AIR QUALITY IMPACT ASSESSMENT

TRANS-CALEDON TUNNEL AUTHORITY & GBN JOINT VENTURE.

MOKOLO CROCODILE WATER AUGMENTATION PROJECT PHASE 2 (MCWAP-2A) – RIVER MANAGEMENT SYSTEM.

CONTRACT NO. 2A-C-PS48-22.

PREPARED FOR:	**GBN-JV & TCTA JOINT VENTURE**
PREPARED BY:	**ENVIRONMENTAL ASSURANCE (PTY) LTD**
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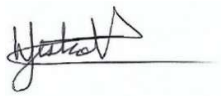
Signature			
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DISCLAIMER

EXECUTIVE SUMMARY

Environmental Assurance (Pty) Ltd. (hereafter referred to as ENVASS) has been appointed by GBN-JV & TCTA Joint Venture (hereafter referred to as GBN-JV) to design, implement and maintain a monthly air quality monitoring programme related to the Phase 2 Mokolo Crocodile Water Augmentation Project (MCWAP-2) – River Management System (hereafter referred to as RMS). The monitoring is implemented to determine an Ambient Air Quality character at three (3) gauging weirs in the Crocodile (west) River. Additionally, to the RMS monitoring, the main focus of the report is to conduct an **Air Quality Impact Assessment** at the three (3) gauging weir localities. Two (2) of the three (3) weirs are located outside Brits, in the North-west province, whilst the remaining one (1) weir is located close to Thabazimbi, in the Limpopo Province.

The report depicts the following:

1. Historic weather data for the site of interest;
2. Discussion on the current ambient air quality condition;
3. The legislative context of impact assessments;
4. Identify possible sources of impacts;
5. Recommendations and management for future construction and operational phases.

Summary of Results

The scope of work performed for the MCWAP-2 is in accordance with Appendix 6 of the Environmental Impact Assessment (EIA) Regulations (2014, as amended), promulgated in terms of Section 24 of the NEMA and the criteria drawn from the Integrated Environmental Management **(**EM) Guidelines Series, Guideline 5: Assessment of Alternatives and Impacts, published by the Department of Environmental Affairs (April 1998). The objective of the report and impact assessment is to identify and assess all the significant impacts that may arise because of the proposed construction and operational phases associated with the MCWAP-2.

It is assumed that the construction phase and to a lesser extent the operational phase of the Weir rehabilitation and re-construction will contribute to the total suspended load in the atmosphere, although off-site impacts are not expected, and the impact is anticipated to be largely concentrated within the construction area. From the current historic weather station data obtained, slightly elevated particulate matter and dust fallout is expected during the construction phase. In order to ensure and prevent this possible outcome, mitigation measures are provided in this report to enable the proposed development to minimise the impact.

The main findings from the impact assessment are as follows:

1. The main sources likely to contribute to cumulative particulate impact are surrounding agricultural activities as well as vehicle entrainment on unpaved road surfaces.

2. The predominant wind direction within the region originated from the East North-east at the Damonsville station and from the North at the Thabazimbi Station.

3. Each Weir locality does have surrounding agricultural / residential receptors.

4. When assessing all available data, it is calculated to have a negligible consequence and a very low to negative significance. The cumulative Impact during the Construction and Operational phases is calculated to be Low.

Additionally, the main activities will result in the following:

1. Construction phase: There is a possibility for elevated off-site dustfall rates, as well as PM10 and PM2.5 concentrations due to the close proximity of the proposed weirs to residential and agricultural areas. The potential exists for exceedances of the residential dustfall limit (600 mg/m^2/day) at the closest residential receptors. With mitigation in place, primarily comprising of water sprays, these impacts would be controlled and brought into compliance.

2. Operational phase: For the operational phase the impact and dust generating activities is reasoned to have little to no effect on the surrounding users. This is primarily due to reduced use of gravel roads and cessation of excavation and infill events, as well as the proposed weirs being in a river which will reduce dust loads.

It is recommended that air quality management measures recommended herein be implemented during the construction and operational phases to ensure the lowest possible impacts on the surrounding environment from proposed weirs occur on the surrounding natural and anthropogenic environments.

A dustfall monitoring network has been established pre-construction to determine baseline and should be continued for the construction phase and for the operational phase to ensure dust levels return to baseline.

The initiation of the dustfall network prior to construction would give an indication of baseline conditions and should be the target dustfall during construction and operational phases through the application of effective mitigation measures. During and after the construction phase management, it will be the responsibility of the Environmental Management team to conduct the dust fallout monitoring.

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GLOSSARY

A list of commonly used acronyms, measurement units and definitions are included below for the purpose of ensuring uniformity in the interpretation of this report.

Table 1: Acronym Table

ACRONYMS	
ASTM	American Society for Testing and Materials
CEMPr	Construction Environmental Management Programme
DFFE	Department of Forestry, Fisheries and the Environment (Previously known as DFFE)
ENVASS	Environmental Assurance (Pty) Ltd
GBN-JV	Gibb Bigen Nyeleti Joint Venture
TCTA	Trans-Caledon Tunnel Authority
NEMA	National Environmental Management Act: Act 109 of 1998.
NEM:AQA	National Environmental Management: Air Quality Act 39 of 2004
PM10	Particulate Matter of less than 10 microns in diameter
AEL	Atmospheric Emissions License
Airshed	Airshed Planning Professionals (Pty) Ltd
mamsl	mean sea level
MES	Minimum Emission Standards
m	metre
m^2	Metre squared
m/s	Metre per second
$mg/m^2/day$	Milligram per metre squared per day
NAAQS	National Ambient Air Quality Standards
NAEIS	National Atmospheric Emissions Inventory System
NDCR	National Dust Control Regulations
NPI	National Pollutant Inventory (Australia)
PM10	Particulate Matter with an aerodynamic diameter of less than 10
PM2.5	Particulate Matter with an aerodynamic diameter of less than 2.5
PV	Photovoltaic
SAAQIS	South African Air Quality Information System
SANS	South African National Standards
Tpa	Tonnes per annum
TSP	Total Suspended Particles
WB	The World Bank
WHO	World Health Organisation
°C	Degrees Celsius
$\mu g/m^3$	Microgram per cubic metre
SANS	South African National Standards

ACRONYMS	
mg/m²/day	Milligram per square meter per day
PPM	Parts per million
µg/m³	Microgram per cubic meter

Table 2: Definition Table

DEFINITIONS	
Ambient air	Outdoor air in the troposphere, excluding air regulated by the relevant national legislation, where air quality is determined in accordance with this standard.
ASTM D1739	Standard test method for the collection measurement of dust fall (settleable particulate matter).
Average period	Period of time over which the average value is determined.
Dust fallout monitoring programme	Means monitoring of gravimetric dust fallout on a continuous basis.
Monthly basis	Period of 30 days (±2 day) as specified by ASTM D1739.
National Dust Control Regulations	Means the National Dust Control regulations, 2013, as published in the Government Gazette (No. 36974) of 1 November 2013 in terms of the National Environmental Management: Air Quality Act 39 of 2004.
Non-residential area	Means any area not classified for residential use as per local town planning scheme.
Residential area	Means any area classified for residential use in terms of the local town planning scheme.
SANS1929: 2011	South African National Standards, Ambient Air Quality – limits for common pollution.

1. INTRODUCTION

Environmental Assurance (Pty) Ltd. (hereafter referred to as ENVASS) has been appointed by Gibb Bigen Nyeleti Joint Venture & Trans-Caledon Tunnel Authority Joint Venture (hereafter referred to as GBN-JV) to design, implement and maintain a monthly air quality monitoring programme related to the Phase 2 Mokolo Crocodile Water Augmentation Project (MCWAP-2) – River Management System (hereafter referred to as RMS). The monitoring is implemented to determine an Ambient Air Quality character at three (3) gauging weirs In the Crocodile (West) River. Additionally, to the "RMS" monitoring, the focus of the report is to conduct an **Air Quality Impact Assessment at the three (3) gauging weir localities.** Two (2) of the three (3) weirs are located outside Brits, in the North-west province, whilst the remaining one (1) weir is located close to Thabazimbi, in the Limpopo Province.

An air quality impact assessment is a systematic process used to evaluate how a specific project, activity, or development might affect the air quality in a particular area. These assessments are commonly conducted for various projects such as industrial facilities, construction projects, transportation developments, and urban planning initiatives. The goal of such an assessment is to identify potential air quality issues, predict the likely impacts, and propose measures to mitigate or minimize these impacts.

Here are the basic steps involved in an air quality impact assessment:

- Project Description: Clearly define the project, including its location, size, and nature. Identify the sources of air pollutants associated with the project.
- Air Quality Character: Measure the existing air quality in the area where the project is planned. This step establishes a baseline to compare against future conditions.
- Emission Inventory: Identify and quantify the pollutants that will be emitted by the project. This includes emissions from vehicles, machinery, industrial processes, etc.
- Impact Prediction: Evaluate the predicted air quality concentrations and compare them with relevant air quality standards and regulations. Determine the potential impact on ambient air quality.
- Mitigation Measures: Recommend measures to mitigate or minimize the adverse air quality impacts. These can include technological improvements, changes in project design, implementation of emission control measures, or changes in project scheduling.
- Monitoring and Compliance: Develop a plan for monitoring air quality during and after project implementation to ensure that the proposed mitigation measures are effective in maintaining acceptable air quality levels.

- Reporting and Documentation: Prepare a comprehensive report detailing the assessment process, findings, methodologies used, and proposed mitigation measures. This report is often submitted to regulatory authorities for approval.

It's important to note that the specific requirements and procedures for an air quality impact assessment may vary depending on local regulations and the nature of the project. Consulting with environmental experts and relevant regulatory authorities is crucial to conducting a thorough and accurate assessment.

2. BACKGROUND

GIBB (Pty) Ltd, Bigen Africa Services (Pty) Ltd, and Nyeleti (Pty) Ltd Joint Venture (GBN-JV) was appointed by the Trans-Caledon Tunnel Authority (the TCTA) for the Consultancy Services for MCWAP-2A RMS. The study area is the reach of the Crocodile River (West) downstream of the Hartbeespoort Dam up to the Vlieëpoort Abstraction Weir. Furthermore, the RMS will also be applicable to the reach of the Moretele River downstream of Klipvoor Dam up to its confluence with the Crocodile River (West), as well as to the reach of the Elands River downstream of Vaalkop Dam up to its confluence with the Crocodile River (West).

The MCWAP-2A will convey 75 million m^3/a from the Crocodile River (West) via a large diameter pipeline to the Lephalale Area from Vlieëpoort south of Thabazimbi. The earlier Mokolo Crocodile River (West) Water Augmentation Project (MCWAP) Feasibility Study concluded that water supply for the MCWAP-2A would be provided primarily from surplus treated wastewater return flows available at Hartbeespoort Dam. The Crocodile River (West) provides the most cost-effective means of conveying this available surplus water from Hartbeespoort Dam to the Proposed Vlieëpoort Diversion Weir near the town of Thabazimbi.

The Feasibility Study also identified the need for the implementation of an RMS in the Crocodile River (West) and some of its tributaries as part of the MCWAP-2A. The RMS is a key component of MCWAP-2A. It will support the efficient operation and functioning of the system, including the effective and efficient management of releases of water from the upstream dams in the Crocodile River (West) Catchment to ensure adequate river flow at Vlieëpoort for the MCWAP-2A, whilst maintaining the Existing Lawful Use (ELU) of water users in the Crocodile River (West) Catchment. Furthermore, the RMS will provide a framework to ensure that the Water Resource Class (further referred to as the Class), the Reserve and Resource Quality Objectives (RQOs) are adhered to as recently gazetted (Government Gazette No. 42775. Government Notice 562 of 2019). The RMS will include the following three (3) river reaches:

- Reach 1: Crocodile River (West), from Hartbeespoort Dam to the downstream Vlieëpoort diversion weir.
- Reach 2: Moretele River downstream of Klipvoor Dam to its confluence with the Crocodile River (West).
- Reach 3: Elands River downstream of Vaalkop Dam to its confluence with the Crocodile River (West).

The RMS will, amongst others, consist of computer models and management systems and will utilise information from its associated infrastructure components. These will include flow gauging stations and abstraction meters to monitor stream flows and water use and abstractions along the Crocodile River (West) and the other river reaches listed above. Critically, these abstractions and the associated impact on available river flows at Vlieëpoort for MCWAP-2A, must be carefully managed, specifically with consideration of the presence of alluvial aquifers adjacent the river channel.

The purpose of the RMS is therefore to ensure that the required flow is maintained at the Proposed Weirs while at the same time allowing the existing lawful users to prevent unauthorised use of the water that is released from the Hartbeespoort Dam, strict control over water abstractions is required.

Eskom Holdings has two (2) power stations, Medupi and Matimba, in the Lephalale Local Municipality (LIM362), which is located within the Waterberg District Municipality (DC36). The power stations are responsible for about 20% of the power capacity of RSA. These power stations run from one water source, the Mokolo River, having the Mokolo dam constructed on it. Demand for water is also expected to increase significantly, due to the environmental requirements of the Department of Forestry, Fisheries and Environment (DFFE) for clean emissions of these power stations. Eskom needs to implement Flue Gas Desulphurisation to clean up the emissions, and this requires water. Water is also required to increase the social requirements, given the current water constraints at the Marapong and Steenbokpan residential areas, and the forecasted population increases envisaged in this area. There is also water earmarked for industrial development, which may include coal, mining and other requirements.

The MCWAP-2 entails the RMS (the construction of gauging weirs), as well as the associated infrastructure and the implementation of measures to mitigate the impact of the project on both the natural and social environment. The objective of the MCWAP-2 is to increase the supply of water to the envisaged developments of the Waterberg area, resulting from growth in energy demand. The Waterberg development is identified as a strategic development node for the country under Strategic Infrastructure Project-1 (SIP-1). This development is expected to result in economic growth, resulting in job creation, tax revenue and an upgraded social infrastructure. Water infrastructure is needed as a catalyst to achieve this social and economic development in the area. The above information was retrieved from the scoping document of the request for proposal.

Figure 1 overleaf represents locality maps of the interested areas, with a) representing the locality map of all three weirs, b) representing the Beestekraal weir, c) representing the Atlanta weir and d) representing the Paul Hugo weir.

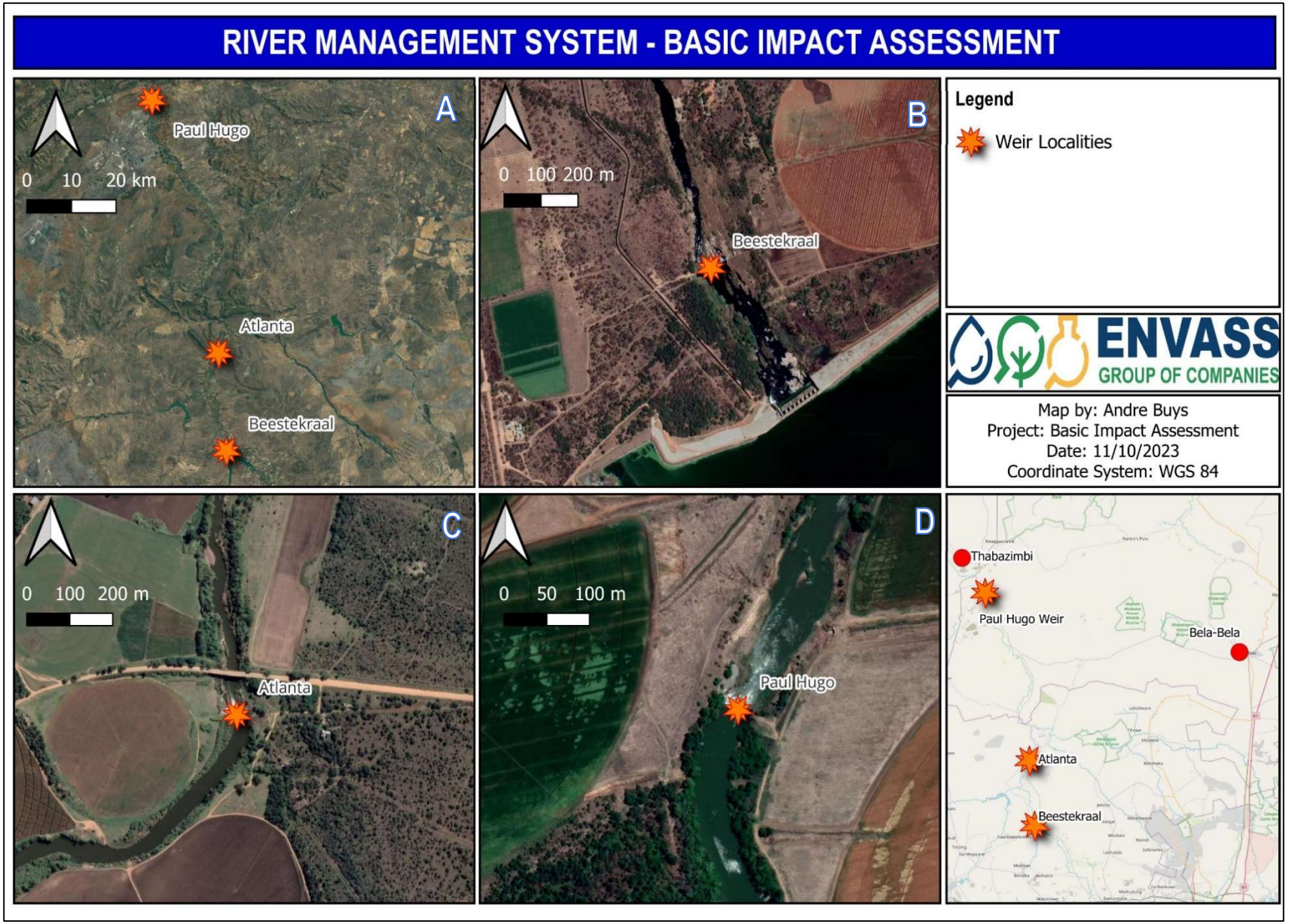

Figure 1: Locality Map of Weir localities

3. LEGISLATIVE CONTEXT AND REFERENCES

Section 28 of the National Environmental Management Act (NEMA), (Act no. 107 of 1998) places a duty of care on any person causing, has caused or may cause significant pollution or degradation of the environment to take reasonable measures to prevent such pollution or degradation from occurring, continuing, or, insofar as such harm to the environment is authorised by law or cannot be reasonably avoided or stopped and rectify such pollution of the environment.

The measures required in terms of subsection (1) may include measures to:

- Investigate, assesses and evaluate the impact on the environment,
- Inform and educate employees on the environmental risk of their work and the manner in which tasks must be performed in order to avoid causing significant pollution or degradation of the environment;
- Cease, modify or control any activity or processes causing pollution or degradation;
- Contain or prevent the movement of pollutants or the cause of degradation;
- Eliminate any source of pollution or degradation; or
- Remedy the effects of pollution or degradation.

3.1 National Air Quality Standards:

The National Environmental Management: Air Quality Act (Act no. 39 of 2004) (AQA) was developed to give effect to NEMA in order to update air quality legislation to comply with general environmental policies and to ensure that the legislation is in line with local and international standards on air quality and air quality management practices. The main objectives of the act are to:

- Enhance and protect air quality;
- Provide reasonable measures and steps to prevent pollution or environmental degradation; and
- To secure sustainable environmental development in conjunction with economic and social development.

In terms of the AQA certain activities and industries, including mining, have the responsibility to:

- Comply with any relevant standards or bylaws;
- Comply with relevant emission standards;
- Comply with the Minister's requirement for the implementation of a pollution prevention plan in respect of a substance declared as a priority air pollutant;
- Comply with an Air Quality Official's legal request for impact reports; and
- Taking reasonable steps to prevent the emission of any offensive odour caused by any activity on their premises.

Guidelines provide a basis for protecting public health from the adverse effects of air pollution and for eliminating or reducing to a minimum, those contaminants of air that are known or likely to be hazardous to human health and well-being (WHO, 2000). The South African Bureau of Standards (SABS), in collaboration with DEA, established ambient air quality standards for criteria pollutants. The National Ambient Air Quality Standards (Republic of South Africa, 2009a and 2012) provide standards for ambient air quality in terms of criteria pollutants and permitted frequency of exceedances.

Air quality guidelines and standards are fundamental to effective air quality management, providing the link between the source of atmospheric emissions and the user of that air at the downstream receptor site. The ambient air quality limits are intended to indicate safe daily exposure levels for the majority of the population, including the very young and the elderly, throughout an individual's lifetime. Air quality guidelines and standards are normally given for specific averaging periods.

The SABS assisted the DEA in the development of ambient air quality standards. National Ambient Air Quality Standards (NAAQS) were determined based on international best practice for PM2.5, PM10, SO2, NO2, ozone (O3), CO, lead (Pb) and benzene. The NAAQS were published in the Government Gazette (no. 32816) on 24 December 2009. The NAAQS are listed in Table 3 below.

Table 3: South African Air Quality Standards (Government Gazette 32816, 2009)

Pollutant	Averaging Period	Limit Value (µg/m³)	Limit Value (ppb)	Frequency of Exceedance (1)	Compliance Date (2)
Benzene	1 year	10	-	0	Immediate – 31 Dec 2014
	1 year	5(b)	-	0	1 Jan 2015
CO	1 hour	30 000	26 000	88	Immediate
	8 hour (c)	10 000	8 700	11	Immediate
NO_2	1 hour	200	106	88	Immediate
	1 year	40	21	0	Immediate
PM10	24 hour	120	-	4	Immediate – 31 Dec 2014
	24 hour	75	-	4	1 Jan 2015
	1 year	50	-	0	Immediate – 31 Dec 2014
	1 year	40	-	0	1 Jan 2015
PM2.5	24 hour	65		4	Immediate – 31 Dec 2015
	24 hour	40	-	4	1 Jan 2016 – 31 Dec 2029
	24 hour	25	-	4	1 Jan 2030
	1 year	25	-	0	Immediate – 31 Dec 2015
	1 year	20	-	0	1 Jan 2016 – 31 Dec 2029
	1 year	15	-	0	1 Jan 2030
SO_2	10 minutes	500	191	526	Immediate
	1 hour	350	134	88	Immediate
	24 hour	125	48	4	Immediate
	1 year	50	19	0	Immediate

Notes:

** The number of averaging periods where exceedance of limit is acceptable.*
***Date after which concentration limits become enforceable.*

3.2 National Regulations for Dust Deposition:

South Africa's Draft National Dust Control Regulations were published on the 27 May 2011 with the dust fallout standards passed and subsequently published on the 1st of November 2013 (Government Gazette No. 36974). These are called the National Dust Control Regulations (NDCR). The purpose of the regulations is to prescribe general measures for the control of dust in all areas including residential and light commercial areas.

Table 4: Four-band scale evaluation criteria for dust deposition (SANS 1929: 2011)

Band Number	Band Description level	Classification	Dust fallout rate (D) (mg/m²/day, 30-day average)	Comment
1	Residential	Ideal	D > 600	Permissible for residential and light commercial
2	Industrial	Acceptable	600 < D < 1200	Permissible for heavy commercial and industrial
3	Action	Tolerable	1200 < D < 2400	Requires investigation and remediation if two sequential months lie in this band, or more than three occur in a year.
4	Alert	Unacceptable	2440 < D	Immediate action and remediation required followed the first incidence of dust fallout rate being exceeded. Incidents report is submitted to the relevant authority.

The National Dust Control Regulations identify the permissible amount of gravimetric dust fallout, as indicated below:

Table 5: Acceptable dust fallout results (GNR 827)

Restriction Areas	Dustfall rate (D) (mg / m² / day, 30-day average)	Permitted frequency of exceeding dust fall rate
Residential Area	D < 600	Two within a year, not sequential months.
Non-residential Area	600 < D < 1200	Two within a year, not sequential months.

4. AIR QUALITY EVALUATION

The baseline evaluation primarily comprises the assessment of near-site surface meteorology and the status quo of the air quality (Petzer, G., p 9).

5.1 Influencing meteorological conditions

Meteorological mechanisms regulate the dispersion, transformation, and eventual removal of pollutants from the atmosphere. The analysis of hourly average meteorological data is necessary to facilitate a comprehensive understanding of the ventilation potential of the site. The vertical distribution air quality pollution is a dominant result of ambient winds. The wind speed determines both the distance of downward transport and the rate of dilution of pollutants. The generation of

mechanical turbulence is similarly a function of the wind speed, in combination with the surface roughness (Petzer, G., 2016, p 9). Meteorological data from the South African Air Quality Information System (SAAQIS) was used in this assessment. The selected data set was downloaded from 01 January 2017 to 01 November 2023. Due to the locations of the weirs, two (2) weather stations will be evaluated, namely1) The Damonsville Weather station near Brits, in close proximity to Weir 1 and 2 which is Beestekraal and Atlanta respectively, and 2) The Thabazimbi Weather station near the Thabazimbi town in close proximity to Weir 3 which is the Paul Hugo weir.

Tables 6 and 7 overleaf summarize the data for the Damonsville and Thabazimbi weather station, respectively. The data set included wind speed, wind direction, temperature, humidity, and rainfall.

Table 6: Damonsville Weather Station Data

Station Name: Damonsville, Type: Average, Time Base: 24 Hour, Period: 01/08/2017 00:00 - 02/11/2023 00:00										
Date Time	Damonsville									
	SO_2	NO_2	NO	NO_X	PM2.5	PM10	Ambient Wind speed	Ambient Wind Direction	Ambient Temp	Rain
	ppb	ppb	ppb	ppb	µg/m3	µg/m3	m/s	Degrees	C°	Mm (total)
Average	2,217	8,387	4,495	12,149	31,58	63,882	1,1	57,95	20,15	3840,6
Standard	11.5	5.7	4.6	9.3	24.9	41.8	0.5	1.4	7.4	
Data Percent	69.1	65.7	68.9	68.9	19.4	19.4	75.2	75.9	78.8	77.5
Number	1725	1640	1720	1720	485	485	1878	1895	1967	1936
Max Date	06/06/2018	13/04/2022	23/06/2019	22/06/2019	08/07/2023	19/07/2023	29/08/2021	08/10/2019	18/02/2018	24/03/2018
Min Date	28/10/2017	19/09/2021	22/06/2020	11/09/2018	11/12/2019	11/12/2019	21/05/2023	08/08/2017	11/07/2023	15/09/2017

Table 7: Thabazimbi Weather Station Data

Station Name: Thabazimbi, Type: Average, Time Base: 24 Hour, Period: 01/01/2017 00:01 - 01/11/2023 00:00										
Date Time	Thabazimbi									
	SO_2	NO_2	NO	NO_X	PM2.5	PM10	Ambient Wind speed	Ambient Wind Direction	Ambient Temp	Rain
	ppb	ppb	ppb	ppb	µg/m3	µg/m3	m/s	Degrees	C°	mm (total)
Average	2,69	7,295	4,453	11,353	24,2	46,042	1,74	359,92	21,85	3290,01
Standard	2.4	6.0	9.4	12.1	19.4	29.8	0.6	1.1	5.2	
Data Percent	89.1	85.5	84.7	86.2	74.8	76.2	94.6	94.6	94.0	94.6
Number	2224	2135	2115	2151	1867	1903	2361	2361	2347	2361
Max Date	16/08/2022	08/05/2021	13/09/2020	13/09/2020	28/05/2022	16/07/2022	07/09/2018	30/08/2022	22/10/2019	29/12/2018
Min Date	09/08/2020	28/08/2020	09/07/2018	27/12/2021	12/10/2021	12/01/2018	01/03/2018	12/01/2018	14/06/2020	01/11/2023

When assessing the information depicted in Table 6 and Table 7, it is evident that the wind originated from the East North-east at the Damonsville station and from the North at the Thabazimbi Station (Figure 2). Both stations had average wind speeds of less than 1,6 m/s which is classified as light air as indicated in Table 8 below. Precipitation represents an effective removal mechanism of atmospheric pollutants and is therefore frequently considered during air pollution studies. Rainfall data was included in the data set provided by SAAQIS. During the period January 2017 and November 2023, an annual average of 760 mm/a, and 650 mm/a was recorded at the Damonsville and Thabazimbi stations, respectively.

Direction	Degree Direction
N	348.75 - 11.25
NNE	11.25 - 33.75
NE	33.75 - 56.25
ENE	56.25 - 78.75
E	78.75 - 101.25
ESE	101.25 - 123.75
SE	123.75 - 146.25
SSE	146.25 - 168.75
S	168.75 - 191.25
SSW	191.25 - 213.75
SW	213.75 - 236.25
WSW	236.25 - 258.75
W	258.75 - 281.25
WNW	281.25 - 303.75
NW	303.75 - 326.25
NNW	326.25 - 348.75

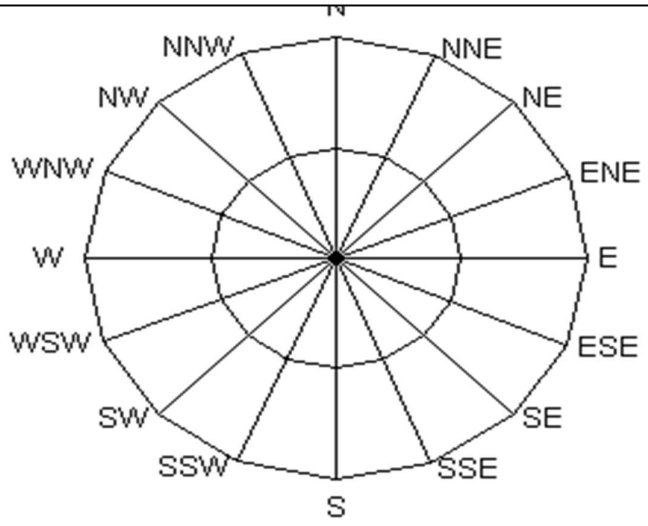

Figure 2: Wind Direction schematic illustration

Table 8: Beaufort Wind Force Scale

Beaufort Wind Force Scale			
Number	**Wind speed (m/s)**	**Description**	**Land Conditions**
0	<0.3 m/s	Calm	Calm. Smoke rises vertically
1	0.3–1.5 m/s	Light air	Wind motion visible in smoke.
2	1.6–3.3 m/s	Light breeze	Wind felt on exposed skin. Leaves rustle.
3	3.4–5.5 m/s	Gentle breeze	Leaves and smaller twigs in constant motion.
4	5.5–7.9 m/s	Moderate breeze	Dust and loose paper raised. Small branches begin to move.
5	8.0–10.7 m/s	Fresh breeze	Branches of a moderate size move. Small trees begin to sway.
6	10.8–13.8 m/s	Strong breeze	Large branches in motion. Whistling heard in overhead wires. Umbrella use becomes difficult. Empty plastic garbage cans tip over.
7	13.9–17.1 m/s	High wind, moderate gale, near gale	Whole trees in motion. Effort needed to walk against the wind. Swaying of skyscrapers may be felt, especially by people on upper floors.
8	17.2–20.7 m/s	Fresh gale	Twigs broken from trees. Cars veer on road.
9	20.8–24.4 m/s	Strong gale	Larger branches break off trees, and some small trees blow over. Construction/temporary signs and barricades blow over. Damage to circus tents and canopies.

Beaufort Wind Force Scale			
Number	Wind speed (m/s)	Description	Land Conditions
10	24.5–28.4 m/s	Whole gale, storm	Trees are broken off or uprooted, saplings bent and deformed, poorly attached asphalt shingles and shingles in poor condition peel off roofs.
11	28.5–32.6 m/s	Violent storm	Widespread vegetation damage. More damage to most roofing surfaces, asphalt tiles that have curled up and/or fractured due to age may break away completely.
12	≥32.7 m/s	Hurricane force	Considerable and widespread damage to vegetation, a few windows broken, structural damage to mobile homes and poorly constructed sheds and barns. Debris may be hurled about.

5.2 Contributing factors

Agricultural activities and vehicle traffic on gravel roads, as well as mining activities, especially towards the Paul Hugo Weir are most likely the largest contributors to particulate emissions in the vicinity.

Particulates represent the main pollutant of concern from the current activities in the region – quarrying operations, existing industrial operations, vehicles and trucks on gravel roads, agricultural field tilling and windblown dust from exposed surfaces. Airborne particulate matter comprises a mixture of organic and inorganic substances, ranging in size, shape and density. These can be divided into Total Suspended Particulates (TSP), thoracic particles or PM10 (particulate matter with an aerodynamic diameter of less than 10 µm) and respirable particles or PM2.5 (particulate matter with an aerodynamic diameter of less than 2.5 µm). PM10 and PM2.5 are associated with health impacts with TSP associated with nuisance dust.

Gaseous emissions derive from the haul trucks, public vehicles, existing industrial operations and domestic fuel burning. These gaseous emissions include primarily sulphur dioxide (SO_2), carbon monoxide (CO), carbon dioxide (CO_2), oxides of nitrogen (NOx) and hydrocarbons. Vehicles on the roads in the town, will also contribute to these gaseous emissions but it is expected that it is not a busy road and therefore the contribution is negligible. Similarly domestic fuel burning can be significant contributors to specifically indoor air pollution (EOH, 2016).

5. QUALITATIVE AIR QUALITY ASSESSMENT

6.1 Construction Phase

Table 9 overleaf provides a list of sources of air pollution associated with the proposed construction activities expected in preparation of the project. The subsequent sections provide a generic description of the parameters influencing particulate emission generation from the various aspects identified.

Table 9: Proposed construction and activities

Proposed Construction	Activity
Beestekraal Weir	
Site Bank Construction	Land clearing activities such as dozing of vegetation and topsoil. Grading of cleared land surfaces. Windblown dust from exposed surface. Vehicle and construction equipment activity on the unpaved roads. Tailpipe emissions from vehicles and construction equipment such as graders, scrapers and dozers.
Erosion Protection	
Proposed rehabilitation works	
Proposed right and left bank access roads	
Refurbishment of Weir	
Atlanta Weir	
Site Bank Construction	Land clearing activities such as dozing of vegetation and topsoil. Grading of cleared land surfaces. Windblown dust from exposed surface. Vehicle and construction equipment activity on the unpaved roads. Tailpipe emissions from vehicles and construction equipment such as graders, scrapers and dozers.
Erosion Protection	
Proposed rehabilitation works	
Proposed right and left bank access roads	
Refurbishment of Weir	
Paul Hugo	
Site Bank Construction	Land clearing activities such as dozing of vegetation and topsoil. Grading of cleared land surfaces. Windblown dust from exposed surface. Vehicle and construction equipment activity on the unpaved roads. Tailpipe emissions from vehicles and construction equipment such as graders, scrapers and dozers.
Erosion Protection	
Proposed rehabilitation works	
Proposed right and left bank access roads	
Gantry construction	

The construction phase normally comprises a series of different operations including land clearing, topsoil removal, road grading, material loading and hauling, stockpiling, compaction, etc. Each of these operations will have their own duration and potential for particulate emission generation. It is anticipated that the extent of dust emissions would vary substantially from day to day depending on the level of activity, the specific operations, and the prevailing meteorological conditions.

Grading and scraping of unpaved road surfaces will give rise to particulate emissions. Graders typically have a blade at the bottom of the equipment removing the top layer of material from the surface. Scrapers work on the same basis but with the blade usually in front. Particulate emissions from graders can be calculated using the US-EPA emission factor for graders and consider the average speed at which it travels (US EPA, 1996).

Clearing of vegetation and topsoil for the infrastructure is likely to be done with bulldozers. The US-EPA equation for particulate emissions, because of bulldozing activities, includes the silt and moisture content of the material (US EPA, 1996).

6.2 Emission Quantification

The below quantification is based on a previous study conducted by Petzer, G., 2016., Report No., 16CES08A. This approach estimates construction emissions for the proposed affected area which is reduced to site specific conditions. Emission factors for heavy construction operations published by the US-EPA (US EPA, 1995), was utilized for the quantification and estimation of dust fallout generation. The approximate emission factors for construction activity operations are given as:

*** ETSP = 2.69 Mg/hectare/month of activity.**

Emissions during the construction can be associated with land clearing, drilling and blasting, ground excavation, cut and fill operations (i.e., earth moving), and construction of a particular facility itself. Dust emissions often vary substantially from day to day, depending on the level of activity, the specific operations, and the prevailing meteorological conditions. A large portion of the emissions results from equipment traffic over temporary roads at the construction site. The temporary nature of construction differentiates it from other fugitive dust sources as to estimation and control of emissions. Construction consists of a series of different operations, each with its own duration and potential for dust generation. In other words, emissions from any single construction site can be expected 1) to have a definable beginning and an end and 2) to vary substantially over different phases of the construction process.

This emission factor is most applicable to construction operations with (i) medium activity levels, (ii) moderate silt contents, and (iii) semi-arid climates and it applies to TSP. Thus, it will result in conservatively high estimates when applied to PM10. Also, because the derivation of the factor assumes that construction activity occurs 30 days per month, it is also regarded as conservatively high for TSP (US EPA, 1995). The emission factor does not provide an indication of which type of activity during construction would result in the highest impacts thus not providing information to develop an effective particulate control plan. For example, secondary particulate sources during construction might be far more significant than the actual on-site construction operations. Such secondary sources may include vehicle activity on off-site roads, quarry operations and stockpiles located away from the actual site (US EPA, 1995; Petzer, G., 2016, p 9).

The total TSP generated during the proposed rehabilitation phase when applying the above-mentioned emission factor is provided in Table 10.

Table 10: Source information and associated emission rates for the construction operations

Facility	Footprint (m²)	Emission rate (tpa)* (mg)
Beestekraal		
All construction work for a period of 3 months	Approximately (3 ha)	20,61
Atlanta		
All construction work for a period of 3 months	Approximately (3 ha)	20,61
Paul Hugo		
All construction work for a period of 3 months	Approximately (3 ha)	20,61

Notes: ***TSP values included in table.*

6.3 Materials handling

The handling of topsoil and gravel for construction operations could be a potential significant source of particulates at the various transfer points. The quantity of particulate emitted depends on various climatic parameters, such as wind speed and precipitation, in addition to non-climatic parameters, such as the nature and volume of the material handled. Fine particulates are most readily disaggregated and released to the atmosphere during the material transfer process, as a result of exposure to strong winds. Increases in the moisture content of the material being transferred will decrease the potential for particulate emission, since moisture promotes the aggregation and cementation of fines to the surfaces of larger particles.

The number of transfer points, the quantify of material, the moisture content of the material and the hourly wind speed will determine the TSP, PM10 and PM2.5 emissions derived from the various transfer points. The construction operations are assumed to be a 12-hour day for 5 days a week, for a total operational period of 3-months.

Materials handling operations can be mitigated through water sprays that can result in a 50% reduction in particulate emissions (NPI, 2011(Petzer, G. 2016, p 9).

6.4 Vehicle entrainment on unpaved roads on-site

Vehicle-entrained particulate emissions from unpaved roads are significant sources of dust, especially where there are high traffic volumes on a road. The force of the wheels travelling on unpaved roads causes the pulverisation of surface material. Particles are lifted and dropped from the rotating wheels, 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 particulate emissions from unpaved roads will vary linearly with the volume of traffic expected on a road.

The magnitude of particulate emissions from paved and unpaved roads is a function of the "silt loading" present on the road surface, and to a lesser extent of the average weight of vehicles travelling on the road (Cowherd and Engelhart,1984; US EPA, 1996). Silt loading refers to the mass of silt-size material (i.e., equal to or less than 75 microns in diameter) per unit area of the travel surface. Silt loading is the product of the silt fraction and the total loading. The amount of particulates (TSP, PM10 and PM2.5) can be estimated using the available EPA emission equations accounting for vehicle weight, number of trips and silt content (US EPA, 2006).

6.5 Windblown particulates

Wind erosion is a complex process, including three different phases of particle entrainment, transport and deposition. It is primarily influenced by atmospheric conditions (e.g., wind, precipitation and temperature), soil properties (e.g., soil texture, composition and aggregation), land-surface characteristics (e.g., topography, moisture, aerodynamic roughness length, vegetation and non-erodible elements), and land-use practice (e.g., farming, grazing and mining) (Shao, 2008).

Windblown particles occur from natural and anthropogenic sources. For wind erosion to occur, the wind speed needs to exceed a certain threshold, called the threshold velocity. This relates to gravity and the inter-particle cohesion that resists removal. Surface properties such as soil texture, soil moisture and vegetation cover influence the removal potential. Conversely, the friction velocity, or wind shear at the surface, is related to atmospheric flow conditions and surface aerodynamic properties. Thus, for particles to become airborne the wind shear at the surface must exceed the gravitational and cohesive forces acting upon them, called the threshold friction velocity (Shao, 2008).

The main sources of windblown particulates associated with the rehabilitation of the proposed project are likely to be, but not limited to topsoil storage piles, and cleared land that would be exposed to wind-blown particulate emissions.

Wind erosion will occur during strong wind conditions when wind speeds exceed the critical threshold required to lift and suspend the particles. This threshold is determined by the parameters that resist removal such as the particle size distribution of the bed material, moisture content and vegetation. A typical wind speed threshold is given as 5.4 m/s for storage piles (US EPA, 1995). Wind data for the sites show an average wind speed of < 1,6 m/s. During high stormy weather periods, a likelihood of wind-blown dust, especially during periods of high wind speeds (more typical in spring and summer) can be expected.

Moisture will act as a binding agent and reduce wind erosion emission by around 50%, depending on the amount of water applied. Alternatives include re-vegetation of temporarily exposed surfaces on which infrastructure will not be constructed (NPI, 2011).

6.6 Qualitative Impact Assessment

The temporary nature of the construction activities, and the likelihood that these activities will be localised and on small areas at any given time, reduces the potential for significant off-site impacts.

The closest residential receptors to the three weirs are summarised in Table 11 overleaf.

Table 11: Sensitive Receptors

Weir	ID	Latitude	Longitude	Description	Distance (m)
Beestekraal	Sensitive Receptor BK 1	-25.397843°	27.574044°	Shongololo Camping Site	630 m
Beestekraal	Sensitive Receptor BK 2	-25.407603°	27.566436°	Thaba lodge	970 m
Beestekraal	Sensitive Receptor BK 3	-25.407523°	27.569801°	Residential Houses (informal)	680 m
Atlanta	Sensitive Receptor AT 1	-25.206677°	27.559716°	Residential Farmhouse	220 m
Atlanta	Sensitive Receptor AT 2	-25.207234°	27.566377°	Residential Houses and Offices	860 m
Atlanta	Sensitive Receptor AT 3	-25.210931°	27.543096°	Residential Farmhouse	1550 m
Paul Hugo	Sensitive Receptor PH 1	-24.693229°	27.400652°	White Silo Guesthouse	830 m
Paul Hugo	Sensitive Receptor PH 2	-24.698166°	27.401296°	Residential Farmhouse	850 m
Paul Hugo	Sensitive Receptor PH 3	-24.693425°	27.395564°	Residential Houses (informal)	1360 m
Paul Hugo	Sensitive Receptor PH 4	-24.694591°	27.389419°	Residential Farmhouse and storage facility	2000 m

All sensitive receptors are more than 200 m from the proposed weirs and construction areas. Windblown particulates may be a problem in this area, but only under conditions of high wind speeds which, based on the historic weather dataset, is only likely to occur for a short duration throughout the year. It is difficult to estimate the distance of impact, but it is deemed that PM10 particles are unlikely to impact on receptors more than 500 meters from the source of emissions. Larger particles of between 10 and 30 µm would settle within 500 m with coarse particles (greater than 30 µm) would deposit within 100 m from the source.

These receptors were considered when the proposed Monitoring programme was established, which is further discussed in Section 6 below.

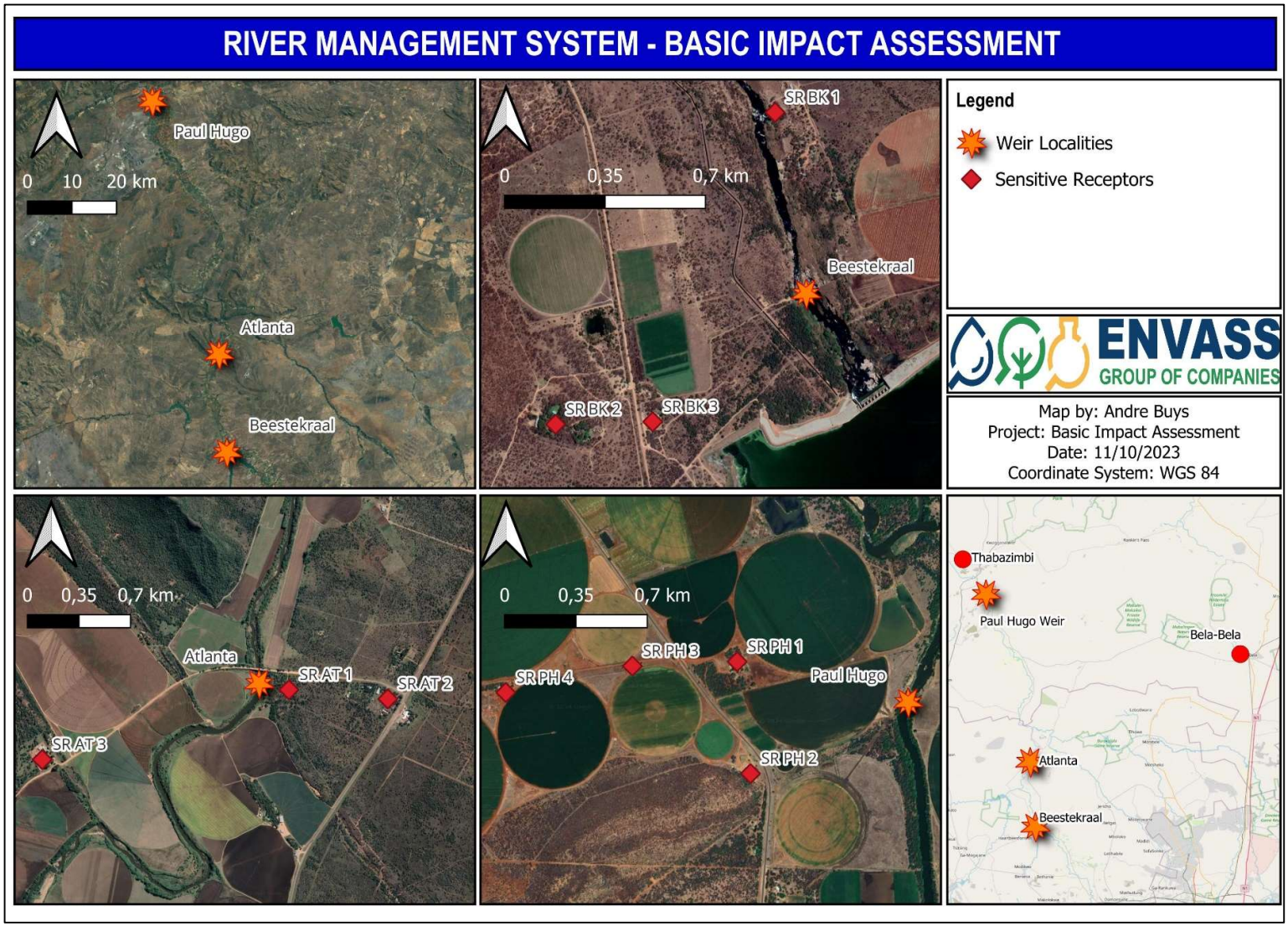

Figure 3: Sensitive Receptors

7 IMPACT ASSESSMENT

7.1 Impact Identification and Assessment Methodology

The objective of the impact assessment is to identify and assess all the significant impacts that may arise as a result of the proposed weirs. The potential impact rating is in accordance with Appendix 6 of the EIA Regulations (2014, as amended), promulgated in terms of Section 24 of the NEMA and the criteria drawn from the IEM Guidelines Series, Guideline 5: Assessment of Alternatives and Impacts, published by the Department of Environmental Affairs (April 1998). The methodology and Criteria were also included in the Tender and Scoping document.

It is crucial to also identify, mitigation measures for each impact in order to determine the significance of the residual impacts (the impact remaining after the mitigation measure has been implemented).

Table 12: Criteria and rating Scales which were used in the Assessment of the Potential Impacts

CRITERIA	RATING SCALES	NOTES
Nature	Positive	An evaluation of the effect of the impact relatedto the proposed development.
	Negative	
Extent	Footprint	The impact only affects the area in which theproposed activity will occur.
	Site	The impact will affect only the developmentarea.
	Local	The impact affects the development area andadjacent properties.
	Regional	The effect of the impact extends beyondmunicipal boundaries.
	National	The effect of the impact extends beyond morethan 2 regional/ provincial boundaries.
	International	The effect of the impact extends beyond countryborders.
Duration	Temporary	The duration of the activity associated with theimpact will last 0-6 months.
	Short term	The duration of the activity associated with theimpact will last 6-18 months.

CRITERIA	RATING SCALES	NOTES
	Medium term	The duration of the activity associated with theimpact will last 18 months-5 years.
	Long term	The duration of the activity associated with theimpact will last more than 5 years.
Severity	High negative	The severity of the impact is rated as High negative as the natural, cultural or social functions and processes are altered to the extent that the natural process will temporarily or permanently cease; and valued, important, sensitive or vulnerable systems or communitiesare substantially affected.
	Moderate negative	The severity of the impact is rated as Moderate negative as the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way; and valued, important, sensitive or vulnerable systems or communities are negatively affected
	Low negative	The severity of the impact is rated as Lownegative as the impact affects the environmentin such a way that natural, cultural and social functions and processes are minimally affected
	Low positive	The severity of the impact is rated as Lowpositive as the impact affects the environment in such a way that natural, cultural and social functions and processes are minimally improved
	Moderate positive	The severity of the impact is rated as Moderate positive as the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way; and valued, important, sensitive or vulnerable systems or communities are positively affected
	High positive	The severity of the impact is rated as High positive as the natural, cultural or social functions and processes are altered to the extent that valued, important, sensitive or vulnerable systems or communities aresubstantially positively affected.
Potential for impact on irreplaceableresources	No	No irreplaceable resources will be impacted.
	Yes	Irreplaceable resources will be impacted.
	Extremely detrimental	
	Highly detrimental	

CRITERIA	RATING SCALES	NOTES
Consequence	Moderately detrimental	A combination of extent, duration, intensity and the potential for impact on irreplaceable resources.
	Slightly detrimental	
	Negligible	
	Slightly beneficial	
	Moderately beneficial	
	Highly beneficial	
	Extremely beneficial	
Probability (the likelihood of the impact occurring)	Unlikely	It is highly unlikely or less than 50 % likely that an impact will occur.
	Likely	It is between 50 and 75 % certain that the impact will occur.
	Definite	It is more than 75 % certain that the impact will occur or it is definite that the impact will occur.
Significance	Very high - negative	A function of Consequence and Probability.
	High - negative	
	Moderate - negative	
	Low - negative	
	Very low	
	Low - positive	
	Moderate - positive	
	High - positive	
	Very high - positive	

Table 13: Explanation of Assessment Criteria

CRITERIA	EXPLANATION
Nature	This is an evaluation of the type of effect (change) the construction, operation and management of the proposed development would have on the affected environment. Will the impact change in the environment be positive, negative or neutral?

CRITERIA	EXPLANATION
Extent or Scale	This refers to the spatial scale at which the impact will occur. Extent of the impact is described as: footprint (affecting only the footprint of the development), site (limited to the site) and regional (limited to the immediate surroundings and closest towns to the site). Extent or scale refers to the actual physical footprint of the impact, not to the spatial significance. It is acknowledged that some impacts, even though they may be of small extent, are of very high importance, e.g. impacts on species of very restricted range. In order to avoid "double counting, specialists have been requested to indicate spatial significance under "intensity" or "impact on irreplaceable resources" but not under "extent" as well.
Duration	The lifespan of the impact is indicated as temporary, short,medium and long term.
Severity	This is a relative evaluation within the context of all the activitiesand the other impacts within the framework of the project. Does the activity destroy the impacted environment, alter its functioning,or render it slightly altered?
Impact on irreplaceableresources	This refers to the potential for an environmental resource to be replaced, should it be impacted. A resource could possibly be replaced by natural processes (e.g., by natural colonization from surrounding areas), through artificial means (e.g. by reseeding disturbed areas or replanting rescued species) or by providing a substitute resource, in certain cases. In natural systems, providingsubstitute resources is usually not possible, but in social systemssubstitutes are often possible (e.g., by constructing new social facilities for those that are lost). Should it not be possible to replace a resource, the resource is essentially irreplaceable e.g., red data species that are restricted to a particular site or habitat ofvery limited extent.
Consequence	The consequence of the potential impacts is a summation of above criteria, namely the extent, duration, intensity and impact on irreplaceable resources.
Probability of occurrence	The probability of the impact occurring based on professional experience of the specialist with environments of a similar nature to the site and/or with similar projects. It is important to distinguish between the probability of the impact occurring and probability that the activity causing a potential impact will occur. Probability is defined as the probability of the impact occurring, not as the probability of the activities that may result in the impact.
Significance	Impact significance is defined to be a combination of the consequence (as described below) and probability of the impact occurring. The relationship between consequence and probability highlights that the risk (or impact significance) must be evaluatedin terms of the seriousness (consequence) of the impact, weighted by the probability of the impact occurring. In simple terms, if the consequence and probability of an impact is high, then the impact will have a high significance. The significance defines the level to which the impact will influence the proposed development and/or environment. It determines whether mitigation measures need to be identified and implemented and whether the impact is important for decision- making.

CRITERIA	EXPLANATION
Degree of confidence inpredictions	Specialists and the EAP team were required to provide an indication of the degree of confidence (low, medium, or high) that there is in the predictions made for each impact, based on the available information and their level of knowledge and expertise. Degree of confidence is not considered in the determination of consequence or probability.
Mitigation measures	Mitigation measures are designed to reduce the consequence or probability of an impact, or to reduce both consequence and probability. The significance of impacts has been assessed both with mitigation and without mitigation.

Table 14 overleaf presents the quantitative criteria that was used to evaluate the perceived direct, indirect and cumulative impacts associated with the proposed weirs.

Table 14: Impact Assessment Criteria and Rating Scales

Duration		Extent		Irreplaceable Resources		Severity		Consequence = (Duration + Extent + Irr) x Severity		Likelihood		Significance = Consequence * Likelihood		Confidence
1	Temporary	1	Footprint	1	Yes	-3	High - negative	-25 to -33	Extremely detrimental	1	Unlikely	-73 to -99	Very high - negative	Low
2	Short term	2	Site	0	No	-2	Moderate - negative	-19 to -24	Highly detrimental	2	Likely	-55 to -72	High - negative	Medium
3	Medium term	3	Local			-1	Low -negative	-13 to -18	Moderately detrimental	3	Definite	-37 to -54	Moderate - negative	High
4	Long term	4	Regional			0	Negligible	-7 to -12	Slightly detrimental			-19 to -36	Low - negative	
		5	National			1	Low -positive	0 to -6	Negligible			0 to -18	Very low - negative	
		6	International			2	Moderate - positive							
						3	High - positive	0 to 6	Negligible			0 to 18	Very Low - positive	
								7 to 12	Slightly beneficial			19 to 36	Low - positive	
								13 to 18	Moderately beneficial			37 to 54	Moderate - positive	
								19 to 24	Highly beneficial			55 to 72	High - positive	
								25 to 33	Extremely beneficial			73 to 99	Very high - positive	

7.2 Ascribing Significance for Decision-Making

The best way of expressing the environmental costs/impacts and the inherent benefit implications fordecision-making is to present them as risks. Risk is defined as the consequence (implication) of an event multiplied by the probability (likelihood)1 of that event. Many risks are accepted or tolerated daily because even if the consequence of the event is serious, the likelihood that the event will occuris low.

Various contingencies are provided to minimise the likelihood of the consequence (serious injury or death) in the event of the parachute not opening, such as a reserve parachute. In risk terms this means distinguishing between the inherent risk (the risk that a parachutist will die if the parachute does not open) and the residual risk (the risk that the parachutist will die if the parachute does not open but with the contingency of a reserve parachute) i.e., the risk before and after mitigation.

7.3 Consequence

The ascription of significance for decision-making becomes then relatively simple. It requires the consequences to be ranked and likelihood to be defined of that consequence. In Table 15, a scoring system for consequence ranking is shown. Two important features should be noted in the table, namely that the scoring doubles as the risk increases and that there is no equivalent 'high' score in respect of benefits as there is for the costs. This high negative score serves to give expression to thepotential for a fatal flaw where a fatal flaw would be defined as an impact that cannot be mitigated effectively and where the associated risk is accordingly untenable. Stated differently, the high scoreon the costs, which is not matched on the benefits side, highlights that such a fatal flaw cannot be 'traded off' by a benefit and would render the proposed project to be unacceptable.

Table 15: Ranking of Consequence

Environmental Cost	Inherent risk
Human health – morbidity / mortality, loss of species	High
Material reductions in faunal populations, loss of livelihoods, individualeconomic loss	Moderate – high
Material reductions in environmental quality – air, soil, water. Loss of habitat, loss of heritage and / or amenity	Moderate
Nuisance	Moderate – low
Negative change – with no other consequences	Low
Environmental Benefits	Inherent benefit
Net improvement in human welfare	Moderate – high
Improved environmental quality – air, soil, water. Improved individuallivelihoods	Moderate
Economic Development	Moderate – Low
Positive change – with no other consequences	Low

7.4 Likelihood

Although the principle is one of probability, the term 'likelihood' is used to give expression to a qualitative rather than quantitative assessment, because the term 'probability' tends to denote a mathematical/empirical expression. A set of likelihood descriptors that can be used to characterise the likelihood of the costs and benefits occurring, is presented in Table 16.

Table 16: Likelihood Categories and Definitions

Likelihood Descriptors	Definitions
Highly unlikely	The possibility of the consequence occurring is negligible
Unlikely but possible	The possibility of the consequence occurring is low but cannot bediscounted entirely
Likely	The consequence may not occur, but a balance of probability suggests it will.
Highly likely	The consequence may still not occur, but it is most likely that it will
Definite	The consequence will occur

It is very important to recognise that the likelihood question is asked twice. The first time the question is asked is the likelihood of the cause and the second as to the likelihood of the consequence. In the tables that follow the likelihood is presented of the cause and then the likelihood of the consequence is presented. A high likelihood of a cause does not necessarily translate into a high likelihood of the consequence. As such the likelihood of the consequence is not a mathematical or statistical 'average' of the causes but rather a qualitative estimate.

7.5 Residual Risk

The residual risk is then determined by the consequence and the likelihood of that consequence. The residual risk categories are shown in Table 17, where consequence scoring is shown in the rows and likelihood in the columns. The implications for decision-making of the different residual risk categories are shown in Table 18.

Table 17: Residual Risk Categories

		Residual risk				
Consequence	High	Moderate	High	High	Fatally flawed	
	Moderate –high	Low	Moderate	High	High	High
	Moderate	Low	Moderate	Moderate	Moderate	Moderate
	Moderate –low	Low	Low	Low	Low	Moderate
	Low	Low	Low	Low	Low	Low
		Highly unlikely	Unlikely but possible	Likely	Highly likely	Definite
		Likelihood				

Table 18: Implications for Decision-Making of the Different Residual Risk Categories

Rating	Nature of implication for Decision – Making
Low	Project can be authorized with low risk of environmental degradation
Moderate	Project can be authorized but with conditions and routine inspections
High	Project can be authorized but with strict conditions and high levels of complianceand enforcement
Fatally Flawed	The project cannot be authorized

7.6 Detailed Impact Assessment

All potential impacts associated with the activities have been categorised according to the respective phases (Construction, rehabilitation and operational) during which they will occur. Impacts associated with Gantry has been outlined below and discussed in terms of their anticipated duration, extent, severity, probability, and significance both prior and post mitigation measures being implemented. It is important to note that two of the Weirs have already been constructed, and the only proposed activity refers to the upgrading construction of the current infrastructure. No decommissioning assessment will form part of the assessment.

7.7 Construction Phase

Please refer below to some of the main impacts that may be experienced during construction.

Table 19: Construction Phase Impact Assessment for the Beestekraal Weir

WEIR REHABILITATION AND CONSTRUCTION – CONSTRUCTION AND MAINTENANCE.				
PROJECT PHASE	*Construction and Maintenance Phase.*			
DIRECT IMPACT	*Land Clearing activities such as dozing and scraping of vegetation and topsoil. This will result in an increase of dust fallout and particulate matter, which may be transported via aeolian processes into the surrounding natural and anthropogenic environments.*			
INDIRECT IMPACT	*Suffocation of plant species within Critical Biodiversity Areas and Ecological Support Areas, as well as an increase in particulate matter generating activities adversely effecting fauna.*			
CUMULATIVE IMPACT	***LOW***			
DIMENSION	**RATING**	**MOTIVATION**	**CONSEQUENCE**	**LIKELIHOOD**
PRE-MITIGATION				
DURATION	1	The duration of the activity associated with the impact is deemed not to last for more than 6 months and is therefore rated as Temporary.	- 3	2
EXTENT	2	The extent of the impact is rated as site as it will affect only the development area.		
SEVERITY	-1	The severity of the impact is rated as Low negative as the impact affects the environment in such a way that natural, cultural and social functions and processes are minimally affected.	Negligible	Likely
IMPACT ON IRREPLACEBLE REOURCES	0	No irreplaceable resources will be impacted.		
SIGNIFICANCE	**- 6**	Very low negative		
PROPOSED MITIGATION MEASURES				

Reduce through controlling measures:

- *Appoint a responsible person, such as an environmental officer or safety, health & environmental manager, to ensure compliance with the EA / EMPr. This person should be responsible for the following:*
  - *ensure compliance with all legislative conditions;*
  - *implementation of all mitigation measures;*
  - *compilation and/or storage of relevant documents (such as maintenance checklists, complaints register, etc.). These documents should be readily available in the event of a site inspection;*
  - *submitting all required reports (e.g., annual report, etc.);*
  - *submitting a summary of complaints (monthly);*
  - *notifying the relevant Licensing Authority when needed;*
- *Undertake/facilitate training for key personnel/contractors or staff to ensure compliance with the internal management plans and conditions.*

- *Submit an application to the relevant Licencing Authority, should any changes be required. The application should be submitted to the relevant licencing authority prior to the changes being made. Any changes to the following will require approval:*
    - *Production processes*
    - *Production increases*
    - *Ownership*
    - *Contact details*
    - *Type and quantities of input materials*
    - *Type and quantities of products*
    - *Production equipment*
    - *Treatment facilities*
    - *Building, plant, site layout or site works*
- *Conduct monitoring (Dust Fallout and PM) and ensure that monitoring is undertaken in accordance with nationally or internationally acceptable methods.*
- *Maintain and report monthly to the Licensing Authority a complaint register. Should a complaint be logged, a report in the required format as per the AEL, should be submitted to the authority.*
- *Should an Environmental Management Programme Report (EMPr) be compiled for the proposed expansion project as part of the EIA process, all recommendations and conditions contained within the EMPr must be implemented and complied with.*

POST-MITIGATION				
DURATION	1	The duration of the activity associated with the impact will last up to 6 months and as such is rated as short term	*-3*	*2*
EXTENT	2	The extent of the impact is rated as footprint as it only affects the area in which the proposed activity will occur		
SEVERITY	-1	The severity of the impact is rated as Low negative as the impact affects the environment in such a way that natural, cultural and social functions and processes are minimally affected.	*Negligible*	*Likely*
IMPACT ON IRREPLACEBLE REOURCES	0	No irreplaceable resources will be impacted.		
SIGNIFICANCE	0	Very low negative		
CONFIDENCE LEVEL				
LOW				

Table 20: Construction Phase Impact Assessment for the Atlanta Weir

WEIR REHABILITATION AND CONSTRUCTION – CONSTRUCTION AND MAINTENANCE.				
PROJECT PHASE	*Construction and Maintenance Phase.*			
DIRECT IMPACT	*Land Clearing activities such as dozing and scraping of vegetation and topsoil. This will result in an increase of dust fallout and particulate matter, which may be transported via aeolian processes into the surrounding natural and anthropogenic environments.*			
INDIRECT IMPACT	*Suffocation of plant species within Critical Biodiversity Areas and Ecological Support Areas, as well as an increase in particulate matter generating activities adversely effecting fauna.*			
CUMULATIVE IMPACT	***LOW***			
DIMENSION	**RATING**	**MOTIVATION**	**CONSEQUENCE**	**LIKELIHOOD**
PRE-MITIGATION				
DURATION	1	The duration of the activity associated with the impact is deemed not to last for more than 6 months and is therefore rated as Temporary.	- 3	2
EXTENT	2	The extent of the impact is rated as site as it will affect only the development area.		
SEVERITY	-1	The severity of the impact is rated as Low negative as the impact affects the environment in such a way that natural, cultural and social functions and processes are minimally affected.	Negligible	Likely
IMPACT ON IRREPLACEBLE REOURCES	0	No irreplaceable resources will be impacted.		
SIGNIFICANCE	**- 6**	Very low negative		
PROPOSED MITIGATION MEASURES				
Reduce through controlling measures: • *Appoint a responsible person, such as an environmental officer or safety, health & environmental manager, to ensure compliance with the EA / EMPr. This person should be responsible for the following:* o *ensure compliance with all legislative conditions;* o *implementation of all mitigation measures;* o *compilation and/or storage of relevant documents (such as maintenance checklists, complaints register, etc.). These documents should be readily available in the event of a site inspection;* o *submitting all required reports (e.g., annual report, etc.);* o *submitting a summary of complaints (monthly);* o *notifying the relevant Licensing Authority when needed;* • *Undertake/facilitate training for key personnel/contractors or staff to ensure compliance with the internal management plans and conditions.*				

- *Submit an application to the relevant Licencing Authority, should any changes be required. The application should be submitted to the relevant licencing authority prior to the changes being made. Any changes to the following will require approval:*
  - *Production processes*
  - *Production increases*
  - *Ownership*
  - *Contact details*
  - *Type and quantities of input materials*
  - *Type and quantities of products*
  - *Production equipment*
  - *Treatment facilities*
  - *Building, plant, site layout or site works*
- *Conduct monitoring (Dust Fallout and PM) and ensure that monitoring is undertaken in accordance with nationally or internationally acceptable methods.*
- *Maintain and report monthly to the Licensing Authority a complaint register. Should a complaint be logged, a report in the required format as per the AEL, should be submitted to the authority.*
- *Should an Environmental Management Programme Report (EMPr) be compiled for the proposed expansion project as part of the EIA process, all recommendations and conditions contained within the EMPr must be implemented and complied with.*

POST-MITIGATION				
DURATION	1	The duration of the activity associated with the impact will last up to 6 months and as such is rated as short term	*-3*	*2*
EXTENT	2	The extent of the impact is rated as footprint as it only affects the area in which the proposed activity will occur		
SEVERITY	-1	The severity of the impact is rated as Low negative as the impact affects the environment in such a way that natural, cultural and social functions and processes are minimally affected.	*Negligible*	*Likely*
IMPACT ON IRREPLACEBLE REOURCES	0	No irreplaceable resources will be impacted.		
SIGNIFICANCE	0	Very low negative		
CONFIDENCE LEVEL				
LOW				

Table 21: Construction Phase Impact Assessment for the Paul Hugo Weir

WEIR REHABILITATION AND CONSTRUCTION – CONSTRUCTION PHASE AND MAINTENANCE.				
PROJECT PHASE	*Construction and Maintenance Phase.*			
DIRECT IMPACT	*Land Clearing activities such as dozing and scraping of vegetation and topsoil. This will result in an increase of dust fallout and particulate matter, which may be transported via aeolian processes into the surrounding natural and anthropogenic environments.*			
INDIRECT IMPACT	*Suffocation of plant species within Critical Biodiversity Areas and Ecological Support Areas, as well as an increase in particulate matter generating activities adversely effecting fauna.*			
CUMULATIVE IMPACT	***LOW***			
DIMENSION	**RATING**	**MOTIVATION**	**CONSEQUENCE**	**LIKELIHOOD**
PRE-MITIGATION				
DURATION	1	The duration of the activity associated with the impact is deemed not to last for more than 6 months and is therefore rated as Temporary.	- 3	2
EXTENT	2	The extent of the impact is rated as site as it will affect only the development area.		
SEVERITY	-1	The severity of the impact is rated as Low negative as the impact affects the environment in such a way that natural, cultural and social functions and processes are minimally affected.	Negligible	Likely
IMPACT ON IRREPLACEBLE REOURCES	0	No irreplaceable resources will be impacted.		
SIGNIFICANCE	**- 6**	Very low negative		
PROPOSED MITIGATION MEASURES				
Reduce through controlling measures: • *Appoint a responsible person, such as an environmental officer or safety, health & environmental manager, to ensure compliance with the EA / EMPr. This person should be responsible for the following:* o *ensure compliance with all legislative conditions;* o *implementation of all mitigation measures;* o *compilation and/or storage of relevant documents (such as maintenance checklists, complaints register, etc.). These documents should be readily available in the event of a site inspection;* o *submitting all required reports (e.g., annual report, etc.);* o *submitting a summary of complaints (monthly);* o *notifying the relevant Licensing Authority when needed;* • *Undertake/facilitate training for key personnel/contractors or staff to ensure compliance with the internal management plans and conditions.*				

- *Submit an application to the relevant Licencing Authority, should any changes be required. The application should be submitted to the relevant licencing authority prior to the changes being made. Any changes to the following will require approval:*
    - *Production processes*
    - *Production increases*
    - *Ownership*
    - *Contact details*
    - *Type and quantities of input materials*
    - *Type and quantities of products*
    - *Production equipment*
    - *Treatment facilities*
    - *Building, plant, site layout or site works*
- *Conduct monitoring (Dust Fallout and PM) and ensure that monitoring is undertaken in accordance with nationally or internationally acceptable methods.*
- *Maintain and report monthly to the Licensing Authority a complaint register. Should a complaint be logged, a report in the required format as per the AEL, should be submitted to the authority.*
- *Should an Environmental Management Programme Report (EMPr) be compiled for the proposed expansion project as part of the EIA process, all recommendations and conditions contained within the EMPr must be implemented and complied with.*

POST-MITIGATION				
DURATION	1	The duration of the activity associated with the impact will last up to 6 months and as such is rated as short term	*-3*	*2*
EXTENT	2	The extent of the impact is rated as footprint as it only affects the area in which the proposed activity will occur		
SEVERITY	-1	The severity of the impact is rated as Low negative as the impact affects the environment in such a way that natural, cultural and social functions and processes are minimally affected.	*Negligible*	*Likely*
IMPACT ON IRREPLACEBLE REOURCES	0	No irreplaceable resources will be impacted.		
SIGNIFICANCE	0	Very low negative		
CONFIDENCE LEVEL				
LOW				

7.8 Operational Phase

It is important to note that the weirs are currently in use. The risk rating for the impact associated with the construction phase is deemed similar and will also have a more minimal impact due to the reduction in on site activities. The following summary highlights the environmental impacts that can be expected during the construction and operational phases:

7.8.1 Particulate Matter

The current dust generating activities at the site include movement of vehicles along the proposed pipeline route. It is important to predict and determine possible areas of emission generation as early identification can help develop mitigation or prevention plans for the specific emission generating activities. A prediction is made possible by using existing examples of emission generating activities on other sites and their effect and measures in place to mitigate. From the activities proposed for this project, the following can be expected to be activities that can cause or lead to the generation of emissions:

Construction Phase where the activities include Rehabilitation and upgrades of the weirs:

- Site establishment including fencing and security;
- Site and vegetation clearing;
- Soil stripping, stockpiling, earthworks and diggings;
- Storage of waste and construction materials;
- Materials transport;
- Foundations and constructions;
- Surfacing;
- Tracked machinery and equipment;
- Heavy mobile vehicles;
- Articulated dump trucks;
- Haul trucks;
- Light motor vehicles;
- Access roads; and
- Materials stockpiles.

From the abovementioned activities, exhaust emissions from construction vehicles and equipment will typically include particulates, such as PM_{10}, carbon monoxide (CO), sulphur dioxide (SO_2) and volatile organic compounds (VOCs). Additionally, disturbance of groundcover caused by groundworks and activities will further impact on particulate matter generation.

Particles can be classified by its aerodynamic properties into coarse particles (gravimetric), PM_{10} (particulate matter with a diameter of less than or equal to 10 microns), PM_4 (particulate matter with a diameter of less than or equal to 4 microns), very fine particles such as $PM_{2.5}$ (particulate matter with a diameter of less than or equal to 2.5 microns) and PM_1 (particulate

matter with a diameter of less than or equal to 1 microns) (Harrison and van Grieken, 1998). The fine particles may contain aerosols such as sulphates and nitrates (they "cling" to particulate matter), combustion particles and/or recondensed organic and metal vapours. The coarse particles contain earth crust materials and fugitive dust from roads and industries (Fenger, 2002).

In terms of health impacts, particulate air pollution effects are broad, but are predominately associated with effects of the respiratory and cardiovascular systems (WHO, 2000). Particle size is important for health because it controls where in the respiratory system a given particle deposits. 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 penetrate deep into the lungs compared to smaller particles (Manahan, 1991).

Larger particles are deposited into the extra thoracic part of the respiratory tract while smaller particles are deposited into the smaller airways leading to the respiratory bronchioles (WHO, 2000). A study by Pope and Burnett (2002) indicated that $PM_{2.5}$ leads to high plaque deposits in arteries, causing vascular inflammation and atherosclerosis (Kaonga and Kgabi, 2009). As yet, no evidence of a threshold in the relationship between particulate concentrations and adverse human health effects have been determined (Burger and Scorgie, 2001; WHO 2005).

- *Short-term (acute) exposure*

Recent studies suggest that short-term exposure to particulate matter leads to adverse health effects, even at low concentrations of exposure (below 100 µg/m^3). Morbidity effects associated with short-term exposure to particulates include increases in lower respiratory symptoms, medication use and small reductions in lung function.

- *Long-term (or chronic) exposure*

Long-term exposure to low concentrations (~10 µg/m^3) of particulates is associated with mortality and other chronic effects such as increased rates of bronchitis and reduced lung function (WHO, 2000). Those most at risk include the elderly, individuals with pre-existing heart or lung disease, asthmatics and children; with an increased risk associated with an increase in exposure (WHO 2005).

Trace gases and aerosols impact the climate through the effect on the radiative balance of the earth. Trace gases such as greenhouse gases absorb and emit infrared radiation which raises the temperature of the earth's surface causing the enhanced greenhouse effect. Aerosol particles have a direct effect by scattering and absorbing solar radiation and an indirect effect by acting as cloud condensation nuclei. Atmospheric aerosol particles range from dust and smoke to mists, smog and haze (IPCC, 2001). Smog and haze are common in regions where certain geographic features, such as mountains, and weather conditions, such as temperature inversions, contribute to the trapping of air pollutants (Kumar and Mohan, 2002). Smog and haze also contribute to visibility degradation through the absorption and scattering of radiation by gases and particulates (Elsom, 1996).

7.9 Dust Management Plan

Based on the qualitative evaluation of the proposed areas, generic management objectives are provided in Table 22. The management and monitoring of all operations at the proposed facility should be evaluated regularly and appropriate actions taken to minimise particulate emissions and impacts and is in line with the National Environmental Management Air Quality Act (Act No. 39 of 2004). A dustfall monitoring network has been established prior to the construction at the weirs, based on the Impact assessment that quantifies the risk and impact of the project. The initiation of the dustfall network prior to construction (12 months) would give an indication of baseline conditions and should be the target dustfall during construction and operational phases through the application of effective mitigation measures. The responsibility of management of the dustfall network could be subcontracted prior to construction. During and after the construction phase management responsibility of the dustfall network can pass to the Site or Environmental Management team.

The dustfall network would ideally use eight dustfall units deployed at or near the property boundary in the cardinal wind directions. Fine particulate monitoring (PM10) would ideally be located at a secure location, with power supply, with easy access, and if possible close to the potential receptors. The dustfall network is further discussed under section 6 below.

Table 22: Proposed Air Quality Management Plan for the proposed construction activities at the Weirs

ASPECT	IMPACT	MANAGEMENT ACTIONS/OBJECTIVES	RESPONSIBLE PERSON(S)	TARGET DATE
Construction of the proposed photovoltaic (solar) energy project				
Land clearing activities such as dozing and scraping of vegetation and topsoil	PM10 and PM2.5 concentrations and dustfall	Water sprays to be applied at the area to be cleared should significantly amounts of dust be generated. Moist topsoil will reduce the potential for dust generation when tipped onto stockpiles. Ensure travel distance between clearing area and topsoil piles to be at a minimum. Keep clearing to a minimum.	Project managers and Contractor(s)	Pre- and during construction
Wind erosion from exposed areas	PM10 and PM2.5 concentrations and dustfall	Ensure exposed areas remain moist through regular water spraying during dry, windy periods. Dust buckets on the boundary should be used to monitor monthly dustfall rates, which should not exceed 1 200 mg/m²/day(a). Dust buckets should monitor dustfall rates further from the construction activities where dustfall rates should not exceed 600 mg/m²/day(b). Speed Restrictions.	Project managers and Contractor(s)	Ongoing and post-operational
Decommissioning phase				
Wind erosion from exposed areas	PM10 concentrations and dustfall	Reshape all disturbed areas to their natural contours. Cover disturbed areas with previously collected topsoil and replant native species.	Project managers and Contractor(s)	Ongoing and post-operational

The risk of dust emissions from a construction site is related to (Holman *et al.*, 2016):

- the activities being undertaken;
- the duration of the activities;

- the size of the site;
- the meteorological conditions;
- the proximity of receptors to the activities;
- the adequacy of the mitigation measures applied to reduce or eliminate dust; and
- the sensitivity of the receptors to dust.

Table 23 provides the criteria used (as stipulated by the Institute of Air Quality Management's (IAQM's)) to determine the dust emission magnitude from a construction site.

Table 23: Dust emission magnitude criteria

Risk	Earthworks	Construction	Trackout
Large	1. Total site area >10000 m². 2. Potentially dusty soil type (e.g., clay). 3. >10 heavy earth moving vehicles active at any one time. 4. Formation of bunds >8m in height. 5. Total material moved >100000 tonnes.	1. Total building volume > 100000m³. 2. On site concrete batching. 3. Sandblasting.	1. > 50 HDV (>3.5t) outward movements in any one day. 2. Potentially dusty surface material (e.g., high clay content) 3. Unpaved road length >100m.
Medium	1. Total site area 2500-10000 m². 2. Moderately dusty soil type (e.g., silt). 3. 3. 5-10 heavy earth moving vehicles active at any one time. 4. Formation of bunds 4-8m in height 5. Total material moved 20000-100000 tonnes.	1. Total building volume 25000- 100000 m³. 2. On site concrete batching. 3. Potentially dusty construction material (e.g., concrete).	1. 10-50 HDV (>3.5t) outward movements in any one day. 2. Moderately dusty surface material (e.g., high clay content). 3. Unpaved road length 50-100m.
Small	1. Total site area < 2500m². 2. Soil type with large grain size (e.g., sand). 3. < 5 heavy earth moving vehicles active at any one time. 4. Formation of bunds < 4m in height. 5. Total material moved < 20000 tonnes.	1. Total building volume < 25000m³. 2. On site concrete batching. 3. Construction material with low potential for dust release (e.g., metal cladding or timber).	1. < 10 HDV (>3.5t) outward movements in any one day. 2. Surface material with low potential for dust release unpaved road length < 50m.

Risk	Earthworks	Construction	Trackout
	6. Earthworks during wetter months.		

Based on the IAQM guidance document for construction operations (Holman *et al*., 2016)(Petzer, G. 2016, p 10), the dust emission magnitude (Table 24) and the sensitivity of the area (low) site-specific mitigation measures for medium risk operations are given in Table 25.

Table 24: Dust emission magnitude

Activity	Dust emission magnitude	Reason for selection
Earthworks	Small	Total site area 440 ha, >10 000 m²
Construction	Small	Total building volume assumed to be >100 000 m³
Trackout	Small	Unpaved road length assumed to be >100 m

Table 25: Highly recommended and desirable mitigation measures for the activities

Mitigation measure	Medium risk operations
Mitigation for all sites: Communications	
Develop and implement a stakeholder communications plan that includes community engagement before work commences on site.	H
Display the name and contact details of person(s) accountable for air quality and dust issues on the site boundary. This may be the environment manager/engineer or the site manager.	H
Display the head or regional office contact information.	D
Mitigation for all sites: Dust management	
Develop and implement a Dust Management Plan (DMP). The level of detail will depend on the risk and should include as a minimum the highly recommended measures in this table. The desirable measures should be included as appropriate for the site.	H
Mitigation for all sites: Dust management – Site management	
Have complaints register on site	H
Record any exceptional incidents that cause dust and/or air emissions, either on- or offsite, and the action taken to resolve the situation in the logbook.	H
Mitigation for all sites: Dust management – Monitoring	
Undertake weekly on-site and off-site inspection, where receptors (including roads) are nearby, to monitor dust, record inspection results, and make the log available to the local authority when asked. This should include regular dust soiling checks of surfaces such as street furniture, cars and windowsills within 100m of site boundary, with cleaning to be provided if necessary.	H
Carry out regular site inspections to monitor compliance with the DMP, record inspection results, and make an inspection log available to the local authority when asked.	H
Increase the frequency of site inspections by the person accountable for air quality and dust issues on site when	D

Mitigation measure	Medium risk operations
activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions.	
Agree dust deposition or real-time PM10 continuous monitoring locations with the Local Authority. Where possible commence baseline monitoring at least three months before work commences on site or, if it a large site, before work on a phase commences.	H
Mitigation for all sites: Dust management – Preparing and maintaining the site	
Plan site layout so that machinery and dust causing activities are located away from receptors, as far as is possible.	H
I feasible, erect solid screens or barriers around dusty activities or the site boundary that are at least as high as any stockpiles on site.	D
Remove materials that have a potential to produce dust from site as soon as possible, unless being re-used on site. If they are being re-used on-site cover as described below.	H
Cover, seed or fence stockpiles to prevent wind whipping.	D
Mitigation for all sites: Dust management – Operating vehicle/machinery and sustainable travel	
Ensure all vehicles switch off engines when stationary - no idling vehicles.	H
Impose and signpost a maximum-speed-limit of 15 mph on surfaced and 10 mph on unsurfaced haul roads and work areas.	H
Mitigation for all sites: Dust management – Operations	
Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g., suitable local exhaust ventilation systems.	H
Ensure an adequate water supply on the site for effective dust/particulate matter suppression/mitigation, using non-potable water where possible and appropriate.	H
Use enclosed chutes and conveyors and covered skips.	H
Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate.	H
Ensure equipment is readily available on site to clean any dry spillages and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods.	H
Mitigation for all sites: Dust management – Waste management	
No fires allowed on site.	H
Measures specific to earthworks	
Re-vegetate earthworks and exposed areas/soil stockpiles to stabilise surfaces as soon as practicable.	D
Only remove the cover in small areas during work and not all at once.	D
Measures specific to construction	
Ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place.	H
For smaller supplies of fine power materials ensure bags are sealed after use and stored appropriately to prevent dust.	D
Measures specific to trackout	
Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable.	H
Implement a hard surfaced haul route or similar, which are regularly damped down with fixed or mobile sprinkler systems, or mobile water bowsers and regularly cleaned that will limit dust generation.	H
Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site where reasonably practicable).	H
Access gates to be located at least 10m from receptors where possible.	H
H – highly recommended **D – desirable**	

8 MONITORING PROGRAMME

The monitoring programme is based on a pro-active approach to assess air quality on a continuous basis, by measuring the air quality levels.

Generated dust can become a nuisance (or health risk) when it is not properly managed and mitigated. Dust can be a concern to the surrounding land users and receiving environment and it is therefore important to determine the potential of dust generated by the activities.

The development and implementation of an air quality monitoring programme is considered to address Sub-Section 1 of the NEMA (Act no. 107 of 1998) Section 28 requirements related to the duty of care and remediation of environmental damage which includes: *"Every person who causes, has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment."*

The SABS, in collaboration with DEA, established ambient air quality standards for criteria pollutants. The National Ambient Air Quality Standards (Republic of South Africa, 2009a and 2012) provide standards for ambient air quality in terms of criteria pollutants and permitted frequency of exceedances.

As construction of the proposed development is expected to give rise to emissions, especially total suspended load in the atmosphere, thus it is recommended that an ambient air quality monitoring programme be implemented during the construction phase. The data can be utilised to record compliance to Government Notice Regulation 827 (published in terms of NEMAQA, Act 39 of 2004) or the SANS 1929:2011 (Ambient Air Quality – limits for common pollution).

The monitoring programme design included a comprehensive desktop review focussed on summarising all required monitoring, analysis and reporting requirements based on the Government Notice 827 (National Dust Control Regulations) of the NEMA (Act no. 39 of 2004), as published in the Government Gazette (No. 36974), 1 November 2013.

8.1 Air quality monitoring, analysis and reporting

It is recommended that the current implemented monitoring programme be *selectively* continued during the construction phase in order to adequately determine possible emission impacts from the activities. It is however additionally recommended that:

- If air nuisance conditions are present or either internal/external complaints received, active indicative monitoring be implemented, and air quality conditions determined.

Table 26 presents the proposed monitoring stations that should continue to be monitored during the construction and operational phases. The points were identified based on the evaluation of the Sensitive Receptors as indicated in Table 11. The monitoring localities is deemed sufficient to adequately measure any impacts on the identified Sensitive Receptors.

Table 26: Proposed Monitoring Locality and Frequency

MONITORING PROGRAMME			
BEESTEKRAAL			
NAME	**LATITUDE**	**LONGITUDE**	**FREQUENCY**
BK DB01	-25,4077	27,57011	Monthly
BK DB02	-25,404	27,57363	Monthly
BK DB03	-25,4037	27,5747	Monthly
BK DB04	-25,4017	27,57441	Monthly
BK DB05	-25,4007	27,57399	Monthly
ATLANTA			
AT DB01	-25,2067	27,559	Monthly
AT DB02	-25,2063	27,558	Monthly
AT DB03	-25,2057	27,55782	Monthly
AT DB04	-25,2063	27,55725	Monthly
AT DB05	-25,2055	27,55712	Monthly
PAUL HUGO			
PH DB01	-24,6948	27,40871	Monthly
PH DB02	-24,6955	27,40828	Monthly
PH DB03	-24,6944	27,40906	Monthly
PH DB04	-24,6937	27,40932	Monthly
PH DB05	-24,6926	27,40978	Monthly

**** E-sampler PM data to be retrieved from a station at each weir and to be reported on monthly***

8.2 Air Quality Analysis Parameters

The rehabilitation of the proposed development will result in increased emissions the following parameters and point source variables have been identified for air quality monitoring taking into consideration proper mitigation measure are implemented to reduce emissions (Table 27).

Table 27: Proposed Air Quality Analysis Package

Proposed Analysis	
Analysis / Parameters	**Frequency**
Insoluble Settleable Particles	To be monitored monthly *within the area where construction is present*.
Particulate Matter (PM): • PM_1; • $PM_{2.5}$; • PM_4; • PM_{10}; and • Total Suspended Particles (TSP).	Additional area assessments to be completed at the construction camp or surrounding communities when nuisance impacts or complaints are noted.

8.3 Reporting

It is recommended that minimum reporting comprise of collated data sheets inclusive of sampling information and analysis results in accordance with the monitored frequency. In order to ensure legal compliance requirements, the following information is recommended to be included into the reporting function:

- Information on the location of sampling sites:
    - Sampling site:
    - Locality name;
    - Latitudinal and longitudinal coordinates,
    - Details of sampling point;
    - Date of sampling;
    - Time of sampling;
    - Name of the sampler;
    - General environment and climatic conditions;
    - Any additional information which will affect the results of the analysis
    - Topographic map and areas (Geographic information System);
- Monitoring protocol and procedures;
- Chain of custody information;
- Analysis and interpretation of the results obtained against applicable limits and comparison against previous and historical results;
- Identification of impact concerns, and problems noted; and

- Identification of trends and abnormalities.

8.4 Summarised Proposed Monitoring Structure and Schedule

The following schedule and programme are currently proposed for the construction phase (Table 28).

Table 28: Proposed Monitoring Schedule

Monitoring Resource	Number of Localities	Proposed Analysis	Frequency
Construction Phase			
Passive Gravimetric Dust Fallout Monitoring	Dust Monitoring Localities be installed as dependant on the current construction area. A minimum of five (5) localities are to be installed and monitored taking into account the four (4) main wind directions (North, East, South and West)	Insoluble Settleable Particles	Monthly
Operational Phase			
Indicative Active Air Quality	Active monitoring to be completed with either a handheld meter or installed E-Sampler as related to the construction camp or surrounding community.	Particulate Matter (PM): • PM 1; • PM 2.5; • PM 4; • PM 10; and • Total Suspended Particles (TSP).	When complaints are received or emission nuisance noted.

8.4.1 Air quality monitoring protocol

In order to ensure proper sample collection and analysis accuracy, field sampling, chain of custody and analysis protocols are provided and described below.

8.4.2 Fieldwork guidelines

According to Government Notice 827 (NEMAQA, act 39 of 2004), dust monitoring should be done in accordance with ASTM D1739-98(2017) Standard Test Method for Collection and Measurement of Dust fall (Settleable Particulate Matter) and the South African National Standards 1929:2011 (Ambient Air Quality – limits for common pollution). Dust buckets of a standard size and shape will be prepared and set up at locations on the borders of the property, relating to the main compass points, so that dust can settle in them for periods of 30+/-2 days. The dust buckets will be sealed on site and sent to a laboratory for analysis. The masses of the water-soluble and –insoluble components of the material collected will then be determined and results will be reported on as mg/m^2/day. This methodology is described according to South African National Standards 1929:2011 and the American Society for Testing and Materials (ASTM) Designation: D 1739-98 (2017). The results for this method of testing are obtained by gravimetric weighing. The apparatus required for this type of monitoring include open-top buckets/containers no less than 150mm in diameter with a height no less than twice its diameter. The buckets must be placed on a stand at a height of 2+/-0.2m above the ground.

8.4.3 Laboratory requirements

All samples should be transported in line with SANAS requirements and submitted to an independent SANAS accredited laboratory (as required by the National Water Act, Act no 36 of 1998) (General Authorisations in terms of Section 39, as amended in 2004) within 48 hours in order to ensure representative chemical and bacteriological quality. It is recommended that a Chain of Custody Procedure (Tracking of samples) related to the collection, transportation and delivery (laboratory) be developed and implemented. Analysis of the samples are done in accordance with the ISO/IEC 17025:2005 standards by an accredited independent laboratory (SANAS) inclusive of:

- Calibration of monitoring equipment and maintenance to ensure accurate data;
- Provide error values in terms of accuracy and precisions of the analytical results; and
- Ensure compliance with applicable legislation, standards and guidelines, including on advising on any changes in legislation.

8.4.4 Passive dust monitoring

Dust buckets of a standard size and shape are prepared and set up at locations within the servitude of the pipeline and ancillary infrastructure, in order for dust to settle for periods of 30 (±2) days. The dust buckets are collected and sealed on-site and sent

to a SANAS accredited laboratory for analysis. The masses of the water-soluble and insoluble components of the material collected are then determined and results are reported as mg/m^2/day. This methodology is described according to South African National Standards 1929:2011 and the American Society for Testing and Materials (ASTM) Designation: D 1739-98 (2017) standards. The results for this method of testing are obtained by gravimetric weighing. The apparatus required for this type of monitoring include open-top buckets/containers no less than 150mm in diameter with a height of no less than twice its diameter. The buckets must be placed on a stand at a height of 2 (±0.2) m above the ground.

Results obtained are evaluated against the four-band scale for dust deposition (SANS 1929:2011) and the National Dust Control Regulation limits (GN827).

8.4.5 Active indicative monitoring

The Met One Instruments, Inc. model E-Sampler is a type of nephelometer that automatically measures and records real-time airborne PM10, PM2.5, or TSP particulate concentration levels using the principle of forward laser light scatter. In addition, the E-Sampler has a built-in 47 mm filter sampler which can optionally be used to collect the particulate for subsequent gravimetric mass or laboratory evaluation.

Laser Light Scatter System

Sample air is drawn into the E-Sampler and through the laser optical module, where the particulate in the sample air stream scatters the laser light through reflective and refractive properties. This scattered light is collected onto a photodiode detector at a near-forward angle, and the resulting electronic signal is processed to determine a continuous, real-time measurement of airborne particulate mass concentrations.

Gravimetric Filter Sampler System

After the sample air stream has been measured by the E-Sampler and exits the optical engine, it passes through the built-in 47 mm filter sampler system. This system allows the particulate to optionally be collected on a filter disc as a second method to obtain airborne particulate mass data, or for laboratory analysis of the particulate. The 47 mm filter system can also be used to determine a gravimetric K-factor (slope multiplier) to correct the E-Sampler real-time signal to match the local particulate type. In this case, a filter disc is weighed on a microbalance before and after being run in the E-Sampler for a period of time. The resulting mass of the dust on the filter is correlated with the concentrations that the E-Sampler recorded over the same time period, and a correction factor is calculated. The E-Sampler can be used with no correction factor in applications where relative particulate trending is appropriate.

Figure 4: Met One Instruments E-Sampler-9800

Additional details of the apparatus:

- Model: E-Sampler-9800;
- Key Features: Real Time Particulate Monitor;
- Description: Particulate and air quality monitoring combined in one instrument.

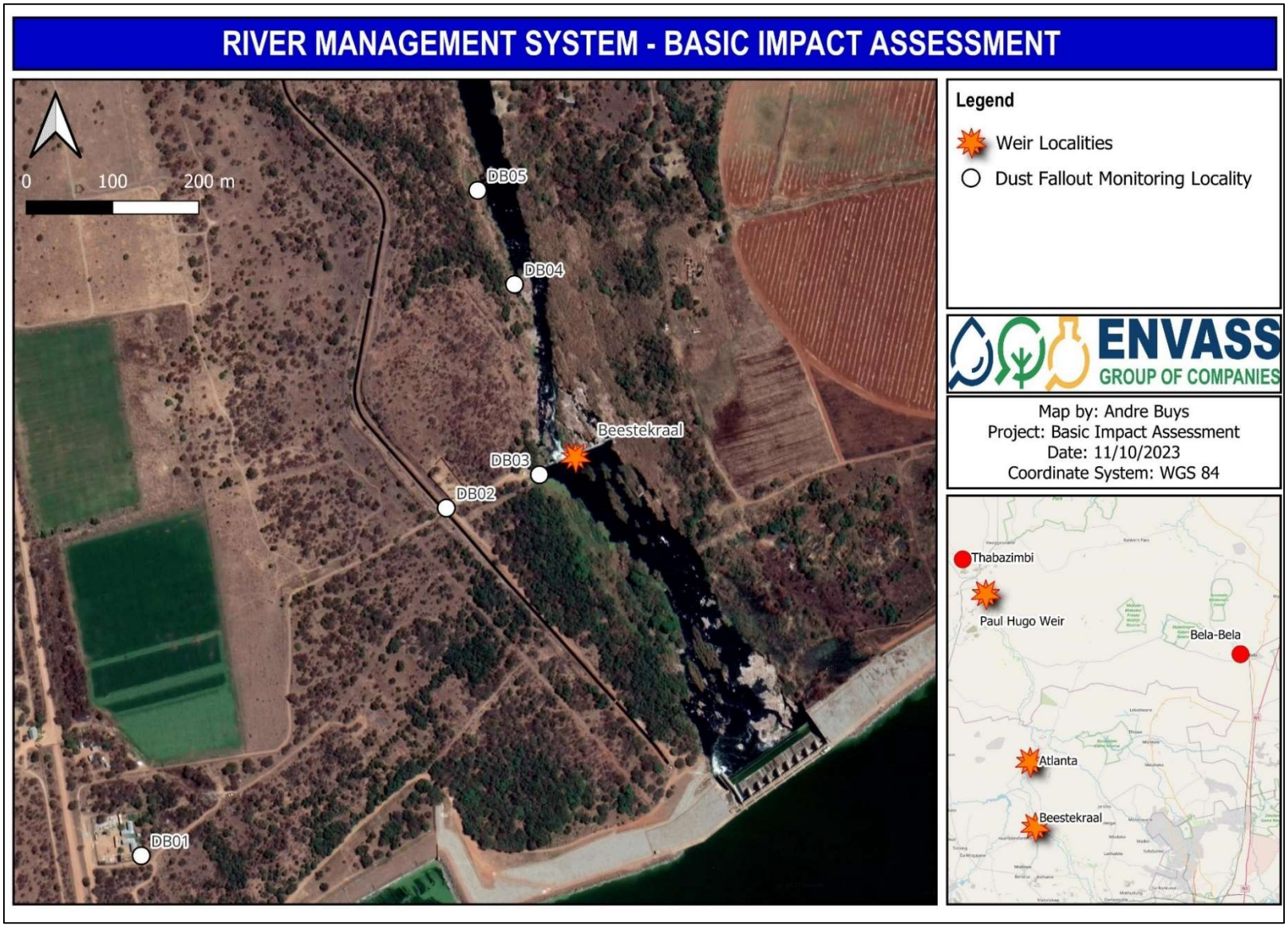

Figure 5: GBN-JV Air Quality Monitoring Localities (Beestekraal)

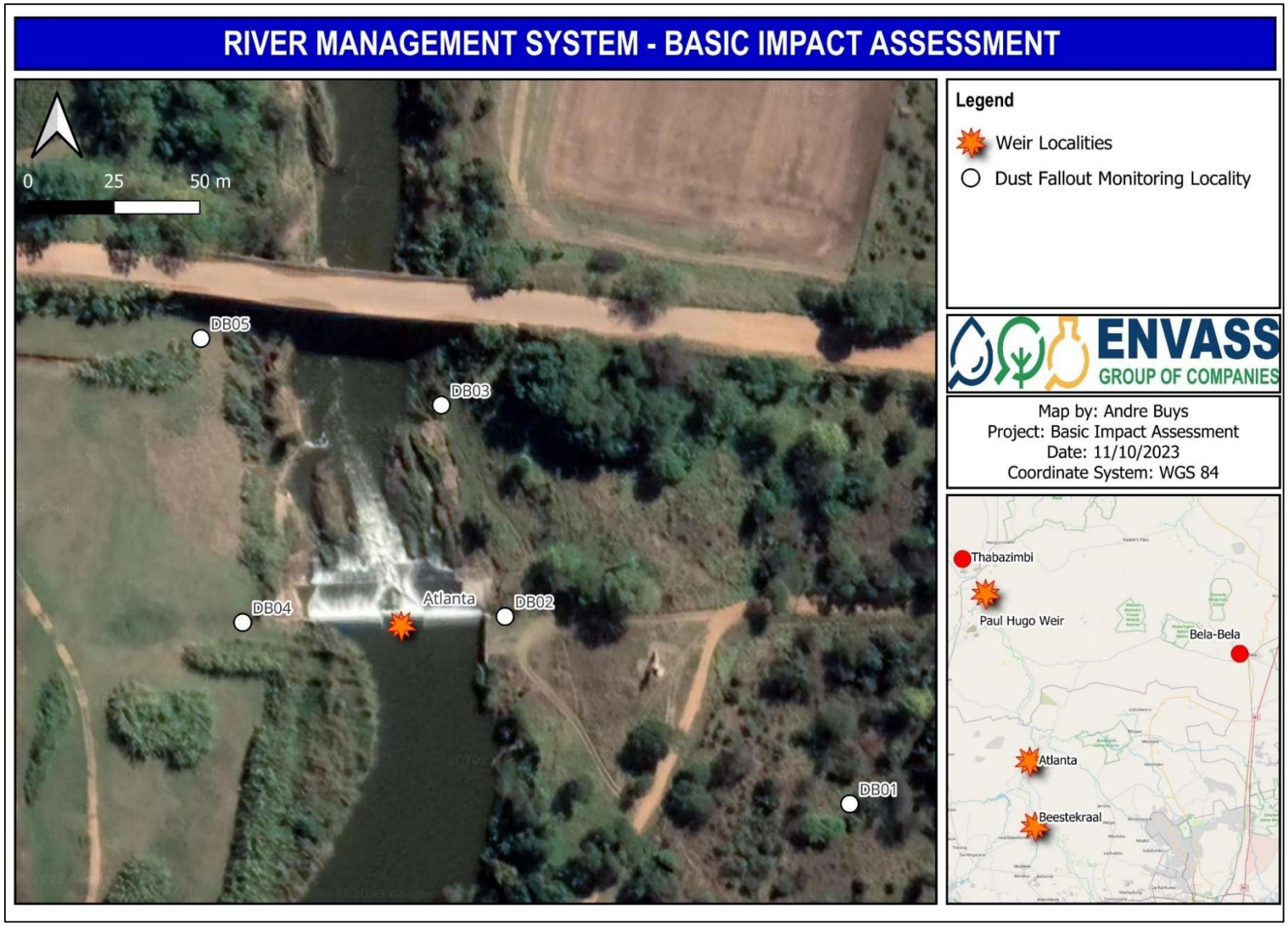

Figure 6: GBN-JV Air Quality Monitoring Localities (Atlanta)

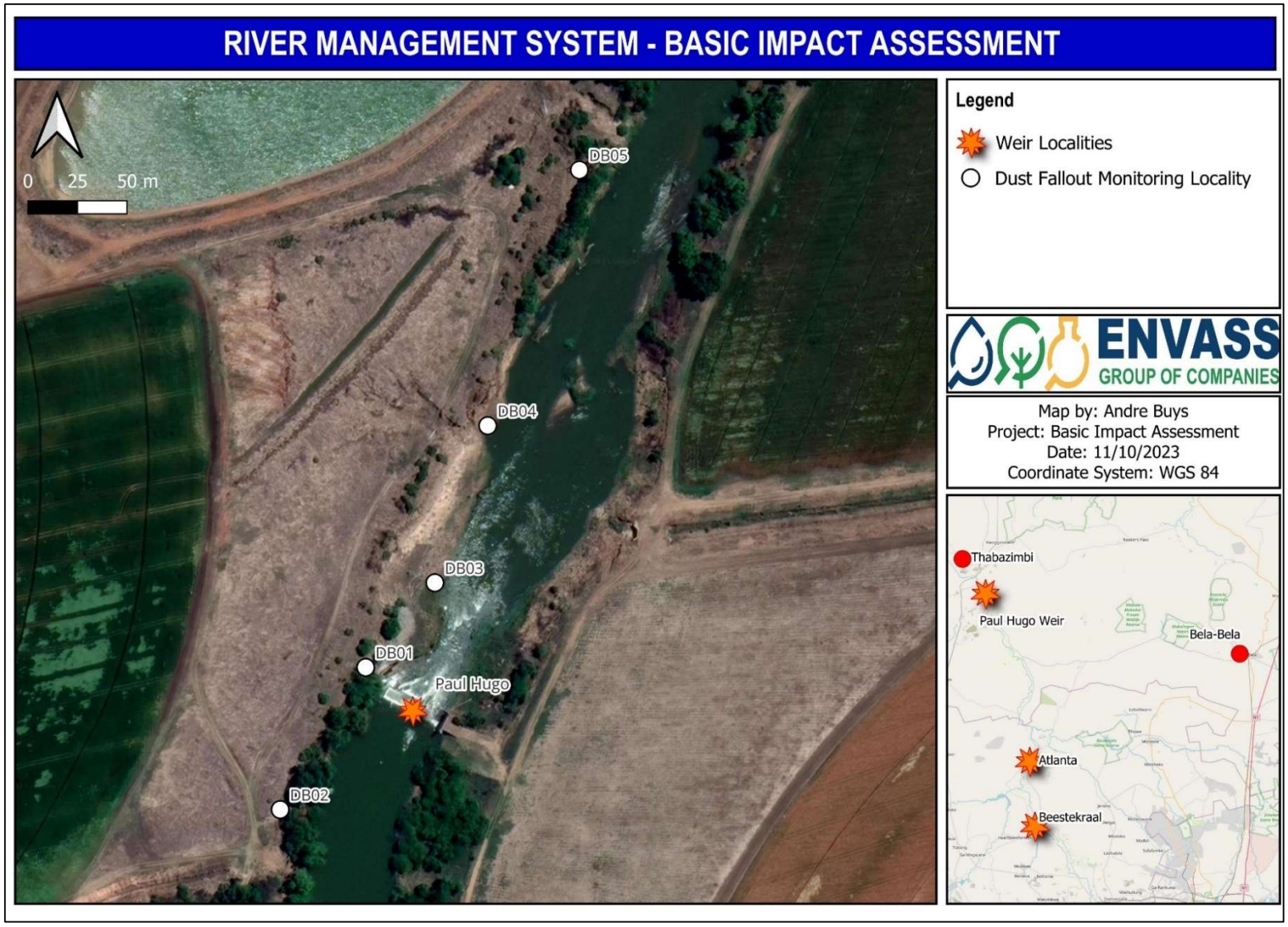

Figure 7: GBN-JV Air Quality Monitoring Localities (Paul Hugo)

9 CONCLUSION AND ASPECTS TO CONSIDER

The scope of work performed for the MCWAP-2 is as per in accordance with Appendix 6 of the EIA Regulations (2014, as amended), promulgated in terms of Section 24 of the NEMA and the criteria drawn from the IEM Guidelines Series, Guideline 5: Assessment of Alternatives and Impacts, published by the Department of Environmental Affairs (April 1998). The objective of the report and impact assessment is to identify and assess all the significant impacts that may arise as a result of the Proposed construction. The information on the report was based on a previous study conducted by G., Petzer, 2016 (refer to Reference list).

It is assumed that the construction phase and to a lesser extent the operational phase of the weir rehabilitation and re-construction will contribute to the total suspended load in the atmosphere, although off-site impacts are not expected, and the impact is anticipated to be concentrated within the construction area. From the current historic weather station data obtained, slightly elevated particulate matter and dust fallout are expected during the construction phase. In order to ensure and prevent this possible outcome, mitigation measures are provided in this report to enable the proposed development to minimise the impact.

The main findings from the impact assessment are as follows:

1. The main sources likely to contribute to cumulative particulate impact are surrounding agricultural activities as well as vehicle entrainment on unpaved road surfaces.

2. Each Weir locality does have surrounding agricultural / residential receptors.

3. When assessing all available data, it is calculated to have a negligible Consequence and a very low to negative Significance. The cumulative Impact during Construction – and Operational phases is calculated at Low.

Additionally, the main activities will result in the following:

1. Construction phase: There is a possibility for elevated off-site dustfall rates, as well as PM10 and PM2.5 concentrations due to the close proximity of the proposed Weirs to residential and agricultural areas. The potential exists for exceedances of the residential dustfall limit (600 mg/m^2/day) at the closest residential receptors. With mitigation in place, primarily comprising of water sprays, these impacts would be controlled and brought into compliance.

3. Operational phase: For the operational phase the impact and dust generating activities is reasoned to have little to no effect on the surrounding users. This is primarily due to reduced use of gravel roads and cessation of excavation and infill events, as well as the proposed weirs being in a river which will reduce dust loads.

It is recommended that air quality management measures recommended herein be implemented during the construction and operational phases to ensure the lowest possible impacts on the surrounding environment from proposed weirs occur on the surrounding natural and anthropogenic environments.

A dustfall monitoring network has been established prior to the construction. The initiation of the dustfall network prior to construction would give an indication of baseline conditions and should be the target dustfall during construction and operational phases through the application of effective mitigation measures. During and after the construction phase management, it will be the responsibility of the Environmental Management team to conduct the dust fallout monitoring.

Section 10 below includes additional mitigation measures.

10 PROPOSED MITIGATION

Aspects	Management action or objective	Responsible Person(s)	Timeframe
Removal of Vegetation Land clearing Excavation Material Transport Material Handling	• Spray areas to be cleared with water. • Ensure minimum travel distance between working areas and stockpiles. • Ensure that topsoil for stockpiles is sprayed with water before tipping to prevent dust generation.		
Construction	• Ensure graded areas are sprayed with water. • Minimise the amount of graded areas. • Ensure that shortest routes are used for material transport. • Load and offload material, as far as possible, downwind of stockpiles. • Actively monitor dust fallout generated on the borders of the site. • Implement monthly site inspection to check for possible areas of dust generation not addressed or not effectively managed.	Environmental Site Officer Contractors & Sub-Contractor Safety and Environmental Officers	Duration of the construction phase

Aspect: Stakeholder Communication	
1	Implement a programme of stakeholder communication that includes community engagement before and during work undertaken on site.
2	Provide a complaint register on site where complaints can be made. This register should enable effective communication of complaints where these are reasonably addressed.
3	Clearly display the contact details of the environmental site office and manager at the construction camps.
Aspect: Dust Management	
4	In instances where exceedances are recorded, the implementation and maintenance of a Dust Management Plan, which provides clear details on preventing, maintaining and improving the air quality in terms of site-specific activities is recommended.
Aspect: Site Management	
5	All complaints should be logged in the complaints register and should be available on the site at all times. All complaints regarding air quality should be adequately investigated and actions taken to reduce the impact in a timely manner should it be required.
6	Note must be taken of incidents that cause air emissions and this must be recorded to ensure that these are resolved and prevented from reoccurring.
Aspect: Monitoring	
7	Weekly site inspections should be undertaken in the vicinity of sensitive receptors. Records should be kept of these routine inspections.
8	Should activities be undertaken during dry and windy conditions, special focus must be taken on the impact and results of the conditions to ensure that minimal impact is occurring.
Aspect: Preparing and maintaining the site	
9	Plan the site layout in such a manner as to ensure that emission generating activities occur as far as possible from sensitive receptors.
10	Should the conditions require it, erect screens and barriers around the sensitive receptors.
11	Ensure that all areas, fencing, barriers and scaffolding is kept clear of debris and dust.
12	Remove any accumulating matter that could serve as emission generator from the site as soon as possible.
Aspect: Operating vehicle/machinery and sustainable travel	
13	Ensure that all vehicles are maintained in good working condition and that they are services on regular intervals.
14	Ensure that all vehicles are switched off when stationary – no vehicles should be idling for extended period.
15	Avoid the use of diesel- or petrol-powered generators and use mains electricity or battery powered equipment as reasonably possible.
16	Impose and regulate a speed limit.
Aspect: Operations	
17	Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g. suitable local exhaust ventilation systems.
18	Ensure an adequate water supply on the site for effective dust/particulate matter suppression/mitigation, using non-potable water where possible.
19	Ensure equipment is readily available on site to clean any dry spillages, and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods.
Waste management	

20	Only use registered waste carriers to take waste off-site.
Measures specific to earthworks	
21	Re-vegetate earthworks and exposed areas/soil stockpiles to stabilise surfaces as soon as practicable. Use Hessian, mulches or tackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable. Only remove the cover in a small area during work and not all at once.
Aspect: Measures specific to construction	
22	Ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place.
23	Ensure cement and other fine powder materials are delivered in enclosed tankers and stored in appropriate storage with suitable emission control systems to prevent escape of material and overfilling during delivery.
24	For smaller supplies of fine power materials ensure bags are sealed after use and stored appropriately to prevent dust.
Aspect: Measures specific to track-out	
25	Use water-assisted dust sweeper(s) on the access roads (where practical) to remove, as soon as practicable any material tracked out of the site.
26	Avoid dry sweeping of large areas.
27	Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport.
28	Record all inspections of haul routes and any subsequent action in a site log book.
29	Install hard surfaced routes (compaction), which are regularly damped down (daily) with fixed or mobile sprinkler systems, or mobile water bowsers and regularly cleaned.
30	Inspect surfaced routes for integrity and instigate necessary repairs to the surface as soon as practicable.

11 REFERENCES

AEPA. (2000). Guidelines for Separation Distances – Consultation Draft. Australian Environmental Protection Agency, August 2000.

ASTM Standard (1739-98). 2004 (Reapproved 2017). Standard Test Method for Collection and Measurement of Dustfall (Settleable Particulate Matter). United States.

Basic Air Quality Impact Assessment for the proposed Special Economic Zone (SEZ) in Upington, December 2016., G Petzer., Report No. 16CES08A.

EOH. (2016). Background Information Document on the Development of a new Special Economic Zone (including a Solar Energy Facility) in Upington, Northern Cape Province. EOH.

GNR 827. 2013. National Environmental Management: Air Quality Act, Act No. 39 of 2004. Government Gazette 36974.

South African National Standards (SANS) 1929. 2011. Ambient Air Quality- Limits for Common Pollutants. Ed. 2. ISBN 978-0-626-26919-7. South Africa

Holman et al. (2016). IAQM Guidance on the assessment of dust from demolition and construction. London: Institute of Air Quality Management. Retrieved from www.iaqm.co.uk/text/guidance/construction-dust-2014.pdf

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

Shao, Y. (2008). Physics ad Modelling of Wind Erosion. Atmospheric and Oceanographic Science Library, 2nd Revised and Expanded Edition. Springer Science.

US EPA. (1995). AP 42, 5th Edition, Volume I, Chapter 13: Miscellaneous Sources, 13.2.3 Heavy Construction Operations.

Retrieved from Technology Transfer Network .

US EPA. (1996). Compilation of Air Pollution Factors (AP-42). United States Environmental Protection Agency.

US EPA. (2006). AP 42, 5th Edition, Volume I, Chapter 13: Miscellaneous Sources, 13.2.2 Introduction to Fugitive Dust Sources, Unpaved Roads. http://www.epa.gov/ttnchief/ap42/.

World Bank Group Pollution Prevention and Abatement Handbook. (1998). Industrial Estates. World Bank Group

APPENDIX A – CURRICULUM VITAE

ENVIRONMENTAL ASSURANCE (PTY) LTD

ANDRE BUYS

ENVIRONMENTAL CONSULTANT / BUSINESS UNIT HEAD

394 Tram Street, New Muckleneuk, Pretoria, 0181

T: 012 460 9768 ; M : 083 555 4354; F : 012 460 3071 ; E mail : andre@envass.co.za

Date of Birth : 18 November 1991; Place of Birth : South Africa

Ethnic Group and Gender: White Male ; Disabilities : None

AREAS OF EXPERTISE

- Compliance Monitoring
- Project Management
- Potable, Ground and Surface Water Quality
- Scientific Report Writing
- Data Analysis & Interpretation
- Hydrogeology
- Soil classification
- Ambient Air and Particulate Matter Quality
- Noise Monitoring
- Geophysics
- GIS, Surfer, Wish and WRPLOT software
- Customer Relationships
- Specialist Report (Visual and Noise assessments)

CAREER HISTORY

Employer
Period
Position
Responsibilities

ENVIRONMENTAL ASSURANCE (PTY) LTD

Andre holds a B.Sc. in Environmental Sciences, followed by a B.Sc. (Hons) specializing in Geology, Geography and Hydrology. He has comprehensive experience and knowledge on compliance monitoring, project management and specialist reporting. As an environmental consultant, Andre has provided several environmental monitoring and geohydrological assessments and specialist input services.

BUSINESS UNIT HEAD / ENVIRONMENTAL SPECIALIST
Environmental Specialist, Environmental Control Officer and Auditor
June 2022 – Current

- Develop and maintain environmental compliance monitoring programmes in conjunction with site audits and assessments. Monitoring co-ordination and planning of all relevant projects. Maintaining data and results from monitoring programmes and databases. Determining financial provision of mine closures. Compile and overseeing reports on water-, soil-, air-quality and site findings, with interpretation of

results and recommendations. Conduct and report on specialist assessments Maintain and build customer relationships with guidance on environmental matters and updates on environmental legislation. Market to potential clients with site specific marketing material. Additionally, conducting Geohydrological studies including Groundwater resource development, Geophysical surveys, Conceptual modelling, Pump tests, Borehole siting, Borehole logging, Groundwater remediation programmes and hydrocensus'.

EDUCATION AND QUALIFICATIONS

North-West University; Honours BSc. Hydrogeology and Hydrology - 2014
North-West University; Degree BSc. Environmental Science Geology and Geography – 2013

PROFESSIONAL STATUS
Registration
Membership

Registered as a Professional Natural Scientist (119183) with the South African Council of Natural Scientific Professions (SACNASP)

PROJECT EXPERIENCE

PROJECT DESCRIPTION	CLIENT
Noise Baseline and Impacts Assessments	Baseline Noise Assessment - Portion159 Diepkloof
	Noise Impact Assessment for Rezoning Application
	Noise Assessment – Erf 49 Wierdapark Township, Pretoria, Gauteng Province.
	Environmental Noise assessment Anglo Platinum Rustenburg Base Metals
	Quarterly Noise Assessment for one year
	Monitoring, Analysis & Reporting Service For Fallout Dust, Point Source Emissions & Environmental Noise
	De Wit Family Trust - Additional Noise Monitoring Survey
Visual Impact Assessments	Nemai Consulting Grootvly Visual Assessment
	GIBB Environmental Rhino PV Visual Assessment
	GIBB Environmental Onderstepoort 1 PV Visual Assessment
	GIBB Environmental Onderstepoort 2 PV Visual Assessment
	Tenboch mining visual Assessment
Environmental Compliance Monitoring	Assmang Dwarsrivier
	Tronox Namakwa Sands
	Tronox KZN
	Samancor Ferrometals
	CEMZA Cement

	Northam Platinum Zondereinde
	Northam Platinum Eland
	Northam Platinum Maroelabult
	Wescoal Mining Elandspruit
	Wescoal Mining Keaton
	Neosho Moabsvelden
	Wescoal Processing Plant
	Wescoal Khanyisa
	Exxaro Grootegeluk
	Exxaro Thabametsi
	Exxaro Grootegeluk Depot
	AECI Mining and Explosives
	Calodex Enstra Waste Disposal Facility
	Anglo American Whiskey Creek
	Keywest Shopping Centre
	Glencore Chrome Kroondal
	Glencore Chrome Rietvly
	Glencore Chrome Boshoek
	Kelvin Power Station
	Potchefstroom Dolomite Risk Project
Groundwater Resource Development and Geophysics	Ganyisa Groundwater Resource Development
	Moretele Groundwater Provision
	Polokwane Groundwater Resource Development
	Majakaneng Water Provision
	Steelpoort Pipeline Geophysical Investigation
	Swaziland Waste Disposal Site Investigation
Environmental Control Officer	Moretele Road Construction Phase 2
	Zululand Anthracite Colliery – Report Approval and Sign-off
Environmental Auditor	Makoya Blinkpan External EMPr Auditor
	Sephaku Cement External Water Use License Auditor
	Ocon Bricks External Water Use License Auditor
	Ocon Bricks External EMPr Auditor

Software Modelling and GIS	Ganyisa Groundwater Resource Development
	Moretele Groundwater Provision
	Polokwane Groundwater Resource Development
	Majakaneng Water Provision
	Steelpoort Pipeline Geophysical Investigation
	Swaziland Waste Disposal Site Investigation