wet)	48.42	45.56	39.26	44.41
PM Emission Rate	mg/s	1,955.22	1,823.88	1,577.52	1,785.54
PM Emission Rate	kg/h	7.04	6.57	5.68	6.43

Isokinetic Rate	%	99	99	100

Appendix C.2 - Test Results: De-dust 3 Stack – CO, NO_x and SO_2

TEST RESULTS SOUTH 32 HOTAZEL MANGANESE MINES (PTY) LTD MAMATWAN DE-DUST 3 STACK LES1072M					
	DATE	20-Feb-24	20-Feb-24	20-Feb-24	
	TEST START	12:20	13:40	15:00	
	TEST STOP	13:23	14:42	16:03	
	TEST	1	2	3	
PARAMETER	PLANT CONDITIONS	STABLE	STABLE	STABLE	Averages
SO_2 Instrumental Analyser Results					
SO_2 Concentration NTP (dry)	mg/Nm³ (dry)	*28.58*	*28.58*	*28.58*	*28.58*
SO_2 Emission Rate	mg/s	*1,130.28*	*1,122.59*	*1,122.90*	*1,125.26*
SO_2 Emission Rate	kg/h	*4.07*	*4.04*	*4.04*	*4.05*
NOx Concentration NTP (dry)	mg/Nm³ (dry)	*6.16*	*6.16*	*6.16*	*6.16*
NOx Emission Rate	mg/s	*243.51*	*241.85*	*241.92*	*242.43*
NOx Emission Rate	kg/h	*0.88*	*0.87*	*0.87*	*0.87*
CO Concentration NTP (dry)	mg/Nm³ (dry)	*2.50*	*2.50*	*2.50*	*2.50*
CO Emission Rate	mg/s	*98.84*	*98.17*	*98.20*	*98.40*
CO Emission Rate	kg/h	*0.36*	*0.35*	*0.35*	*0.35*

Isokinetic Rate	%	99	99	100

Italic, underlined values are below the detection limit.

Appendix D.1 - Test Results: Main Stack – PM, O_2, CO_2, and Test Parameters

TEST RESULTS SOUTH 32 HOTAZEL MANGANESE MINES (PTY) LTD MAMATWAN MAIN STACK LES1072M					
	DATE	05-Dec-23	05-Dec-23	05-Dec-23	
	TEST START	15:01	16:30	17:51	
	TEST STOP	16:05	17:34	18:55	
	TEST	1	2	3	
PARAMETER	PLANT CONDITIONS	STABLE	STABLE	STABLE	Averages
O_2	% (dry)	18.85	18.82	19.04	18.90
CO	ppm (dry)	48,641.33	43,556.31	18,448.63	36,882.09
CO_2	% (dry)	3.32	3.20	2.92	3.14
Dry Gas Density	kg/Nm³	1.31	1.31	1.31	1.31
Barometric Pressure	mb	887.20	887.20	887.20	887.20
Static Pressure	mb	-1.37	-1.37	-1.37	-1.37
Absolute Pressure	mb	885.83	885.83	885.83	885.83
Moisture Concentration	%	2.25	2.33	2.03	2.20
Gas Temperature	°C	139.83	138.11	138.61	138.85
Wet Gas Density	kg/Nm³	1.30	1.30	1.30	1.30
Duct Size	m	3.20	3.20	3.20	
Duct Area	m²	8.04	8.04	8.04	
Gas Density	kg/m³	0.75	0.75	0.75	0.75
Dynamic Pressure	mb	3.13	3.05	3.07	3.08
Sample Time	sec	3,780	3,780	3,780	
Gas Velocity	m/s	28.88	28.46	28.60	28.65
Gas Volume Flow (actual)	m³/s (actual)	232.30	228.93	230.01	230.41
Gas Volume Flow NTP (wet)	Nm³/s (wet)	134.32	132.93	133.39	133.55
Gas Volume Flow NTP (dry)	Nm³/s (dry)	131.30	129.83	130.68	130.60
Gas Volume Flow (actual)	m³/h (actual)	836,287	824,142	828,031	829,487
Gas Volume Flow NTP (wet)	Nm³/h (wet)	483,567	478,540	480,214	480,774
Gas Volume Flow NTP (dry)	Nm³/h (dry)	472,670	467,394	470,461	470,175
Nozzle Diameter	mm	4.50	4.50	4.50	
Sampled Volume (dry)	m³	1.69	1.68	1.71	
Sampled Volume NTP (dry)	Nm³	0.98	0.98	0.99	
PM Collected	mg	167.07	89.01	88.30	
PM Concentration (dry)	mg/m³ (dry)	98.81	52.97	51.78	67.85
PM Concentration NTP (dry)	mg/Nm³ (dry)	170.89	91.22	89.29	117.13
Sampled Volume (wet)	m³ (wet)	1.73	1.72	1.74	
Sampled Volume NTP (wet)	Nm³ (wet)	1.00	1.00	1.01	
PM Concentration (wet)	mg/m³ (wet)	96.59	51.73	50.73	66.35
PM Concentration NTP (wet)	mg/Nm³ (wet)	167.04	89.09	87.47	114.54
PM Emission Rate	mg/s	22,437.53	11,843.05	11,668.40	15,316.33
PM Emission Rate	kg/h	80.78	42.63	42.01	55.14

Isokinetic Rate	%	100	101	101

Appendix D.2 - Test Results: Main Stack – CO, NO_x and SO_2

TEST RESULTS SOUTH 32 HOTAZEL MANGANESE MINES (PTY) LTD MAMATWAN MAIN STACK LES1072M					
	DATE	05-Dec-23	05-Dec-23	05-Dec-23	
	TEST START	15:01	16:30	17:51	
	TEST STOP	16:05	17:34	18:55	
	TEST	1	2	3	
PARAMETER	PLANT CONDITIONS	STABLE	STABLE	STABLE	Averages
SO_2 Collected	mg	285.25	296.93	321.63	
SO_2 Concentration (dry)	mg/m³ (dry)	168.71	176.69	188.61	178.00
SO_2 Concentration NTP (dry)	mg/Nm³ (dry)	291.77	304.29	325.23	307.10
SO_2 Concentration (wet)	mg/m³ (wet)	164.91	172.57	184.78	174.09
SO_2 Concentration NTP (wet)	mg/Nm³ (wet)	285.19	297.21	318.62	300.34
SO_2 Emission Rate	mg/s	38,308.49	39,506.89	42,501.85	40,105.75
SO_2 Emission Rate	kg/h	137.911	142.225	153.007	144.381
NOx Concentration NTP (dry)	mg/Nm³ (dry)	279.69	251.43	257.08	262.73
NOx Emission Rate	mg/s	36,722.46	32,643.95	33,595.81	34,320.74
NOx Emission Rate	kg/h	132.20	117.52	120.94	123.55
CO Concentration NTP (dry)	mg/Nm³ (dry)	60,785.49	54,430.91	23,054.65	46,090.35
CO Emission Rate	mg/s	7,980,969.64	7,066,849.23	3,012,863.87	6,020,227.58
CO Emission Rate	kg/h	28,731.49	25,440.66	10,846.31	21,672.82

Isokinetic Rate	%	100	101	101

Appendix E: Uncertainties Reporting Summaries – De-dust 1 Stack

AEL Reporting Summaries SOUTH 32 HOTAZEL MANGANESE MINES (PTY) LTD MAMATWAN DE-DUST 1 STACK LES1072M							
Substance or mixture of substances		Concentrations			Emission rate (flux)		
		Average	Uncertainty (95% confidence, k=2)		Average	Uncertainty (95% confidence, k=2)	
Common name	Chemical symbol	mg/Nm³ (dry)	mg/Nm³ (dry)	%	mg/s	mg/s	%
Particulate matter	N/A	30.95	± 1.10	± 3.5	414.12	± 16.34	± 3.9
Carbon dioxide	CO_2	13,744	± 261	± 1.9	183,908	± 4165	± 2.3
Carbon monoxide	CO	*2.50*	*± 0.05*	*± 2.0*	*33*	*± 0.88*	*± 2.6*
Nitrogen oxides	NOx expressed as NO_2	*6.16*	*± 0.13*	*± 2.0*	*82*	*± 2.21*	*± 2.7*

Limit of Quantification (LOQ):

- Where the results are below the laboratory test method's LOQ, they are calculated and reported at the LOQ
- Where the average includes a result from a value below the LOQ, it is shown as *italics*.
- Where the average is of all the results from values below the LOQ, it is shown as *underlined italics*.

Appendix F.: Uncertainties Reporting Summaries – De-dust 2 Stack

AEL Reporting Summaries SOUTH 32 HOTAZEL MANGANESE MINES (PTY) LTD MAMATWAN DE-DUST 2 STACK LES1072M							
Substance or mixture of substances		Concentrations			Emission rate (flux)		
		Average	Uncertainty (95% confidence, k=2)		Average	Uncertainty (95% confidence, k=2)	
Common name	Chemical symbol	mg/Nm³ (dry)	mg/Nm³ (dry)	%	mg/s	mg/s	%
Particulate matter	N/A	11.22	± 0.54	± 4.8	212.73	± 10.86	± 5.1
Carbon dioxide	CO_2	13,744	± 261	± 1.9	260,538	± 5901	± 2.3
Carbon monoxide	CO	*2.50*	*± 0.05*	*± 2.0*	*47*	*± 1.24*	*± 2.6*
Sulphur dioxide (instrumental analyser)	SO_2	*28.58*	*± 0.07*	*± 0.3*	*542*	*± 11.81*	*± 2.2*
Nitrogen oxides	NOx expressed as NO_2	*6.16*	*± 0.13*	*± 2.0*	*117*	*± 3.12*	*± 2.7*

Limit of Quantification (LOQ):

- Where the results are below the laboratory test method's LOQ, they are calculated and reported at the LOQ
- Where the average includes a result from a value below the LOQ, it is shown as *italics*.
- Where the average is of all the results from values below the LOQ, it is shown as *underlined italics*.

Appendix G: Uncertainties Reporting Summaries – De-dust 3 Stack

AEL Reporting Summaries SOUTH 32 HOTAZEL MANGANESE MINES (PTY) LTD MAMATWAN DE-DUST 3 STACK LES1072M							
Substance or mixture of substances		Concentrations			Emission rate (flux)		
		Average	Uncertainty (95% confidence, k=2)		Average	Uncertainty (95% confidence, k=2)	
Common name	Chemical symbol	mg/Nm³ (dry)	mg/Nm³ (dry)	%	mg/s	mg/s	%
Particulate matter	N/A	45.34	± 1.56	± 3.4	1,785.54	± 68.86	± 3.9
Carbon dioxide	CO_2	13,744	± 261	± 1.9	541,127	± 12255	± 2.3
Carbon monoxide	CO	*2.50*	*± 0.05*	*± 2.0*	*98*	*± 2.58*	*± 2.6*
Sulphur dioxide (instrumental analyser)	SO_2	*28.58*	*± 0.07*	*± 0.3*	*1,125*	*± 24.54*	*± 2.2*
Nitrogen oxides	NOx expressed as NO_2	*6.16*	*± 0.13*	*± 2.0*	*242*	*± 6.49*	*± 2.7*

Limit of Quantification (LOQ):

- Where the results are below the laboratory test method's LOQ, they are calculated and reported at the LOQ
- Where the average includes a result from a value below the LOQ, it is shown as *italics*.
- Where the average is of all the results from values below the LOQ, it is shown as *underlined italics*.

Appendix H: Uncertainties Reporting Summaries – Main Stack

AEL Reporting Summaries SOUTH 32 HOTAZEL MANGANESE MINES (PTY) LTD MAMATWAN MAIN STACK LES1072M							
Substance or mixture of substances		Concentrations			Emission rate (flux)		
		Average	Uncertainty (95% confidence, k=2)		Average	Uncertainty (95% confidence, k=2)	
Common name	Chemical symbol	mg/Nm³ (dry)	mg/Nm³ (dry)	%	mg/s	mg/s	%
Particulate matter	N/A	117.13	± 3.96	± 3.4	15,316.33	± 581.61	± 3.8
Carbon dioxide	CO_2	61,730	± 3483	± 5.6	8,062,563	± 182600	± 2.3
Carbon monoxide	CO	46,090.35	± 3449.31	± 7.5	6,020,228	± 157939.61	± 2.6
Nitrogen oxides	NOx expressed as NO_2	262.73	± 5.37	± 2.0	34,321	± 918.61	± 2.7
Sulphur dioxide (wet chemical)	SO_2	307.10	± 10.41	± 3.4	40,105.75	± 1525.42	± 3.8

Limit of Quantification (LOQ):

- Where the results are below the laboratory test method's LOQ, they are calculated and reported at the LOQ
- Where the average includes a result from a value below the LOQ, it is shown as *italics*.
- Where the average is of all the results from values below the LOQ, it is shown as *underlined italics*.

ATTACHMENTS

Building 1, Maxwell Office Park
Magwa Crescent West, Waterfall City
Midrand, 1685
South Africa