Bat Environmental Impact Assessment (EIA) Report

For the proposed Hendrina Green Hydrogen and Ammonia (GHA) Facility,

Mpumalanga, South Africa

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Applicable Legislation

Legislation dealing with biodiversity applies to bats and includes the following:

NATIONAL ENVIRONMENTAL MANAGEMENT: BIODIVERSITY ACT, 2004 (ACT 10 OF 2004; Especially sections 2, 56 & 97). The Act calls for the management and conservation of all biological diversity within South Africa. Bats constitute an important component of South African biodiversity and therefore all species receive attention, in addition to those listed as Threatened or Protected.

THE SOUTH AFRICAN BEST PRACTICE GUIDELINES for preconstruction studies recommends sensitivity map buffer rules and mitigation by avoidance. MacEwan, K., Sowler, S., Aronson, J., and Lötter, C. 2020. *South African Best Practice Guidelines for Pre-construction Monitoring of Bats at Wind Energy Facilities - ed 5*. South African Bat Assessment Association.

THE BAT MORTALITY THRESHOLD GUIDELINES imposes sustainable bat mortality thresholds for operating wind farms, indicating when wind farms need to apply active mitigation measures. MacEwan, K., Aronson, J., Richardson, E., Taylor, P., Coverdale, B., Jacobs, D., Leeuwner, L., Marais, W., Richards, L. 2018. *South African Bat Fatality Threshold Guidelines – ed 2*. South African Bat Assessment Association.

Contents

1 OBJECTIVES AND TERMS OF REFERENCE FOR THE STUDY 9

2 INTRODUCTION 9

2.1 Project Description 9

2.2 The Bats of South Africa 16

2.1 Bats and Green Hydrogen and Ammonia facilities 17

3 METHODOLOGY 18

3.1 Literature-based and On-site Inspections 18

3.2 Active & Passive Monitoring 18

3.3 Bat Sensitivity Mapping 22

3.4 Assumptions and Limitations 22

4 RESULTS AND DISCUSSION 23

4.1 Land Use, Vegetation, Climate and Topography 23

4.1.1 Eastern Highveld Grassland 24

4.2 Currently Confirmed, Previously Recorded and Literature-based Species Probability of Occurrence 24

4.3 Conservation and protected areas, known sensitivities and caves/roosts within 100km of the site 29

4.4 Sensitivity Mapping 32

4.5 Cumulative impact consideration within a 30km radius 35

5 IMPACT ASSESSMENT 36

5.1 Construction and Operational phases 36

5.2 Cumulative impact 38

6 MITIGATION OPTIONS PERTAINING TO THE EMPr 40

6.1 Minimisation of light pollution and artificial habitat creation 40

7 MITIGATION ACTION PLAN FOR INCLUSION INTO THE EMPr 41

7.1 Step 1: Minimisation of light pollution and artificial habitat creation (refer to Section 6.1) 41

8 CONCLUSION 42

9 REFERENCES 44

Table i. Explanation of abbreviations

Abbreviation	Explanation
ACR	African Chiroptera Report
BESS	Battery Energy Storage System
DEA	Department of Environmental Affairs
DMRE	Department of Mineral Resources and Energy
EIA	Environmental Impact Assessment
IRP	Integrated Resource Plan
MM	Meteorological ("Met") Mast
REC	Renewable Energy Complex
REF	Renewable Energy Facility
REIPPPP	Renewable Energy Independent Power Producer Procurement Programme
SABAA	South African Bat Assessment Association
SEA	Strategic Environmental Assessment
ShM	Short Mast (passive bat detection system)
WEF	Wind Energy Facility
COD	Commercial Operation Date
Bp/h	Bat passes per hour
GHA	Green Hydrogen and Ammonia

NEMA Requirements

The content of a specialist report is specified in the EIA Regulations GN R. 982, as amended (4 Dec 2014) Appendix 6. A specialist report prepared in terms of these Regulations must contain:

NEMA Requirement	Section/page in report
Details of the specialist who prepared the report, and the expertise of that specialist to compile a specialist report including a curriculum vitae.	Separate Curriculum Vitae
A declaration that the specialist is independent in a form as may be specified by the competent authority.	Page iii
An indication of the scope of, and the purpose for which, the report was prepared.	Section 1
An indication of the quality and age of the base data used for the specialist report.	Sections 3; 4
A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change.	Sections 4; 5
The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment.	Section 3
A description of the methodology adopted in preparing the report or carrying out the specialised process, inclusive of equipment and modelling used.	Section 3
Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure.	Section 5
An identification of any areas to be avoided, including buffers.	Section 4.4
A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers.	Section 4.4
A description of any assumptions made and any uncertainties or gaps in knowledge.	Section 3.4

A description of the findings and potential implications of such findings on the impact of the proposed activity, or activities.	Sections 4 and 5
Any mitigation measures for inclusion in the EMPr.	Sections 6 and 7
Any conditions for inclusion in the environmental authorisation.	Sections 5, 6, 7 and 8
Any monitoring requirements for inclusion in the EMPr or environmental authorisation.	Section 5, 6 and 7
A reasoned opinion whether the proposed activity or portions thereof should be authorised, and regarding the acceptability of the proposed activity or activities. And 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.	Sections 5, 6, 7 and 8
A description of any consultation process that was undertaken during the course of preparing the specialist report.	Sections 3

1 OBJECTIVES AND TERMS OF REFERENCE FOR THE STUDY

The objectives and terms of reference for the impact assessment are to provide the following:

- A description of the baseline characteristics and conditions of the receiving environment (e.g., site and/or surrounding land uses including urban and agricultural areas).
- An evaluation of the predicted impacts of the project on the receiving environment.
- Consider and evaluate the cumulative impacts in terms of the current and proposed activities in the area.
- Recommendations to avoid negative impacts, as well as feasible and practical mitigation, management and/or monitoring options to reduce negative impacts that can be included in the Environmental Management Programme.
- A reasoned opinion as to whether the proposed activity, or portions of the activity should receive Environmental Authorisation.

2 INTRODUCTION

This document is the 12-month Pre-construction Bat Environmental Impact Assessment (EIA) Report for the proposed Hendrina Green Hydrogen and Ammonia (GHA) Facility completed by Animalia Consultants (Pty) Ltd.

2.1 Project Description

The Project is located 17km west of Hendrina, in the Steve Tshwete Local Municipality, of the Nkangala District Municipality, Mpumalanga Province. The proposed Hendrina GHA facility will be provided with power by the proposed Hendrina North & South WEFs, and are located within the same site boundary. Three alternative Project locations are being investigated for the development of the proposed Project:

Site Alternative 1 is located on Portion 3 of the Farm Dunbar 189IS, at the site of an old abandoned farmyard and has three powerline options from the associated Hendrina North and South Wind Energy Facilities ("WEF") as follows:

- Powerline option 1 is up to 2km in length, to the Hendrina North WEF substation Option 1 on Portion 1 of the Farm Dunbar 189IS;
- Powerline option 2 is up to 7km in length, to the Hendrina North WEF substation Option 2 on Portion 3 of the Farm Hartebeestkuil 185IS;
- Powerline option 3 is up to 1.5km in length, to the Hendrina South WEF substation on Portion 3 of the Farm Dunbar 189IS.

Water supply to the Site:

- Constructing a new pipeline (up to 16km) from the Komati Power Station.

Site Alternative 2 is located on Portion 3 of the Farm Dunbar 189IS and Portion 18 of the Farm Weltevreden 193IS, adjacent to the proposed Hendrina South WEF substation and has three powerline options from the associated wind farms as follows:

- Powerline option 1 is up to 3km in length to the Hendrina North WEF Option 1 substation on Portion 1 of the Farm Dunbar 189IS;
- Powerline option 2 is up to 8km in length to the Hendrina North WEF substation Option 2 on Portion 3 of the Farm Hartebeestkuil 185IS;
- Powerline option 3 is up to 0.5km in length to the Hendrina South WEF substation on Portion 3 of the Farm Dunbar 189IS;

Water supply to the Site:

- Constructing a new pipeline (up to 16km) from the Komati Power Station.

Site Alternative 3 is located on Portions 14 and 15 of the Farm Weltevreden 193IS and has three powerline options from the associated wind farms as follows:

- Powerline option 1 is up to 5km in length to the Hendrina North WEF Option 1 substation on Portion 1 of the Farm Dunbar 189IS;

- Powerline option 2 is up to 5km in length to the Hendrina North WEF substation Option 2 on Portion 3 of the Farm Hartebeestkuil 185IS;
- Powerline option 3 is up to 7km in length to the Hendrina South WEF substation on Portion 3 of the Farm Dunbar 189IS.

Water supply to the Site:

- Constructing a new pipeline (up to 16km) from the Komati Power Station.

ENERTRAG SA, is proposing the development of up to 150MW green hydrogen and ammonia facility ('Facility'). The Facility will encompass approximately 25 hectares of land (three alternative locations being assessed).

"Green" hydrogen and ammonia production differs from traditional production technologies in that the process relies exclusively on renewable resources (renewable energy) and for input air and water (feedstock), to produce commercially usable green hydrogen and ammonia. The only solid waste stream is the production of brine from the water treatment plant.

A gaseous 'waste' (oxygen) is generated from the electrolyses process. Another source of gaseous 'wastes' is from the Air Separation Unit. This is where nitrogen is removed from the air and the other natural gases as expelled back to the environment.

Traditional hydrogen and ammonia are produced through the burning of fossil fuels (coal or natural gas) to provide the required energy needed for their production. This method of production results in 'brown' hydrogen as fossil fuels are used and therefore carbon forms an integral part of such traditional hydrogen production.

Commercially, hydrogen is used as a fuel for transport in hydrogen fuel cells. Alternatively, hydrogen is used for welding and in the production of other chemicals such as methanol and hydrochloric acid and also has other commercial uses like the filling of balloons. It is also a primary input to the production of ammonia. Ammonia in turn is primarily used in the production of ammonium nitrate (fertiliser) and is also used as refrigerant gas and the manufacture of plastics, explosives, textiles, pesticides and other chemicals. Ammonia can also be used as a stable ‘carrier’ of hydrogen, allowing hydrogen to be readily stored and transported.

The production, storage and transport of hydrogen and ammonia is an industry undergoing in-depth research and developments. Consequently, technological solutions are constantly being improved and changing. Thus, the below Facility description is based on available technological solutions, however, the underlying fundamentals will remain.

The facility comprises the following components as summarised in **Table 2.1**, where the footprint and capacities are presented. These parameters on based on the assumption that an up to 150MW electrolyser is installed (maximum). These components are detailed further below, but comprise the following general components:

- Water treatment.
- Electrolyser.
- Air separator.
- Ammonia processing unit.
- Liquid air energy system (LAES) for nitrogen storage.
- Feedstock and product storage.
- Utilities.
- Gantry and loading bay.

Associated infrastructure further include:

- Electrical infrastructure required for power supply to the facility.
- Temporary and permanent laydown areas required for temporary storage and assembly of components and materials.
- Access road/s to the site and internal roads between project components, with a width of up to up to 6m wide respectively.
- Fencing and lighting.
- Lightning protection.

- Telecommunication infrastructure.
- Stormwater channels.
- Water pipelines
- Offices.
- Operational control centre.
- Operation and Maintenance Area / Warehouse / workshop.
- Ablution facilities.
- A gate house.
- Control centre, offices, warehouses.
- Security building.

Table 2-1. Components and specifications of the proposed Hendrina GHA facility.

No.	Component	Footprint (Ha)	Storage Capacity (m^3 / tons)	Maximum Throughput (m^3 / tpa)	Conversion	Note
1	Water Reservoir	2	6 800 / 6 800	800 / 800	Density of water taken as 1 000 kg/m3	Process and utilities water
2	Water Treatment Unit	1.5	N/A	192 000 / 192 000	Density of water taken as 1 000 kg/m3	Process and utilities water
3	Electrolyser Unit	1	N/A	(1 239 157 – 301 932 367) / 20 000	Density of hydrogen can be 16.14kg/m3 at 200 barg and 25 °C or 0.06624 kg/m3 at 0 barg and 90 °C depending on the operating conditions of the unit.	Hydrogen Output Oxygen Output
4	Air Separation Unit	0.5	N/A	92 905 405 / 110 000	The density of air taken as 1.184 kg/m3	Air Input
5	Ammonia Processing Unit	2	N/A	149 253 / 100 000	The density of liquid ammonia taken 670 kg/m3 at -33 °C at 1 atm	Ammonia Output
6	Liquid Air Storage System (LAES)	1	3 983/ 3 505	460 227 / 405 000	The density of liquid nitrogen taken 880 kg/m3 at -33 °C at 1 atm	Nitrogen Storage
7	Liquid Ammonia Storage Tank	2	2 273/ 1 523	261 194 / 175 000	The density of liquid ammonia taken as 670 kg/m3 at -196 °C at 1 atm	
8	Hydrogen and Oxygen Storage Tank Farm	12	59 566/ 800	5 576 208 / 90 000	A density of 16.14kg/m^3 for hydrogen at 200 barg and 25 °C. Oxygen density estimated at liquid boiling point and 1 atmosphere pressure, totaling 1141 kg/m^3.	Hydrogen and Oxygen storage (combined tank farm), i.e. feedstock storage
9	Ancillary infrastructure	3	n/a	n/a	n/a	Includes temporary and permanent laydown areas, parking, offices and other related infrastructure.
	Total Footprint	25				

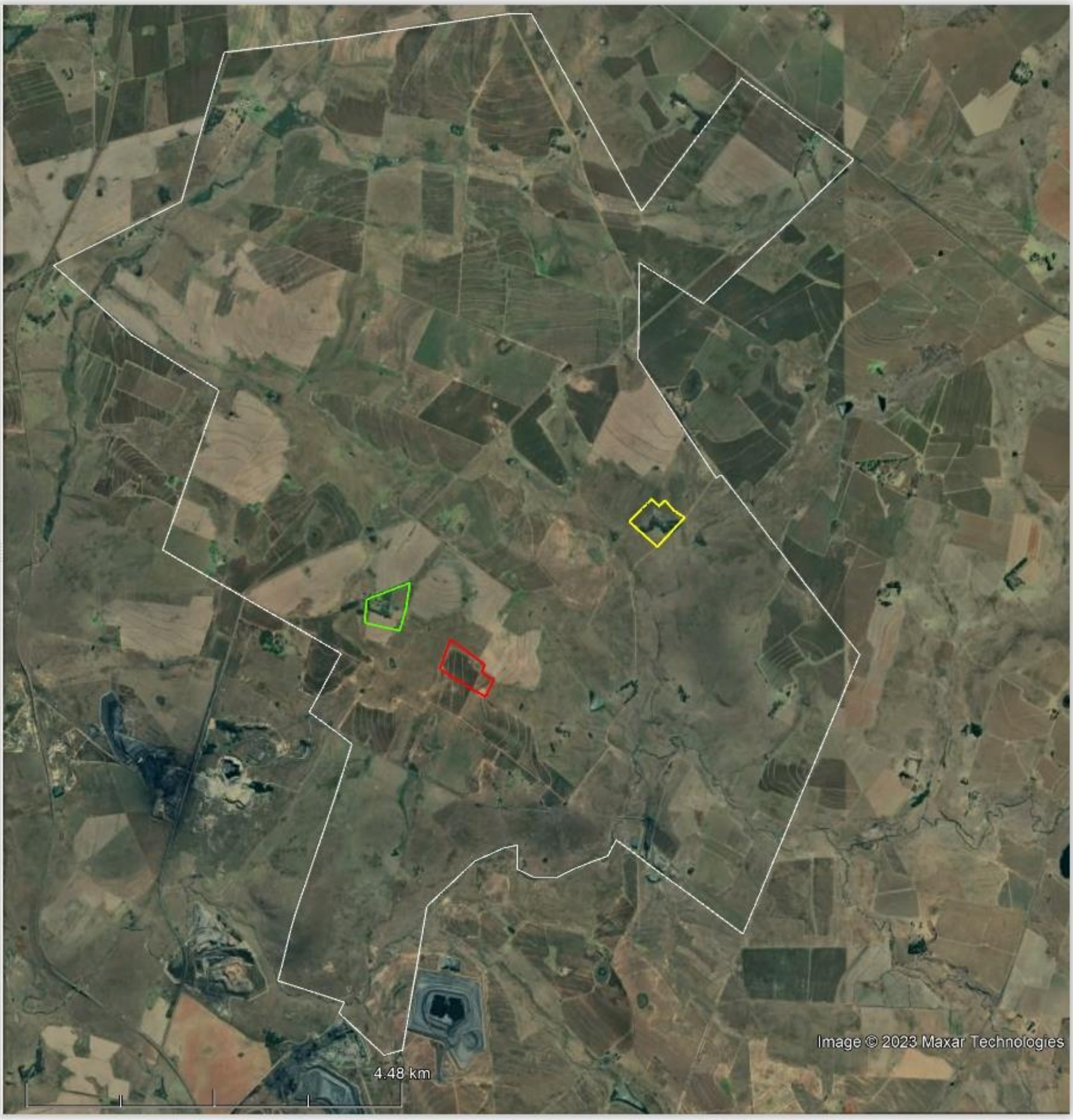

Figure 2-1. Proposed locations of the three options for the Hendrina GHA facility. Green = Option 1; Red = Option 2; Purple = Option 3.

2.2 The Bats of South Africa

Bats form part of the Order Chiroptera and are the second largest group of mammals after rodents. They are the only mammals to have developed true powered flight and have undergone various skeletal changes to accommodate this. The forelimbs are elongated, whereas the hind limbs are compact and light, thereby reducing the total body weight. This unique wing profile allows for the manipulation of wing camber and shape, exploiting functions such as agility and manoeuvrability. This adaption surpasses the static design of the bird wings in function and enables bats to utilise a wide variety of food sources, including, but not limited to, a large diversity of insects (Neuweiler 2000). Species-based facial features may differ considerably as a result of differing lifestyles, particularly in relation to various feeding and echolocation navigation strategies. Most South African bats are insectivorous and are capable of consuming vast quantities of insects on a nightly basis (Taylor 2000, Tuttle and Hensley 2001) however, they have also been found to feed on amphibians, fruit, nectar and other invertebrates. As a result, insectivorous bats are the predominant predators of nocturnal flying insects in South Africa and contribute greatly to the suppression of these numbers. Their prey also includes agricultural pests such as moths and vectors for diseases such as mosquitoes (Rautenbach 1982, Taylor 2000).

Urban development and agricultural practices have contributed to the deterioration of bat populations on a global scale. Public participation and funding of bat conservation are often hindered by negative public perceptions and unawareness of the ecological importance of bats. Some species choose to roost in domestic residences, causing disturbance and thereby decreasing any esteem that bats may have established. Other species may occur in large communities in buildings, posing as a potential health hazard to residents in addition to their nuisance value. Unfortunately, the negative association with bats obscures their importance as an essential component of ecological systems and their value as natural pest control agents, which actually serves as an advantage to humans.

Many species of bats roost in large communities and congregate in small areas. Therefore, any major disturbances within and around the roosting areas may adversely impact individuals of different communities concurrently (Hester and Grenier 2005). Secondly, nativity rates of bats are much lower than those of most other small mammals. This is because, for the most part, only one or two pups are born per female per annum. Under natural circumstances, a population's numbers may accumulate over long periods of time. This is due to the longevity of up to 30 years (O'Shea *et al*. 2003) and the relatively low predation of bats when compared to other small mammals. However, bat populations are not able to adequately recover after mass mortalities and major roost disturbances.

2.1 Bats and Green Hydrogen and Ammonia facilities

Currently there is no evidence of these facilities posing a direct threat of fatality impact on bats during operation. However, roosting and foraging habitats may be destroyed during the construction phase. This is primarily due the fact that such facilities require areas of land to be cleared, and in some cases, earthworks are required for levelling purposes. This can result in habitat that is suitable for micro roosts, such as rocky outcrops, clumps of trees and certain vegetation being destroyed, which can also be fatal to bats residing in such roosts. Natural vegetation can support higher insect food quantities and diversity than cleared land, therefore foraging habitat can also be displaced.

The presence of security lights on and around these facilities creates significant light pollution that can impact bat feeding habits and species compositions negatively, by artificially discouraging photophobic (light averse) species and favouring species that readily forage around insect-attracting lights. Additionally, if the buildings and associated infrastructure for these facilities are placed close to wind turbines, the light pollution at these buildings can attract photophilic bat species, thereby significantly increasing their chances of being killed by moving blades of turbines within close proximity.

3 METHODOLOGY

3.1 Literature-based and On-site Inspections

The site is evaluated by comparing the amount of surface rock (possible roosting space), topography (influencing surface rock in most cases), vegetation (possible roosting spaces and foraging sites), climate (can influence insect numbers and availability of fruit), and presence of surface water (influences insects and acts as a source of drinking water) to identify bat species that may be impacted by the project. These comparisons are done principally by briefly studying the geographic literature of each site, available satellite imagery and by ground-truthing with site visits. The probability of occurrence based on the above-mentioned factors are estimated for the species both expected and confirmed on site as well as the larger surrounding area.

3.2 Active & Passive Monitoring

Several site visits were made to the Hendrina GHA site between August 2020 and October 2021. Passive data are available from October 2020 to October 2021 on the short masts and August 2020 to June 2021 on the Met Mast. Passive data can ground truth bat sensitivity features and habitats delineated in the bat sensitivity constraints map and collect bat activity data for different seasons. The passive bat activity data are presented in the Hendrina North and South WEF's EIA bat assessment, since the seasonality of the 12-months of data does not influence the predicted impacts of the proposed Hendrina GHA facility. The proposed Hendrina GHA and Hendrina North and South WEF's share the same site boundary.

Passive bat detection systems (**Figure 3.**1) were set up on a meteorological mast with microphones at 10m, 55m and 110m. Additionally, five short mast bat detection systems were also set up, with microphones at 7m (referred to as HDShM1 –HDShM5). These systems were set to gather bat activity data every night for 12 months to form part of the long-term pre-construction monitoring and inform the EIA study.

The data is analysed by classifying (as near to species level as possible) and counting positive bat passes detected by the systems. A bat pass is defined as a sequence of ≥1 echolocation calls where the duration of each pulse is ≥2ms (one echolocation call can consist of numerous pulses). A new bat pass is identified by a >1 000ms period between pulses. These bat passes are summed into hourly intervals which are used to calculate nocturnal distribution patterns over time. Times of sunset and sunrise are automatically adjusted with the time of year.

Nightly bat totals over time are useful for displaying abrupt peaks in activity on specific nights or short time periods, and to visually represent the spread of bat activity over the monitoring period.

Table 3-1. Equipment setup and site visit information.

Site visit dates	Setup	18 – 20 Nov 2020 (Met Mast) 13 – 15 Dec 2020 (Short Mast)
	Interim visit 1	11 – 13 January 2021
	Season 1 site visit	18 – 20 February 2021
	Interim visit 2	17 – 19 March 2021
	Interim visit 3	17 – 19 April 2021
	Season 2 site visit	26 – 29 May 2021
	Interim visit 4	11 – 13 June 2021
	Interim visit 5	28 – 31 July 2021
	Season 3 site visit	28 – 31 Aug 2021
	Interim visit 6	1 – 3 Oct 2021
	Interim visit 7	17 – 19 Nov 201
	Season 4 site visit	12 – 16 Dec 2021
	Quantity on site	1

Met mast passive bat detection systems	Microphone heights	10m, 55m, 110m
Short mast passive bat detection systems	Quantity on site	1
	Microphone height	7m
Type of passive bat detector		SM4BAT Full Spectrum
Recording schedule		Each detector was set to operate in continuous trigger mode from dusk each evening until dawn (times were automatically adjusted in relation to latitude, longitude and season).
Trigger threshold		>16KHz, -18dB
Trigger window (time of recording after trigger ceased)		1 000ms (1 second)
Microphone gain setting		12dB
Compression		W4V-8
Single memory card size (each system uses 4 cards)		64GB
Battery size		17Ah; 12V
Solar panel output		10 Watts
Solar charge regulator		6 - 8 Amp with low voltage/deep discharge protection
Other methods		Terrain was investigated during the day for habitat observations.

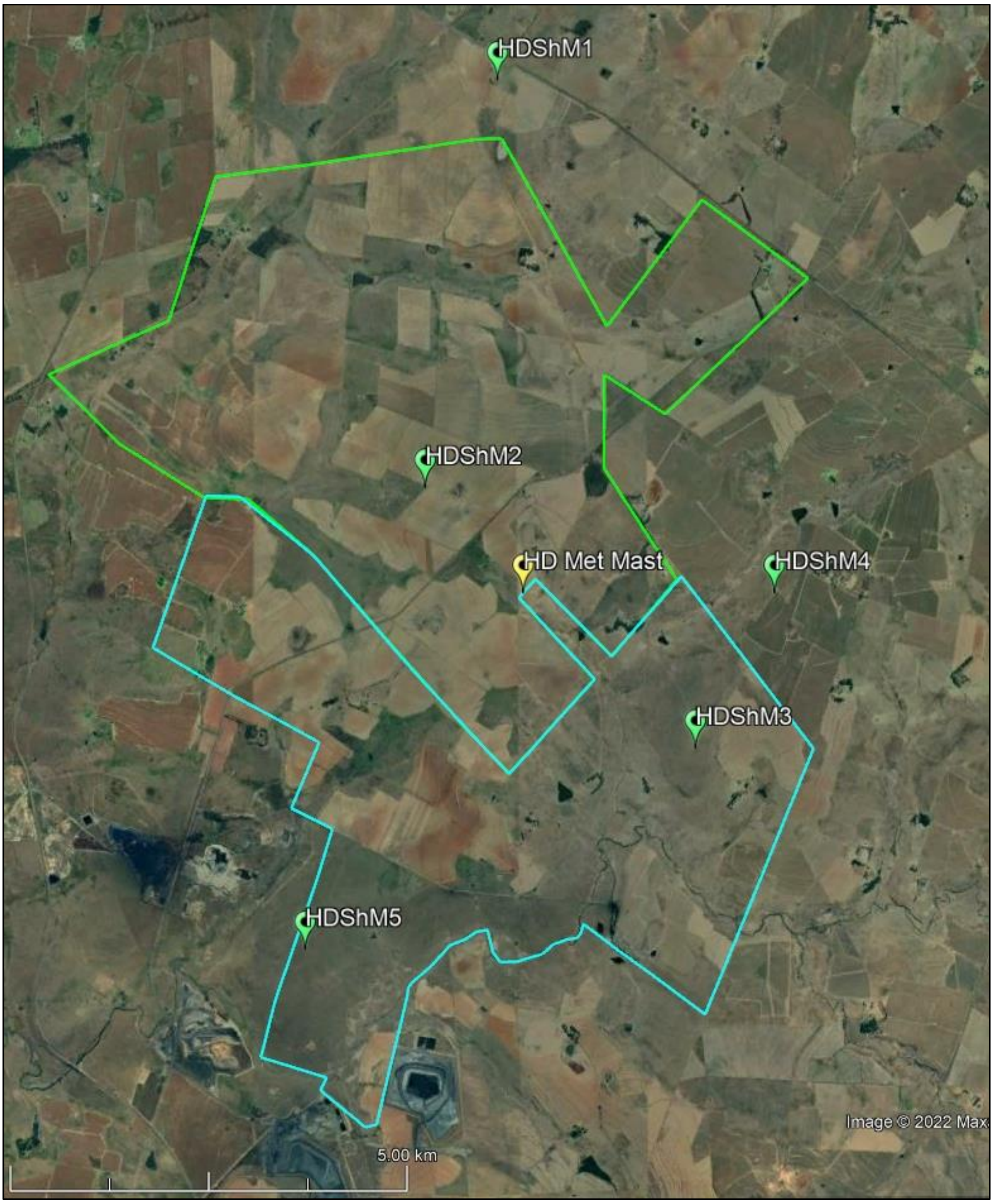

Figure 3.1. Positions of the passive bat detection systems on site. The five Short Mast systems, HDShM1-5 are shown (green pins), as well as the location of the Meteorological Mast system (HD Met Mast, yellow pin).

3.3 Bat Sensitivity Mapping

Google Earth satellite imagery and verifications during site visits were used to spatially demarcate areas of the site with high and medium sensitivities relating to bat species ecology and habitat preferences. The map considers man-made structures and habitat alterations (such as dams), as well as natural terrain features that are likely to offer roosting and foraging opportunities for bat species found in the broader site area. With regards to hydrology features, distinction has been made between permanent and seasonal water sources. Clumps of trees (as opposed to scattered or single trees) offer significantly better roosting and foraging habitat on this site; they have received priority during sensitivity mapping.

3.4 Assumptions and Limitations

As with any environmental study, there are certain assumptions and limitations that exist around the current knowledge we possess regarding bats and their behaviour, movements and distribution. Some important points are discussed briefly below:

- Distribution maps of South African bat species still require further refinement, thus the bat species proposed to occur on the site (and not detected in the area yet) should be considered precautionary. If a species has a distribution marginal to the site, it was assumed to occur in the area.

- The migratory paths of bats are largely unknown, thus some uncertainty in this regard will remain until the end of operational monitoring of at least 2 years.

- The sensitivity map is based partially on satellite imagery and from detailed site visits, although given the large extent of the site, there is always the possibility that what has been mapped may differ slightly to what is on the ground.

4 RESULTS AND DISCUSSION

4.1 Land Use, Vegetation, Climate and Topography

The proposed Project Site falls within the Grassland Biome, and the Mesic Highveld Grassland Bioregion. A single vegetation unit is found on site: **Eastern Highveld Grassland** (**Figure 4.1**, Mucina & Rutherford 2012). According to Olson *et al.* (2012) the site is located in the larger Highveld Grasslands ecoregion. The general geology for this vegetation unit on site includes shales and sandstones which are not prone to cave formation suitable for roosting bats. Land use type is predominantly agricultural in nature and consists of grazing for livestock and ploughed soil for mixed crops.

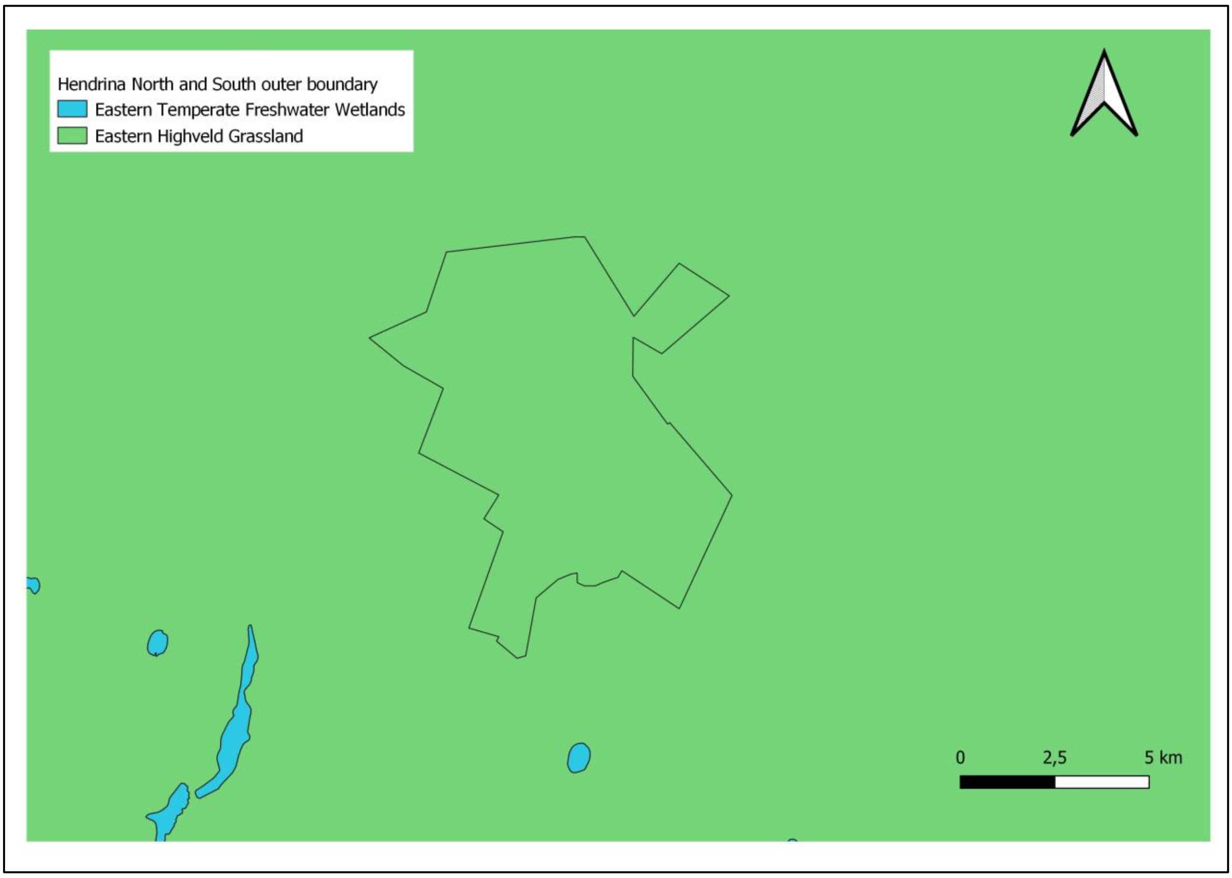

Figure 4.1. Vegetation units present on the proposed Site (Mucina & Rutherford 2012).

4.1.1 Eastern Highveld Grassland

The Eastern Highveld Grassland vegetation unit is present across the entirety of the Site. It consists of slight to moderately undulating plains of short dense grassland cover. Important taxa include *Aristida*, *Digitaria*, *Eragrostis*, *Themeda* and *Tristachya*. Some isolated rocky outcrops may occur, with associated sour grasses and certain woody species. There is a strongly seasonal rainfall pattern; precipitation ranges from 650 – 900mm per annum, predominantly in the summer. Very limited areas of this vegetation unit are currently conserved in statutory reserves and overall, the unit is endangered (Mucina & Rutherford 2006).

4.2 Currently Confirmed, Previously Recorded and Literature-based Species Probability of Occurrence

Table 4.1 indicates the species of bat which have been confirmed to occur on site, those unconfirmed species which may potentially occur on site, as well as those occurring in the broader area of the site based on literature review. For each species, the risk of impact by wind energy infrastructure was assigned by MacEwan *et al*. (2020) based on their distributions, altitudes at which they fly, and foraging ecology. The predicted risk of impact incurred by substations is inferred by literature-based foraging ecology for each species.

Table 4-1 Species currently confirmed on site, previously recorded in the area, or potentially occurring. Roosting and foraging habitats in the study area, conservation status and risk of impact are also briefly described per species (Monadjem *et al.* 2020).

Species	Common name	Occurrence in area*	Conservation status (SANBI & EWT, 2016)	Possible roosting habitat in the larger area of the site	Possible foraging habitat in the larger area of the site	Risk of impact for GHA
Tadarida aegyptiaca	Egyptian free-tailed bat	Confirmed on site	Least Concern (2016 Regional Listing)	Hollows in trees, and behind the bark of dead trees. The species has also taken to roosting in roofs of buildings.	It forages over a wide range of habitats; its preferences of foraging habitat seem independent of vegetation. It seems to forage in all types of habitats.	Medium to Low (GHA)
Sauromys petrophilus	Robert's flat-headed bat	Confirmed on site	Least Concern (2016 Regional Listing)	Crevices in rocks, expansion joints in bridges and crevices in buildings.	Open air forager that will forage over grassland and other open terrain on site.	Medium to Low (GHA)
Mops midas	Midas free-tailed bat	Confirmed in 100km radius	Least Concern (2016 Regional Listing)	Hollows in trees, and behind the bark of dead trees. The species has also taken to roosting in roofs of buildings.	It forages over a wide range of habitats; its preferences of foraging habitat seem independent of vegetation. It seems to forage in all types of habitats.	Medium to Low (GHA)
Laephotis (Neoromicia) capensis	Cape serotine	Confirmed on site	Least Concern (2016 Regional Listing)	Roosts in the roofs of houses and buildings, and also under the bark of trees.	It appears to tolerate a wide range of environmental conditions from arid semi-desert areas to montane grasslands, forests, and savannahs. But is predominantly a medium height clutter edge forager on site.	High (GHA)
Laephotis zuluensis	Zulu serotine	Confirmed in 100km radius	Least Concern (2016 Regional Listing)	Roosts under the bark of trees, and possibly roofs of buildings.	Predominantly a medium height clutter edge forager on site.	Medium to Low (GHA)

Pipistrellus hesperidus	Dusky pipistrelle	Confirmed in 100km radius	Least Concern (2016 Regional Listing)	Roosts under the bark of trees, and possibly roofs of buildings.	Prefers vegetation edges and clutter with open water sources.	Medium to Low (GHA)
Pipistrellus rusticus	Rusty pipistrelle	Confirmed in 100km radius	Least Concern (2016 Regional Listing)	Roosts under the bark of trees, and possibly roofs of buildings.	Prefers vegetation edges and clutter with open water sources.	Medium to Low (GHA)
Miniopterus natalensis	Natal long-fingered bat	Confirmed on site	Least Concern (2016 Regional Listing)	Caves and mine tunnels present in the larger area, may also take residence in suitable hollows such as culverts under roads.	Clutter-edge forager. May forage in more open terrain during suitable weather.	Medium (GHA)
Miniopterus fraterculus	Lesser long-fingered bat	Confirmed in 100km radius	Least Concern (2016 Regional Listing)	Caves and mine tunnels present in the larger area.	Clutter-edge forager. May forage in more open terrain during suitable weather.	Medium (GHA)
Eptesicus hottentotus	Long-tailed serotine	Confirmed on site	Least Concern (2016 Regional Listing)	It is a crevice dweller roosting in rock crevices in the larger area, as well as other crevices in buildings.	It generally seems to prefer woodland habitats, and forages on the clutter edge. But may still forage over open terrain occasionally.	Medium to Low (GHA)
Myotis tricolor	Temmink's myotis	Confirmed in 100km radius	Least Concern (2016 Regional Listing)	Caves and mine tunnels present in the larger area, may also take residence in suitable hollows such as culverts under roads.	Clutter-edge forager. May forage in more open terrain during suitable weather.	Medium (GHA)
Myotis welwitschii	Welwitsch's myotis	Confirmed in 100km radius	Least Concern (2016 Regional Listing)	Caves and mine tunnels present in the larger area, may also take residence in suitable hollows such as culverts under roads.	Clutter-edge forager, unlikely on site due to preference for mountains/hillsides.	Medium (GHA)
Taphozous mauritianus	Mauritian tomb bat	Confirmed in 100km radius	Least Concern (2016 Regional Listing)	Roost against the walls of buildings under roof overhangs or on large tree	Open terrain forager may forage over open grasslands on site.	Medium (GHA)

				trunks. Often vigilant and conspicuous during daytime.		
Rhinolophus blasii	Blasius's horseshoe bat	Confirmed in 100km radius	Near Threatened (2016 Regional Listing)	Caves and mine tunnels present in the larger area.	Vegetation clutter forager, clumps of trees on site.	Medium (GHA)
Rhinolophus clivosus	Geoffroy's horseshoe bat	Confirmed in 100km radius	Least Concern (2016 Regional Listing)	Caves and mine tunnels present in the larger area.	Vegetation clutter forager, clumps of trees on site.	Medium (GHA)
Rhinolophus swinnyi	Swinny's horseshoe bat	Confirmed in 100km radius	Vulnerable (2016 Regional Listing)	Caves and mine tunnels present in the larger area.	Vegetation clutter forager, clumps of trees on site.	Medium (GHA)
Rhinolophus simulator	Bushveld horseshoe bat	Confirmed in 100km radius	Least Concern (2016 Regional Listing)	Caves and mine tunnels present in the larger area.	Vegetation clutter forager, clumps of trees on site.	Medium (GHA)
Scotophilus dinganii	Yellow-bellied house bat	Confirmed on site	Least Concern (2016 Regional Listing)	Roofs of buildings and other suitable hollows.	Clutter-edge forager. May forage in more open terrain during suitable weather.	Medium to Low (GHA)
Nycteris thebaica	Egyptian slit-faced bat	Confirmed in 100km radius	Least Concern (2016 Regional Listing)	Suitable hollows such as culverts under roads, vacant buildings and hollow tree trunks.	Vegetation clutter forager, clumps of trees on site.	High (GHA)
Cloeotis percivali	Percival's short-eared trident bat	Confirmed in 100km radius	Endangered (2016 Regional Listing)	Caves and mine tunnels present in the larger area.	Vegetation clutter forager, clumps of trees on site.	High (GHA)
Hipposideros caffer	Sundevall's leaf-nosed bat	Confirmed in 100km radius	Least Concern (2016 Regional Listing)	Caves and mine tunnels present in the larger area. Possibly hollows such as road culverts.	Vegetation clutter forager, clumps of trees on site.	High (GHA)

Epomophorus wahlbergi	Wahlberg's epauletted fruit bat	Confirmed in 100km radius	Least Concern (2016 Regional Listing)	Roosts in dense foliage of large, leafy trees in the larger area, and may travel several kilometres each night to reach fruiting trees.	Feeds on fruit, nectar, pollen and flowers. If and where available on or near site.	Low (GHA)

*Occurrence of species records based on ACR 2020 and Monadjem *et al*. 2020

4.3 Conservation and protected areas, known sensitivities and caves/roosts within 100km of the site

There is only a single conservation area within 100km of the site, namely the Ramsar-recognised Verloren Valei Nature Reserve on the outer extent of the 100km boundary (see Figure 4.2). This has no bearing on the current site and will not be discussed further.

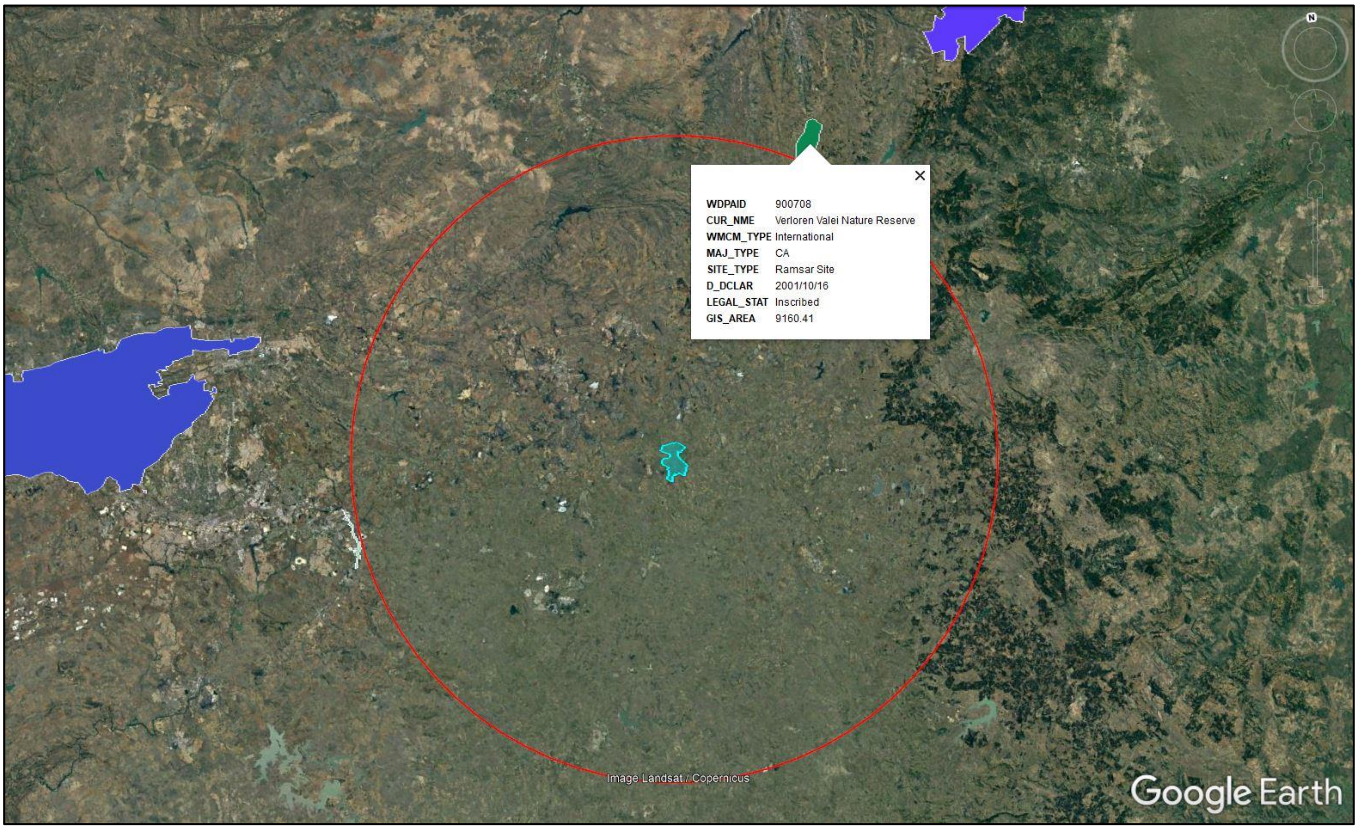

Figure 4.2. Protected areas within a radius of approximately 100km (red line) around the site (light blue polygon) (DEA, 2021)

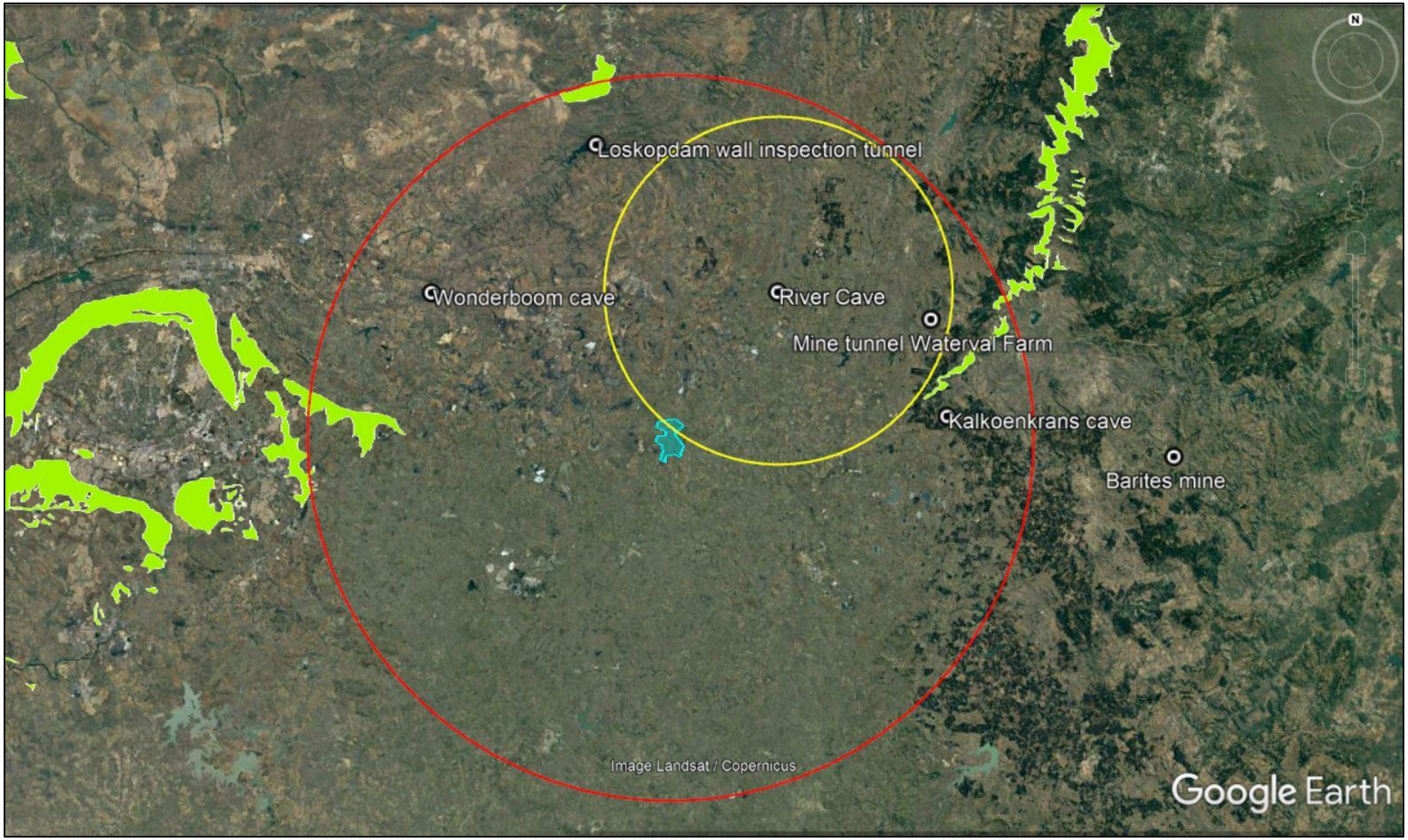

Figure 4.3. Approximate 100km radius (red circle) surrounding the site (light blue polygon). Dolomite geology represented in lime green (SEA data), and known bat roosts depicted with white circles. River Cave falls marginally within 50km of site (yellow circle).

Figure 4.3 shows the dolomitic geology of the greater area, with an approximate 100km site boundary radius shown in red. At its nearest, this extends to approximately 70km north-north-east and 73km west of the Site. Dolomite is known to be prone to good cave formation, and many bat colonies are supported in such caves in the country, particularly in the province of Gauteng. Museum records of bats collected from three caves, one mine and one inspection tunnel within approximately 100km of the site exist. Specimens of *Miniopterus natalensis* and *Rhinolophus clivosus* were collected from River Cave (47km north-east of site); *R. simulator*, *Myotus tricolor* and *Cloeotis percivali* from a mine tunnel on Waterval Farm (79km east-north-east); *Nycteris thebaica, Hipposideros caffer, Miniopterus natalensis, R. simulator* from Loskopdam wall inspection tunnel (80 km north); *R. simulator*, *R. blasii*, *R. clivosus* and *Miniopterus fraterculus* from Kranskalkoen Cave (78km east); and *R. clivosus, Cloeotis percivali, Miniopterus natalensis* from Wonderboom cave (75km north west). The habitat preferences and sensitivity of these species have been discussed in **Table 4.1.**

The Strategic Environmental Assessment (SEA) assigns 50km buffers to large bat roosts for wind energy, but provide no information for GHA facilities. All of the above locations are further than 50km from the proposed site with the exception of River Cave (47km north-east of site). Cave bats do not utilise an area around a cave in a radial buffer shape, and therefore the bat sensitivity map will provide for foraging habitat around the River Cave, since it's almost 50km from the proposed Site. It is also unlikely that light pollution, which is considered the main impact of the proposed GHA facility, will have a significant effect on the River Cave at 47km.

4.4 Sensitivity Mapping

The national Screening Tool does not provide information for a Green Hydrogen and Ammonia theme in relation to bats, therefore the sensitivity map is based on the specialist site visits and data gathered during the 12-month assessment.

Google Earth satellite imagery and verifications during site visits were used to spatially demarcate areas of the site with high and moderate sensitivities relating to bat species ecology and habitat preferences, where high sensitivities are no-go zones for certain GHA infrastructure (**Tables 4-2 & 4-3**). **Figure 4-4** depicts the sensitive areas of the site, based on features identified to be important for foraging and roosting of the species that are most likely to occur on site.

Considering the bat sensitivity map, both location Options 1 & 3 are intruding onto high bat sensitivity areas, and should be relocated to be outside these areas, or not be selected as preferred options.

Table 4.2. Description of parameters used in the development of the sensitivity map.

Last revision	**November 2021**
High sensitivities and 200m buffers	Clumps/rows of tall trees and buildings that can provide roosting space for bats, or attract foraging bats
	Pans and depressions
	Dams
	Drainage lines capable of supporting riparian vegetation
	Other water bodies and other sensitivities such as manmade structures, buildings, houses, barns, sheds.
Moderate sensitivities and 150m buffers	Seasonal wetlands
	Seasonal drainage lines

Table 4.3. The significance of sensitivity map categories for each infrastructure component for the Grid connection substations.

Sensitivity	GHA buildings	Roads and cables	Internal overhead transmission lines	Substation and construction camp/yards)
High Sensitivity	These areas are 'no-go' zones for infrastructure where earthworks and vegetation clearing are required.	Preferably keep to a minimum within these areas where practically feasible.	Allowed inside these areas.	Avoid these areas.
High Sensitivity buffer	Allowed inside these areas.	Allowed inside these areas.	Allowed inside these areas.	Allowed inside these areas.
Moderate Sensitivity	Not favourable for infrastructure where earthworks and vegetation clearing are required.	Allowed inside these areas.	Allowed inside these areas.	Allowed inside these areas.
Moderate Sensitivity buffer	Allowed inside these areas.	Allowed inside these areas.	Allowed inside these areas.	Allowed inside these areas.

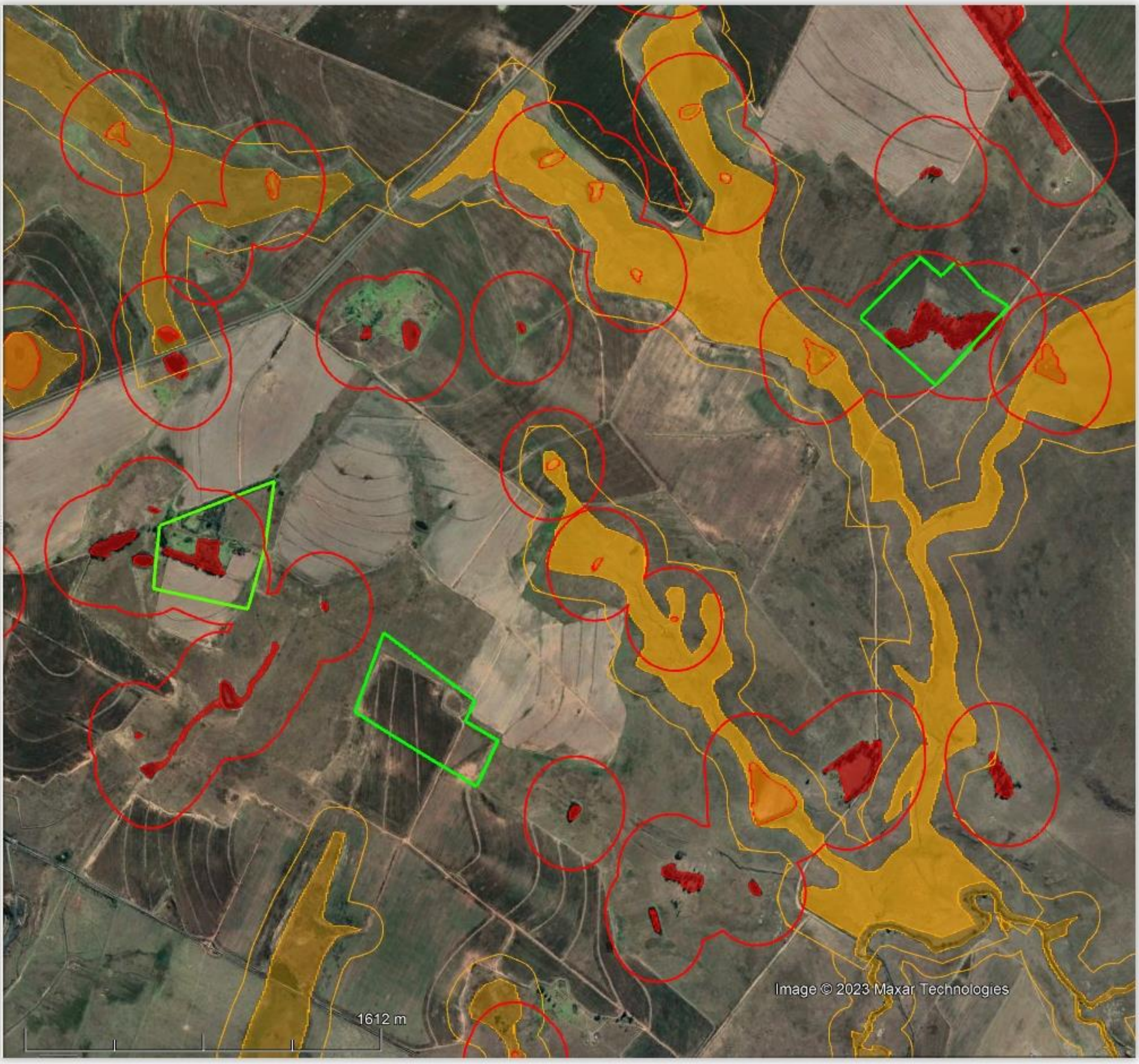

Figure 4.4. Bat sensitivity map of the site. Site area indicated in a white boundary. Sensitivity polygons are provided in .kml format with this report. Shaded red = high sensitivity; Red line = 200m high sensitivity buffer; Shaded orange = medium sensitivity; Orange line = 150m medium sensitivity buffer. The three options for the GHA facility are indicated in green.

4.5 Cumulative impact consideration within a 30km radius

Four Solar PV Facilities within 30km of the Project have been proposed or approved as follows:

- Eskom Duvha PV Facility: Approved (26km north-west)
- Eskom Arnot PV Facility: In Process (26km north-east)
- Forzando PV Facility: In Process (1.5km south-west)
- Halfgewonnnen PV Facility: Proposed (1.3km west)

Should significant (unmitigated) light pollution be created at the Forzando or Halfgewonnen Solar PV Facilities which border almost directly with the Project, cumulative impacts will be relevant.

5 IMPACT ASSESSMENT

Tables 5-1 & 5-2 below indicate the assessed impacts associated with the proposed Hendrina GHA facility during the construction and operational phases. No significant impacts are identified for the decommissioning phase.

5.1 Construction and Operational phases

Table 5.1. Identified potential impacts of the proposed Hendrina GHA facility as well as possible mitigation measures.

Potential impact	Recommended mitigation
	Construction phase
Loss of foraging habitat by clearing of vegetation.	Adhere to the sensitivity map criteria. Rehabilitate cleared vegetation where possible at areas such as laydown yards.
Roost destruction during earthworks.	Adhere to the sensitivity map criteria, choose location alternatives that don't intrude into high bat sensitivities.
	Operational phase
Increased bat mortalities due to light attraction and habitat creation.	Only use lights with low sensitivity motion sensors that switch off automatically when no persons are nearby, to prevent the creation of regular insect gathering pools. This will be at all infrastructure buildings. For buildings, avoid tin roofs and roof structures that offer entrance holes into the roof cavity. The storm water drainage plan must avoid creations of artificial ponds/open water sources or wetlands near turbines (closer than 300m from any turbine base), of the proposed Hendrina North & South WEF's turbines. As such artificial water sources will increase insect activity and therefore bat activity in the area. This can result in the GHA facility increasing the likelihood of bats being killed by the WEF's.

Table 5.2. Assessed potential impacts of the proposed Hendrina GHA facility during the construction and operational phases.

CONSTRUCTION PHASE																			
Impact nr	Aspect	Description	Stage	Character	Ease of Mitigation	Pre-Mitigation							Post-Mitigation						
						(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Impact 1:	Loss of foraging habitat by clearing of vegetation.	Bat foraging habitat will be destroyed during construction.	Construction	Negative	Easy	1	1	3	2	4	**28**	**N2**	1	1	3	2	3	**21**	**N2**
					Significance	**N2 - Low**							**N2 - Low**						
Impact 2:	Roost destruction during earthworks.	Bat roosts in trees and buildings may be destroyed during construction, this can cause bat mortalities or permanent disturbances to roosts.	Construction	Negative	Easy	4	1	3	2	2	**20**	**N2**	4	1	3	2	1	**10**	**N1**
					Significance	**N2 - Low**							**N1 - Very Low**						
OPERATIONAL PHASE																			
Impact nr	Receptor	Description	Stage	Character	Ease of Mitigation	Pre-Mitigation							Post-Mitigation						
						(M+	E+	R+	D)x	P=	S		(M+	E+	R+	D)x	P=	S	
Impact 3:	Increased bat mortalities due to light attraction and habitat creation.	Floodlights and other lights at buildings, will attract insect eating bats and therefore significantly increase the likelihood of these bats being impacted on by moving turbine blades of the adjacent wind energy facilities. Habitat creation in the roofs of nearby buildings, creation of wetlands or open water sources due to stormwater drainage can cause a similar increased risk factor.	Operational	Negative	Easy	4	2	3	4	5	**65**	**N4**	4	2	3	4	2	**26**	**N2**
					Significance	**N4 - High**							**N2 - Low**						

5.2 Cumulative impact

Table 5.3. Identified potential cumulative impacts of the proposed Hendrina GHA facility, as well as possible mitigation measures.

Potential impact	Recommended mitigation
	Operational phase
Increased bat mortalities due to light attraction and habitat creation.	Each facility to only use lights with low sensitivity motion sensors that switch off automatically when no persons are nearby, to prevent the creation of regular insect gathering pools. This will be at all infrastructure buildings. For buildings, avoid tin roofs and roof structures that offer entrance holes into the roof cavity. The storm water drainage plan must avoid creations of artificial ponds/open water sources or wetlands near turbines (closer than 300m from any turbine base), of the proposed Hendrina North & South WEF's turbines. As such artificial water sources will increase insect activity and therefore bat activity in the area. This can result in the GHA facility increasing the likelihood of bats being killed by the WEF's

Table 5.4. Assessed potential cumulative impacts of the proposed Hendrina GHA facility.

Impact nr	Receptor	Description	Stage	Character	Ease of Mitigation	Pre-Mitigation							Post-Mitigation						
						(M+	E+	R+	D)x	P=	S		(M+	E+	R+	D)x	P=	S	
Impact 1:	Increased bat mortalities due to light attraction and habitat creation.	Floodlights and other lights at buildings, will attract insect eating bats and therefore significantly increase the likelihood of these bats being impacted on by moving turbine blades of the adjacent wind energy facilities. Habitat creation in the roofs of nearby buildings, creation of wetlands or open water sources due to stormwater drainage can cause a similar increased risk factor. Considering several facilities, the overall mortality rate will be significantly higher with an increased likelihood of impact.	Cumulative	Negative	Easy	4	3	3	4	3	**42**	**N3**	4	3	3	4	2	**28**	**N2**
						N3 - Moderate							**N2 - Low**						

6 MITIGATION OPTIONS PERTAINING TO THE EMPr

Additional to the mitigation of the facility placement (adhering to a bat sensitivity map), the available options to minimise bat mortalities are discussed in this section. Details on how each option must be implemented is explained in the step-by-step Mitigation Action Plan in Section 7.

6.1 Minimisation of light pollution and artificial habitat creation

A mitigation to consider in the design of the Hendrina GHA facility is to keep artificial lighting to a minimum on the infrastructure (O&M buildings and on wind turbines), while still adhering to safety and security requirements. For example, this can be achieved by having floodlights down-hooded, installing passive motion sensors onto lights around buildings and possibly utilising lights with lighting colours (also referred to as lighting temperatures) that attract fewer insects. Light pollution will impact bat feeding habits and species compositions negatively, by artificially discouraging photophobic (light averse) species and favouring species that readily forage around insect-attracting lights.

Stormwater management should also avoid creating artificial wetlands and open water sources near turbines of the proposed Hendrina North & South WEF's (closer than 300m from any turbine base), as this will increase insect and bat activity around turbines.

The likelihood of bats being killed by moving turbine blades increases significantly when they are attracted to their proximity when it has become an improved foraging airspace due to the presence of artificial light or artificial water sources. This can result in the Hendrina GHA facility increasing the likelihood of bats being killed by the proposed Hendrina North & South WEF's.

7 MITIGATION ACTION PLAN FOR INCLUSION INTO THE EMPr

7.1 Step 1: Minimisation of light pollution and artificial habitat creation (refer to Section 6.1)

During the planning phase for the Hendrina GHA facility it must become mandatory to only use lights with low sensitivity motion sensors that switch off automatically when no persons are nearby, to prevent the creation of regular insect gathering pools, where practically possible without compromising security requirements. This applies to all GHA infrastructure/buildings. Floodlights should be down-hooded and where possible, lights with a colour (lighting temperature) that attract less insects should be used. This mitigation step is a simple and cost-effective strategy to effectively decrease the chances of bat mortalities.

Bi-annual visits to the facility at night must be conducted for the operational lifetime of the facility by operational staff of the facility, to assess the lighting setup and whether the passive motion sensors are functioning correctly. The bat specialist conducting the operational bat mortality monitoring of the proposed Hendrina North & South WEF's must conduct at least one visit to site during nighttime to assess the placement and setup of outside lights on the facility. When lights are replaced and maintenance on lights is conducted, this Mitigation Action Plan must be consulted.

The storm water drainage plan must avoid creating artificial wetlands and open water sources near turbines of the proposed Hendrina North & South WEF's (closer than 300m from any turbine base), as this will increase insect and bat activity around turbines of these WEF's.

8 CONCLUSION

This 12-month Pre-construction Bat EIA Report considered information gathered from site visits between August 2020 and October 2021, the scientific literature, and satellite imagery.

Currently there is no evidence of GHA facilities posing a direct threat of fatality impact on bats during operation. However, roosting and foraging habitats may be significantly impacted during the construction phase. This is primarily due the fact that such facilities require areas of land to be cleared, and in some cases, earthworks are required for levelling purposes. This can result in habitat that is suitable for micro roosts, such as clumps of trees and certain vegetation being destroyed, which can also be fatal to bats residing in such roosts.

The presence of security lights on and around these facilities creates significant light pollution that can impact bat feeding habits and species compositions negatively, by artificially discouraging photophobic (light averse) species and favouring species that readily forage around insect-attracting lights. Additionally, if the buildings and associated infrastructure for these facilities are placed close to wind turbines of nearby WEF's, such as the proposed Hendrina North & South WEF's (which the proposed GHA facility is sharing a site). The stormwater management should also avoid creating artificial wetlands and open water sources near turbines of the proposed Hendrina North & South WEF's (closer than 300m from any turbine base). The likelihood of bats being killed by moving turbine blades increases significantly when they are attracted to their proximity when it has become an improved foraging airspace due to the presence of artificial light or artificial water sources. This can result in the Hendrina GHA facility increasing the likelihood of bats being killed by the proposed Hendrina North & South WEF's.

At its nearest, this extends to approximately 70km north-north-east and 73km west of the Site. Dolomite is known to be prone to good cave formation, and many bat colonies are supported in such caves in the country, particularly in the province of Gauteng. Museum records of bats collected from three caves, one mine and one inspection tunnel within approximately 100km of the site exist. Specimens of *Miniopterus natalensis* and *Rhinolophus clivosus* were collected from River Cave (47km north-east of site); *R. simulator*, *Myotus tricolor* and *Cloeotis percivali* from a mine tunnel on Waterval Farm (79km east-north-east); *Nycteris* *thebaica, Hipposideros caffer, Miniopterus natalensis, R. simulator* from Loskopdam wall inspection tunnel (80 km north); *R. simulator*, *R. blasii*, *R. clivosus* and *Miniopterus fraterculus* from Kranskalkoen Cave (78km east); and *R. clivosus, Cloeotis percivali, Miniopterus natalensis* from Wonderboom cave (75km north west).

The Strategic Environmental Assessment (SEA) assigns 50km buffers to large bat roosts for wind energy, but provide no information for GHA facilities. All of the above locations are further than 50km from the proposed site with the exception of River Cave (47km north-east of site). Cave bats do not utilise an area around a cave in a radial buffer shape, and therefore the bat sensitivity map will provide for foraging habitat around the River Cave, since it's almost 50km from the proposed Site. It is also unlikely that light pollution, which is considered the main impact of the proposed GHA facility, will have a significant effect on the River Cave at 47km.

The High Bat Sensitivity areas designated by the specialist in the Sensitivity Map supplied with this report are expected to have elevated levels of bat activity and support greater bat diversity. Where high sensitivities are no-go zones for certain GHA infrastructure (**Tables 4-2 & 4-3**), and **Figure 4-4** depicts the sensitive areas of the site based on features identified to be important for foraging and roosting of the species that are most likely to occur on site.

Considering the bat sensitivity map, both location Options 1 & 3 are intruding onto high bat sensitivity areas, and should be relocated to be outside these areas, or not be selected as options. **Therefore, location Option 2 is the only alternative for the proposed Hendrina GHA facility.**

The pre-construction bat monitoring of the proposed Hendrina North & South WEF's has been completed and informs the EIA phase assessment of the proposed Hendrina GHA facility since these renewable energy facilities are within the same site boundary.

Thus far, from a bat impact perspective, if the Mitigation Action Plan is incorporated into the EMPr, no reasons have been identified for the proposed Option 2 location of the Hendrina GHA facility not to receive Environmental Authorisation.

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