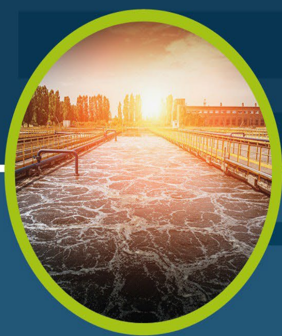
Appendix G2: Climate Change



Royal HaskoningDHV
Enhancing Society Together

SPECIALIST DECLARATION FORM – AUGUST 2023

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

REPORT TITLE

Development of a New Malt Plant, in the Sedibeng District Municipality

Kindly note the following:

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

1. SPECIALIST INFORMATION

Title of Specialist Assessment	climate change assessment report: New Malting Facility, Sedibeng District Municipality
Specialist Company Name	Airshed Planning Professionals (Pty) Ltd
Specialist Name	Dr Theresa (Terri) Bird
Specialist Identity Number	[redacted]
Specialist Qualifications:	PhD (Wits)
Professional affiliation/registration:	Pr.Sci.Nat
Physical address:	62 Constantia Avenue, Mnandi AH, Centurion, 0157
Postal address:	PostNet Suite #18 Private Bag x59, Halfway House, 1685
Postal address	Click or tap here to enter text.
Telephone	[redacted]
Cell phone	Click or tap here to enter text.
E-mail	[redacted]

[redacted]

2. DECLARATION BY THE SPECIALIST

I, Theresa Bird declare that –

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

[redacted]

Signature of the Specialist

Airshed Planning Professionals (Pty) Ltd

Name of Company:

2024-07-14

Click or tap to enter a date.

Date

3. UNDERTAKING UNDER OATH/ AFFIRMATION

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

[redacted]

Signature of the Specialist

Airshed Planning Professionals (Pty) Ltd

Name of Company

2024-07-14

Click or tap here to enter text.

Date

Click or tap here to enter text. [redacted]

Rev. Fr. Rodney George
ex officio Marriage officer
BD 41144

Signature of the Commissioner of Oaths

Click or tap to enter a date. 14TH JULY 2024

Date

CLIMATE CHANGE ASSESSMENT REPORT:
New Malting Facility
Sedibeng, Gauteng Province

Project done on behalf of **Royal Haskoning DHV (Pty) Ltd**

Project Compiled by:
T Bird
G Petzer

Project Manager
T Bird

Report No: 23RHD04 Revision 2 | **Date:** 25 July 2024

Address: 62 Constantia Avenue, Mnandi AH, Centurion
Postal: PostNet Suite #18 Private Bag x59, Halfway House, 1685
Tel: +27 (0)11 805 1940

Report Details

Project Name	Climate Change Assessment: New Malting Plant, Sedibeng DM
Client	Royal Haskoning DHV (Pty) Ltd
Report Number	23RHD04
Report Version	Revision 2
Date	July 2024
Prepared by	Terri Bird, Pr.Sci.Nat, PhD (Wits) Gillian Petzer, (Pr. Eng.) BEng. (Chemical) (University of Pretoria)
Reviewed by	Hanlie Liebenberg-Enslin (PhD, University of Johannesburg)
Notice	Airshed Planning Professionals (Pty) Ltd is a consulting company located in Midrand, South Africa, specialising in all aspects of air quality, ranging from nearby neighbourhood concerns to regional air pollution impacts as well as noise impact assessments. The company originated in 1990 as Environmental Management Services, which amalgamated with its sister company, Matrix Environmental Consultants, in 2003.
Declaration	Airshed is an independent consulting firm with no interest in the project other than to fulfil the contract between the client and the consultant for delivery of specialised services as stipulated in the terms of reference.
Copyright Warning	Unless otherwise noted, the copyright in all text and other matter (including the manner of presentation) is the exclusive property of Airshed Planning Professionals (Pty) Ltd. It is a criminal offence to reproduce and/or use, without written consent, any matter, technical procedure and/or technique contained in this document.

Revision Record

Revision Number	Date	Reason for Revision
Draft	15 July 2024	Draft for client review
Revision 2	25 July 2024	Minor edits to the significance rating description

Executive Summary

Malteries Soufflet operates more than 41 malting plants worldwide and is currently the biggest maltster in the world. Through its operations, the Group has developed extensive knowledge in the malt processing to achieve high quality malt and to optimize energy consumption. The proposed project involves the establishment of a Malting Plant located in the Sedibeng District Municipality of Gauteng, South Africa.

The Facility is to be established at Graceview Industrial Park in Sedibeng which is located in the southern part of Gauteng. The site has been zoned as an industrial development area. Graceview Industrial Park is selected as the best location for the following reasons:

- Strategically located next to potential customers
- Availability of ample land for industrial zone development
- Located in close proximity to the national highway network
- Ease of access to raw materials, and
- Availability of variety of types of labour and creation of employment opportunities.

Airshed Planning Professionals (Pty) Ltd (Airshed) was appointed by Royal Haskoning DHV (Pty) Ltd to conduct a climate change assessment for the project. The climate change specialist study assesses the significance of impacts of the project greenhouse gas (GHG) emissions generated, along with the potential impact of climate change on the operation of the project.

The physical risks of climate change on the study area (based on the IPCC's fifth assessment report (AR5) data downscaled for South Africa[1]) can be summarised as follows:

- Climate:
  - Temperature:
    - Baseline: 1.22 hot days (90th percentile)
    - High mitigation[2] Representative Concentration Pathways (RCP) [RCP4.5] climate situation: 10.4 hot days with an increase in temperature of 2.7°C (90th percentile)
    - Low mitigation[3] climate situation [RCP8.5]: 13.4 hot days with an increase in temperature of 3.1°C (90th percentile)
  - Rainfall:
    - Baseline: 9.3 extreme rainfall days (90th percentile)
    - High mitigation RCP4.5 climate situation: an increase of 56 extreme rainfall days with an increase in rainfall of 86 mm (90th percentile)
    - Low mitigation RCP8.5 climate situation: an increase of 1.5 extreme rainfall days with an increase in rainfall of 137 mm (90th percentile)
- Hazards assuming the low mitigation RCP8.5 climate situation:
  - The area of the project is at unknown (but likely low to moderate) risk of wildfires with the projection of 27 fire danger days over the project area;

[1] While the IPCC Sixth Assessment Report (AR6) is more recent, it is based on climate projections at a scale of 100 km x 100 km. The literature source consulted ("The Greenbook") includes locally downscaled (8 km x 8 km) and re-projected impacts based on the same input data used in AR5, but this has not yet been updated with the input data used for the global climate projections in AR6.

[2] High mitigation RCP4.5 is based on a CO_2 concentration of 560 ppm by 2100

[3] Low mitigation RCP8.5 is based on a CO_2 concentration of 950 ppm by 2100

- The area of the project has an unknown risk (likely low) of drought with the Standardized Precipitation Index of -1.06 for the project area;
- The area of the project has an unknown (likely medium) risk of encountering increasing heat stresses; and,
- The area of the project has an unknown risk of flooding (likely moderate) with a slight increase in extreme rainfall days for the project area (0.99).

Based on the information available at the conceptual phase of design, Scope 1 emissions for the project construction would be 2 645 t CO_2e (mostly due to fuel use of 473 t CO_2e per annum). In the operational phase, Scope 1 emissions over the project lifetime amount to 950 102 t CO_2e (19 002 t CO_2e per annum) due to gas combustion in the combined heat and power genset (CHP). This was calculated to represent a maximum 0.0054% of the remaining South African annual GHG budget. The site clearance and replacement with permanent infrastructure would potentially result in a reduction in the National grassland carbon sink by 0.002%.

The proposed (design mitigated) project is rated to have a **low** to **moderate** impact significance, depending on the significance rating method used. This is because Scope 1 GHG emissions during the operational phase will not exceed the 25 Gg CO_2-e per year threshold. There are few additional mitigation measures applicable to the project for Scope 1 emissions, except burning less gas, which would result in a similar significance rating to the no-go option (moderate).

It is the opinion of the specialist that the project has a low to moderate impact on climate change in respect of the remaining National budget and therefore its approval is supported.

Table of Contents

List of Tables

List of Figures

List of Acronyms and Symbols

AFF	Agriculture, Forestry and Fishing
Airshed	Airshed Planning Professionals (Pty) Ltd
AR5	IPCC's fifth assessment report
AR6	IPCC's sixth assessment report
BAU	Business-As-Usual
BOD	Biological oxygen demand
°C	Degrees Celsius
CCA	Climate Change Assessment
CCS	Carbon Capture and Sequestration (or Carbon Capture and Storage)
CH_4	Methane
CHP	Combined heat and power genset
CMIP	Coupled Model Intercomparison Project
CO_2	Carbon dioxide
DFFE	Department of Forestry, Fisheries and Environment (previously Department of Environmental Affairs - DEA)
DWS	Department of Water and Sanitation
ECMWF	European Centre for Medium-Range Weather Forecasts
EIA	Environmental Impact Assessment
GCMs	Global Climate Change Models
GDP	Gross domestic product
GHG	Greenhouse gases
GHGIP	National Greenhouse Gas Improvement Programme
GN	Government notice
GVA	Gross Value Added
GWh	Gigawatt hour (one billion (10^9) watt hours)
GWP	Global warming potential
HFCs	Hydrofluorocarbons
ICT	Information and Communication Technology
IPCC	Intergovernmental Panel on Climate Change
LNG	Liquid Natural Gas
l/d	Litres per day
LULUCF	Land-Use, Land-Use Change and Forestry
mm/yr	Millimetres per year
MW	Megawatt
MWh	Megawatt hour
N_2O	Nitrous oxide
NAAQS	National Ambient Air Quality Standards
NAEIS	National Atmospheric Emission Inventory System
NCEP	National Centres for Environmental Prediction
NEM:AQA	National Environmental Management: Air Quality Act
NDCs	Nationally determined contributions
NOAA	National Oceanic and Atmospheric Administration
O_3	Ozone
PFCs	Perfluorocarbons
PV	Photovoltaic

RCA4	Rossby Centre regional model
RCPs	Representative Concentration Pathways
SAAELIP	South African Atmospheric Emission Licensing and Inventory Portal
SAAQIS	South African Air Quality Information System
SAGERS	South African Greenhouse Gas Emission Reporting System
SF_6	Sulfur hexafluoride
SPI	Standardized Precipitation Index
SSP	Shared Socioeconomic Pathway
SST	Sea surface temperatures
TJ	Terajoules (one trillion (10^{12}) joules; 0.278 GWh)
UNFCCC	United Nations Framework Convention on Climate Change

Note:

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

NEMA Regulation (2017), Appendix 6

NEMA Regulations - Appendix 6	Relevant section in report
Details of the specialist who prepared the report.	Report Details (page i)
The expertise of that person to compile a specialist report including curriculum vitae.	Appendix A: Impact Assessment Methodology

Impact Assessment Methodology

The potential environmental impacts associated with the project will be evaluated acc intensity, probability and significance of the impacts, whereby:

- Nature: A brief written statement of the environmental aspect being impacted upo
- Extent: The area over which the impact will be expressed. Typically, the severity different scales. This is often useful during the detailed assessment phase of a p determined significance or intensity of an impact. For example, high at a local sca
- Duration: Indicates what the lifetime of the impact will be;
- Intensity: Describes whether an impact is destructive or benign;
- Probability: Describes the likelihood of an impact actually occurring; and
- Cumulative: In relation to an activity, means the impact of an activity that in itself m significant when added to the existing and potential impacts eventuating from simila in the area.

This approach incorporates two aspects for assessing the potential significance of impa which are further sub-divided as follows:

Occurrence		
Probability of occurrence	Duration of occurrence	Scale/extent of impa

To assess each of these factors for each impact, the following four ranking scales are u

Criteria for the ranking of impacts

Probability	
5 - Definite/ don't know	5 - Permanent
4 - Highly probable	4 - Long-term
3 - Medium probability	3 - Medium-term (8 - 15
2 - Low probability	2 - Short-term (0 - 7 operational life of the ac
1 - Improbable	1 – Immediate
0 – None	0 - None
Scale	
5 - International	10 - Very high/ don't kn
4 - National	8 - High
3 - Regional	6 - Moderate
2 - Local	4 - Low
1 - Site only	2 - Minor
0 – None	0 - None

Once these factors have been ranked for each impact, the significance of the two aspects, occurrence and
assessed using the following formula:

SP (significance points) = (magnitude + duration + scale) x probability

The maximum value is 100 significance points (SP). The impact significance is then rated as follows:

Impact significance:

SP >75	Indicates high environmental significance	An impact which could influence the decision or not to proceed with the project regardless mitigation.
SP 30 – 75	Indicates moderate Environmental significance	An impact or benefit which is sufficiently impo management and which could have an in decision unless it is mitigated.
SP <30	Indicates low environmental significance	Impacts with little real effect and which shou influence on or require modification of the pro
+	Positive impact	An impact that constitutes an improvement c conditions

Impacts must be assessed and rated before and after mitigation.

Appendix B: Authors Curriculum Vitae (page 52)

A declaration that the person is independent in a form as may be specified by the competent authority.	Report Details (page i)
An indication of the scope of, and the purpose for which, the report was prepared.	Background and Context (page 2) Purpose and Scope (page 2)
An indication of quality and age of base data used.	Section 3
A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change.	Sections 3 and 4.8 and 6
The date and season of the site investigation and the relevance of the season to the outcome of the assessment.	No site investigation was conducted. Baseline description of the area was included from national databases as relevant to the specialist study.
A description of the methodology adopted in preparing the report or carrying out the specialised process.	Section 4
The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure.	Section 3
An identification of any areas to be avoided, including buffers.	Not applicable

A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers.	Not applicable
A description of any assumptions made and any uncertainties or gaps in knowledge.	Sections 4.4 and 4.5
A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment.	Section 3 and 5
Any mitigation measures for inclusion in the EMPr.	Section 5.2
Any conditions for inclusion in the environmental authorisation	None recommended
Any monitoring requirements for inclusion in the EMPr or environmental authorisation.	None recommended
A reasoned opinion as to whether the proposed activity or portions thereof should be authorised.	Section 6
If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan.	Section 6
A description of any consultation process that was undertaken during the course of carrying out the study.	Not applicable
A summary and copies if any comments that were received during any consultation process.	Comments received will be dealt with by the EAP through the S&EIA process and will be recorded in the associated reports.
Any other information requested by the competent authority.	None

1. INTRODUCTION

1.1 Background and Context

Malteries Soufflet operates more than 41 malting plants worldwide and is currently the biggest maltster in the world. Through its operations, the Group has developed extensive knowledge in the malt processing to achieve high quality malt and to optimize energy consumption. The proposed project involves the establishment of a Malting Plant located in the Sedibeng District Municipality of Gauteng, South Africa.

The Facility is to be established at Graceview Industrial Park in Sedibeng which is located in the southern part of Gauteng (Figure 1-1). The site has been zoned as an industrial development area. Graceview Industrial Park is selected as the best location because of the following reasons:

- Strategically located next to potential customers;
- Availability of ample land for industrial zone development;
- Located in close proximity to the national highway network;
- Ease of access to raw materials; and,
- Availability of variety of types of labour and creation of employment opportunities.

Airshed Planning Professionals (Pty) Ltd (Airshed) was appointed by Royal Haskoning DHV (Pty) Ltd to conduct a climate change assessment for the project.

1.2 Purpose and Scope

The main purpose of the project is to develop a climate change assessment (CCA) for the proposed Sedibeng Maltings Plant. To successfully develop a CCA, the following tasks are included in the scope of work for the Construction and Operational Phases of the project:

1. Estimate greenhouse gas (GHG) emissions during the construction and operation of the project covering scope 1 and scope 2 emissions;
2. As far as is possible at conceptual phase of the project quantify Scope 3 emissions;
3. Compare GHG emissions to the global and national emission inventories and to international benchmarks for the project;
4. Consider the robustness of the project in terms of forecasted climate change impacts to the area over the lifetime of the project;
5. Propose management and mitigation strategies;
6. Compile a report that complies with the requirements of Appendix 6 of the EIA Regulations, 2014 (Government Notice (GN) R 982 of 2014, as amended); and/or
7. The Department of Forestry, Fisheries and Environment (DFFE) “Protocols for the assessment and minimum report content requirements of environmental impacts” (GN 320 of 2020 and GN 1150 of 2020); and/or
8. Any other applicable sector-specific guidelines and protocols.

1.3 Process Description

The developers plan to establish a malt production plant with an annual capacity of 100 000 tonnes (per year) in Phase 1 and 135 000 tonnes (per year) in Phase 2 for the local market. The proposed site layout is represented in Figure 1-2. The malting production process combines four separate stages:

- Barley Intake and Storage;
- Steeping: Initiation of growth through forced grain hydration;
- Germination: Controlled growth of barley to facilitate endosperm modification; and,
- Kilning: The termination of grain growth to fix extract potential and malt specifications through grain dehydration.

Following harvest barley must be sufficiently dried to prevent germination and reduce the risk of microbial infections occurring prior to use. If dried incorrectly the quality of the grain will deteriorate in store. Barley harvested from the field will vary in moisture content from around 13% in a dry year to 20% in a wet year. Whatever the moisture at intake, barley must be dried down to about 13% for safe storage. Above 13% moisture, the grain is susceptible to insect attack. After drying, barley is cooled and stored until it is ready for use. During storage the grain respires, even though at a low rate, and must be kept fresh by aeration. All (medium to long term) barley silos are fitted with low volume fans for this purpose. The barley is cleaned using vibrating screens and sieves, in combination with air jets and magnets. These act to remove any non-barley material that is not of equal size or weight.

The process of malting is the forced growth of the barley grain to achieve the required endosperm modification. By allowing the grain to germinate under controlled conditions, the ability of the grain to produce hydrolytic enzymes can be manipulated. Hydrolytic enzymes released during germination are required to partially degrade (or modify) the starchy endosperm during malting and later to release fermentable extract during mashing. The steeping process for Soufflet Malting project will be carried out using eight cylindrical stainless-steel tanks. The processes that take place during steeping are as follows:

- Moisture content of the grain is increased to 40% - 45%;
- Increased respiration rate;
- Initiation of enzymatic activity that will continue during the germination phase;
- Washing dust off and leaching of substances from outer layers of grains;
- Production of waste steep liquors with high biological oxygen demand (BOD); and,
- "Chitting" - the appearance of the coleorhiza, surrounding the first rootlet.

After steeping, the activated and chitted barley at about 42% moisture is transferred into the germination vessel and levelled. The germination process consists of five days of actively managing the aerobic respiration process that was activated during steeping. Oxygen and moisture must be provided to the barley, and the carbon dioxide (CO_2) and heat generated must be dissipated by aeration. Apart from helping to maintain bed hydration, circulating air replenishes the supply of oxygen for the grain and purges out any CO_2 that could stifle respiration. By maintaining air circulation, cooling of the grain bed is also accomplished.

Following the completion of germination, the green malt is transferred to the kiln for finishing. The proposed project plans to install two circular kilns with a capacity of 250 tonnes each , with both being installed during Phase 1. The kilning section of the malting plant, contained in two floors (one per each kilning stage) located side by side and a so called “energy building” for kiln fans, heating system, heat recovery, air ducts and flaps. In order to reduce heat consumption, a glass tube heat exchanger allows recovering heat from air going out of the kiln to air coming in. Drying occurs in two different stages. Initially, moisture is removed from the grain from approximately 44% to 12%. With an upward flow of air, this process takes approximately 12 to 24 hours to pass through the bed for a double-deck kiln, depending upon the airflow. This phase of drying is rapid and is referred to as the “free-drying” or “withering” stage. The second phase of drying where the malt is dried from 12% to 4% occurs in a much slower process, commonly referred to as the “curing” stage. Since the respiration losses of CO_2 from the barley (during germination and kilning) are not derived from fossil fuel combustion, and are part of short-term carbon cycling, these losses are not typically quantified in climate change assessments.

Energy to power the proposed prosed will be provided through a combined heat and power genset (CHP) with a capacity of 8 MW of heating energy, 4 MW of cooling energy and 3 MW of electrical power through the CHP Plant, heat pumps and heat exchangers. Approximately 94 GWh (338.4 TJ) of liquified natural gas (LNG) will be used in the CHP annually, in Phase 2 of the project. Two 8 MW back-up boilers (using LNG) are planned for when the CHP is unavailable due to maintenance and breakdowns. CHP technology is a highly efficient energy process, producing fewer combustion by-products – including CO_2 - per unit of energy output than traditional heat and power generation systems, up to 70% more efficient (Department for Business, Energy and Industrial Strategy, 2021). Where power from a CHP unit replaces electrical power from old coal-fired power stations, there is both of reduction in GHG emissions along with reductions in other air pollutants, like sulfur dioxide and oxides of nitrogen, due to low sulfur content fuel (like natural gas) and more modern combustion equipment respectively. For example, CO_{2-e} emissions per unit input heat value from gas can be 50% lower than the coal and are therefore considered to be low carbon technology (Department for Business, Energy and Industrial Strategy, 2021).

The cooling system will use ammonia as a refrigerant in a closed loop system with a total storage capacity of 2 000 m^3. Ammonia is considered an aerosol precursor gas, which has relevance to climate change through the influence of aerosols on reflecting incoming solar radiation. Significant emissions from the refrigeration system would potentially only be through a loss of containment event. Minor emissions may occur due to fugitive losses (and were not estimated).

The malting process consumes large amounts of water on a daily basis. The expected water usage for the current mandate based on the process mass energy balance spreadsheet is projected at 1 000 m^3/day at peak load. The arrangement of the water storage tanks is described below:

- One (1) freshwater tank of 1 000 m^3 available water storage volume. This volume includes 10% spare capacity for malt production usage demand for 24 hours.
- One (1) process water tank of 1 000 m^3 available water storage volume. This volume including the option to be 50% recycled water.

Liquid effluent from the process is (at this stage of design) likely to be discharged to an off-site wastewater treatment facility. In total (including domestic sewage from the Administration building) approximately 575 m^3 per day (in Phase 1[4]) will be generated. Effluent will be temporarily stored in a concrete tank below the steeping building that will have a capacity of 1 000 m^3.

[4] Linear estimate for Phase 2 based on malt production is ~780 m^3

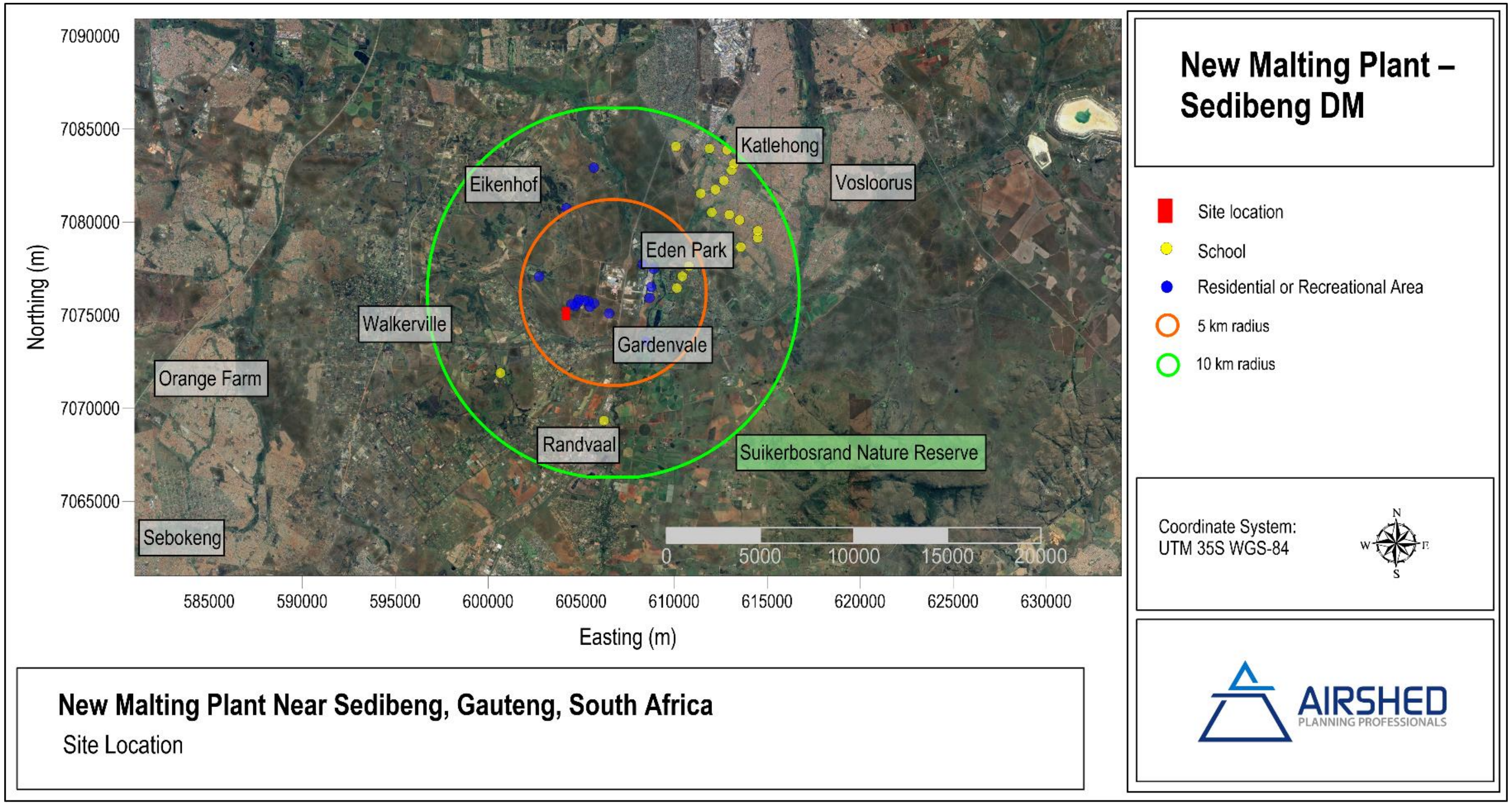


Figure 1-1: Location of the map of the facility in relation to its surroundings

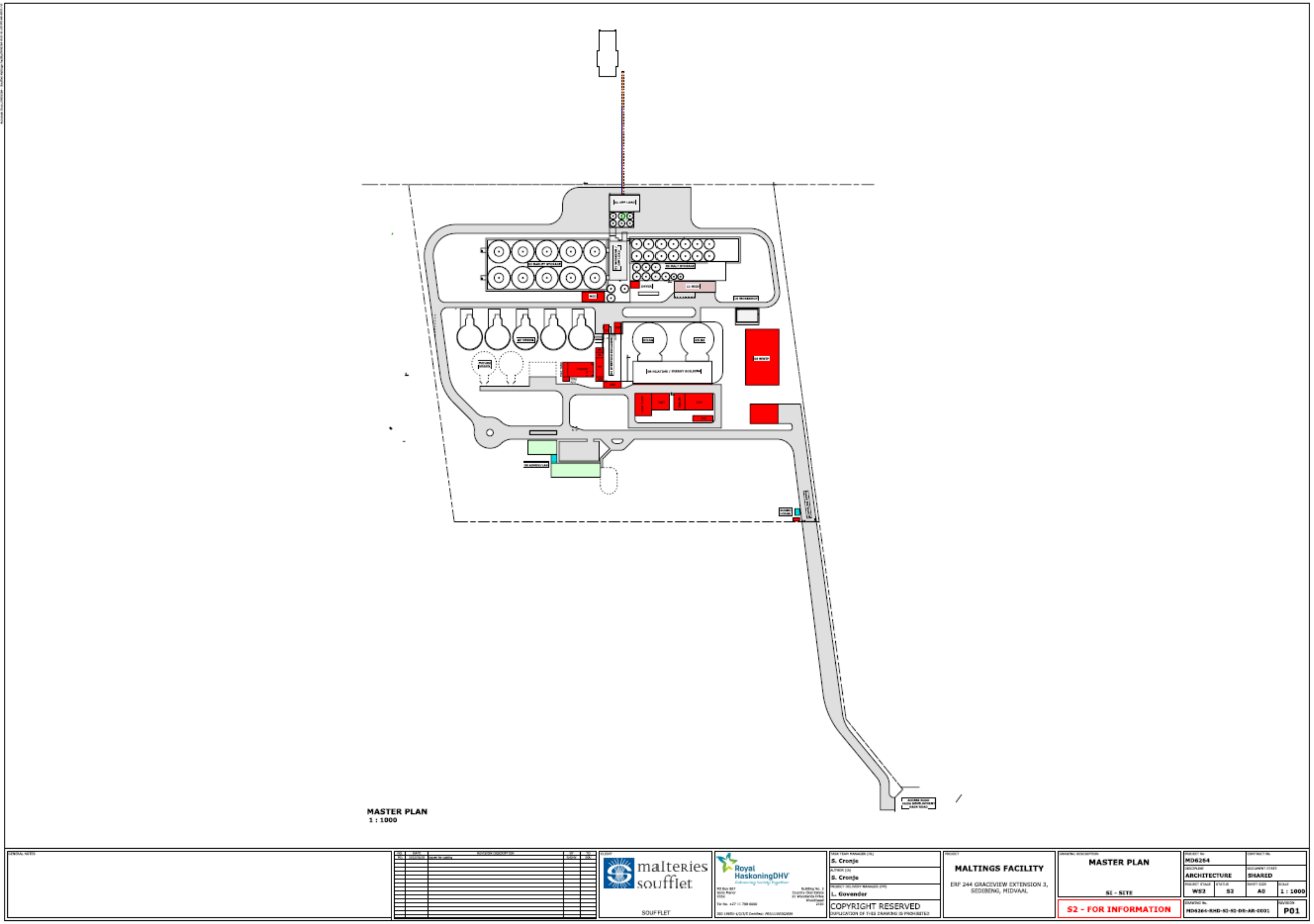


Figure 1-2: Site Layout for the proposed New Malting Plant

2 REGULATORY CONTEXT AND IMPACT ASSESSMENT CRITERIA

Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of thermal infrared radiation emitted by the Earth's surface, the atmosphere itself, and by clouds. This property causes the greenhouse effect. Water vapour (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4) and ozone (O_3) are the primary greenhouse gases in the earth's atmosphere. Moreover, there are a number of entirely human-made GHGs in the atmosphere, such as the halocarbons and other chlorine and bromine containing substances, dealt with under the Montreal Protocol. Beside CO_2, N_2O and CH_4, the Kyoto Protocol deals with sulfur hexafluoride (SF_6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) (IPCC, 2007). Human activities since the beginning of the Industrial Revolution (taken as the year 1750) have produced a 40% increase in the atmospheric concentration of carbon dioxide, from 280 ppm in 1750 to 423 ppm in April 2024 (NOAA, 2024). This increase of CO_2 in the Earth's atmosphere has occurred despite the uptake of a large portion of the emissions by various natural "sinks" involved in the carbon cycle (NOAA, 2024). Anthropogenic CO_2 emissions (i.e., emissions produced by human activities) come from combustion of fossil fuels, principally coal, oil, and natural gas, along with waste processing and decomposition, deforestation, soil erosion and animal agriculture (IPCC, 2007).

The following sections describe the alignment of South African national policies regarding greenhouse gas emissions and reporting with international agreements and targets.

2.1 International Agreements

In 1992, countries joined an international treaty, the United Nations Framework Convention on Climate Change, (UNFCCC) as a framework for international cooperation to combat climate change by limiting average global temperature increases and the resulting climate change, and coping with impacts that were, by then, inevitable.

By 1995, countries launched negotiations to strengthen the global response to climate change, and, two years later, adopted the Kyoto Protocol. The Kyoto Protocol legally binds developed country parties to emission reduction targets. The Protocol's first commitment period started in 2008 and ended in 2012. As agreed in Doha in 2012, the second commitment period began on 1 January 2013 and will end in 2020 (UNFCCC, 2017) but due to lack of ratification has not come into force.

The Paris Agreement (2016) builds upon the Convention and – for the first time – brings all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects, with enhanced support to assist developing countries to do so. As such, it charts a new course in the global climate effort.

The central aim of the Paris Agreement is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2.0°C above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5°C. Additionally, the agreement aims to strengthen the ability of countries to deal with the impacts of climate change. To reach these ambitious goals, appropriate financial flows, a new technology framework and an enhanced capacity building framework will be put in place, thus supporting action by developing countries and the most vulnerable countries, in line with their own national objectives.

The Paris Agreement requires all Parties to put forward their best efforts through "nationally determined contributions" (NDCs) and to strengthen these efforts in the years ahead. This includes requirements that all Parties report regularly on their emissions and on their implementation efforts.

In 2018, Parties took stock of the collective efforts in relation to progress towards the goals set in the Paris Agreement to inform the preparation of NDCs. There will also be a global stocktake every five years to assess the collective progress towards achieving the purpose of the Agreement and to inform further individual actions by Parties. As of October 2022, 194 Parties of the 197 Parties to the UNFCCC Convention, including South Africa, had ratified the Paris Agreement. South Africa submitted its NDC to the UNFCCC on 25 September 2016 and an updated NDC in September 2021.

2.2 South African National Climate Change Response Policy 2011

South Africa ratified the UNFCCC in August 1997 and acceded to the Kyoto protocol in 2002, with effect from 2005. However, since South Africa is an Annex 1 country it implies no binding commitment to cap or reduce GHG emissions. South Africa later also ratified the Paris Agreement (as signed on 22 April 2016) which although not bound to commit to a cap or reduce GHG emissions, pledged to reduce emissions by 34% below Business-As-Usual (BAU) emissions by 2020 and 42% below BAU by 2025. The proposed 2030 target range represents a 28% reduction in GHG emissions commitment from the original 2015 NDC targets. However, these original goals were ambitious, and South Africa subsequently shifted from BAU-based targets for 2020 and 2025 in terms of the Cancun Agreement under the UNFCCC, to absolute GHG emissions targets under the Paris Agreement. This update demonstrates reducing the upper range of South Africa's targets by a more realistic 17% for 2025 and 28% for 2030, respectively.

The National Climate Change Response White Paper, passed by Cabinet in October 2011, stated that in responding to climate change, South Africa has two objectives: to manage the inevitable climate change impacts and to contribute to the global effort in stabilising GHG emissions at a level that avoids dangerous anthropogenic interference with the climate system. The White Paper proposes mitigation actions, especially a departure from coal-intensive electricity generation, be implemented in the short- and medium-term to match the GHG trajectory range. Peak GHG emissions are expected between 2020 and 2025 before a decade long plateau period and subsequent reductions in GHG emissions.

The White Paper also highlighted the co-benefit of reducing GHG emissions by improving air quality and reducing respiratory diseases by reducing ambient particulate matter, ozone, and sulfur dioxide concentrations to levels in compliance with the National Ambient Air Quality Standards (NAAQS) by 2020. To achieve these objectives, the Department of Forestry, Fisheries and Environment (DFFE) established a national GHG emissions inventory that reports through the South African Atmospheric Quality Information System (SAAQIS).

The draft Climate Change Bill was published for comment on the 8th of June 2018 and introduced to parliament on the 18th of February 2022 (B9-2022). The Bill is aligned with international policies guidelines and South Africa's NDC and aim to reduce GHG emissions as primary driver to anthropogenic climate change. The aim of the Bill is to achieve an effective climate change response through a long-term just transition to a low carbon economy that is climate resilient and allows for sustainable development of South Africa. When in force, the Bill will:

- Establish provincial and municipal forums on climate change which will be responsible for co-ordinating climate change response actions in each province.
- Strengthen the establishment of the Presidential Climate Change Coordinating Commission (4PC). Although, the 4PC has already been established and has been working for the Government since December 2020, its establishment only carries legal force after the Bill becomes an Act.
- Establish a National Adaptation Strategy to guide South Africa's adaptation to the impacts of climate change and develop adaptation scenarios which anticipate the likely impacts over the short, medium, and long term.
- Determine a national GHG emissions trajectory, which must be reviewed every five years, and which indicates an emissions reduction objective.

- Put in place a 5-yearly sectoral emission targets for identified sectors and sub-sectors that must be aligned with the national GHG emissions trajectory and include quantitative and qualitative GHG emission reduction goals.
- Bring into force the carbon budget allocation mechanism, which will be linked to the Carbon Tax Act, which will replace the current National Pollution Prevention Plan mechanism which is enforced under the National Environmental Management: Air Quality Act (NEM:AQA).

The Bill is nearing the end of its parliamentary process having been passed by the National Council of Provinces and been returned to the National Assembly for concurrence. It is likely to be enacted during the operational lifetime of the proposed project activities, if not before.

2.3 Nationally Determined Contribution

The first South African NDC submission was completed in 2016. This was undertaken to comply with decision 1/CP.19 and 1/CP.20 of the Conference of the Parties to the UNFCC. An update of the first NDC was published submitted to the UNFCCC on 27 September 2021[1] in preparation for the 26th Conference of the Parties (held in Glasgow, Scotland in November 2021). This document describes South Africa's NDC on adaptation, mitigation and finance and investment necessities to undertake the resolutions with updated revisions to the adaptation goals and mitigation targets.

As part of the updated adaption portion the following goals have been assembled:

1. Goal 1: Enhance climate change adaptation governance and legal framework.
2. Goal 2: Develop an understanding of the impacts on South Africa of 1.5 and 2°C global warming and the underlying global emission pathways through geo-spatial mapping of the physical climate hazards, and adaptation needs in the context of strengthening the key sectors of the economy. This will provide the scientific basis for strengthening the national and provincial governments' readiness to respond to climate risk.
3. Goal 3: Implementation of National Climate Change Adaptation Strategy adaptation interventions for the period 2021 to 2030, where priority sectors have been identified as biodiversity and ecosystems; water; health; energy; settlements (coastal, urban, rural); disaster risk reduction, transport infrastructure, mining, fisheries, forestry, and agriculture.
4. Goal 4: Mobilise funding for adaptation implementation through multilateral funding mechanisms.
5. Goal 5: Quantification and acknowledgement of the national adaptation and resilience efforts.

As part of the mitigation portion the following have been, or can be, implemented at National level:

- The approval of 79 (5 243 MW) renewable energy Independent Power Producer projects as part of a Renewable Energy Independent Power Producer Procurement Programme. An additional 6 300 MW is being deliberated.
- A "Green Climate Fund" has been created to back green economy initiatives. This fund will be increased in the future to sustain and improve successful initiatives.
- It is intended that by 2050 electricity will be decarbonised.
- Carbon Capture and Sequestration (or Carbon Capture and Storage) (CCS).
- To support the use of electric and hybrid electric vehicles.
- Reduction of emissions can be achieved through the use of energy efficient lighting; variable speed drives and efficient motors; energy efficient appliances; solar water heaters; electric and hybrid electric vehicles; solar photovoltaic; wind power; CCS; and advanced bioenergy.

[1] https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/South%20Africa%20First/South%20Africa%20updated%20first%20NDC%20September%202021.pdf

- Updated targets based on revised 100-year global warming potential (GWP) factors (published in the Annex to decision 18/CMA.1 of the Intergovernmental Panel on Climate Change's (IPCC) fifth assessment report (AR5) and based on exclusion of land sector emissions arising from natural disturbance. The updated NDC mitigation targets, consistent with South Africa's fair share, are presented in Table 2-1.

Table 2-1: South Africa's NDC mitigation targets

Year	Target	Corresponding period
2025	South Africa's annual GHG emissions will be in a range between 398 - 510 Mt CO_2-e.	2021-2025
2030	South Africa's annual GHG emissions will be in a range between 398 - 440 Mt CO_2-e.	2026-2030

2.4 Greenhouse Gas Emissions Reporting

Regulations pertaining to GHG reporting using the National Atmospheric Emission Inventory System (NAEIS) were published on 3 April 2017 (Government Notice (GN) 257 in Government Gazette 40762 and amendment – GNR 994 in Government Gazette 43712). The South African mandatory reporting guidelines focus on the reporting of Scope 1 emissions only. The proposed project – with a will be required to register (within 30 days of commissioning the facility) and report GHG emissions annually (under the category 1A2E – Energy use in Food Processing, Beverages and Tobacco). The three broad scopes for estimating GHG are:

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

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

The DFFE is working together with local sectors to develop country specific emissions factors in certain areas; however, in the interim the IPCC's default emission figures may be used to populate the SAAQIS GHG emission factor database. These country specific emission factors will replace some of the default IPCC emission factors. Methodological guidelines for GHG emission estimation, which include country specific emission factors for fuels used in stationary and mobile combustion, have been issued (DFFE, 2022b)

Also, the Carbon Tax Act (Act 15 of 2019) includes details on the imposition of a tax on the CO_2-e of GHG emissions. Certain production processes indicated in Annexure A of the Declaration of Greenhouse Gases as Priority Pollutants (GN 710 in GG 40966, 21 July 2017) with GHG more than 0.1 Mt/year (100 000 tonnes/year), reported as carbon dioxide equivalent (CO_2-e), are required to submit a pollution prevention plan to the Minister for approval. The proposed project will be required to report CO_2-e emissions but may not be required to prepare a pollution prevention plan, unless directed by the minister.

2.5 GHG Inventories

2.5.1 National GHG Emissions Inventory

South Africa is a GHG contributor and is undertaking steps to mitigate and adapt to the changing climate. DFFE is categorised as the lead climate change institution and is required to coordinate and manage climate related information such as development of mitigation, monitoring, adaption and evaluation strategies (DFFE, 2022a). This includes the establishment and updating of the National GHG Inventory. The National Greenhouse Gas Improvement Programme (GHGIP) has been initiated; it includes sector specific targets to improve methodology and emission factors used for the different sectors as well as the availability of data.

The 2022 National GHG Inventory was prepared using the 2006 IPCC Guidelines (IPCC, 2006). According to the draft 9th National GHG Inventory Report (DFFE, 2024), the total GHG emissions in 2022 were estimated at approximately 478.888 $MtCO_2$-e (excluding Land Use, Land Use Change and Forestry - LULUCF). This was a 2.2% decrease from the 2000 total GHG emissions (excluding LULUCF). LULUCF is estimated to be a net carbon sink which reduces the 2022 GHG emissions to 435.828 $MtCO_2$-e. The assessment (excluding LULUCF) showed the main sector contributing to GHG emissions in 2022 to be the energy sector, contributing 78% to the total GHG emissions.

2.5.2 GHG Emission Inventory for the Sector

The proposed project would be categorised in the Energy category for both the global GHG inventory and for the national GHG inventory, reporting under subcategory 1A2e – Energy use in Food Processing, Beverages and Tobacco. According to the World Resources Institute – CAIT Climate Data Explorer[2] the 2021 global GHG emissions from the energy category were approximately 36 020 Mt CO_2e. The South African Energy sector contributed 426.2 Mt CO_2e, ~1% of the global emissions from the Energy sector in 2021.

2.5.3 Draft National Guideline for Consideration of Climate Change in Development Applications, June 2021

The DFFE published (on 25 June 2021) a notice under the NEMA requesting public comment on the *Draft National Guideline for the consideration of climate change implications in applications for environmental authorisation, atmospheric emission licences and waste management licences.*

The Draft National Guideline has been developed to support the inclusion of climate change considerations into the Environmental Impact Assessment (EIA) process, and to create a consistent approach for such incorporation, which will help proponents to assess:

- how a proposed development will likely exacerbate climate change;
- the impact of a development on features (natural and built) that are crucial for climate change adaptation and resilience; and,
- the sustainability of a development in the context of climate change projection.

The Guideline puts forward "a consistent approach in providing interested and affected parties (for example, proponents, EAPs and specialists) with the minimum requirements to consider when undertaking a climate change assessment, which forms part of an application for environmental authorisation, an atmospheric emissions licence, and/or waste management licence". One of the impact requirements for a climate change assessment is an estimation of the GHG emissions, direct and indirect (including upstream GHG emissions) that will be released into the atmosphere annually throughout the impact related to the activity.

The comment period for amendments to the draft guideline has now closed but the final guideline has not yet been published. As far as possible the guideline has been followed in the preparation of this climate change impact assessment in support of environmental authorisation.

2 http://cait.wri.org/

3 PHYSICAL RISKS OF CLIMATE CHANGE ON THE REGION

The discussions of physical risks of climate change discussed in this section are likely to be relevant to the project as well as to the communities surrounding the project even if the project is not authorised.

3.1 Vulnerability

The Green Book (CSIR, 2024); was developed to be an online platform providing quantitative scientific evidence on the likely impacts that climate change and urbanisation will have on South Africa's cities and towns. A profile for each local municipality, including individual settlements and neighbourhoods, was built in terms the rates of socio-economic, economic, physical and environmental risks associated with urbanisation, population growth and climate change (Le Roux, et al., 2019). The risk profile was accessed for the Midvaal Local Municipality[3]. The Midvaal Local Municipality socio-economic vulnerability score[4] (out of 10) is 3.0 for 1996, reducing to 2.2 for 2011. The lower score in 2011 compared to 1996 indicates improvement of socio-economic factors. The Midvaal Local Municipality for socio-economic vulnerability ranks 4th out of 9 in the province and 26th out of 213 in the country. The Midvaal Local Municipality economic vulnerability score[5] (out of 10) is 2.9 for 1996, increasing to 5.1 for 2011. This high score indicates high economic pressure. The economic vulnerability ranks 4th out of 9 in the province and 88th out of 213 in the country. The physical vulnerabilities[6] ranks 6th out of 9 in the province and 40th out of 213 in the country. The environmental vulnerability[7] ranks 1st out of 9 in the province and 96th out of 213 in the country.

3.2 Climate

3.2.1 Baseline Climate

Climate change metrics focus on temperature; the number of very hot days (where temperatures exceed 35°C); rainfall and extreme rainfall events (more than 20 mm in 24 hours). The baseline (1961 to 1990) annual averages for these metrics were accessed for the area near the project site from the South Africa 'Green Book'[8] (CSIR, 2024). The metrics include three percentiles[9] (10th, 50th, and 90th) as an indication of the variability within the measured data set.

Baseline annual average temperature was in the range 15.78°C (10th percentile) and 16.02°C (90th percentile) (Figure 3-1) with the number of very hot days varying between 0.74 (10th percentile) and 1.22 (90th percentile) days per year (Figure 3-2). The rainfall ranges between 951 mm (10th percentiles) and 983 mm (90th percentiles) (Figure 3-3). Extreme rainfall days varied between 7.7 (10th percentile) and 9.3 (90th percentile) days per year (Figure 3-4).

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[3] https://riskprofiles.greenbook.co.za/

[4] Defined as the vulnerability of households based on household composition; education and health; access to basic services; safety and security.

[5] Defined as the susceptibility of the municipality to external shocks based on economic diversity; size of economy; labour force; gross domestic product (GDP) growth rate; and inequality.

[6] Defined by the physical fabric of connectedness of the settlements within the municipalities and structural robustness.

[7] This indicator represents the balance between preserving the natural environmental and the pressures of population growth, urbanisation, and economic development. The indicator is based on air quality, environmental governance and competition between ecology and the urban environment.

[8] https://greenbook.co.za/

[9] A percentile is a statistical measure to indicate the value below which a given percentage of observations in a group of observations falls. For example, the 90th percentile is the value below which 90% of the observations fall. The 10th percentile is the value below which 10% of the observations fall.

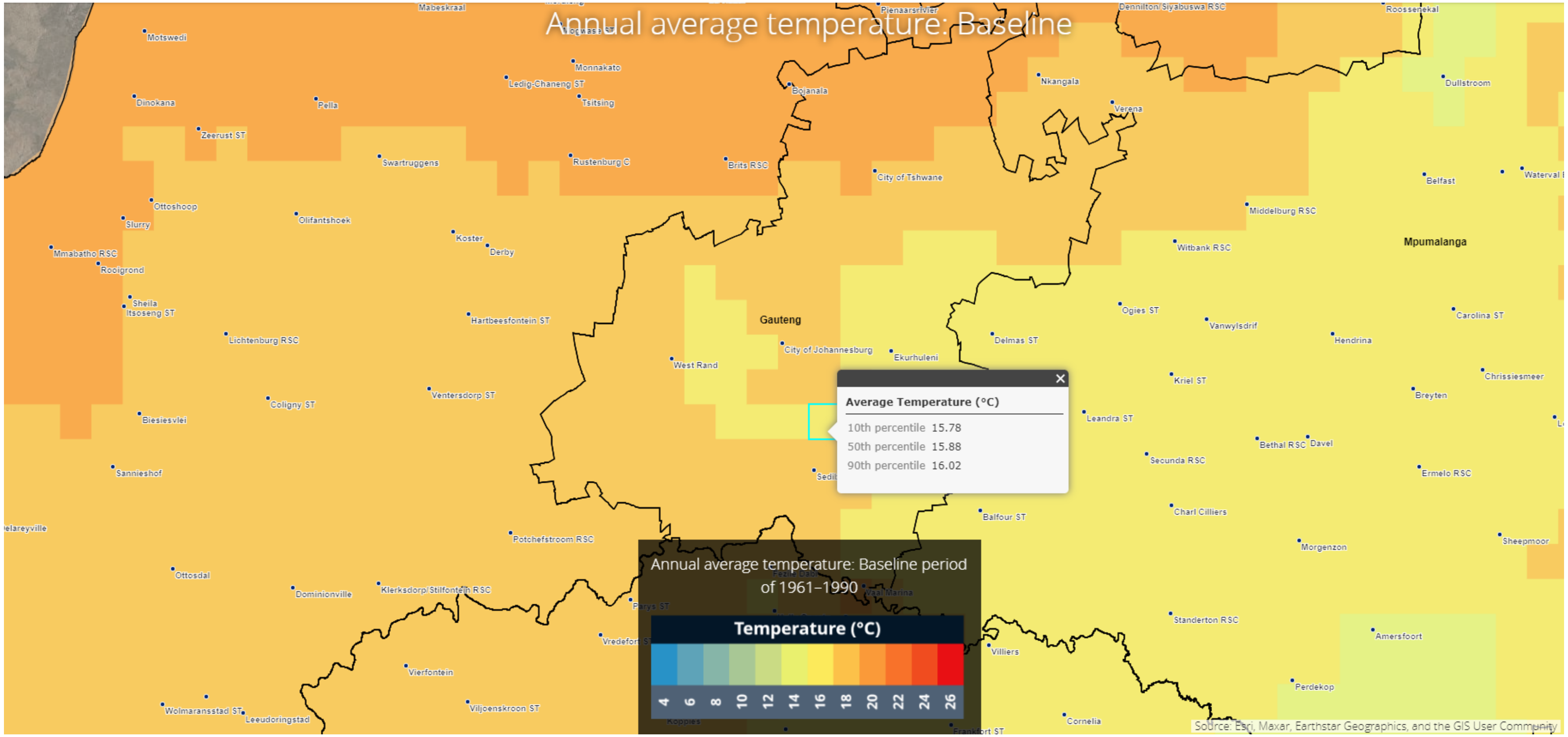


Figure 3-1: Baseline (1961 to 1990) annual average temperature for the project area (CSIR, 2024)

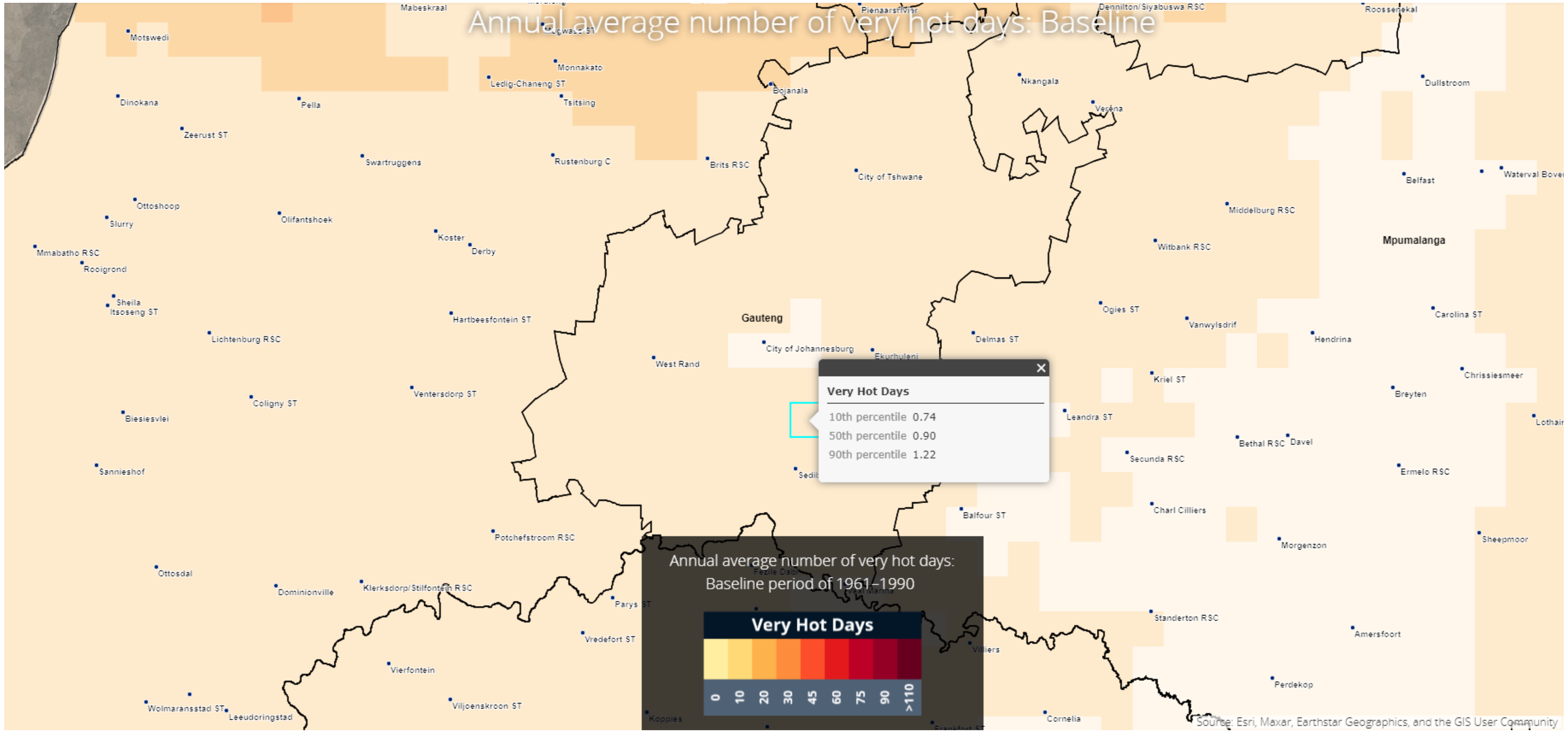


Figure 3-2: Baseline (1961 to 1990) number of very hot days (>35°C) annually for the project area (CSIR, 2024)

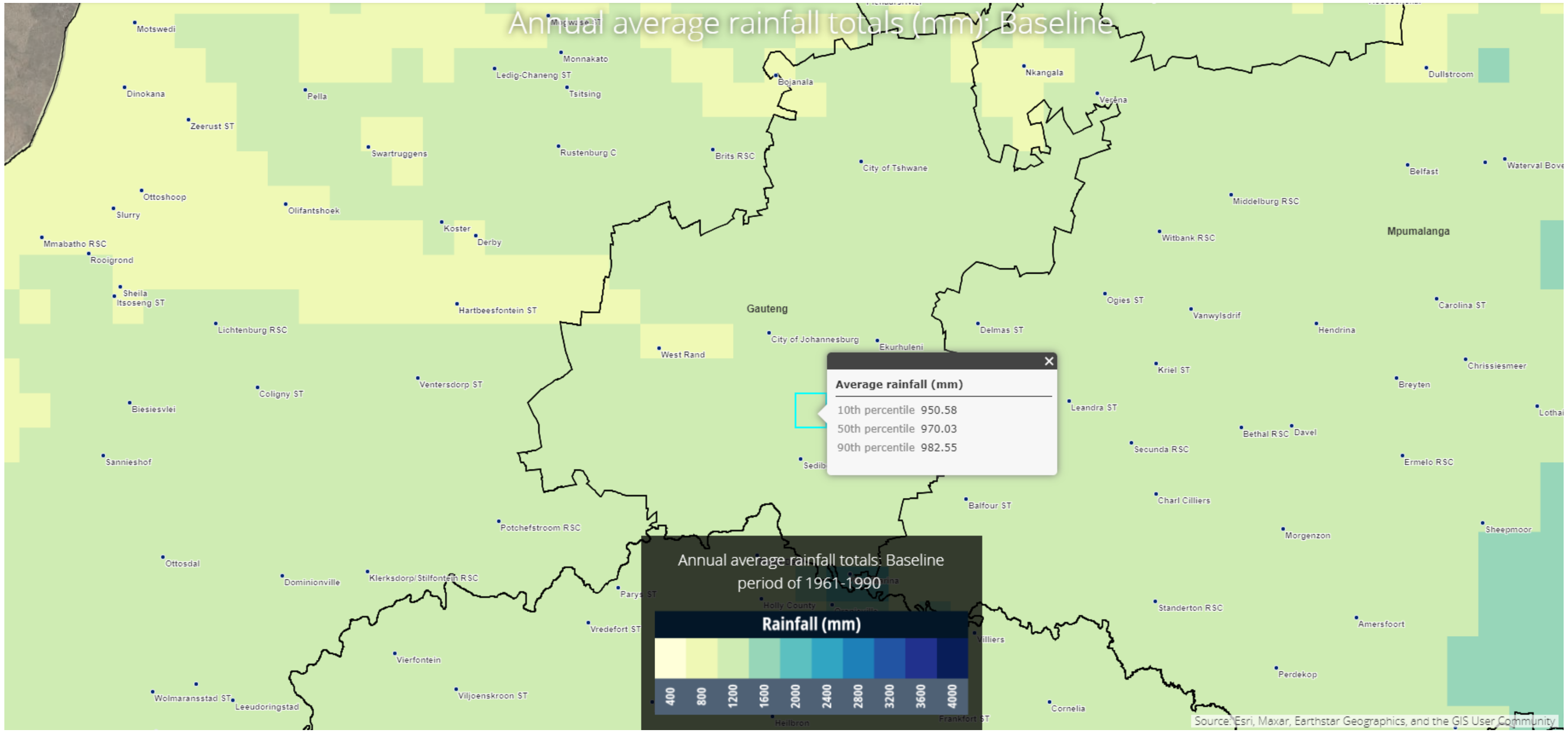


Figure 3-3: Baseline (1961 to 1990) annual average rainfall for the project area (CSIR, 2024)

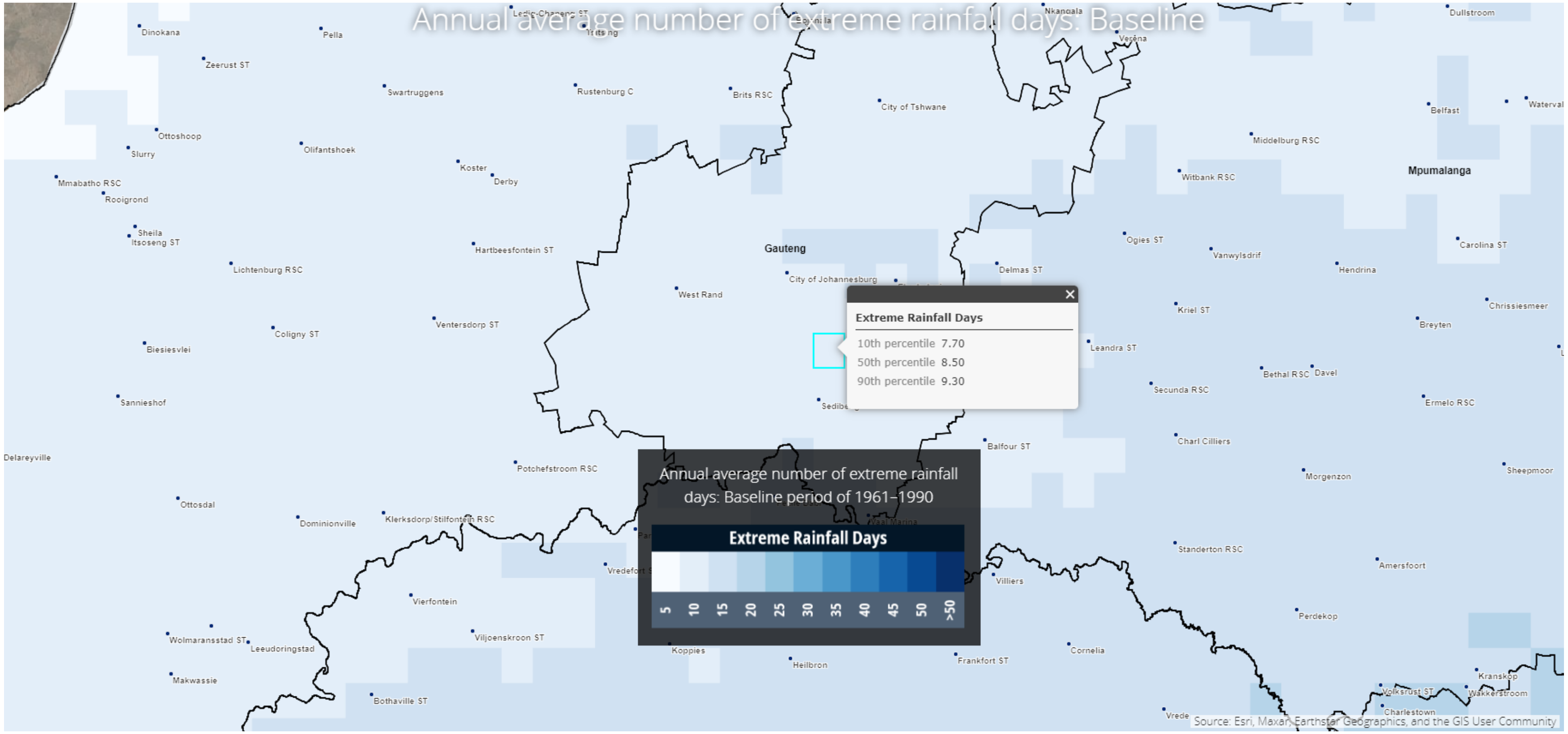


Figure 3-4: Baseline (1961 to 1990) annual average number of extreme rainfall days (>20 mm in <24 hours) for the project area (CSIR, 2024)

Recent changes in climatic conditions near the project site were accessed from MeteoBlue[1] a weather forecasting platform developed at the University of Basel, Switzerland and based on models of National Oceanic and Atmospheric Administration (NOAA) or National Centres for Environmental Prediction (NCEP). The data sets also include historical climate data tracking changes in climate by referencing ERA5, the fifth generation ECMWF (European Centre for Medium-Range Weather Forecasts) atmospheric reanalysis of the global climate, for the period between 1979 to 2023, with a spatial resolution of 30 km. Based on a point selected close to the project site, a slight increase in the annual average temperatures have been observed with temperatures measuring 15.9°C in 1979 to 17.4°C in 2023 (Figure 3-5 – top panel). The lower part the graph shows the so-called warming stripes. Each coloured stripe represents the average temperature for a year - blue for colder and red for warmer years. The change in rainfall over the same period (1979 – 2023) displays a slight decreasing trend (Figure 3-6), where the difference from long-term average for each year in the data set is visualised by the stripes in the lower panel of Figure 3-6 (brown stripes indicate lower than average rainfall and green stripes above average rainfall).

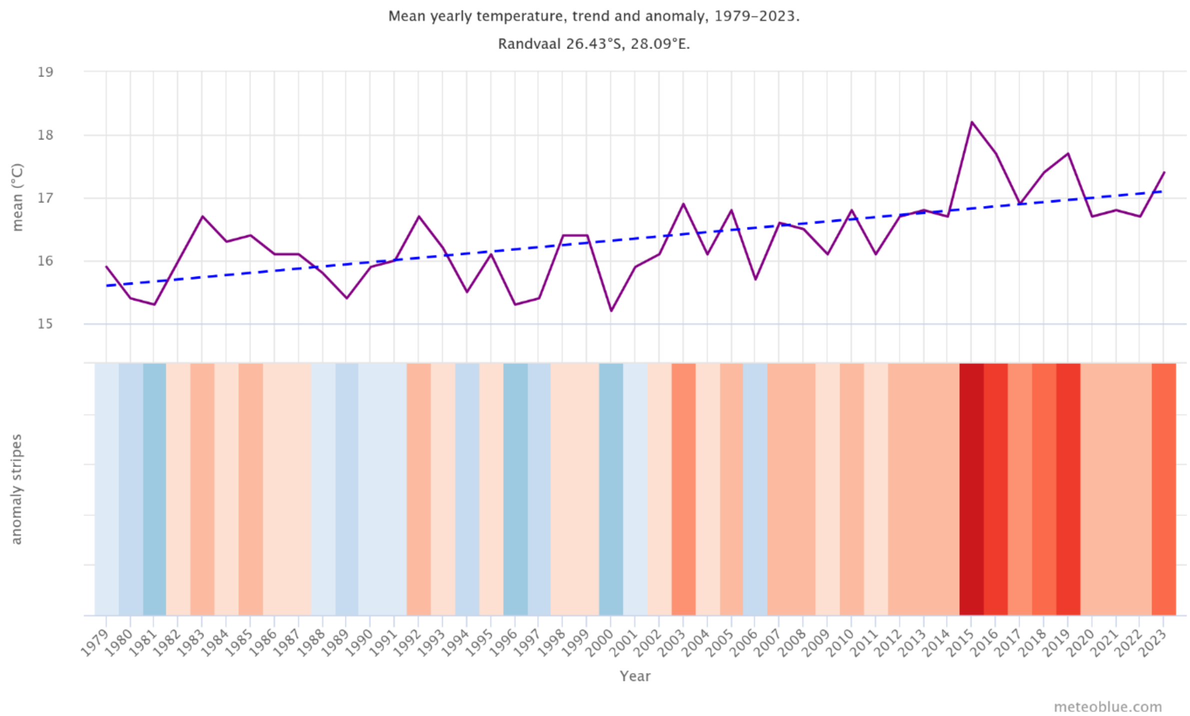


Figure 3-5: Annual average temperature (top panel) and temperature anomaly (lower panel) between 1979 and 2023 (meteoblue AG, 2024)

[1] https://www.meteoblue.com

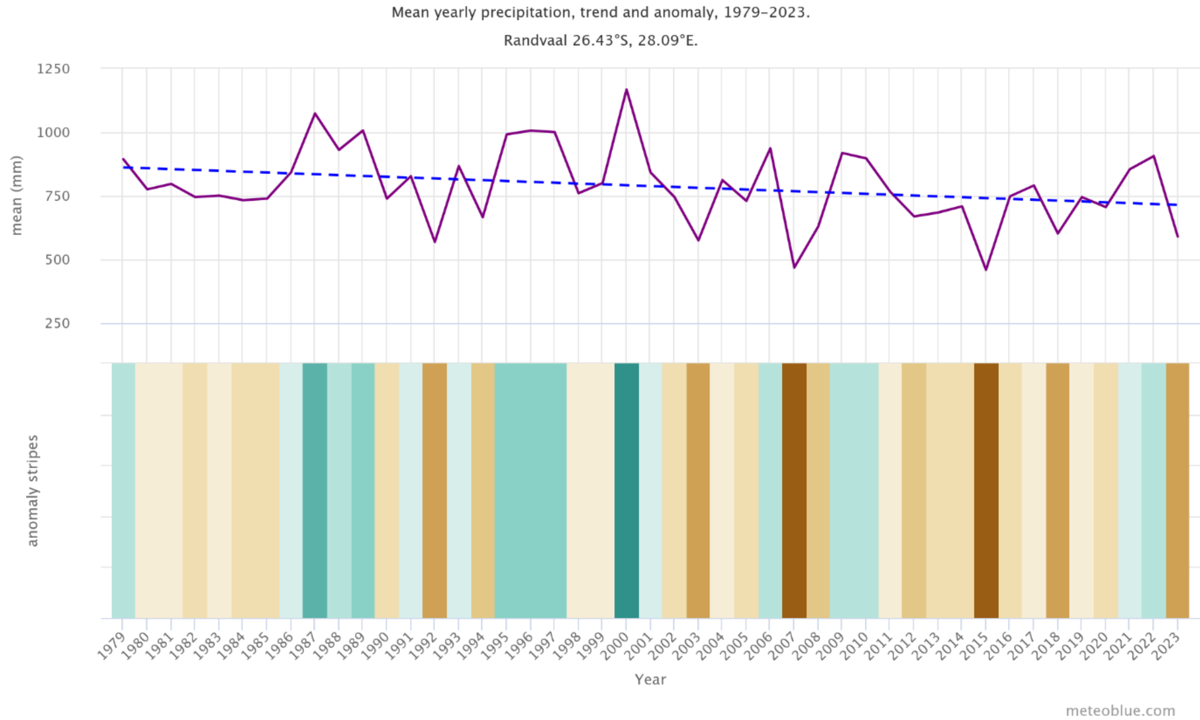


Figure 3-6: Annual average rainfall (top panel) and rainfall anomaly (lower panel) between 1979 and 2023 (meteoblue AG, 2024)

3.2.2 Projected Future Climate

Findings from downscaled climatic simulations using six global climate models, at an 8 km x 8 km resolution over South Africa, for the time slab 2021 to 2050 were included in the Green Book (CSIR, 2024; Engelbrecht, 2019).

In the Green Book, two trajectories are included downscaled projections for South Africa based on the four Representative Concentration Pathways (RCPs) discussed in the IPCC's AR5[2] (IPCC, 2013). RCPs are defined by their influence on atmospheric radiative forcing in the year 2100. RCP4.5 represents an addition to the radiation budget of 4.5 W/m^2 as a result of an increase in GHGs. The two RCPs selected were RCP4.5 representing the medium-to-low pathway and RCP8.5 representing the high pathway. RCP4.5 is based on a CO_2 concentration of 560 ppm and RCP8.5 on 950 ppm by 2100. RCP4.5 is based on if current interventions to reduce GHG emissions being sustained (after 2100 the concentration is expected to stabilise or even decrease). RCP8.5 is based on if no interventions to reduce GHG emissions being implemented (after 2100 the concentration is expected to continue to increase).

3.2.2.1 RCP4.5 Trajectory

The Green Book projected temperature changes in the near future (2021 to 2050) indicate a 50th percentile increase of 2.25°C and a 90th percentile increase of 2.74°C (Figure 3-7, Engelbrecht, 2019). The number of very hot days are expected to increase to 7.8 days per year (50th percentile) (Figure 3-8). Between 2021 and 2050 the annual rainfall near the project site was projected to increase by 55 mm per year (50th percentile) (Figure 3-9, Engelbrecht, 2019), with extreme rainfall days increasing by 1.2 (50th percentile) (Figure 3-10, Engelbrecht, 2019).

[2] While the IPCC Sixth Assessment Report (AR6) is more recent, it is based on climate projections at a scale of 100 km x 100 km. The Greenbook includes locally downscaled (8 km x 8 km) and re-projected impacts based on the same input data used in AR5, but this has not yet been updated with the input data used for the global climate projections in AR6.

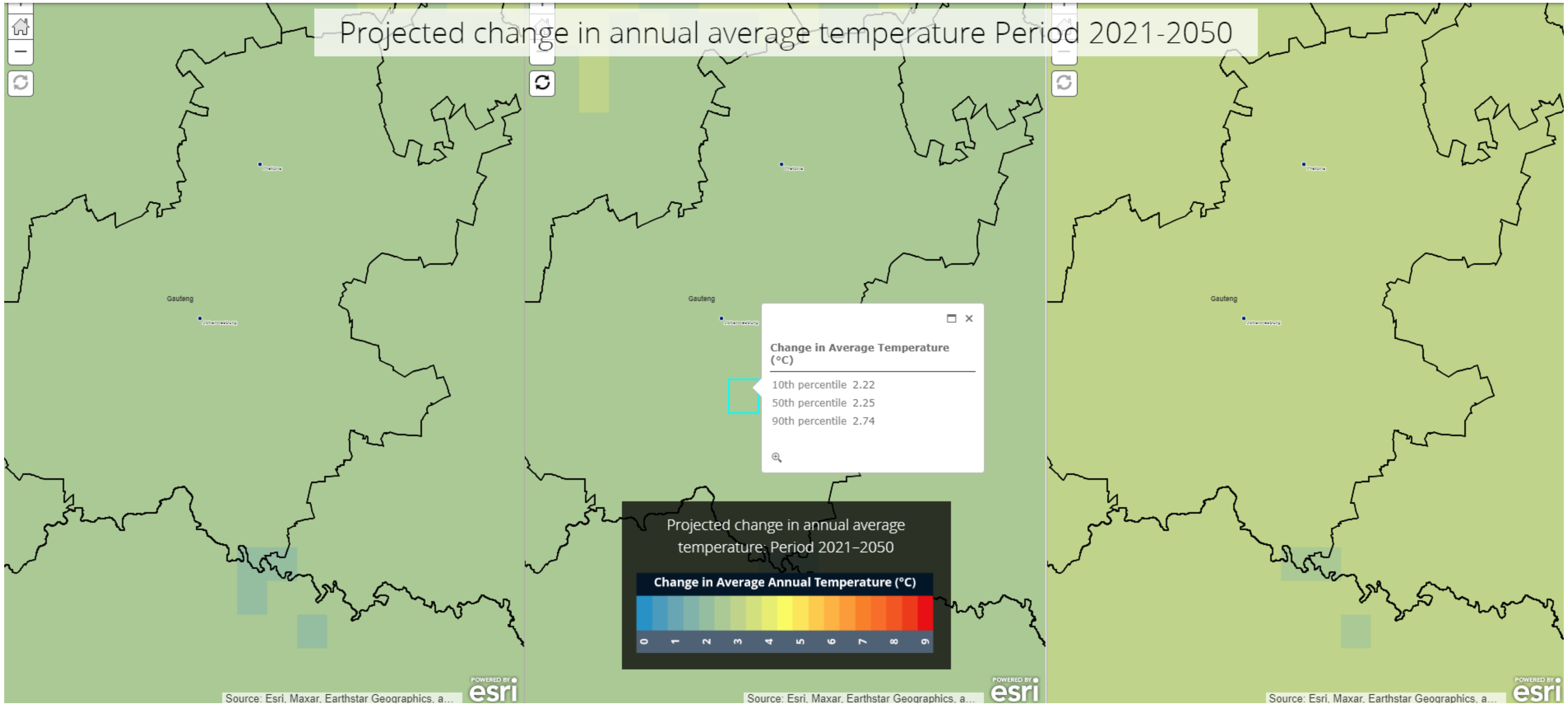


Figure 3-7: Projected change in annual average temperature for the near future (2021 – 2050) for the RCP4.5 trajectory

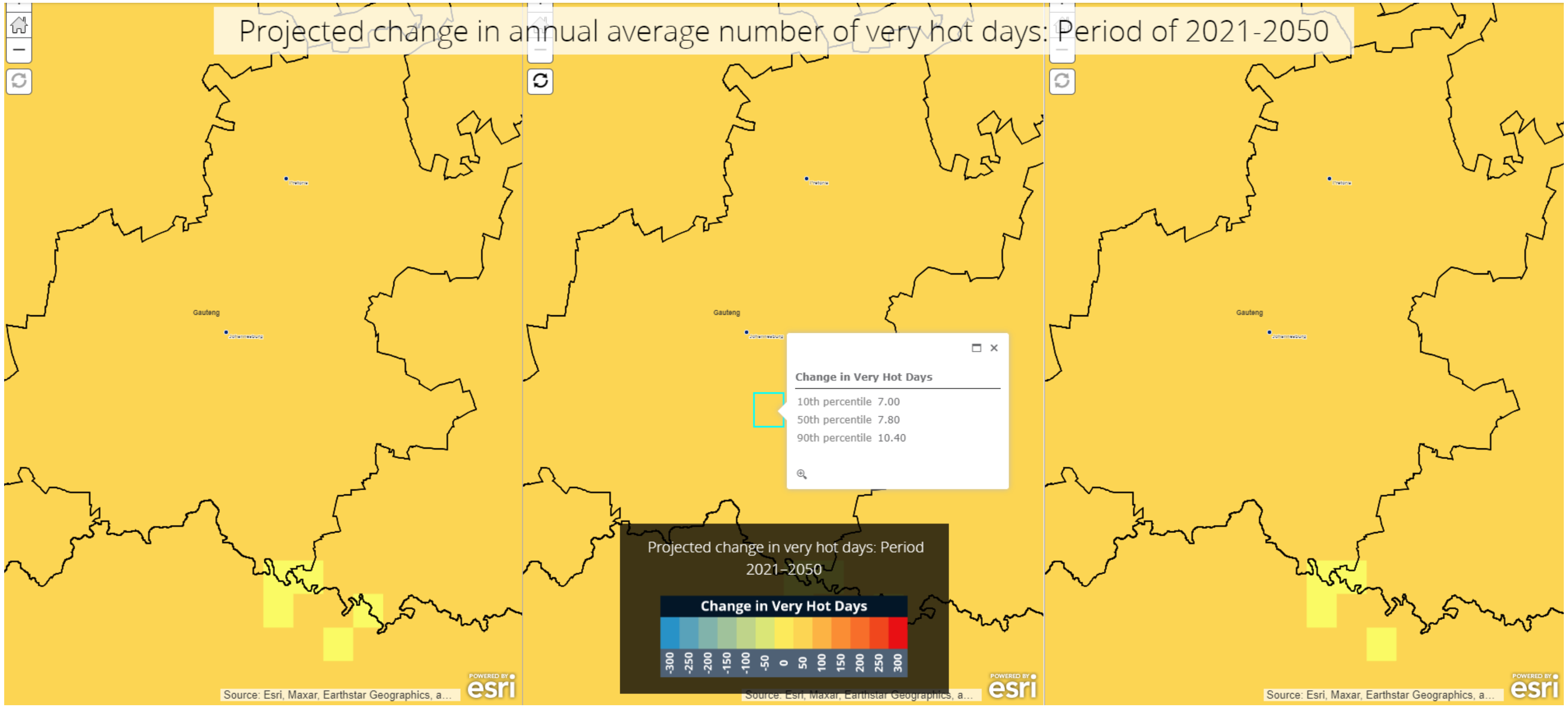


Figure 3-8: Projected change in very hot days for the near future (2021 – 2050) for the RCP4.5 trajectory

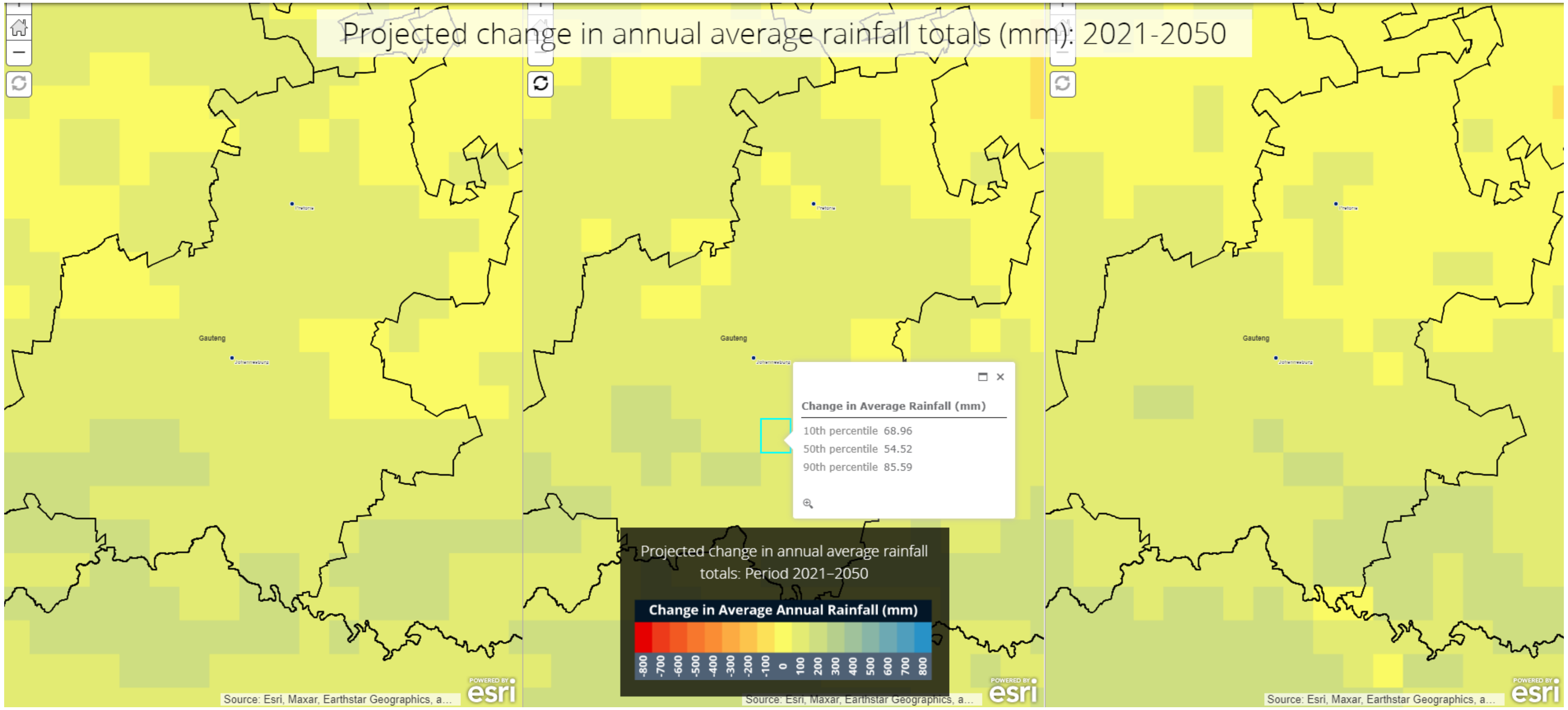


Figure 3-9: Projected change in annual average rainfall for the near future (2021 – 2050) for the RCP4.5 trajectory

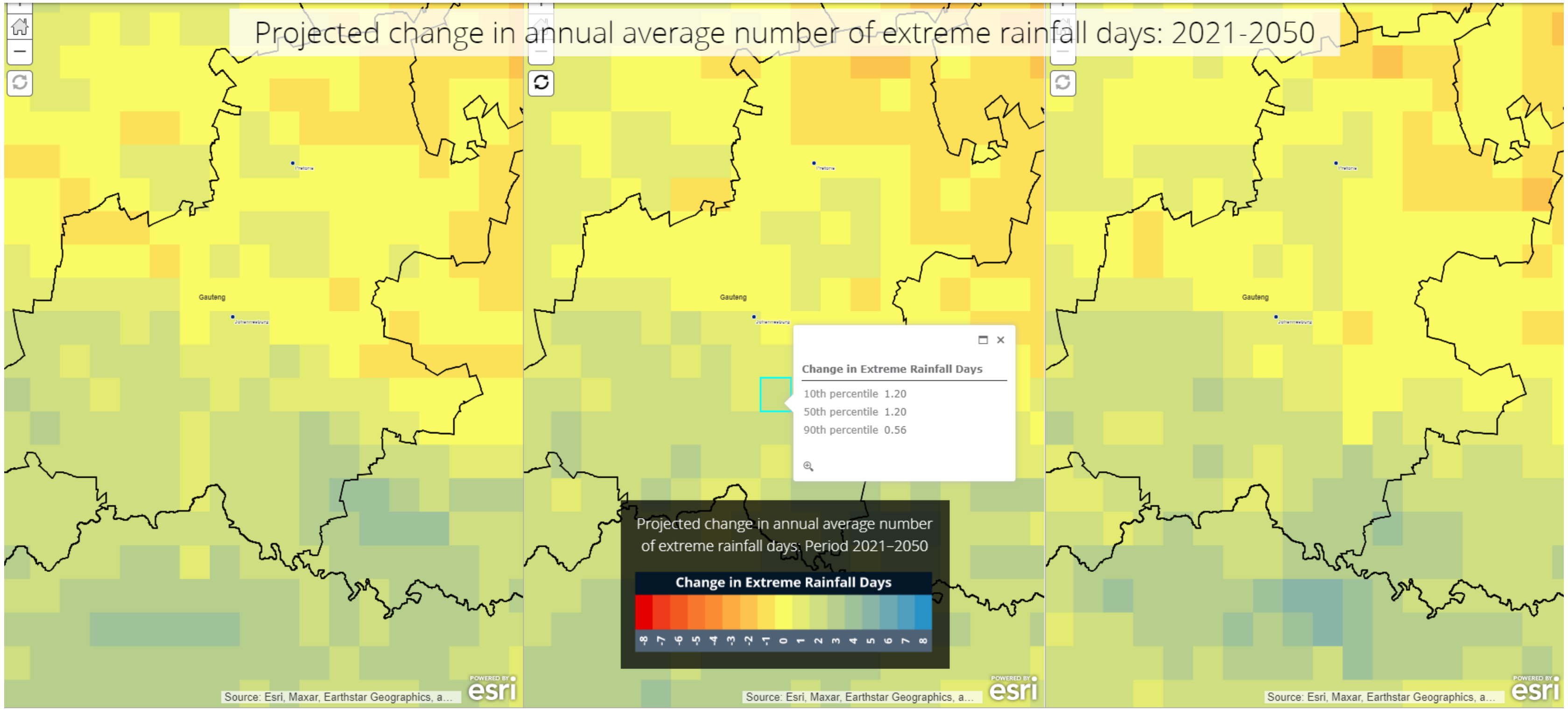


Figure 3-10: Projected change in annual average number of extreme rainfall days (>20 mm in <24 hours) for RCP4.5 trajectory

3.2.2.2 RCP8.5 Trajectory

The Green Book projected temperature changes in the near future (2021 to 2050) indicate a 50th percentile increase of 2.76°C and a 90th percentile increase of 3.08°C (Figure 3-11, Engelbrecht, 2019). The number of very hot days are expected to increase to 10.2 days per year (50th percentile) (Figure 3-12). Between 2021 and 2050 the annual rainfall near the project site was projected to increase by 89 mm per year between 2021 and 2050 (50th percentile) (Figure 3-13, Engelbrecht, 2019), with extreme rainfall days increasing to 1.3 (50th percentile) (Figure 3-14, Engelbrecht, 2019).

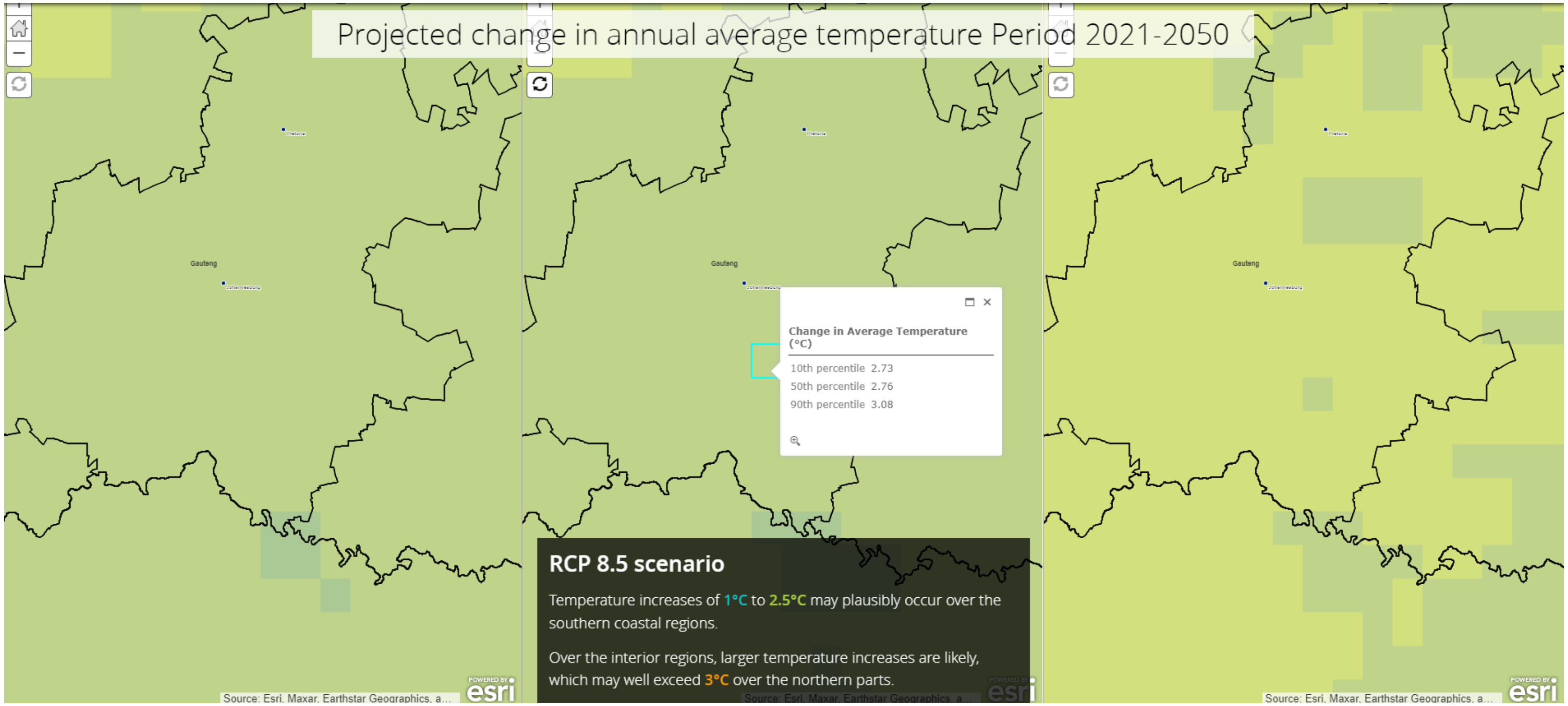


Figure 3-11: Projected change in annual average temperature for the near future (2021 – 2050) for the RCP8.5 trajectory

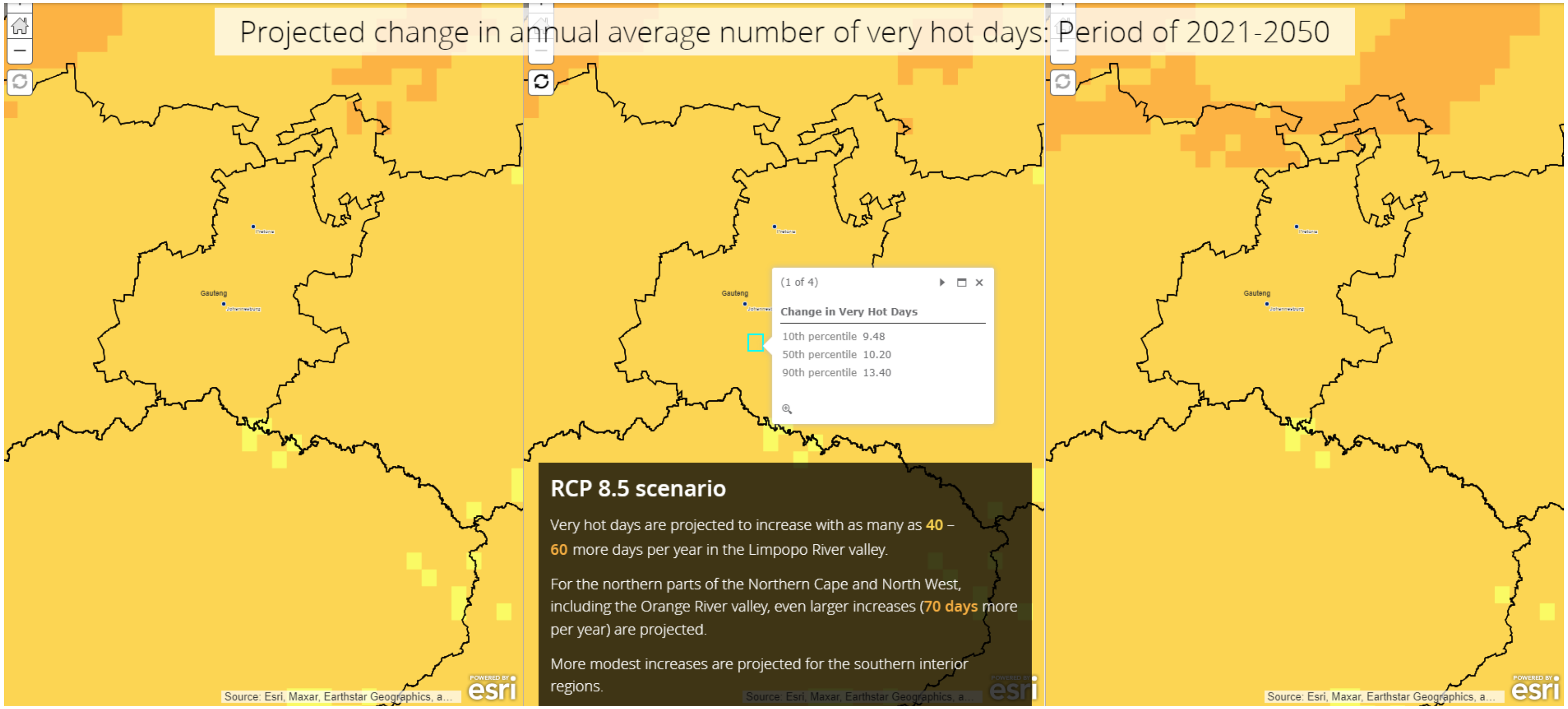


Figure 3-12: Projected change in very hot days for the near future (2021 – 2050) for the RCP8.5 trajectory

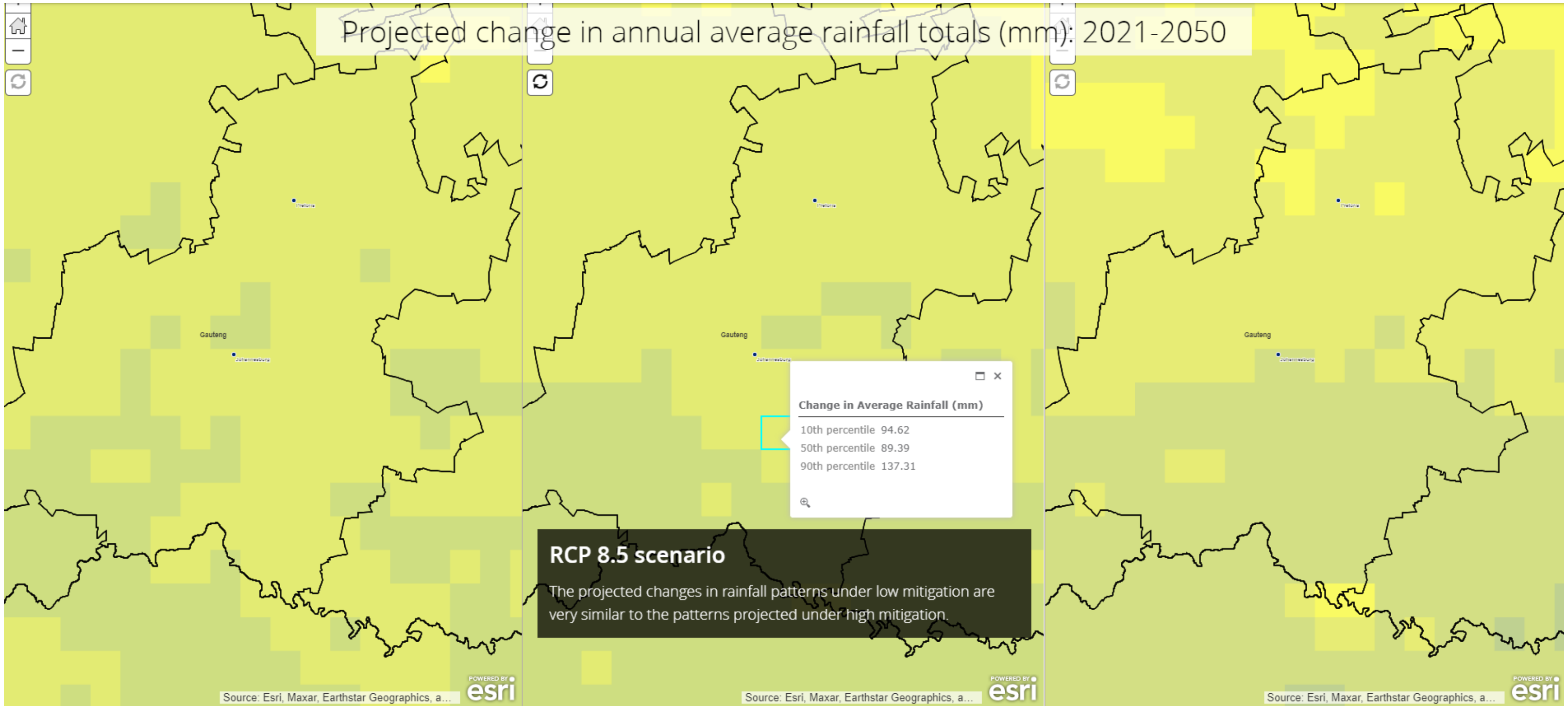


Figure 3-13: Projected change in annual average rainfall for the near future (2021 – 2050) for the RCP8.5 trajectory

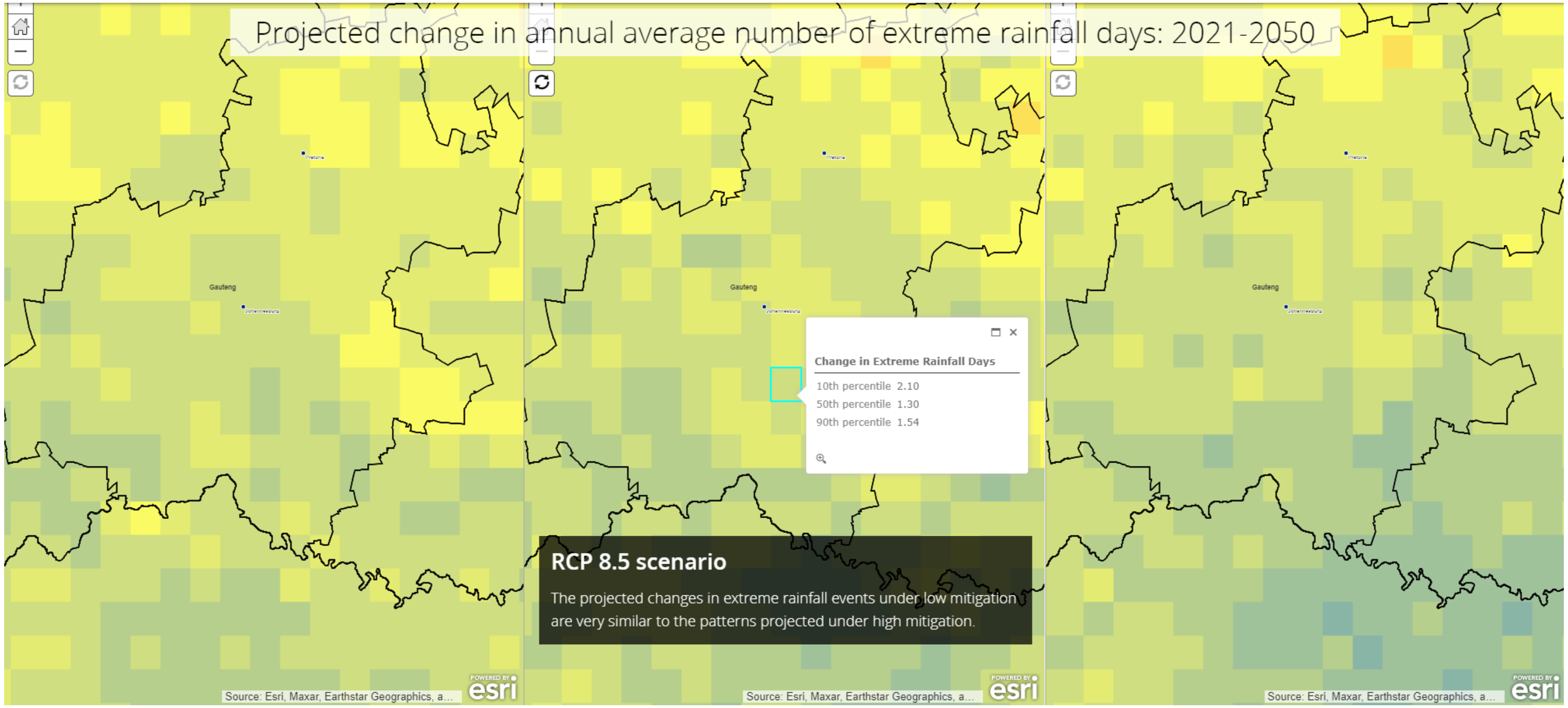


Figure 3-14: Projected change in annual average number of extreme rainfall days (>20 mm in <24 hours) for RCP8.5 trajectory

3.2.2.3 *IPCC's Sixth Assessment Report: Temperature and Rainfall Projections*

The most recent IPCC data are from the Coupled Model Intercomparison Project (CMIP) which were derived from the sixth phase of the CMIPs (CMIP6) and supports the IPCC's Sixth Assessment Report (AR6) which was released on 9 August 2021 (Working Group I), 28 February 2022 (Working Group II) and 4 April 2022 (Working Group III). Projection data is presented at a 1.0º x 1.0º (100 km x 100 km) resolution. The scenarios are the result of complex calculations that depend on how quickly humans curb greenhouse gas emissions, whilst also capturing socioeconomic changes in areas such as population, urban density, education, land use and wealth. For example, a rise in population is assumed to lead to higher demand for fossil fuels and water. Education can affect the rate of technology developments. Emissions increase when land is converted from forest to agricultural land. Each scenario is labelled to identify both the emissions level and the so-called Shared Socioeconomic Pathway, or SSP, used in those calculations. This first scenario is the only one that meets the Paris Agreement's goal of keeping global warming to around 1.5°C above preindustrial temperatures, with warming hitting 1.5°C but then dipping back down and stabilizing around 1.4°C by the end of the century. Projected changes are defined relative to a historical 29-year period (1981 to 2010).

The AR6 projections for the study area for the scenario RCP4.5 indicate an increase in annual average temperatures of 1.9°C for the period 2041 to 2060. The projections for the RCP8.5 indicate an increase in annual average temperatures of 2.5°C for the period 2041 to 2060 (IPPC, 2024). Although the AR5 and AR6 projections are based on different baselines, and the definitions of the scenarios are not exactly the same, the temperature projections are similarly increasing for the two future scenarios with the projections for the AR6 slightly lower than for the AR5.

The AR6 projections for rainfall in the study area for RCP4.5 indicate a decrease in annual rainfall of 4% for the period 2041 to 2060. The projections for RCP8.5 indicate a decrease of rainfall of 3.7% for the period 2041 to 2060 (IPPC, 2024). This projection is different to that of the AR5 that indicates an increase in rainfall for both future scenarios. These differences, however, could be accounted for in the different baselines used, the difference in averaging periods (i.e. mean verses percentiles) and the difference in projected period (i.e. 2021 – 2050 and 2041 – 2060).

3.3 Hazards

The Green Book risk profile includes an assessment of projected risk to the Midvaal Local Municipality in 2050, mostly based on the low mitigation RCP8.5 climate simulations, and highlights the following:

- The area of the project is at unknown (but likely low to moderate) risk of wildfires with the projection of 27 fire danger days over the project area (Figure 3-15);
- The area of the project has an unknown risk (likely low) of drought with the Standardized Precipitation Index (SPI)[16] of -1.06 for the project area (Figure 3-16);
- The area of the project has an unknown (likely medium) risk of encountering increasing heat stresses (Figure 3-17); and,
- The area of the project has an unknown risk of flooding (likely moderate) with a slight increase in extreme rainfall days for the project area (0.99) (Figure 3-18).

[16] The Standardized Precipitation Index (SPI) is a widely used index to characterize meteorological drought on a range of timescales. SPI index.

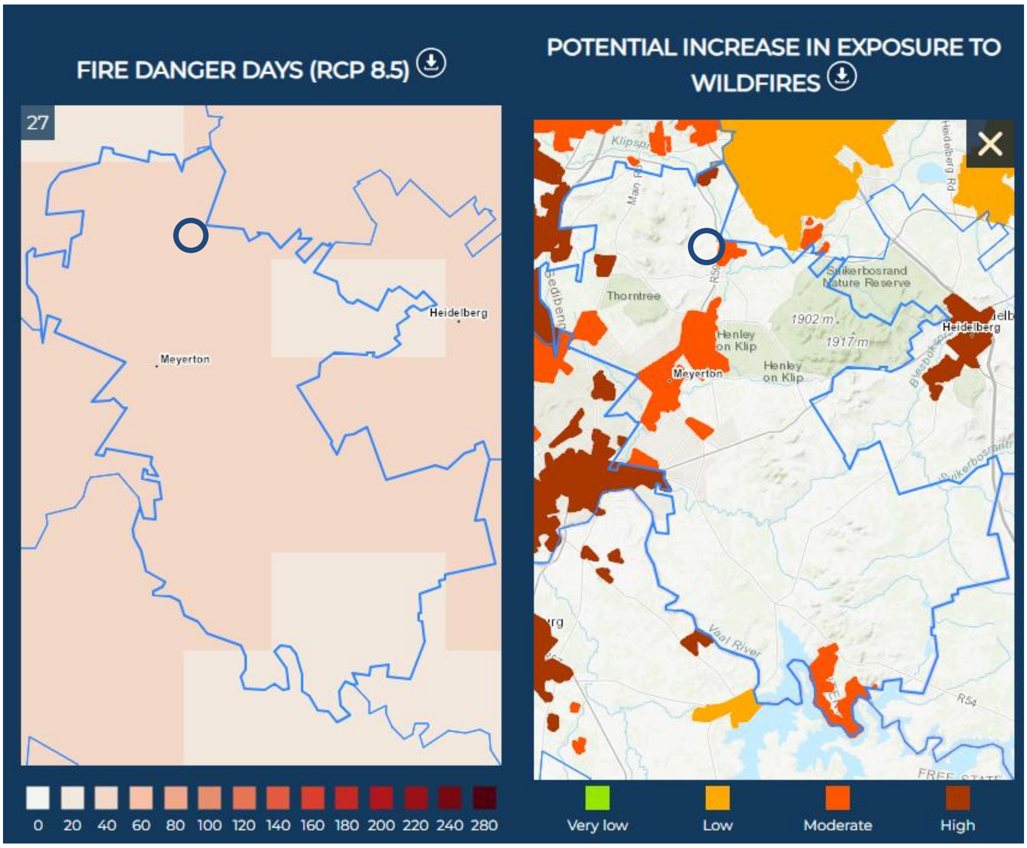


Figure 3-15: Risk of increased wildfires for Midvaal Local Municipality in 2050 based on RCP8.5 trajectory (dark blue marker indicates approximate location of the project)

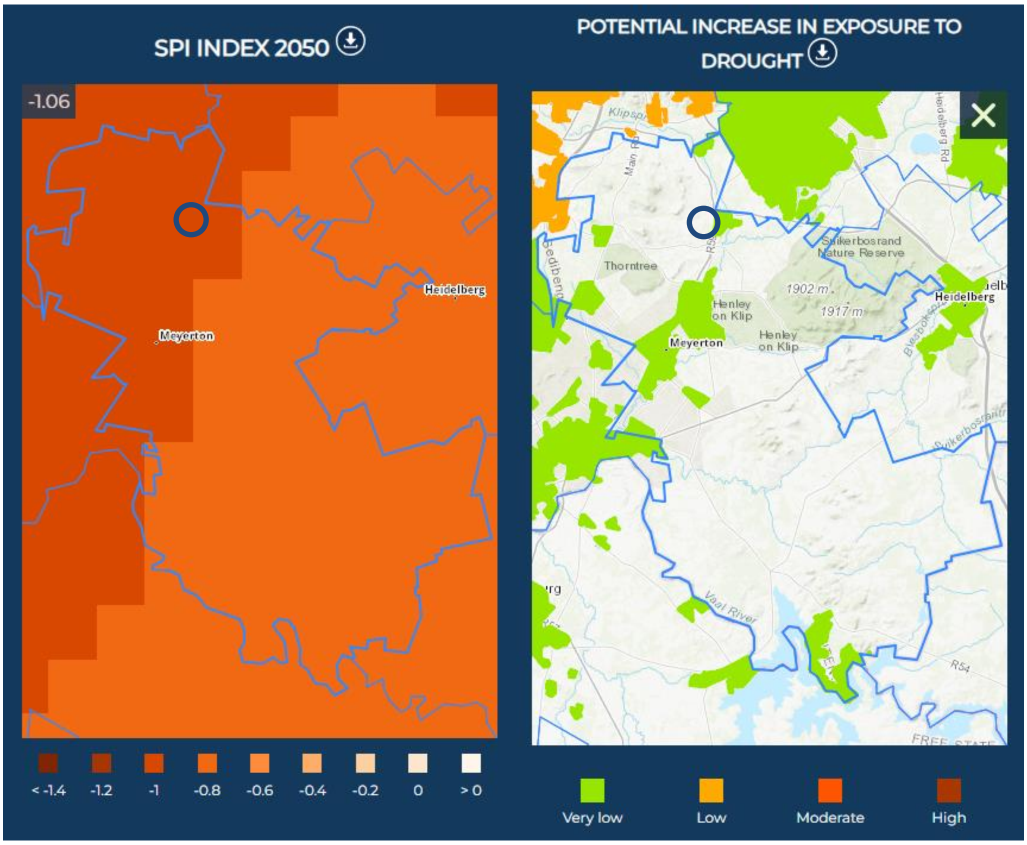


Figure 3-16: Risk of increased drought tendencies for Midvaal Local Municipality in 2050 based on RCP8.5 trajectory (dark blue marker indicates approximate location of the project)

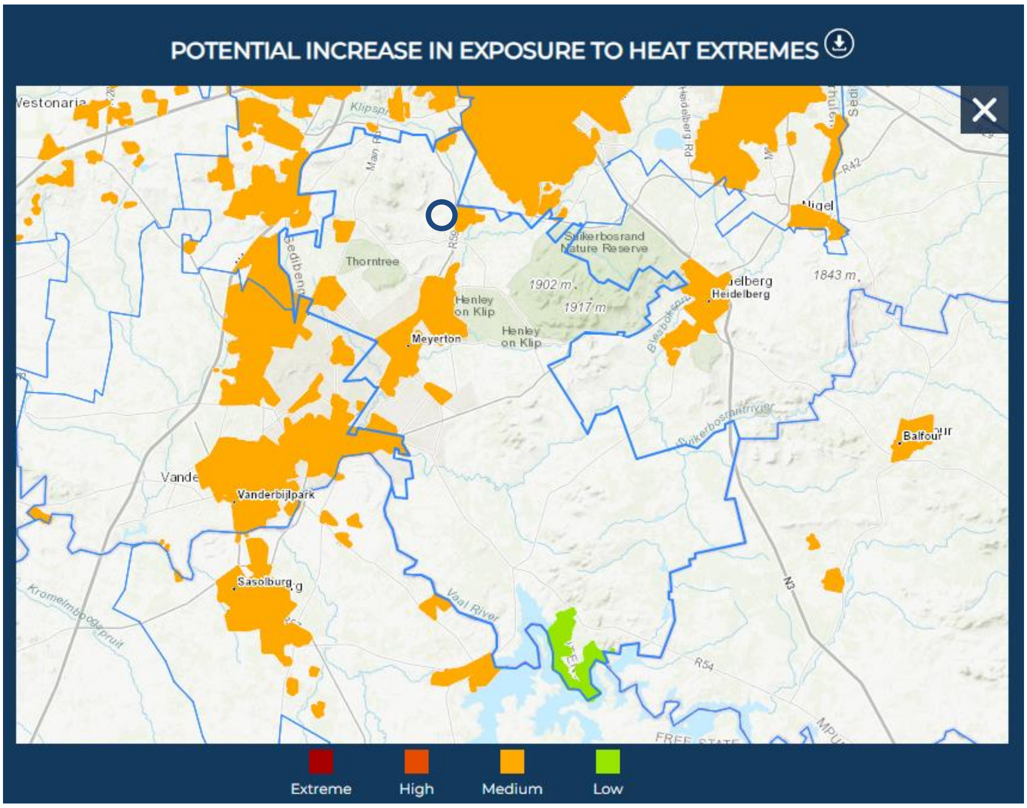


Figure 3-17: Risk of increased heat extremes for Midvaal Local Municipality in 2050 based on RCP8.5 trajectory (dark blue marker indicates approximate location of the project)

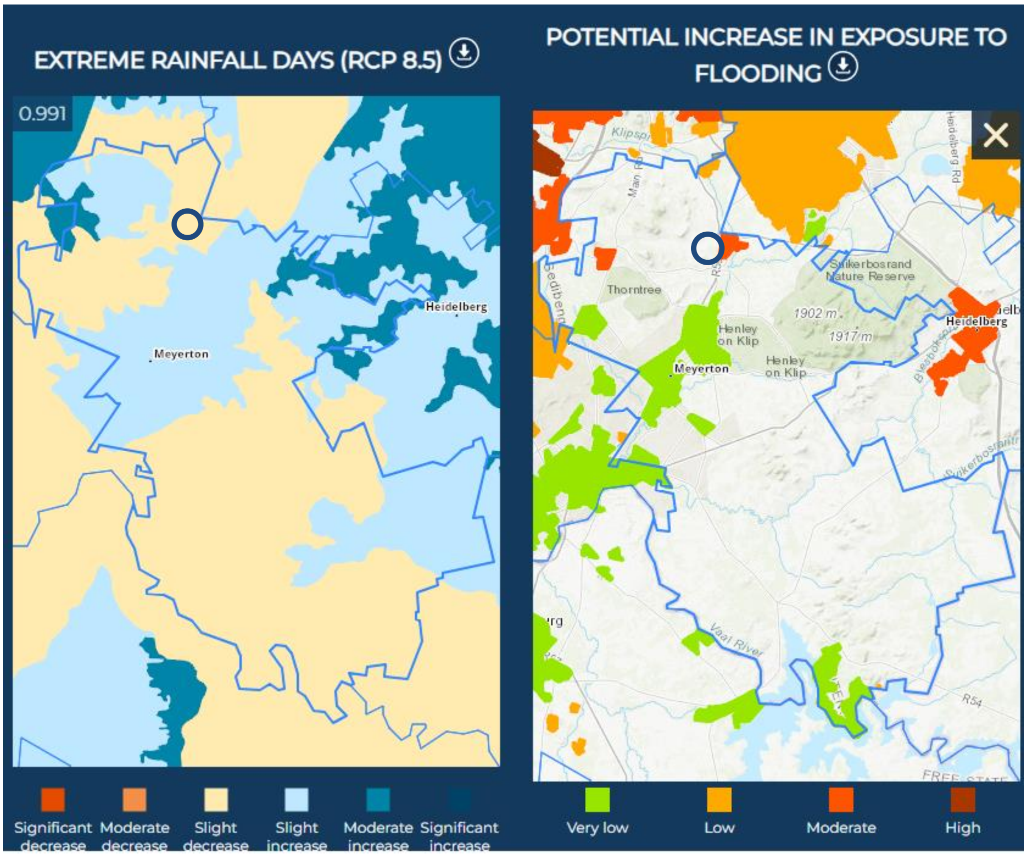


Figure 3-18: Risk of increased flooding for Midvaal Local Municipality in 2050 based on RCP8.5 trajectory (dark blue marker indicates approximate location of the project)

In addition to the hazards identified in the Green Book, Hofste, *et al.,* (2019) rate the project area as extremely high water stress (Figure 3-19) with no increase or decrease in the water stress projection for the future (2050 based on a conservative low mitigation trajectory) (Figure 3-20).

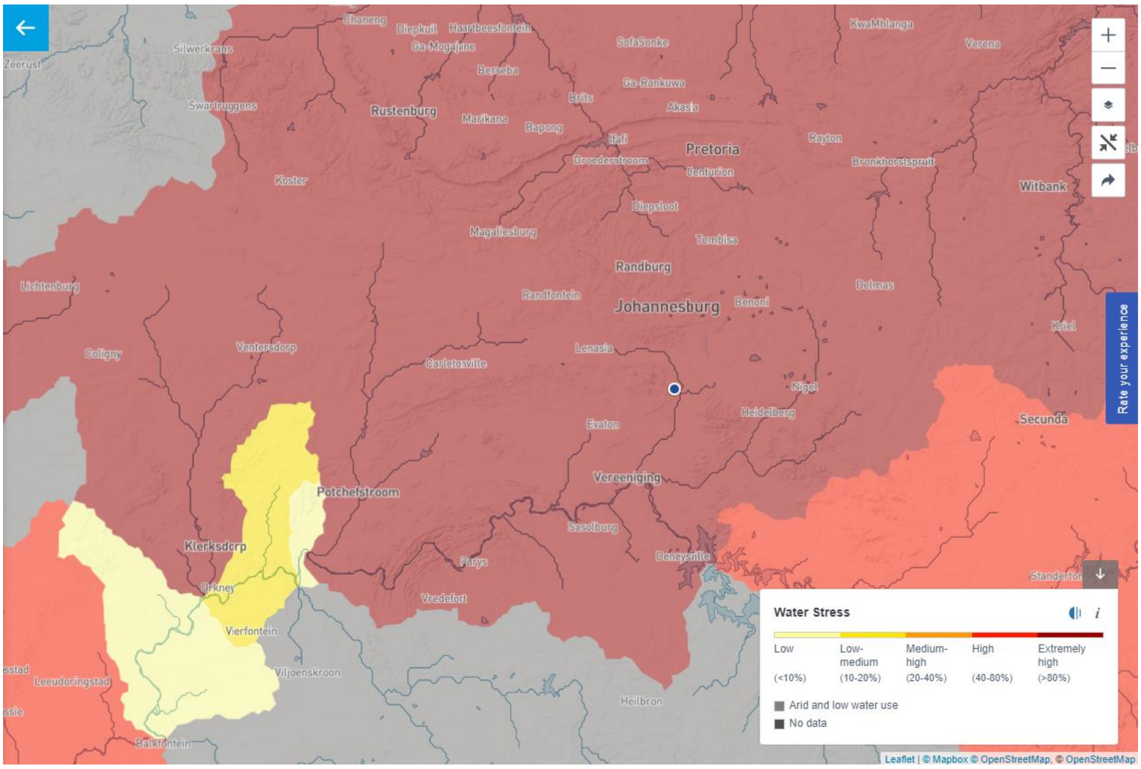


Figure 3-19: Current water stress for the project area (Hofste, et al., 2019) (blue dot indicates project location)

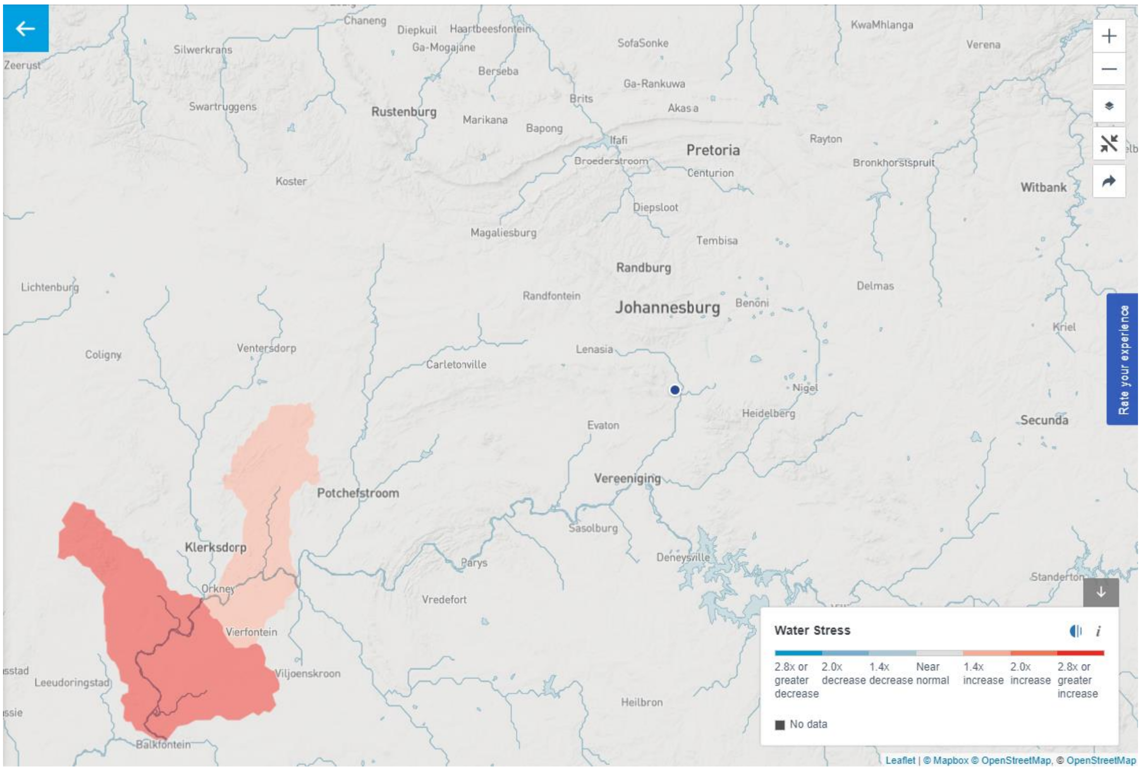


Figure 3-20: Projected (2050) water stress for the project area (Hofste, et al., 2019) (blue dot indicates project location)

3.4 Vegetation Disturbance

The vegetation type that will be disturbed over the lifetime of the proposed project is Carletonville Dolomite Grassland in the Dry Highveld Grassland Bioregion (South African National Biodiversity Institute, 2024). This information was used in the quantification of permanent GHG sink losses due to project infrastructure for the CCA.

3.5 Impact of Climate Change

To understand the impact that climate change might have on the major resources of the Midvaal Local Municipality it is first necessary to provide an overview of the current situation, which has been provided for water, economy, and agriculture.

3.5.1 Water Supply

3.5.1.1 Current Resources

Figure 3-21 provides the current water supply vulnerability (i.e., demand versus supply) for the Midvaal Local Municipality (0.8) based on the data compiled for the Department of Water and Sanitation (DWS) All Town's Study (Cole, 2017). The current water demand for the municipality is lower (537.1 l/d (litres per day)) than the supply (671.37 l/d), with 100% sourced from surface water.

3.5.1.2 Impact on Resources

Figure 3-22 shows the estimated current and future water supply vulnerability (i.e., the ratio of demand to supply) based on: 1) a local water supply perspective incorporating changes to population growth coupled with exposure to climate risk (based on impacts on local runoff), and 2) a regional water supply perspective (based on impacts of regional water supply assuming supply is part of the integrated regional and national bulk water supply network). The mean annual precipitation for the municipality is predicted to decrease by 1% for 2050 with a regional urban water supply slight increase of 0.5%.

3.5.2 Surface Water

3.5.2.1 Current Situation

The Midvaal Local Municipality is within the Vaal Primary Catchment (Figure 3-23). Figure 3-24 depicts the current annual and monthly surface water runoff, precipitation and evaporation for the Vaal Primary Catchment associated with the Midvaal Local Municipality. Precipitation and evaporation for the municipality is currently 672 mm/year and 1 626 mm/year respectively.

3.5.2.2 Projected Impact

Figure 3-25 provides the projected monthly change for future (2050) evaporation, precipitation, and estimated runoff values. The precipitation is projected to decrease during winter months with the evaporation increasing during winter months.

WATER AVAILABILITY

SURFACE WATER USAGE	
Demand Per Capita (l/p/d)	537.1
Supply Per Capita (l/p/d)	671.37
Current Vulnerability	0.8

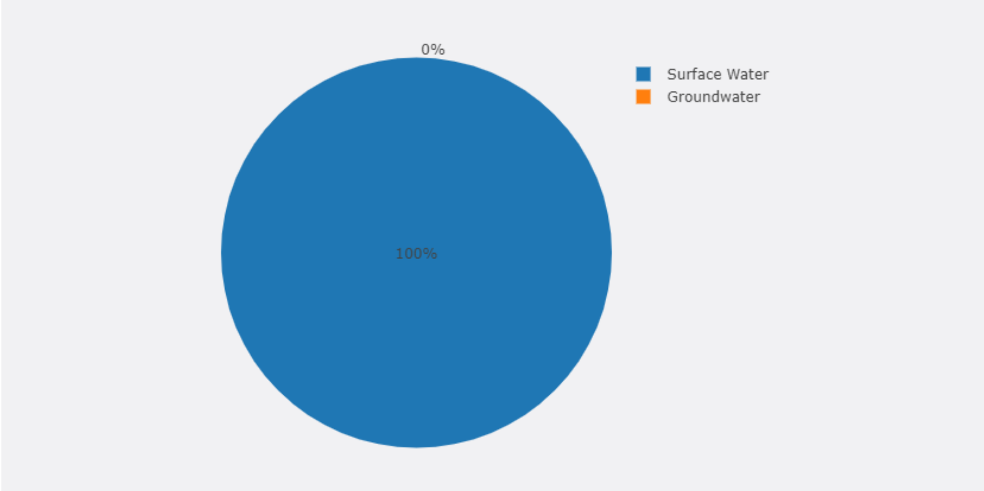
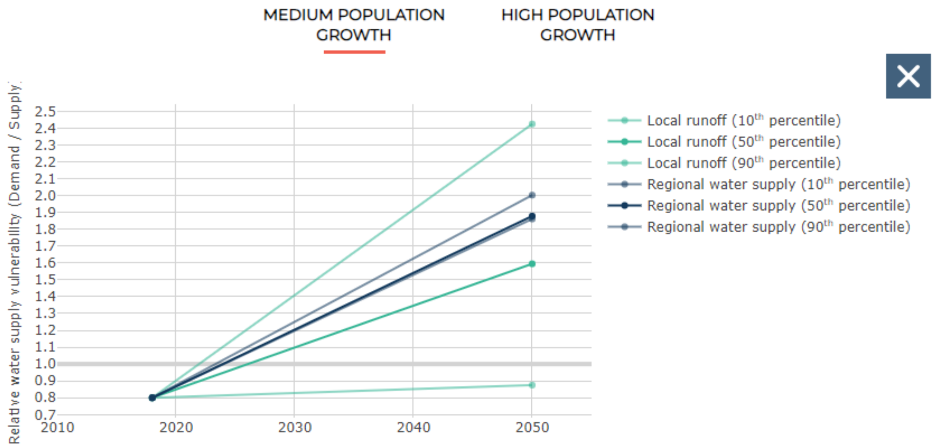


Figure 3-21: Current water availability for the Midvaal Local Municipality



VULNERABILITY CONTRIBUTION FACTORS	PERCENTAGE CHANGE
Mean annual precipitation	-1.02%
Mean annual evaporation	10.66%
Mean annual runoff	18.31%
Regional urban water supply	0.48%
Population growth	113.17%

Figure 3-22: Estimated current and future (2050) water supply vulnerability based on medium population growth for the Midvaal Local Municipality

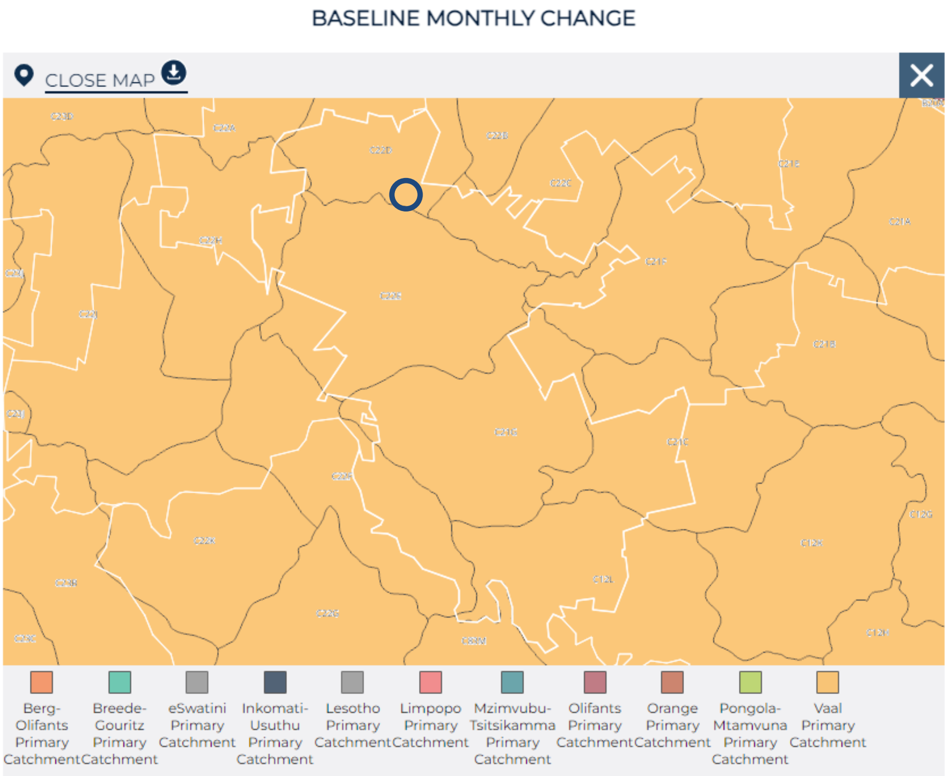


Figure 3-23: Quaternary catchment areas for the study area (dark blue marker indicates approximate location of the project in quaternary catchment C226)

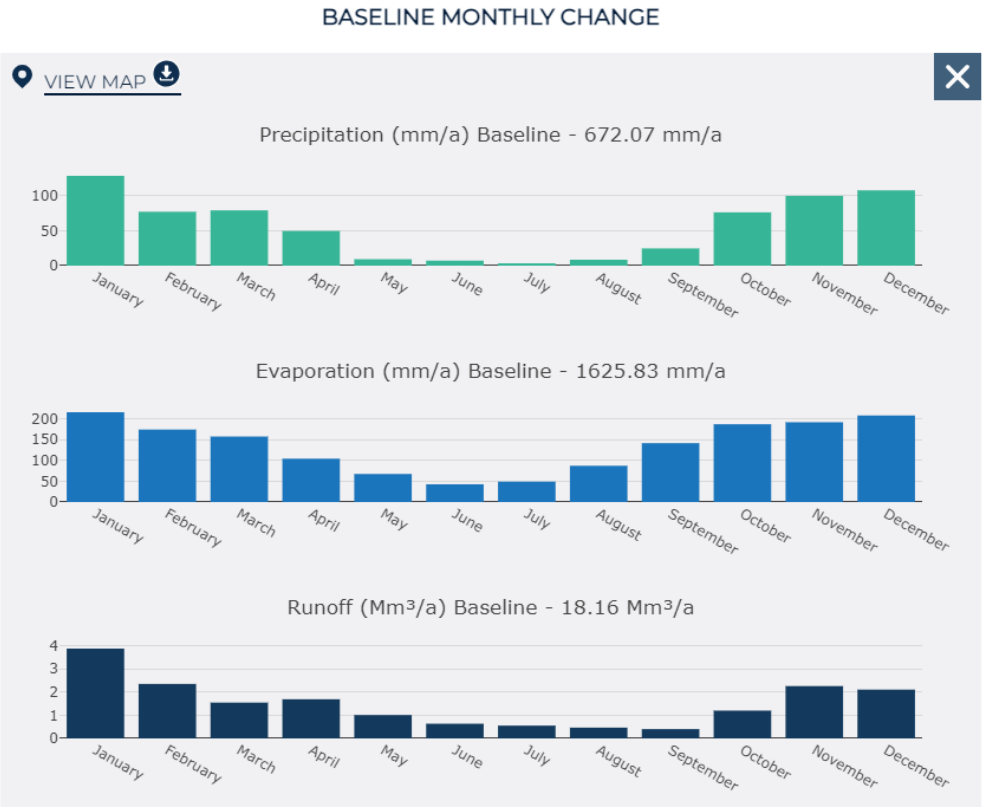


Figure 3-24: Current annual and monthly surface water runoff, precipitation and evaporation for the Midvaal Local Municipality which falls under the Vaal Primary Catchment

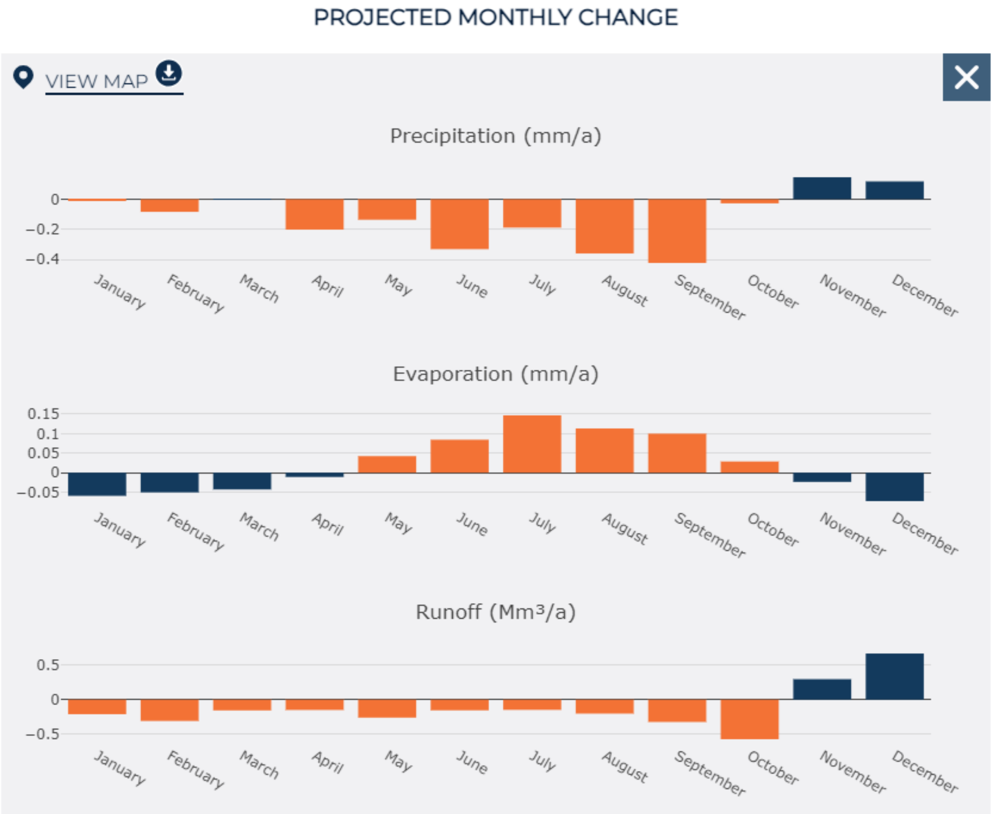


Figure 3-25: Projected monthly change to future (2050) evaporation, precipitation, and estimated runoff values

3.5.3 Ground Water

3.5.3.1 Current Situation

The groundwater recharge potential map indicates the occurrence and distribution of groundwater resources across the country, showing distinctive recharge potential zones. The groundwater dependency map indicates where settlements get their main water supply from, be it groundwater, surface water or a combination of both sources. Settlements that rely on groundwater, either entirely or partially, are deemed groundwater dependent. The area of the project is not groundwater dependent and get all their water from surface water (Figure 3-26).

3.5.3.2 Projected Impact

A groundwater depletion risk map was created to determine which of South Africa's groundwater dependent settlements may be most at risk to groundwater depletion based on decreasing groundwater aquifer recharge potential and significant increases in population growth pressure by 2050.The groundwater depletion risk map (Figure 3-27) is based on the settlement aquifer recharge potential of the 50th percentile RCP8.5 scenario, and the medium population growth scenario. Based on this information, there is no potential change for the project area with the project area not dependant on groundwater.

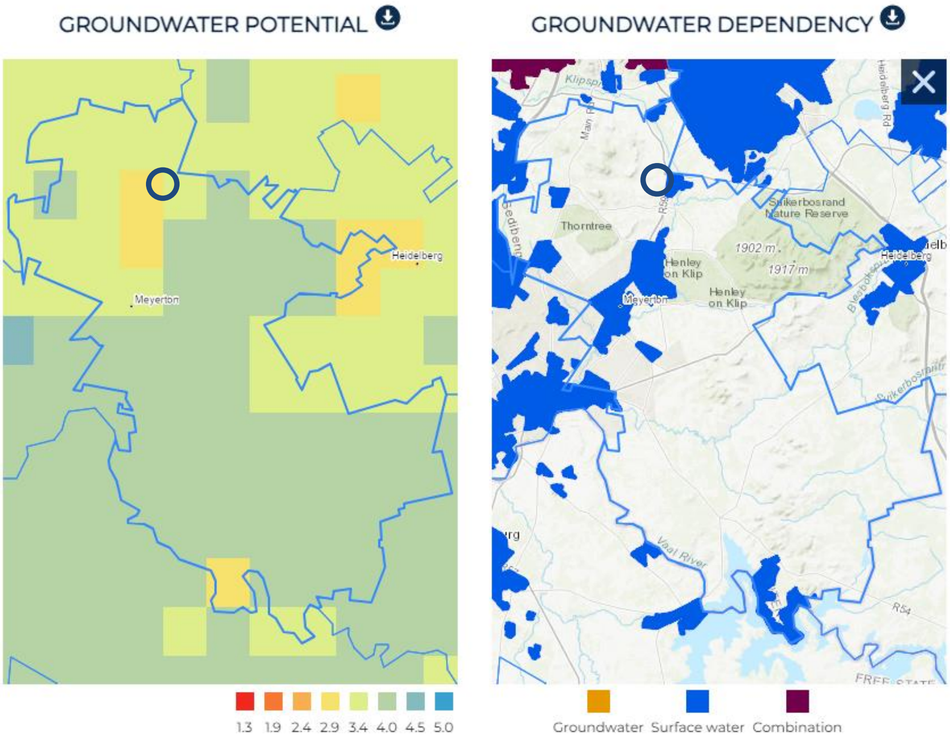


Figure 3-26: Groundwater potential and dependency for the Midvaal Local Municipality (dark blue marker indicates approximate location of the project)

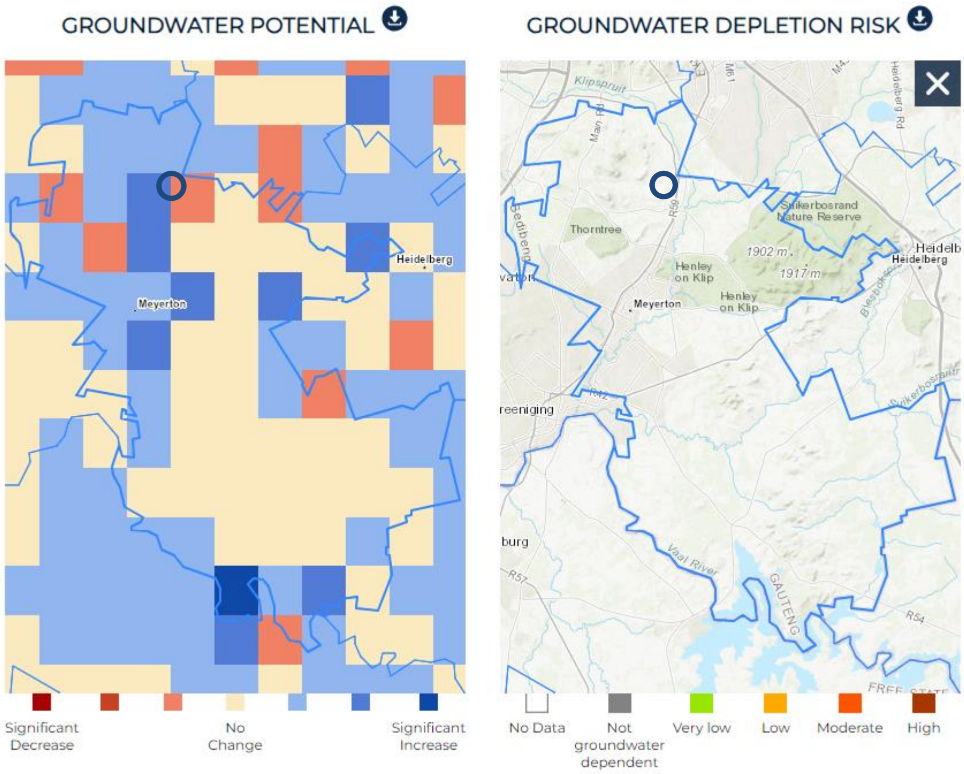


Figure 3-27: Groundwater potential and depletion for 2050 for the Midvaal Local Municipality (dark blue marker indicates approximate location of the project)

3.5.4 Economy

Figure 3-27 shows the contribution that the different economic sectors make to the total Gross Value Added (GVA)[17] of the Midvaal Local Municipality as well as its national GVA rank (total GVA contribution to the national GVA). Manufacturing makes up the highest economic sector to the total GVA at 33.5%. The Midvaal Local Municipality ranks 54th in the national GVA rank. Table 3-1 summarises the forecasted economic gains or losses for the Midvaal Local Municipality, under both the RCP4.5 and RCP8.5 scenarios, for each of the contributing economic sectors.

3.5.5 Agriculture, Forestry and Fisheries

The main agricultural commodities for the Midvaal Local Municipality are maize and beef cattle (Table 3-2). Agriculture, Forestry and Fishing (AFF) contribute 1.17% to Midvaal GVA production and 5.03% to Midvaal Municipalities total employment. The total AFF GVA production of Midvaal Local Municipality contributes 0.12% to the national AFF GVA, ranking them as the 170th biggest contributor (Table 3-2).

The main agricultural commodities for 2050 for the municipality remain maize and beef cattle (under an RCP8.5 low-mitigation scenario) (Table 3-3). The climate for the municipality is expected to be hotter and wetter with more extreme rainfall events. There is a potential increase in maize yield for near future with the heat stress negatively impacting production towards the end of 2050. The hot, moist conditions will increase the spread of disease and parasites which would negatively impact the beef production.

3.5.6 Other Resources

The impacts of climate change on other resources are summarised in Table 3-4.

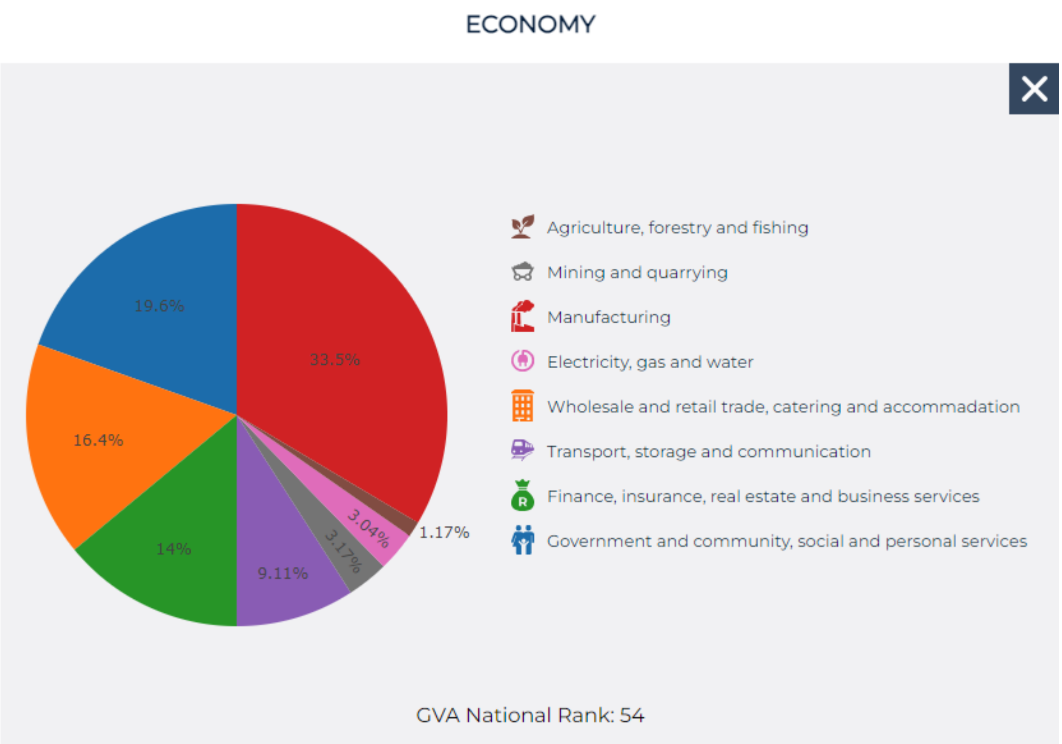


Figure 3-28: The contribution that the different economic sectors make to the total GVA of the Midvaal Local Municipality

[17] Gross value added (GVA) is an economic productivity metric that measures the contribution of a corporate subsidiary, company, or municipality to an economy, producer, sector, or region.

Table 3-1: Forecasted economic gains or losses for the RCP4.5 and RCP8.5 scenarios

RCP 4.5 Impacts		RCP 8.5 Impacts	
Average	-4.41%	Average	-4.59%
Agriculture Sector	-10.94%	Agriculture Sector	-11.58%
Forestry Sector	-12.66%	Forestry Sector	-13.4%
Fishing Sector	0% -	Fishing Sector	0% -
Mining Sector	1.19%	Mining Sector	1.26%
Manufacturing Sector	3.46%	Manufacturing Sector	4.29%
Electricity & Gas Sector	-13.7%	Electricity & Gas Sector	-14.51%
Water Sector	1.62%	Water Sector	1.71%
Service Sector	-4.27%	Service Sector	-4.52%

Table 3-2: Economic contribution of main commodities for Midvaal Local Municipality

MAIN COMMODITIES		
MAIZE FOR GRAIN	BEEF CATTLE	
AFF contributes 1.17% to Midvaal GVA production	AFF contributes 5.03% to Midvaal total employment	The total AFF GVA production of Midvaal Municipality contributes 0.12% to the national AFF GVA, ranking them as the 170th biggest contributor

Table 3-3: Projected economic contribution of main commodities for Midvaal Local Municipality

MAIN COMMODITIES	
MAIZE FOR GRAIN	BEEF CATTLE
CLIMATE IMPACT	
Change in climate expected: Hotter and wetter with more extreme rainfall events.	
Potential increase in maize yield for near future. However, towards 2050, heat stress can negatively impact on production.	Increased water availability. Hot and moist conditions cause increased spread of disease and parasites. Reduced growth & reproduction performance due to heat stress.

Table 3-4: The impacts of climate change on other resources

Parameter	Results of Climate Change				Reference
	Increase in temperature and heat stress	Drought and decrease in rainfall	Increase in rainfall and inland flooding	Increased wind speed	
Transport and Mobility	• Increased rate of infrastructure deterioration leading to pavement failure including cracking, rutting, potholes, flushing, and stripping. • Increased stress on bridges, particularly expansion joints, through thermal expansion and increased movement. • Corrosion of steel reinforcing in concrete structures due to increase in surface salt levels in some locations. • Increased infrastructure maintenance cost for road repair and reconstruction work, causing traffic delays and emergency service response delays. • Increased frequency and intensity of wildfires leading to more road closures. • Increased vehicle accidents, due to low pavement adhesion, leading to higher rates of transport-related fatalities.	• Reduced water resources available for construction and maintenance. • Reduced production of some agricultural produce leading to changes in freight flows in the network.	• Increased rate of infrastructure deterioration, especially in areas with poor infrastructure maintenance history. • Temporary and permanent flooding of road, rail, port and airport infrastructure. • Structural integrity of roads, bridges and tunnels could be compromised by higher soil moisture levels. • Potential destruction of bridges and culverts. • Erosion of embankments and road bases leading to undermining of roads or railways. • Increased risk of landslides, slope failures, road washouts and closures. • Undermining of bridge structures (scouring). • Closure of roadways and tunnels leading to traffic delays. • Transportation system disruptions, impacts to traffic signalling and low water crossings. • Increased weather-related accidents.	• Increased drag on vehicles resulting in increased fuel consumption. • Increased safety risk for pedestrians and cyclists due to flying objects or being uncontrollably dragged by winds, additionally leading to reduced trip making by pedestrians and cyclists.	(Mokonyama & Van Wyk, 2018)
Solid Waste	• Increased risk of combustion at open waste disposal sites and illegal dumps and increase in explosion risk associated with methane gas. • Increased rate of decay of putrescible waste resulting in increased odour, breeding of flies, and attracting of vermin. • Increased health and safety concern regarding heat stroke to staff collecting waste. • Increased risk of landfill site instability and failure due to changes in consumption patterns with increased waste creation (i.e., glass, plastic and paper cups).		• Increased risk of flooding due to pressure on stormwater and leachate management systems at landfills. • Increased demand for capacity to cope with large volumes of waste generated by flood events. • Increase in soil saturation causing decreased stability of slopes and landfills linings (if clay or soil based) at waste management facilities. • Inundation of waste releasing contaminants to waterways, pathways and low elevation zones. • Potential loss of value and degradation of paper and cardboard for recycling due to increased moisture content. • Increased flooding causing the risk of localised disruption of waste collection rounds. • Flooding in areas with untreated, dumped waste causing the risk of groundwater contamination. • Increased flooding causing the risk of litter entering the storm water systems.	• Possible increase in nuisance due to waste dispersed by high winds leading to increased health effects associated with particulate matter (air pollution).	(Oelofse, 2018)
Stormwater	• Potential risk of undermining the temperature regime of temperature-sensitive stormwater ponds and receiving waters, resulting in a decrease in water quality. • Increased corrosion in stormwater drains due to a combination of higher temperatures, increased strengths, longer retention times, and stranding of solids.	• Increased shrinking soils increasing the potential for cracking, increased infiltration and exfiltration of water mains and sewers, which in turn exacerbates treatment and groundwater or storm water contamination.	• Increased risk of flooding due to pressure on stormwater systems. • Increased risk of litter entering the stormwater systems. • Increased risk of damage and failure of stormwater systems due to overloading during floods and intense rainfall events. • Failure of stormwater treatment devices during high flow events leading to by-pass and / or flushing of contaminated water. • High wet-weather hydraulic loads and bottlenecks in stormwater and networks due to inflow and sewer infiltration, leading to local inundation and overflows of untreated wastewater. • Increased rainfall causes soil erosion thus damaging underground stormwater systems. • Increased surface and stream erosion causing deposition of sediments in receiving environments. • Stream morphology for undeveloped, developing and fully developed urban areas, may change, hence affecting existing outfall structures and potential stormwater pond locations.	• Increased wind speed and intensity causing changes in rainfall over complex topography including increasing upwind of hills and ranges.	(Dunker & Van Wyk, 2018)

Parameter	Results of Climate Change				Reference
	Increase in temperature and heat stress	Drought and decrease in rainfall	Increase in rainfall and inland flooding	Increased wind speed	
Sanitation	• Increased heat waves, accompanied by dry weather, can exacerbate already stressed water supply systems leading to competition between sectors for water services, affecting sanitation.	• Decrease in water supply for sanitation through decrease in available water to flush sewage systems adequately. • Declining annual rainfall threatening the viability of water-borne sanitation systems, and the capacity of surface water to dilute, attenuate and remove pollution. • Sewers are structurally vulnerable to drying, hence shrinking soils increase the potential for cracking, increased infiltration, and exfiltration, which in turn exacerbates treatment and groundwater or storm water contamination. • Increased corrosion in sewers due to a combination of higher temperatures, increased strengths, longer retention times, and stranding of solids.	• Increased wet-weather hydraulic loads and bottleneck in stormwater and sanitary sewer networks due to inflow and sewer infiltration, causing local inundation and overflows of untreated wastewater. • Increased rainfall and heavy rainfall events increasing the washing of faecal matter into water sources due to flooding of wastewater treatment works. • Increased risk of flooding resulting in both infrastructure damage and contamination of surface and groundwater supplies. • Increased groundwater levels due to flooding, putting risk on sewage treatment plants (which are often positioned on low-lying ground as sewerage systems rely on gravity). • Increased vulnerability of sewerage pipe systems due to their size and complexity, and their exposure to multiple flood damage threats from source, through treatment, to delivery. • Increased vulnerability of pit toilets (widely used in rural areas) due to flooding, causing serious environmental contamination. • Increase in groundwater recharge and groundwater levels causing flooding of subsurface infrastructure such as pit toilets or septic tanks.		(Duncker, 2018)
Information and Communication Technology	• Increased weathering and deterioration of infrastructure resulting in increased maintenance and repair costs. • Heat stress causing structural damage to infrastructure. • Increased energy demands during heatwaves resulting in power outages which can impact on delivery of telecommunications services. • Increases in temperature and higher frequency, duration, and intensity of heat waves increasing the risk of overheating in data centres, exchanges, and base stations, which can result in increased failure rates of equipment. • Increased mean temperature increasing operating temperature of network equipment which may cause malfunctions if it surpasses design limits.	• Decreased precipitation leading to land subsidence and heave, reducing the stability of telecommunications infrastructure above and below ground (foundations and tower structures).	• Increased risk of flooding of low-lying infrastructure, access holes and underground facilities. • Increases in storm frequency or intensity increasing the risk of damage to aboveground transmission infrastructure and impacting on telecommunications service delivery. • Increases in storm frequency leading to more lightning strikes, consequently damaging transmitters, and overhead cables, causing power outages. • Increased cost of insurance for infrastructure in areas with repeated incidents of flooding, as well as withdrawal of risk coverage in vulnerable areas by private insurers. • Road closures due to flooding thus inhibiting service and/or restoration efforts. • Rising sea levels and corresponding increases in storm surges, increasing the risk of saline corrosion of coastal telecommunications infrastructure, and leading to erosion or inundation of coastal and underground infrastructure.	• Increased risk of storm surges impacting on coastal infrastructure. • Increased storm intensity and frequency impacting on electricity and telecommunications infrastructure.	(Naidoo, 2018)

Parameter	Results of Climate Change				Reference
	Increase in temperature and heat stress	Drought and decrease in rainfall	Increase in rainfall and inland flooding	Increased wind speed	
Health	• More exposure to high temperatures causing increased health risks including heat strokes. • Heat waves increase threat of cardiovascular, kidney, and respiratory disorders. • Increase in fire danger days causing increased loss of life and damage to health infrastructure. • Wildfire smoke significantly reducing air quality, both locally and in areas downwind of fires. Smoke exposure increases respiratory and cardiovascular hospitalizations; emergency department visits; medication dispensations for asthma, bronchitis, chest pain, chronic obstructive pulmonary disease, and respiratory infections; and medical visits for lung illnesses. • Increased emissions in biogenic volatile organic compounds from vegetation causing increases in air pollution. • Increase in evaporative emissions from cars contributing to exposure to, and health impacts from, air pollution. • Increase in distribution of vector-borne diseases in warmer areas. • Increased water temperatures leading to an increase in algal blooms which can likely lead to increases in food- and waterborne exposures. • Increased temperatures combined with fewer clouds (e.g., from increased subsidence that is projected for parts of South Africa) causing increased exposure to Information and Communication Technology which will have negative impacts on health. • Increased temperatures increasing the reaction between certain pollutants and sunlight and heat, resulting in more severe hazardous smog events.	• Decreased soil moisture potentially creating more wind-blown dust which has negative impacts on air quality. • Increase in water-borne diseases and diarrhoeal diseases due to inadequate water availability. • Decreased precipitation causing changes in salinity of water, resulting in an increase in algal blooms which can likely lead to increases in food- and waterborne exposures. • Increase in stagnant air, decreasing air quality.	• Wetter climate combined with increased temperatures may have negative health impacts as many diarrhoeal diseases vary seasonally, typically peaking during the rainy season. • Extreme rainfall and higher temperatures increasing the prevalence of fungi and mould indoors, with increased associated health concerns. • Increased flooding increasing the risk of drinking and wastewater treatment facilities being flooded, meaning that diarrhoeal diseases can be transmitted as wastewater systems overflow or drinking water treatment systems are breached. • Increase in natural disasters (e.g., floods) creating a conducive environment for the occurrence of mental health problems.	• Increase in wind-blown dust combined with low humidity causing increased cases of meningitis (Davis, 2014).	(Garland, 2018)
Energy	• Increased heat causing expansion of overhead cables, and cable sag. Sagging below a certain level result in a reduction in the amount of electricity transmitted. • Increased heat stress on electricity transmission networks (overhead cables). • Increase in heat island effect increasing energy demand for cooling, leading to grid stress. • Increased threat of wildfires causing widespread damage to infrastructure and causing disruptions to service provision.		• Increase in flooding causing damage to electricity transmission and distribution infrastructure, poles, lines and sub-stations. • Increase in frequency and cost of maintenance of concrete structures due to frequent and intense rainfall, flooding, or sea level rise. • Increased repair events increasing stress put on service crews and resulting in delays to power restoration.	• Winds causing damage to energy supply infrastructure as winds cause overhead lines to sag, reducing electricity transmission. • Extreme winds causing poles and trees to fall, causing further damage to energy supply infrastructure such as overhead lines.	(Thambiran & van Wyk, 2018)

Parameter	Results of Climate Change				Reference
	Increase in temperature and heat stress	Drought and decrease in rainfall	Increase in rainfall and inland flooding	Increased wind speed	
Ecosystem Services	• Increased risks of water shortages increasing demand for irrigation of gardens and agriculture. • Increased evapotranspiration rates with rising temperatures, reducing the water available in reservoirs and water available for reliant ecosystems. • Increase in temperature leading to water loss via evapotranspiration resulting in decreased water quality and loss of wetlands. • Loss or degradation of indigenous species, including threatened species or ecosystems. • Increased threat from invasive species as competition for water increases. • Dieback or death of susceptible plants (e.g., street trees) and animals (e.g., fish). • Reduced availability of water and increased evapotranspiration resulting in reductions in harvested area (cropping area), yield (ton/ha) and quality. • Warmer winters resulting in reduced period of dormancy (rest period) in deciduous fruit crops, decreasing the production and quality of associated food products. • Warmer climate resulting in shifts in the growing season and life cycles of various plants, including crops, resulting in pests and diseases having a greater destructive impact as well as a shift in climatically suitable areas for specific crops. • Increased humidity levels resulting in higher rates of microbial growth in fresh produce, reducing their expiry time. • Increased heat stress on crops changes the micro-nutrients of crops products, decreasing the nutrient density and quality of food. • Increased water temperature leading to increased growth of aquatic weeds which increases breeding of disease vectors and reduces water oxygen levels. • Milder winters and reduced frost increase the duration of the growing season, increasing the survival rate of insects and diseases. • Increased sea surface temperatures (SST) causing shifts in the spatial distribution of fish species. • Increased SST and ocean acidification decreases marine phytoplankton growth and synthesis of omega-3 polyunsaturated fatty acids (PUFA's), affecting the oceanic food chain and consequent ecosystems. • Increased heat stress and higher humidity levels potentially resulting in the exceedance of the temperature humidity index in livestock, causing reduced immunity, fertility, productivity and even mortality of livestock.	• Decreased amounts of rainfall reaching ecosystems as settlements use rainwater harvesting techniques for increased household use. • Increased reliance on irrigation and greater demand for water to maintain public open space and gardens. • Reduced planting and pollination leading to greater risk of erosion and soil loss. • Increasing temperatures together with increased intensity of drought will potentially increase the occurrence of algal blooms in reservoirs and dams which are damaging to ecosystem functioning and water services. • Drought and decreased rainfall causing wetland habitat loss. • Locally specific changes in humidity levels will have impacts on local vegetation. • Increased threat to watershed and aquifer recharge areas, affecting vegetation. • Reduced soil moisture availability increasing moisture stress leading to dieback and death of plants and the loss or degradation of indigenous communities, including threatened species or ecosystems. • Increased moisture stress leading to decline in crop yield and quality, and reduced fodder quantity and quality for livestock. • Drying up of aquatic systems, perennial systems will become seasonal and seasonal systems will die off and be replaced by terrestrial plants. • Increased spread of drought-adapted alien invasive plant species.	• Rainfall in shorter and more violent spells making recharging groundwater difficult. • Increase in intensity of rainfall and flooding leading to increased surface runoff, resulting in increased soil erosion, soil loss and degradation. • Increased rainfall and floods resulting in waterlogged soils which increase the likelihood of crop failure. • Increasingly saturated soils leading to more standing water (ponding) which can result in more insect (pest) activity and their potential to carry diseases. • Increased wave energy and run-up (sea level rise and more storms) causing degradation of natural coastal defence structures.	• Evapotranspiration rates increase with wind speed, reducing the water available in reservoirs and water available for reliant ecosystems. • Increased rate of fire spread and spotting (the ignition of fires ahead of the main fire front) of fires. • Potential damage to or uprooting of vegetation including trees, which can also damage infrastructure. • Potential wind damage to crops, reducing yield and quality (e.g., sandblasting and fruit fall). • Increased windblown materials (e.g., dust, litter) increasing the need for maintenance and city cleaning. • Degradation of natural coastal defence structures and increased damage to hard coastal infrastructure.	(Pieterse & Crankshaw, 2018)
Culture and Heritage	• Increased temperature having significant impacts on the comfort levels of built heritage resources, resulting in the building no longer being fit-for-purpose. • Increased demand for additional heating and cooling resulting in the installation of heating, ventilation, and air-conditioning systems with potential negative consequences on the heritage value. • Increased heat stress potentially impacting on the materials and structural integrity of heritage resources. • Migration of several plant species due to changing climate patterns, posing a threat to the conservation of biodiversity hotspots, and potentially altering heritage places. • Increase in veld and forest fires raising the threat of fire to all heritage resources, natural and built, as well as posing health risks to heritage resource dwellers from exposure to smoke and ash pollution.	• Decreased rainfall impacting negatively on ground moisture levels and thus the geological conditions of sensitive heritage resources. Drying out clays, for example, will shrink and potentially undermine founding conditions.	• Increased rainfall in areas with clay soils resulting in swelling which poses a threat to the structural integrity of heritage resources. • Increased floods and changes in precipitation resulting in increasing vulnerability of archaeological evidence buried underground due to changing stratigraphic integrity of the soils. • Increased threat to materials and structural integrity of heritage resources exposed to higher humidity/ precipitation levels.		(van Wyk, 2018)

4 GHG EMISSIONS INVENTORY

4.1 Approach and Methodology

This assessment has been undertaken in accordance with the principles of:

- ISO 14064-1:2006 Greenhouse gases – Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals.
- Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard (GHG Protocol) (World Business Council for Sustainable Development and World Resources Institute, 2015).
- Draft National Guideline for the consideration of climate change implications in applications for environmental authorisation, atmospheric emission licences and waste management licences (Government Gazette No.44761:559, June 2021).
- Methodological Guidelines for Quantification of Greenhouse Gas Emissions (DFFE, 2022).

These guidelines are considered representative of good practice GHG accounting internationally and are applicable to the project.

The Greenhouse Gas Protocol Corporate Accounting and Reporting Standard (WRI & WBCSD, 2004), provides two approaches. This includes the assessment of GHGs based on: (1) the organisational boundaries and (2) operational boundaries. For the calculation of GHG footprint for the project, the operational boundary approach was selected.

4.1.1.1 Organisational Boundaries

For corporate reporting, two distinct approaches can be used to consolidate GHG emissions: the equity share and the control approaches. Companies shall account for, and report, their consolidated GHG data according to either the equity share or control approach as presented below.

In setting organizational boundaries, a company selects an approach for consolidating GHG emissions and then consistently applies the selected approach to define those businesses and operations that constitute the company for the purpose of accounting and reporting GHG emissions. If the reporting company wholly owns all its operations, its organizational boundary will be the same whichever approach is used. For companies with joint operations, the organizational boundary and the resulting emissions may differ depending on the approach used. In both wholly owned and joint operations, the choice of approach may change how emissions are categorized when operational boundaries are set.

4.1.1.2 Operational Boundaries

To help delineate direct and indirect emission sources, improve transparency, and provide utility for different types of organizations and different types of climate policies and business goals, three “scopes” (scope 1, scope 2, and scope 3) are defined for GHG accounting and reporting purposes (Figure 4-1).

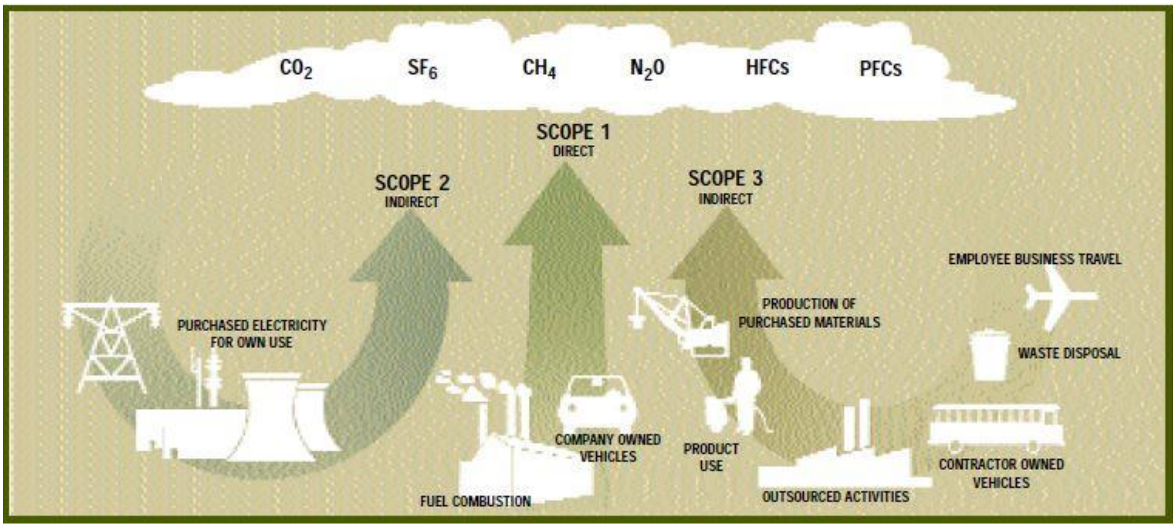


Figure 4-1: Overview of scopes and emissions (WRI & WBCSD, 2004)

4.1.1.3 Scope 1: Direct GHG Emissions

Direct GHG emissions occur from sources that are owned or controlled by the company, for example, emissions from combustion in owned or controlled vehicles, etc.; and/or emissions from production in owned or controlled process equipment.

4.1.1.4 Scope 2: Electricity - Indirect GHG Emissions

Scope 2 accounts for GHG emissions from the generation of purchased electricity consumed by the company. Purchased electricity is defined as electricity that is purchased or otherwise brought into the organizational boundary of the company. Scope 2 emissions physically occur at the facility where electricity is generated.

4.1.1.5 Scope 3: Other Indirect GHG Emissions

Scope 3 is an optional reporting category that allows for the treatment of all other indirect emissions. Scope 3 emissions are a consequence of the activities of the company but occur from sources not owned or controlled by the company. Some examples of scope 3 activities are extraction and production of purchased materials; transportation of purchased materials and product distribution; and use of sold products.

4.2 Greenhouse Gases and Global Warming Potential

The GHGs used in this assessment and the corresponding global warming potential (GWP) for each GHG are listed in Table 4-1 as stipulated in the recent Methodological Guidelines for Quantification of Greenhouse Gas Emissions (DFFE, 2022) published by the Department of Forestry, Fisheries and Environment. GWP is a metric used to quantify and communicate the relative contributions of different substances to climate change over a given time horizon. GWP accounts for the radiative efficiencies of various gases and their lifetimes in the atmosphere, allowing for the impacts of individual gases on global climate change to be compared relative to those for the reference gas carbon dioxide.

Table 4-1: Greenhouse gasses and 100-year global warming potentials

Greenhouse Gas	Global Warming Potential
Carbon dioxide (CO_2)	1
Methane (CH_4)	23
Nitrous oxide (N_2O)	296

4.3 Assessment Boundary

The following GHG emissions have been considered:

- Fuel (diesel) consumption during construction activities;
- Fuel (natural gas) consumption during construction activities;
- Purchased goods for site construction;
- Loss of carbon stocks due to land clearance;
- Water consumption during project operations;
- Transport of raw materials to and byproduct distribution from site; and,
- Wastewater treatment.

4.4 Exclusions

The following were excluded from the inventory:

- Scope 1 Diesel used in stationary combustion (generators) during the construction phase as fuel use estimates are not yet available.
- Process CO_2 emissions from the barley germination, drying and malting process.
  - Losses of CO_2 from the barley (during germination, drying and kilning) are not derived from fossil fuel combustion, and are part of short-term carbon cycling; these losses are not typically quantified in climate change assessments.
- Emissions from wastewater treatment was estimated as a Scope 3 source, however, there is a possibility that an on-site water treatment plant may be commissioned. It is assumed that estimated emissions from this activity would be equal whether the activity is on-site (resulting in direct emissions) or by a contracted third-party (resulting in indirect emissions).
- Scope 2 Electricity consumption during project activities.
  - Electricity needs during construction phase were unknown at this stage.
  - After commissioning, the CHP units will generate required electricity needs. Grid electricity will only be used as backup when all CHP units are offline.
- Scope 3 categories not regarded applicable to the project, including:
  - Embodied emissions in equipment used and transport of equipment (and materials) to the project site.
  - Water supply requirements and wastewater generation during construction phase.
  - Transport and disposal of waste materials to a Waste Management Area.
  - Worker commuting (during construction and operational phases).
  - Capital Goods.
  - Upstream Leased Assets.
  - Downstream Leased Assets.
  - Franchises.
  - Investments.
- Emissions which are likely to be negligible compared with other emissions from the project, including:

- Emissions associated with combustion of fuels used in minor quantities such as welding gases, oils and greases.
- GHG precursor pollutants (including SO_2, NO_2, non-methane volatile organic compounds, and ammonia).

- Due to the conceptual state of planning, some information for Scope 1 and Scope 3 emissions were not yet available.

4.5 Source Data and Assumptions

The input data and assumptions used in estimating GHG emissions for the different phases of the project are provided in Table 4-2 and Table 4-3.

Table 4-2: Greenhouse gas assessment source data and assumptions for the construction phase of the project

Construction	Value	Unit	Comments
Construction period	24	months	
Area cleared	5.5	ha	area permanently covered
Diesel consumed (stationary)		litres	unknown at this stage
Diesel consumed (Mobile/Vehicles)	172 800	litres	estimated for 300 kW motor at 50% load
Distance travelled by materials to site		km	unknown at this stage
Concrete required	22 961	m³	provided
Steel required	49 437	tonnes	provided
Bricks	892 763	number of bricks	provided
Raw water requirement		ML	unknown at this stage
Municipal Waste generated		t	unknown at this stage
Distance travelled from site to landfill in a year		km	unknown at this stage
Distance travelled by commuters by car		km	unknown at this stage
Distance travelled by commuters by taxi		km	unknown at this stage

Table 4-3: Greenhouse gas assessment source data and assumptions for the operation phase of the project

Operation	Value	Unit	Comments
Malt production (Phase 2)	130 000	tonnes/year	Phase 2
Operation period	50	years	
Scope 1			
Diesel (stationary combustion)		litres	unknown at this stage
Diesel (mobile combustion - vehicles)		litres	unknown at this stage
Natural gas	338	TJ/year	CHP and stand-by boilers
Scope 2			
Electricity consumed by operations (kWh)	-	kWh	Power requirements fulfilled by CHP
Scope 3			
Raw water requirement	365	ML per year	Daily rate provided
Wastewater treatment	283	ML per year	Estimated for Phase 2
Raw materials and products to site	4 050 000	km per year	calculated from given distances and volumes
Municipal Solid Waste (tonnes)		t	unknown at this stage
Distance travelled from site to landfill in a year		km	unknown at this stage
Distance travelled by commuters by car		km	unknown at this stage
Distance travelled by commuters by taxi		km	unknown at this stage

4.6 Emission Factors

The emission factors were mainly sourced from the:

- South African Methodological Guidelines for Quantification of Greenhouse Gas Emissions *gazetted by the* Department of Forestry, Fisheries and Environment, No. 47257(2598) (DFFE, 2022b).

- IPCC guidelines (IPCC, 2006)
- UK Government GHG Conversion Factors for Company Reporting developed by Department for Environment Food & Rural Affairs (DEFRA) and Department for Business, Energy & Industrial Strategy (DEFRA, 2024).

The list of emission factors used for the assessment is provided in Table 4-3.

Table 4-4: Emission factors used in the assessment

Emission factors	Value	Unit	Source	Comment	Reference document	Link
Scope 1 - Direct Emissions						
Diesel - mobile combustion	74638	kg CO_2 per TJ	(DFFE, 2022)	Diesel oil	Table A.3 (country specific)	
	3.9	kg CH_4 per TJ			Table A.1 (IPCC, 2006)	
	3.9	kg N_2O per TJ			Table A.1 (IPCC, 2006)	
Natural gas - stationary combustion	56100	kg CO_2 per TJ	(DFFE, 2022)		Table A.1 (IPCC, 2006)	
	1.0	kg CH_4 per TJ			Table A.1 (IPCC, 2006)	
	0.1	kg N_2O per TJ			Table A.1 (IPCC, 2006)	
Land clearing	139.333	t CO_2 per ha soil carbon (30 cm depth)	(DFFE, 2024)	Grassland conversion to settlements (industrial)	IPCC default for high activity clay soils	https://www.dffe.gov.za/sites/default/files/legislations/unfccc_greenhousegasinventoryreport9_g50607gon4772.pdf
	12.283	t CO_2 per ha biomass carbon			Section 6.6	
	2.842	t CO_2 per ha dead organic matter			Section 6.6	
Scope 3 - Indirect Emissions						
3.1 Well-to-tank fuels						
Diesel (100% mineral diesel)	0.62409	kg CO_2e per litre	(DEFRA, 2024)	WTT - fuels	DEFRA EF (published 8 July 2024)	https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2024
Natural gas	0.07214	kg CO_2e per kWh (Net CV)	(DEFRA, 2024)	WTT - fuels	DEFRA EF (published 8 July 2024)	https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2024
3.2 Upstream Transportation and Distribution						
Heavy goods vehicle	0.81517	kg CO_2e per km	(DEFRA, 2024)	All HGVs (average laden) - freighting goods	DEFRA EF (published 8 July 2024)	https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2024
3.3 Construction						
Concrete	0.119	t CO_2e per tonne	(DEFRA, 2024)	Material used - construction	DEFRA EF (published 8 July 2024)	https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2024
Steel	1.91	t CO_2e per tonne	World Steel Association - Environmental Sustainability	Environmental performance for CO2 emissions intensity	Sustainability indicators 2022	https://worldsteel.org/media-centre/press-releases/2022/sustainability-indicators-2022/

Emission factors	Value	Unit	Source	Comment	Reference document	Link
			Indicators 2022			
Bricks	0.24	t CO_2e per tonne	(DEFRA, 2024)	Material used - construction	DEFRA EF (published 8 July 2024)	https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2024
3.4 Water supply						
Water supply	153	kg CO_2e per million litres	(DEFRA, 2024)	Water supply delivered through mains supply network	DEFRA EF (published 8 July 2024)	https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2024
3.5 Waste generated						
Water treatment	186	kg CO_2e per million litres	(DEFRA, 2024)	Water treatment used for water returned into the sewage system through mains drains	DEFRA EF (published 8 July 2024)	https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2024
Conversion factors	**Value**	**Unit**	**Source**	**Comment**	**Reference document**	**Link**
Diesel calorific value (mobile sources)	0.043	TJ/tonne				
Diesel - density	0.8255	kg/l	SA Technical Guidelines (country specific)	Table D1	DFFE, 2022	https://www.dffe.gov.za/sites/default/files/legislations/technicalguidelinesformrvofemissionsbyindustry_0.pdf
Natural gas (calorific value)	38.1	MJ/Nm³	SA Technical Guidelines (country specific)	Table D2	DFFE, 2022	https://www.dffe.gov.za/sites/default/files/legislations/technicalguidelinesformrvofemissionsbyindustry_0.pdf
Density of concrete	2.4	t/m³				
Diesel calorific value	35.5	MJ/l	SA Technical Guidelines	Table D1	DFFE, 2022	
Bricks - mass	3	kg/brick				https://www.claybrick.org.za/faqs/61

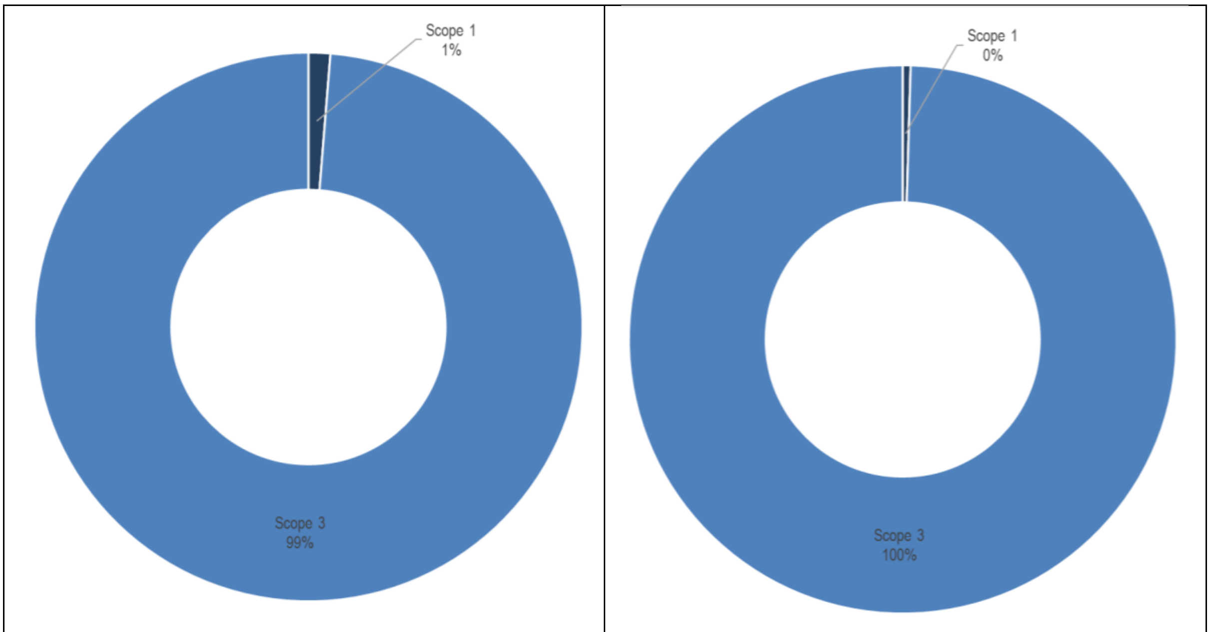
4.7 Emissions

The estimated GHG emissions for construction (103 064 t CO_2e) and operational phases (4 081 076 t CO_2e) of the project is provided in Table 4-5. The GHG emission contribution for the construction and operational phases of the show that the operational phase will contribute 2% of the total project annual GHG emissions.

Table 4-5: Estimated annual GHG emissions over the lifespan of the project

Source	Input		Annual Emissions (t CO_2e)			
	Value	Units	Scope 1	Scope 2	Scope 3	Total
Construction Phase						
Fuel and Energy related activities						
Diesel (Stationary Combustion)	-	litres	-			-
Diesel (Mobile Combustion)	172 800	litres	473			473
Electricity	-	kWh		-		-
Land clearing	5.5	ha	850			850
Well-to-tank fuel						
Diesel	172 800	litres			108	108
Upstream Transportation and Distribution						
Raw materials transport to site	-	km			-	-
Purchased goods						
Concrete	22 961	m³			6 544	6 544
Steel	49 437	tonnes			94 424	94 424
Bricks	892 763	bricks			647	647
Water supply and reagents						
Water supply	-	ML			-	-
Waste generated						
Municipal Waste	-	t			-	-
Transport of waste to landfill sites	-	km			-	-
Employee Commuting						
Own Vehicle	-	km			-	-
Taxi	-	km			-	-
Total tCO_{2-e}			*1 323*	-	*101 723*	*103 046*
Operational Phase						
Fuel and Energy related activities						
Diesel (Stationary Combustion)	-	litres	-			-
Diesel (Mobile Combustion)	-	litres	-			-
Natural gas (Stationary Combustion)	338	TJ/year	19 002			19 002
Electricity	-	kWh		-		-
Well-to-tank fuel						
Natural gas	94 000 000	kWh			6 781	6 781
Upstream Transportation and Distribution						
Raw materials and byproduct transport	4 050 000	km			4 055 184	4 055 184
Water supply and reagents						
Water supply	365	ML			56	56
Waste generated						
Municipal Waste	-	t			-	-
Transport of waste to landfill sites	-	km			-	-
Wastewater treatment	283	ML			52.6	52.6
Employee Commuting						
Own Vehicle	-	km			-	-
Taxi	-	km			-	-
Total tCO_{2-e}			*19 002*	-	*4 062 074*	*4 081 076*

The GHG emissions provided as a percentage per scope for project and construction and operations is provided in Figure 4-3. Scope 3 makes up the majority of the GHG emissions for both construction (99%) and operation (100%). Scope 1 emissions for the project construction are 2 645 tCO_2e (mostly due to fuel use of 473 tCO_2e per annum). In the operational phase, Scope 1 emissions over the project lifetime amount to 950 102 tCO_2e (19 002 tCO_2e per annum) due to gas combustion in the CHP. For comparison, international reporting considers a small facility as producing 10 000 tCO_2e per annum, medium at 25 000 tCO_2e per annum and large at 100 000 tCO_2e per annum (for Scope 1 and 2 emissions). The New Malting Plant in Sedibeng is therefore a medium-sized facility. Scope 3 emissions are mostly driven by purchased goods (especially steel) in the Construction phase, and the transport of raw materials and by-product distribution during the operational phase.



(a) Construction phase | (b) Operational phase

Figure 4-2: Percentage GHG emissions per scope for project activities

4.8 The Project's GHG Impact

4.8.1 Impact on the National Remaining Carbon Budget and the National Inventory

According to the updated first NDC (Section 2.3), the South African remaining carbon budget is in the range of 398 – 510 Mt CO_2e for 2025 and 350 – 420 Mt CO_2e by 2030. Using the lower end of the range for 2030, the project Scope 1 activities would contribute approximately 0.0004% (construction) and 0.0054% (operational) respectively of the remaining carbon budget per year and represent a contribution of 0.00028% (construction) and 0.004% (operational) to the 2022 National GHG inventory total. The clearance of 5.5 ha and coverage of this area with permanent infrastructure will reduce the National grassland carbon sink (grasslands remaining grasslands) by 0.002%.

4.8.2 Alignment with National Policy

Most of the South African GHG policy is in early phases of implementation where GHG emissions have been reported to DFFE since 31 March 2018 and the Carbon Tax Bill came into effect on the 1 June 2019. The New Malting Plant will be required to align GHG reporting with national policy, including annual reporting requirements.

Due to the improved efficiency and cleaner technology, CHPs align with the National policy as a low carbon technology.

5 PHYSICAL RISKS OF CLIMATE CHANGE ON THE PROJECT AND ADAPTATION MEASURES

5.1 Physical Risks of Climate Change to the Project's Operations

With the increase in temperature, there is the likelihood of an increase in discomfort and possibility of heat related illness (such as heat exhaustion, heat cramps, and heat stroke). Both these have the potential to negatively affect employee performance and productivity along with process efficiency.

From a process point of view, elevated ambient temperatures (up to 45°C) may slightly increase evaporative fuel losses from vehicles and increase temperature related wear on equipment. Similarly, there will be increased water use for drinking water and process operations. Although additional risk of drought is likely to be low (see Section 3.3), on-site storage, rainwater capture or other mitigation and adaptation considerations may need to be investigated.

A low to moderate risk of increased wildfires is projected for the vicinity (see Section 3.3). Emergency plans should include the risk of responding to and managing of uncontrolled wildfires potentially crossing the project fence line where cover vegetation could be ignited.

5.2 Project Mitigation and Adaptation Measures

Climate change management includes both mitigation and adaptation. The main aim of mitigation is to stabilise or reduce GHG concentrations as a result of anthropogenic activities. This is achievable by lessening sources (emissions) and/or enhancing sinks through human intervention. Mitigation measures are typically the focus of the energy, transport and industry sectors (Thambiran & Naidoo, 2017). Adaptation measures, on the other hand, focus on minimising the impact of climate change, especially on vulnerable communities and sectors. Inclusion of the climate change adaptation in business strategic implementation plans is one of the outcomes defined in the Draft National Climate Change Adaptation Strategy (Government Gazette No.42466:644, May 2019).

To minimise project specific GHG (Scope 1) emissions would require lower fuel use or use alternative lower-carbon fuels. The CHP units are already a low carbon technology, but other alternatives could be investigated, for example photovoltaic solar to meet some heat and electricity demands, reducing the quantities of gas combusted in the CHP units. Where possible, in plant-owned vehicles using lower-carbon fuels (compressed natural gas or biofuels) and incentivising their use by delivery and distribution subcontractors would reduce emissions due to energy use. Effective rehabilitation of above-ground and soil-based carbon stocks could be an effective carbon sink during rehabilitation after construction, and rehabilitation efforts should consider the establishment of artificial or reconstructed wetlands where these have been disturbed by construction operations and permanent infrastructure.

Carbon offset options could include investment in REDD+ (Reducing Emissions from Deforestation and forest Degradation) initiatives (Thambiran & Naidoo, 2017). REDD+ initiatives in developing countries incentivise communities to undertake forestry and related activities that can contribute to reducing land-based GHG emissions associated with deforestation and degradation and through sequestration of CO_2 in forests and agroforestry (Thambiran & Naidoo, 2017). REDD+ programmes are also mechanisms for socio-economic development. However, the expansion of the forestry industry in South Africa, will require quantification of the impact of expanded activities on water resources (as highlighted in the Draft National Climate Change Adaptation Strategy, Government Gazette No.42466:644, May 2019).

From an adaption perspective, additional support infrastructure can reduce the climate change impact on the employees. For example, improving the thermal and electrical efficiency of buildings to reduce electricity consumption for air conditioning, ensuring adequate water supply for staff drinking water, amending summer operating hours to avoid the hottest part of the day and potential health and safety impacts for employees, having shaded green rest areas for employees during their shift breaks.

6 MAIN FINDINGS, IMPACT ASSESSMENT AND RECOMMENDATIONS

6.1 Main Findings

A New Malting Plant is proposed for development in the Sedibeng District Municipality. The process description, fuel use, construction requirements and raw material and byproduct delivery and distribution requirements were used together with local and internationally published emission factors to calculate direct and indirect GHG emissions for the proposed project. Locally published literature was referred to for an understanding of the baseline climate, recent changes in climate and projected changes to climate for the area.

Based on the information available at the conceptual phase of design, Scope 1 emissions for the project construction would be 2 645 t CO_2e (mostly due to fuel use of 473 t CO_2e per annum). In the operational phase, Scope 1 emissions over the project lifetime amount to 950 102 t CO_2e (19 002 t CO_2e per annum) due to gas combustion in the CHP. This was calculated to represent a maximum 0.0054% of the remaining South African annual GHG budget. The site clearance and replacement with permanent infrastructure would potentially result in a reduction in the National grassland carbon sink by 0.002%.

The project will be required to report CO_2-e emissions annually via the SAGERS web-based monitoring and reporting system.

Projected future climate scenarios indicate that the area, under the RCP8.5 trajectory (with no mitigation), is likely to have higher average temperatures, between 2.76°C and 3.08°C. Rainfall is also projected to increase in the short-term (up to 2050) with an increase in extreme rainfall days. Low to moderate risk of increased likelihood of wildfires, drought, heat stress and flooding.

6.2 Impact Assessment

Climate change is likely to impact the existing communities, even if the proposed project does not go ahead. If the project is authorised, climate change is likely to affect employee health and safety along with plant operations. The significance of the potential climate change impacts due to the proposed project activities was assessed according to the methodology adopted by Royal Haskoning DHV (Appendix A). Since climate change is a global phenomenon, the criterion is not fully applicable to an assessment of the impacts of GHG emissions on climate change. However, the criterion is currently the best tool for the climate change impact analysis.

The project is expected to have a "moderate" negative risk rating specifically considering the potential GHG emissions and the contribution to the remaining South African Carbon budget, while the significance of physical risks to the project due to global climate change (due to historical global GHG emissions) is also expected to be "moderate" (Table 6-1). Note that the scale of climate change impact is always national or wider and therefore can result in an overly conservative significance. The overall consequence and significance are not influenced by the extent, but rather by the intensity of emissions in relation to the remaining carbon budget. There is some potential for mitigation of the GHG emissions that may reduce the indirect emissions which would have an indirect impact on South Africa's remaining carbon budget. Although some change in climate has already been documented for the area, most climate change impacts on local communities will occur post-closure.

Table 6-1: Potential impact significance rating for climate change

Project Activity	Climate Change		Consequence			Probability	Significance Rating
	Description	Impacts	Magnitude	Scale	Duration		
No – go	Facility is not authorised	Climate change impact risks to the facility	Moderate (6)	National (4)	Permanent (5)	Likely (3)	Moderate (45)
Project operational activities	Impact from operational activities associated with the project	Contribution to the Remaining South African Carbon Budget	Minor (2)	National (4)	Long (4)	Expected (4)	Moderate (40)
	Impact on operational activities associated with the project and local communities (post-closure)	Climate change impact risks to the project	Moderate (6)	National (4)	Permanent (5)	Likely (3)	Moderate (45)

6.2.1 Alternative Significance Rating

Other literature (Murphy & Gillam, 2013) suggests use of thresholds (Table 6-2) presented as tonnes of CO_2e per year, as basis for specific consideration of the specific elements to be assessed in the EIA, as guidance states that the contribution of an individual project to climate change cannot be measured.

Table 6-2: GHG emissions in EIA – Elements to consider

GHG emissions (Gg CO_2-e/year)	Qualitative rating	Elements of assessment to consider
GHGs < 25	**Low**	**Quantify GHG**
25 < GHGs < 100	Low	Look at possible mitigation, quantify GHG, place in context
100 < GHGs < 1 000	Medium	As above AND prepare management plan, describe existing climate conditions, consider how changes in climate may affect project and surroundings
GHGs > 1 000	High	As above AND consider adaptation analyses

Based on the suggested thresholds from Table 6-2, at calculated annual GHG emissions including both direct and indirect emissions, the proposed (design mitigated) project would be rated as **low** to **moderate** (depending on the rating methodology used) since Scope 1 GHG emissions will not exceed the 25 Gg CO_2-e per year threshold. There are few additional mitigation measures applicable to the project for Scope 1 emissions, except burning less gas, which would result in a similar significance rating as to the no-go option (moderate).

Conclusion

It is the opinion of the specialist that the project has a low to moderate impact on climate change in respect of the remaining National budget and therefore its approval is supported.

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APPENDIX A: IMPACT ASSESSMENT METHODOLOGY

Impact Assessment Methodology

The potential environmental impacts associated with the project will be evaluated according to its nature, extent, duration, intensity, probability and significance of the impacts, whereby:

- Nature: A brief written statement of the environmental aspect being impacted upon by a particular action or activity;
- Extent: The area over which the impact will be expressed. Typically, the severity and significance of an impact have different scales. This is often useful during the detailed assessment phase of a project in terms of further defining the determined significance or intensity of an impact. For example, high at a local scale, but low at a regional scale;
- Duration: Indicates what the lifetime of the impact will be;
- Intensity: Describes whether an impact is destructive or benign;
- Probability: Describes the likelihood of an impact actually occurring; and
- Cumulative: In relation to an activity, means the impact of an activity that in itself may not be significant but may become significant when added to the existing and potential impacts eventuating from similar or diverse activities or undertakings in the area.

This approach incorporates two aspects for assessing the potential significance of impacts, namely occurrence and severity, which are further sub-divided as follows:

Occurrence		Severity	
Probability of occurrence	Duration of occurrence	Scale/extent of impact	Magnitude (severity) of impact

To assess each of these factors for each impact, the following four ranking scales are used:

Criteria for the ranking of impacts

Probability	Duration
5 - Definite/ don't know	5 - Permanent
4 - Highly probable	4 - Long-term
3 - Medium probability	3 - Medium-term (8 - 15 years)
2 - Low probability	2 - Short-term (0 - 7 years) (impact ceases after the operational life of the activity)
1 - Improbable	1 – Immediate
0 – None	0 - None
Scale	**Magnitude**
5 - International	10 - Very high/ don't know
4 - National	8 - High
3 - Regional	6 - Moderate
2 - Local	4 - Low
1 - Site only	2 - Minor
0 – None	0 - None

Once these factors have been ranked for each impact, the significance of the two aspects, occurrence and severity, must be assessed using the following formula:

SP (significance points) = (magnitude + duration + scale) x probability

The maximum value is 100 significance points (SP). The impact significance is then rated as follows:

Impact significance:

SP >75	Indicates high environmental significance	An impact which could influence the decision about whether or not to proceed with the project regardless of any possible mitigation.
SP 30 – 75	Indicates moderate Environmental significance	An impact or benefit which is sufficiently important to require management and which could have an influence on the decision unless it is mitigated.
SP <30	Indicates low environmental significance	Impacts with little real effect and which should not have an influence on or require modification of the project design.
+	Positive impact	An impact that constitutes an improvement over pre-project conditions

Impacts must be assessed and rated before and after mitigation.

APPENDIX B: AUTHORS CURRICULUM VITAE

CURRICULUM VITAE

Name	Theresa (Terri) Leigh Bird
Nationality	South African
Employer	Airshed Planning Professionals (Pty) Ltd
Position	Senior Consultant
Profession	Air Quality Specialist Consultant
Years with Firm	12 years

MEMBERSHIP OF PROFESSIONAL SOCIETIES

- National Association for Clean Air (NACA), 2012 to present
- South African Council for Natural Science Professions (Pr.Sci.Nat.), 2016 to present

EXPERIENCE

Projects contributing to Environmental Impact Assessments

Project type	Experience
Mining (including coal, platinum, tin, gold, and rare earth minerals)	▪ At least five proposed open-cast coal mining projects, mostly in South Africa and Botswana ▪ Air quality assessment for the expansion of an underground platinum mine to include a concentrator facility and tailings facility. ▪ Assessment of underground mining of cassiterite (the mineral ore mined for tin) in the Democratic Republic of Congo. The project included the assessment of emissions along a long-distance haul road from the mine to Mombasa for export. ▪ Assessment of open-cast and underground mining of gold-rich ore, including gold plant activities, in order to design an air quality monitoring network. ▪ Three rare earth mineral mining projects included dispersion model runs to assist the radiation specialist assessment of impact of radioactive compounds. ▪ The impact of mine tailings facilities on a proposed mixed use (residential and commercial) development, especially consideration to particulate matter and potential hazardous compounds on the residents of the development.
Power Stations	▪ A project assessing the impact of Namibian coal-fired power station on urban air quality, in the context of many small industrial sources. ▪ The assessment of retrofitting improved particulate emission controls on an existing coal-fired power station on the Mpumalanga Highveld. ▪ The assessment of impact of a floating power plant, fuelled by various potential liquid fuels, docked in a port servicing an industrial development zone.

Projects contributing to Environmental Impact Assessments

Project type	Experience
	▪ Professional opinion on the impact of solar power facilities (one concentrated solar power (CSP) and one photovoltaic (PV)) on ambient air quality. ▪ The assessment of three coal-fired power stations in Botswana, including two projects where the assessment assessed the combined impact of an open-cast coal mine and the associated coal-fired power station. ▪ Assessment of gas- and liquid fuel-to-power facilities using a mix of fuel options and abatement technologies.
Ash disposal facilities for coal-fired power stations	▪ Conducted the assessment of impact of ash disposal facilities coal-fired power stations requiring additional disposal area. Assessment included the estimation of increased life-time cancer risk as a result of exposure to carcinogenic metals in the wind-blown dust from the disposal facilities.
Tyre pyrolysis plant	▪ Assisted on an assessment of a plant that will use waste tyres as raw material to produce machine and vehicle oils.
Mineral alloy plant	▪ Project for a plant that uses multiple listed activities to recovery metals, via thermal processes, to produce ferroalloys that are pressed into briquettes for dispatch to clients.
Domestic waste landfill	▪ Assessing the health and odour impacts of a domestic waste landfill to support residential development plans for the area.
Hazardous waste landfill	▪ Assessing the health and odour impacts of a hazardous waste landfill to support the reduction of the required buffer zone.
Thermal oxidation of industrial waste	▪ The project quantified the impact of an industrial thermal oxidation plant for waste disposal and considered upgrading of new technology to meet more stringent emission standards.
Marine Repair Facility	▪ The project quantified the impact on air quality of a marine vessel repair facility in the context of a busy port which includes an iron-ore transfer yard.
Industrial complexes	▪ Air quality impact of a large industrial special economic zone development (project assistant) ▪ Impact of road traffic on air quality associated with the development of an automated supplier park.

Air Quality Management Plans (AQMP) and Policy Developments

Project type	Experience
Priority Area Level AQMP	▪ Involvement included: - baseline assessment of climatic conditions and ambient air quality across the Province; - collation of questionnaires from point-source emission; - point-source emissions inventory database management ▪ Contributor to management plan write-up. ▪ The management intervention strategies proposed in the AQMP were a collaborative effort of the technical project team, which included the client, stakeholders, and consultants.
Provincial Level AQMP	▪ Involvement included: - baseline assessment of climatic conditions and ambient air quality across the Province; - collation of questionnaires from point-source emission;

Air Quality Management Plans (AQMP) and Policy Developments

Project type	Experience
	- point-source emissions inventory database management ▪ Assisted with quantification of vehicle emissions and with dispersion modelling of baseline emissions. ▪ Main contributor to management plan write-up. ▪ The management intervention strategies proposed in the AQMP were a collaborative effort of the technical project team, which included the client and consultants.
Metropolitan city level AQMP	▪ Contributed to the emission inventory of industrial sources ▪ Collaborative project with the Council for Scientific Research (CSIR)
New Policy Development	▪ Involved in a project to assess the impact of fuel burning appliances towards a controlled fuels policy in a metropolitan municipality.
Platinum smelter complex	▪ Fugitive dust emissions from ground-level sources and materials handling were a concern for a platinum smelter complex. The project scope included the identification of all sources; the quantification and ranking of emissions; and proposed management strategies. A risk assessment model was used to assess where the variability of emission sources would constitute a risk if improperly managed.
Diamond mine	▪ The project scope for a Botswana-based diamond mine approaching end-of-life required the assessment of current and future impacts of operations on the ambient air quality; including the development of an air quality management plan and the proposal of an ambient air quality monitoring network, based on the findings of the impact assessment.

Atmospheric Impact Reports (AIR)

Project type	Experience
Coal-to-liquid fuel refineries	▪ Postponement application included four sites with multiple point-sources and modelling iterations for all sources emitting at four different levels for multiple pollutants. ▪ A collaborative project where responsibilities included: model simulations, post-processing and extractions; management of model extractions and management of file transfer for peer review process; graphic summaries results; mapping of results; and, graphic presentation of measured ambient air quality. My contributions to the written report included: report template sections (as per Government Gazette No. 36904: 747); summary of meteorological data used in the assessment; measured ambient air quality; results analysis, interpretation and write-up; and, a literature review of potential impacts of the operations on the environment. ▪ The assessment of impact of petroleum storage tanks storing products of the tar process on the ambient air quality, especially with respect to total volatile organic compounds (TVOCS).
Crude oil refinery	▪ Postponement application included emissions from multiple point-sources, and fugitive emissions from storage tanks; modelling iterations for all sources emitting at two different levels for sulfur dioxide [from point sources] and total volatile organic compounds (TVOCS) [from tanks]. ▪ A collaborative project where I focused on the point-sources, including the model simulations; post-processing and extractions; graphic results summaries; and,

Atmospheric Impact Reports (AIR)

Project type	Experience
	graphic presentation of measured ambient air quality. Contributions to the written report included: report template sections; summary of meteorological data used in the assessment; measured ambient air quality; results analysis, interpretation and write-up.
Fertilizer production	▪ Assessment report (prepared as AIR) included emissions from multiple point-sources; modelling iterations for all sources emitting at two different levels for particulate matter and ammonia emissions. ▪ A collaborative project where my responsibilities included: model simulation setup, post-processing and extractions; graphic summaries results; mapping of results; and, graphic presentation of measured ambient air quality. My contributions to the written report included: report template sections (as per Government Gazette No. 36904: 747); summary of meteorological data used in the assessment; measured ambient air quality; results analysis, interpretation and write-up.
Platinum smelter	▪ Postponement application included emissions from the smelter furnace and converter; modelling iterations for the sources emitting at two different levels where the pollutant of concern was sulfur dioxide.
Veterinary waste incinerator	▪ New Atmospheric Emissions License (AEL) application for a State Veterinary incinerator. The assessment included calculating emission rates from the incinerator; dispersion modelling; preparation of an AIR (as per Government Gazette No. 36904: 747); and completing the technical sections of the AEL application.
Galvanizing plant	▪ The project assessed the impact of a steel galvanising plant on air quality in a developing industrial development zone. Pollutants of concern included hydrochloric acid (HCl).
Secondary Aluminium Smelter	▪ A project involving the assessment of a secondary aluminium smelter in an already developed urban industrial area
Refractory product facility	▪ A project for a facility producing monolithic refractories and dried 'ready-shape' refractory castables made specially for industrial equipment and refractory installations.
Waste to energy facility	▪ A project to assess the impact of a general waste to energy project, using pyrolysis, located in a tourism, recreational, commercial and residential area of the Western Cape province.
Impact screening at receptors	▪ Assessment of air quality impact at sensitive receptors based on measurements at monitoring stations where not collocated.
NEMA Section 30	▪ Assessment of air quality impact due to industrial 'upset' events including simulating the off-site impacts for short-term high-emission events.

Ambient air quality monitoring projects

Project type	Comments regarding project details and involvement
Ferrochrome smelter complex	▪ Compiled reports for the dustfall monitoring campaign for a period of 12 months. Results were compared with the relevant legislation and recommendations made for source management as required.
Platinum smelter complex	▪ Project scope required monthly reports of the ambient sulfur dioxide concentrations downwind of a platinum smelter complex, for a 12-month

	reporting period. Report preparation included: data cleaning and filtering; data analysis, presentation; and report write-up.
Dustfall monitoring	▪ Collate, summarise and report on dustfall rates, and metal content, after laboratory analysis. Projects include: baseline monitoring prior to active coal mining; landfill dustfall monitoring; baseline dustfall monitoring for a residential development.
Ambient air quality monitoring	▪ Using radiello™ passive samplers to assess ambient pollutant concentrations. Projects include: volatile organic compounds around industrial waste water dams; pre-development levels near a medical waste incinerator; pre-development levels near a coal-fired power station; levels near a hazardous landfill; monitoring near an operational natural gas compression plant.
Asbestos monitoring	▪ Air and soil sampling and reporting for asbestos fibres
Petroleum product storage tanks	▪ Calculation of annual (volatile organic compound) emissions from petroleum storage tanks for the purposes of emissions reporting via the National Atmospheric Emission Inventory System.

Emissions Reporting and Offset Projects

Prepared emissions inventories for online submission via the Atmospheric Emission Inventory System (NAEIS)

Project types

- Coal Mine
- Liquid fuel to power plant
- Dispersion modelling of air quality offset projects
- Manufacturer of alloys and associated products
- Petroleum product tank farm

Greenhouse Gas Emissions Foot-printing and Climate Change Impact Statements

Project type	Comments regarding project details and involvement
Coal Mine	▪ Quantified the direct and indirect (due to imported electricity) emissions for a coal mine on the Highveld. ▪ Assessed the climate risks and vulnerabilities of the project and surrounding communities due to increasing ambient temperatures, water scarcity, risk of intense storms.
Gas-to-power plant	▪ Quantified the direct and indirect (due to imported electricity) emissions for a risk mitigation gas-to-power plant on South Africa's north-east coast. Avoided emissions from coal-fired power plants were also considered. ▪ Assessed the climate risks and vulnerabilities of the project and surrounding communities due to increasing ambient temperatures; risk of intense storms, including tropical cyclones; sea level rise and coastal stability.
Liquid fuel to power plants	▪ Quantified the direct and indirect (due to imported electricity) emissions for a risk mitigation liquid fuel-to-power plant, used to support solar PV arrays, in South Africa's Northern Cape Province. ▪ Assessed the climate risks and vulnerabilities of the project and surrounding communities due to increasing ambient temperatures, water scarcity, risk of intense storms.
Calcination plant	▪ Quantified the direct and indirect (due to imported electricity) emissions from a calcination facility on the Highveld. ▪ Assessed the climate risks and vulnerabilities of the project and surrounding communities due to increasing ambient temperatures; water scarcity and risk of intense storms.
Liquid fuel refinery	▪ Quantified the direct and indirect (due to imported electricity) emissions for liquid fuel refinery.

	▪ Assessed the climate risks and vulnerabilities of the project and surrounding communities due to increasing ambient temperatures; water scarcity; sea level rise; and storm water surges.
General Waste Landfill	▪ Quantified the direct and indirect (due to imported electricity and vehicle fuel use) emissions for a general waste landfill. ▪ Assessed the climate risks and vulnerabilities of the project and surrounding communities due to increasing ambient temperatures and water scarcity.

SOFTWARE PROFICIENCY

- Atmospheric Dispersion Models: AERMOD, CALPUFF, ADMS (United Kingdom), CALINE, GRAL.
- Emissions models: COPERT and GASSIM
- Graphical Processing: Surfer, ArcGIS
- The R Project for Statistical Computing, especially with the package "openair"

EDUCATION

University of the Witwatersrand

Ph.D. (School of Animal, Plant and Environmental Sciences) (2006 - 2011)	Thesis title: **Some impacts of sulfur and nitrogen deposition on the soils and surface waters of the Highveld grasslands, South Africa.**
M.Sc. (School of Animal, Plant and Environmental Sciences) (1999 – 2001).	Dissertation title: **Some effects of prescribed understory burning on tree growth and nutrient cycling, in *Pinus patula* plantations.**
B.Sc. (Hons) (Botany) (1998)	Project title: **The rate of nitrogen mineralization in plantation soils, in the presence of *Eucalyptus grandis* wood chips.** *Courses*: Wetland ecology, Ecophysiology and Environmental studies.
B.Sc. (1995 – 1997)	Botany III, Geography III, Zoology II.

COURSES COMPLETED AND CONFERENCES ATTENDED

- Paper presented at the International Union of Air Pollution Prevention and Environmental Protection Associations World Clean Air Congress, 2013 in Cape Town, South Africa,29 September - 4th October 2013
  - *Paper entitled*: Nitrogen cycling in grasslands and commercial forestry plantations: the influence of land-use change
  - *Co-authors*: T.L. Bird, M.C. Scholes, Y. Scorgie, G. Kornelius, N.-M. Snyman, J. Blight, and S. Lorentz
- Paper prepared for the National Association for Clean Air (NACA) annual conference, 2012 in Rustenburg, South Africa, 1-2 November 2012, Rustenburg. Annual Conference Proceedings ISBN 978-0-620-53886-2, Electronic Proceedings ISBN 978-0-620-53885-5
  - *Paper entitled*: Developing an Air Quality Management Plan: Lessons from Limpopo
  - *Co-authors*: T. Bird, H. Liebenberg-Enslin*, R. von Gruenewaldt, D. Modisamongwe, P. Thivhafuni, and, T. Mphahlele

- National Association for Clean Air (NACA) annual conference, 2017 in Johannesburg, South Africa, 4-6 October 2017, Rustenburg. Annual Conference Proceedings ISBN 978-0-620-77240-2, Electronic Proceedings ISBN 978-0-620-53885-5
  - *Poster entitled*: Air Pollution in sub-tropical urban and suburban areas: Do trends indicate vegetation as a pollution source?
  - *Co-authors*: T. Bird, G. Petzer, N. von Reiche

COURSES PRESENTED

Training organisation	Details of involvement
National Association for Clean Air (NACA)	▪ Presenting the module regarding the Development of Air Quality Management Plans ▪ Module forms part of a 5-day course presented annually ▪ Atmospheric dispersion modelling training with AERMOD and CALPUFF
Centre for Environmental Management (CEM), University of the North-West (Potchefstroom)	▪ Presented two modules: 1. Development of Air Quality Management Plans 2. Air Pollution Meteorology ▪ Modules forms part of a 2-day course presented annually, or at special request

COUNTRIES OF WORK EXPERIENCE

South Africa, Botswana, Mozambique, Democratic Republic of Congo, Namibia, Tanzania

LANGUAGES

Language	Proficiency
English	Full professional proficiency
Afrikaans	Good understanding; fair spoken and written

REFERENCES

Name	Position	Contact Number
Dr. Hanlie Liebenberg Enslin	Managing Director at Airshed Planning Professionals	[redacted]
Dr Lucian Burger	Director at Airshed Planning Professionals	[redacted]
Dr. Gerrit Kornelius	Associate of Airshed Planning Professionals	[redacted]

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CERTIFICATION

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

[redacted]

20 June 2024