Terrestrial Biodiversity Assessment

prepared in accordance with the
"*Protocol for the Specialist Assessment and minimum report content requirements for environmental impacts on Terrestrial Biodiversity*"

Green Hydrogen and Ammonia Facility near Hendrina in Mpumalanga Province

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Terrestrial Biodiversity Assessment report for the proposed Hendrina Green Hydrogen and Ammonia Facility in Mpumalanga Province.

for

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4 October 2022

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SPECIALIST DETAILS & DECLARATION

This report has been prepared in accordance with the "Protocol for the specialist assessment and minimum report content requirements for environmental impacts on terrestrial animal species, terrestrial plant species and terrestrial biodiversity", as promulgated in terms of Section 24 (5) of the National Environmental Management Act, 1998 (Act No. 107 of 1998), published in GN. No. 320 dated 20 March 2020. It has been prepared independently of influence or prejudice by any parties.

The details of Specialists are as follows:

Specialist	Qualification and accreditation
Dr David Hoare	• PhD Botany • Pr.Sci.Nat. 400221/05 (Ecological Science, Botanical Science)

Declaration of independence:

David Hoare Consulting (Pty) Ltd is an independent consultant and hereby declares that it does not have any financial or other vested interest in the undertaking of the proposed activity, other than remuneration for the work performed in terms of the National Environmental Management Act, 1998 (Act 107 of 1998). In addition, remuneration for services provided by David Hoare Consulting (Pty) Ltd is not subjected to or based on approval of the proposed project by the relevant authorities responsible for authorising this proposed project.

Disclosure:

David Hoare Consulting (Pty) Ltd undertakes to disclose, to the competent authority, any material information that has or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the National Environmental Management Act, 1998 (Act 107 of 1998) and will provide the competent authority with access to all information at its disposal regarding the application, whether such information is favourable to the applicant or not.

Based on information provided to David Hoare Consulting (Pty) Ltd by the client and in addition to information obtained during the course of this study, David Hoare Consulting (Pty) Ltd presents the results and conclusion within the associated document to the best of the author's professional judgement and in accordance with best practice.

_____ 4 October 2022

Dr David Hoare Date

TERMS OF REFERENCE

The specialist study is required to follow the published Protocols, provided in full below for the assessment of impacts on Terrestrial Biodiversity. Note that the Protocols require determination of the level of sensitivity, which then determines the level of assessment required, either a full assessment, or a Compliance Statement.

PROTOCOL FOR THE SPECIALIST ASSESSMENT AND MINIMUM REPORT CONTENT REQUIREMENTS FOR ENVIRONMENTAL IMPACTS ON TERRESTRIAL BIODIVERSITY

This site sensitivity assessment follows the requirements of The Environmental Impact Assessment Regulations, as promulgated in terms of Section 24 (5) of the National Environmental Management Act, 1998 (Act No. 107 of 1998), published in GN. No. 320 dated 20 March 2020.

General information

1.1. An applicant intending to undertake an activity identified in the scope of this protocol, on a site identified on the screening tool as being of "**very high sensitivity**" for terrestrial biodiversity, must submit a Terrestrial Biodiversity Specialist Assessment.

1.2. An applicant intending to undertake an activity identified in the scope of this protocol on a site identified by the screening tool as being "**low sensitivity**" for terrestrial biodiversity, must submit a Terrestrial Biodiversity Compliance Statement.

1.3. However, where the information gathered from the site sensitivity verification differs from the designation of "very high" terrestrial biodiversity sensitivity on the screening tool and it is found to be of a "low" sensitivity, then a Terrestrial Biodiversity Compliance Statement must be submitted.

1.4. Similarly, where the information gathered from the site sensitivity verification differs from that identified as having a "low" terrestrial biodiversity sensitivity on the screening tool, a Terrestrial Biodiversity Specialist Assessment must be conducted.

1.5. If any part of the proposed development footprint falls within an area of "very high" sensitivity, the assessment and reporting requirements prescribed for the "very high" sensitivity apply to the entire footprint, ***excluding linear activities*** *for which impacts on terrestrial biodiversity are temporary and the land in the opinion of the terrestrial biodiversity specialist, based on the mitigation and remedial measures, can be returned to the current state within two years of the completion of the construction phase*, in which case a compliance statement applies. Development footprint in the context of this protocol means the area on which the proposed development will take place and includes any area that will be disturbed.

Terrestrial Biodiversity Specialist Assessment

2.1. The assessment must be prepared by a specialist registered with the South African Council for Natural Scientific Professionals (SACNASP) with expertise in the field of terrestrial biodiversity.

2.2. The assessment must be undertaken on the preferred site and within the proposed development footprint.

2.3. The assessment must provide a baseline description of the site which includes, as a minimum, the following aspects:

2.3.1. a description of the ecological drivers or processes of the system and how the proposed development will impact these;

2.3.2. ecological functioning and ecological processes (e.g. fire, migration, pollination, etc.) that operate within the preferred site;

2.3.3. the ecological corridors that the proposed development would impede including migration and movement of flora and fauna;

2.3.4. the description of any significant terrestrial landscape features (including rare or important flora-faunal associations, presence of strategic water source areas (SWSAs) or freshwater ecosystem priority area (FEPA) sub-catchments;

2.3.5. a description of terrestrial biodiversity and ecosystems on the preferred site, including:

(a) main vegetation types;
(b) threatened ecosystems, including listed ecosystems as well as locally important habitat types identified;
(c) ecological connectivity, habitat fragmentation, ecological processes and fine-scale habitats; and
(d) species, distribution, important habitats (e.g. feeding grounds, nesting sites, etc.) and movement patterns identified;

2.3.6. the assessment must identify any alternative development footprints within the preferred site which would be of a "low" sensitivity as identified by the screening tool and verified through the site sensitivity verification; and

2.3.7. the assessment must be based on the results of a site inspection undertaken on the preferred site and must identify:

2.3.7.1. terrestrial critical biodiversity areas (CBAs), including:
(a) the reasons why an area has been identified as a CBA;
(b) an indication of whether or not the proposed development is consistent with maintaining the CBA in a natural or near natural state or in achieving the goal of rehabilitation;
(c) the impact on species composition and structure of vegetation with an indication of the extent of clearing activities in proportion to the remaining extent of the ecosystem type(s);
(d) the impact on ecosystem threat status;
(e) the impact on explicit subtypes in the vegetation;
(f) the impact on overall species and ecosystem diversity of the site; and
(g) the impact on any changes to threat status of populations of species of conservation concern in the CBA;

2.3.7.2. terrestrial ecological support areas (ESAs), including:
(a) the impact on the ecological processes that operate within or across the site;
(b) the extent the proposed development will impact on the functionality of the ESA; and
(c) loss of ecological connectivity (on site, and in relation to the broader landscape) due to the degradation and severing of ecological corridors or introducing barriers that impede migration and movement of flora and fauna;

2.3.7.3. protected areas as defined by the National Environmental Management: Protected Areas Act, 2004 including-
(a) an opinion on whether the proposed development aligns with the objectives or purpose of the protected area and the zoning as per the protected area management plan;

2.3.7.4. priority areas for protected area expansion, including-
(a) the way in which the proposed development will compromise or contribute to the expansion of the protected area network;

2.3.7.5. SWSAs including:
(a) the impact(s) on the terrestrial habitat of a SWSA; and
(b) the impacts of the proposed development on the SWSA water quality and quantity (e.g. describing potential increased runoff leading to increased sediment load in water courses);

2.3.7.6. FEPA sub-catchments, including-
(a) the impacts of the proposed development on habitat condition and species in the FEPA sub catchment;

2.3.7.7 indigenous forests, including:

(a) impact on the ecological integrity of the forest; and
(b) percentage of natural or near natural indigenous forest area lost and a statement on the implications in relation to the remaining areas.

2.4. The findings of the assessment must be written up in a Terrestrial Biodiversity Specialist Assessment Report.

Terrestrial Biodiversity Specialist Assessment Report

3.1. The Terrestrial Biodiversity Specialist Assessment Report must contain, as a minimum, the following information:

3.1.1. contact details of the specialist, their SACNASP registration number, their field of expertise and a curriculum vitae;
3.1.2. a signed statement of independence by the specialist;
3.1.3. a statement on the duration, date and season of the site inspection and the relevance of the season to the outcome of the assessment;
3.1.4. a description of the methodology used to undertake the site verification and impact assessment and site inspection, including equipment and modelling used, where relevant;
3.1.5. a description of the assumptions made and any uncertainties or gaps in knowledge or data as well as a statement of the timing and intensity of site inspection observations;
3.1.6. a location of the areas not suitable for development, which are to be avoided during construction and operation (where relevant);
3.1.7. additional environmental impacts expected from the proposed development;
3.1.8. any direct, indirect and cumulative impacts of the proposed development;
3.1.9. the degree to which impacts and risks can be mitigated;
3.1.10. the degree to which the impacts and risks can be reversed;
3.1.11. the degree to which the impacts and risks can cause loss of irreplaceable resources;
3.1.12. proposed impact management actions and impact management outcomes proposed by the specialist for inclusion in the Environmental Management Programme (EMPr);
3.1.13. a motivation must be provided if there were development footprints identified as per paragraph 2.3.6 above that were identified as having a “low” terrestrial biodiversity sensitivity and that were not considered appropriate;
3.1.14. a substantiated statement, based on the findings of the specialist assessment, regarding the acceptability, or not, of the proposed development, if it should receive approval or not; and
3.1.15. any conditions to which this statement is subjected.

3.2.The findings of the Terrestrial Biodiversity Specialist Assessment must be incorporated into the Basic Assessment Report or the Environmental Impact Assessment Report, including the mitigation and monitoring measures as identified, which must be incorporated into the EMPr where relevant.

3.3. A signed copy of the assessment must be appended to the Basic Assessment Report or Environmental Impact Assessment Report.

LIMITATIONS, ASSUMPTIONS & UNCERTAINTIES

The following assumptions, limitations, uncertainties are listed regarding the ecological assessment of the Hendrina site:

- The assessment is based on a field survey conducted 3-7 February 2020. The current study is based on an extensive site visit as well as a desktop study of the available information. The time spent on site was adequate for understanding general patterns across affected areas. The seasons in which the fieldwork (peak summer flowering period) was conducted was ideal for assessing the composition and condition of the vegetation.
- The vegetation was in good condition for sampling at the time of the field assessment, and the species lists obtained are considered reliable and relatively comprehensive.
- Compiling the list of species that could potentially occur on site is limited by the paucity of collection records for the area. The list of plant species that could potentially occur on site was therefore taken from a wider area and from literature sources that may include species that do not occur on site and may miss species that do occur on site. To compile a comprehensive site-specific list of the biota on site, studies would be required that would include different seasons, be undertaken over several years and include extensive sampling. Due to time constraints, this was not possible for this study. However, the comprehensive field survey is sufficient for the purposes of this report.

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INTRODUCTION

Background

ENERTRAG South Africa (hereafter "ENERTRAG SA") is a subsidiary of the German-based ENERTRAG AG, a hydrogen and renewable energy developer founded in 1992. ENERTRAG AG has an established track-record of renewable energy projects around the world, comprising over 100 wind turbines with an installed capacity of over 760MW, and over 500 employees. Current Projects are in Germany, United Kingdom, France, Poland, Bulgaria and Belarus.

ENERTRAG SA was established in 2017, with the intention to investigate and develop renewable energy projects in South Africa. The transition from coal-based energy supply to renewables in the Country is inevitable, as coal resources are depleted, coal-based power stations reach the end of their economic life and considering international obligations and commitments to reduced emissions. The Project development area is blanketed with numerous coal prospecting and mining rights. Coal mining and energy derived from coal mining is the likely alternative to the Project. ENERTRAG SA are developing renewable energy projects to contribute to the Just Transition that promises to de-carbonise South Africa's energy sector and aims to:

- replace coal-based electricity with renewable electricity
- decarbonise different sectors of the economy through the replacement of fossil-based hydrogen and ammonia with green hydrogen and ammonia.

ENERTRAG SA proposes to develop the Hendrina Renewable Energy Complex, the complex comprises of five separate projects. The projects are:

- Hendrina North Wind Energy Facility (up to 200MW) over 3600ha;
- Hendrina South Wind Energy Facility (up to 200MW) over 2900ha;
- Hendrina North Grid Infrastructure (up to 275kV) – 15km;
- Hendrina South Grid Infrastructure (up to 275kV) – 16km;
- **Green Hydrogen and Ammonia Facility (up to 25ha).**

Each of these projects are being assessed, as part of the Complex development, and involve the undertaking of Listed Activities identified in the Environmental Impact Assessment (EIA) Regulations, 2014 (as amended) and as such require an Environmental Authorisation in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) before being undertaken.

This report pertains specifically to the **Green Hydrogen and Ammonia Facility** ("the Project").

This document is intended to provide a description of the proposed Project. The Project is being developed for private off-take by nearby mining and industrial operations. This project description is intended to provide sufficient project detail to facilitate effective Environmental Impact Assessment (EIA) for the proposed project in different specialist disciplines. If additional detail is required, please contact WSP.

Project description

The Project is located 17km west of Hendrina, in the Steve Tshwete Local Municipality, of the Nkangala District Municipality, Mpumalanga Province. Three alternative 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.

Site Alternative 1 requires 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;

Site Alternative 2 requires constructing a new pipeline (up to 17km) 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.

Site Alternative 3 requires constructing a new pipeline (up to 19km) from the Komati Power Station.

The Project, and associated water pipeline and powerlines, is proposed to affect the following farm portions:

Parent Farm	Farm No	Portion No
Facility Alternative Site 1		
Dunbar	189IS	3
Facility Alternative Site 2		
Dunbar	189IS	3
Weltevreden	193IS	18
Facility Alternative Site 3		
Weltevreden	193IS	14
Weltevreden	193IS	15
Associated pipelines and powerlines may affect portions of the following land parcels:		
Bultfontein	187IS	1
Bultfontein	187IS	2
Bultfontein	187IS	3
Bultfontein	187IS	4
Bultfontein	187IS	6
Bultfontein	187IS	10
Bultfontein	187IS	14
Dunbar	189IS	0
Dunbar	189IS	1

Dunbar	189IS	2
Dunbar	189IS	4
Dunbar	189IS	5
Dunbar	189IS	6
Dunbar	189IS	7
Geluk	26IS	6
Geluk	26IS	7
Hartebeestkuil	185IS	3
Komati Power Station	56IS	0
Wilmansrust	47IS	1
Wilmansrust	47IS	3
Wilmansrust	47IS	9

METHODOLOGY

The detailed methodology followed as well as the sources of data and information used as part of this assessment is described below.

Approach

The study commenced as a desktop-study followed by a site-specific field study on 3– 7 February 2020. The site is within the Grassland Biome with a peak rainfall season in summer, which occurs from October to March. There is, however, a delay between rainfall and vegetation growth, which means the peak growing season is from November to April, with most perennial species characteristic of the vegetation being easily identifiable from January to March. The timing of the survey was therefore ideal in terms of assessing the vegetation condition and flora composition of the site.

During the field survey, all major natural variation on site was assessed and select locations were traversed on foot. A hand-held Garmin GPSMap 64s was used to record a track within which observations were made. Digital photographs were taken of features and habitats on site, as well as of all plant species that were seen. All plant species recorded were uploaded to the iNaturalist website.

Aerial imagery from Google Earth was used to identify and assess habitats on site. Patterns identified from satellite imagery were verified on the ground. From this ground survey, as well as ad hoc observations on site, a checklist of plant species occurring on site was compiled. Digital photographs were taken at locations where features of interest were observed.

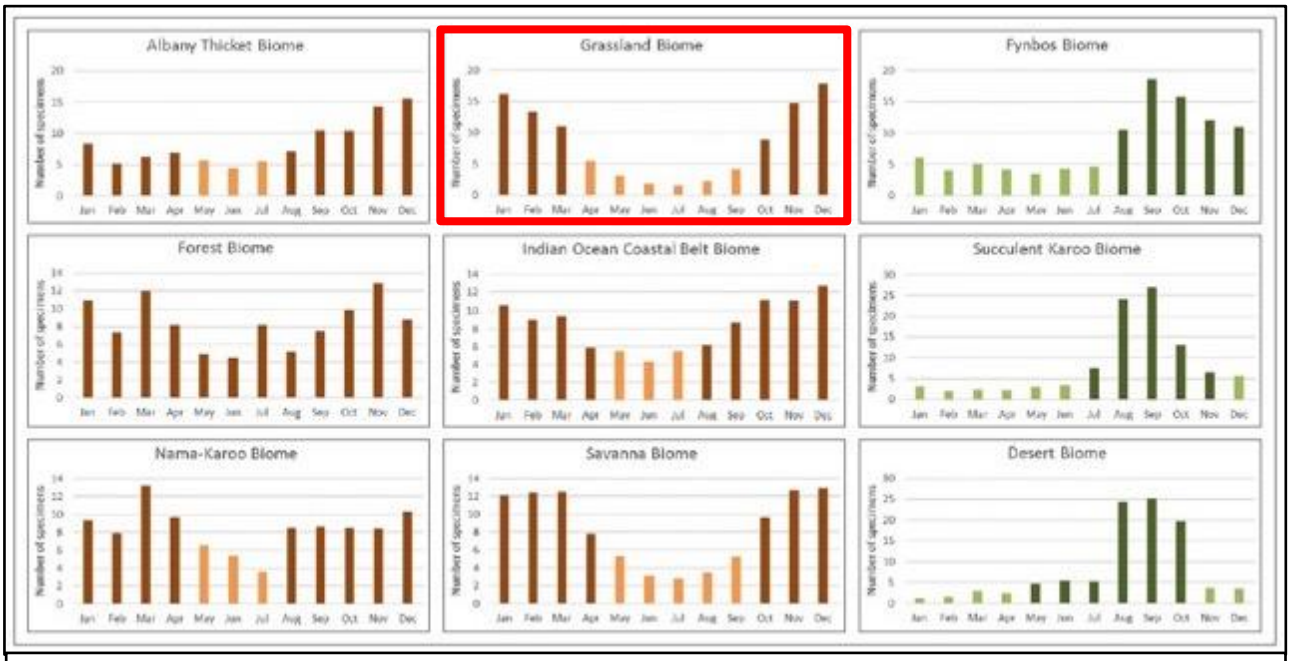

Figure 1: Recommended survey periods for different biomes (Species Environmental Assessment Guidelines).

Sources of information

Regional Vegetation

- Broad vegetation types occurring on site were obtained from Mucina and Rutherford (2006), with updates according to the SANBI BGIS website (http://bgis.sanbi.org), as follows:
    - Mucina, L. and Rutherford, M.C. (editors) 2006. Vegetation map of South Africa, Lesotho and Swaziland: an illustrated guide. Strelitzia 19, South African National Biodiversity Institute, Pretoria.
    - South African National Biodiversity Institute 2018 Final Vegetation Map of South Africa, Lesotho and Swaziland [Vector] 2018. Available from the Biodiversity GIS website, downloaded on 23 September 2021.

Threatened Ecosystems

- The conservation status of the vegetation types were obtained from Mucina and Rutherford (2006) and the National List of Ecosystems that are Threatened and in need of protection (GN1002 of 2011), published under the National Environmental Management: Biodiversity Act (Act No. 10, 2004).
- The plant species checklist of species that could potentially occur on site was compiled from a plant species checklist extracted from the NewPosa database of the South African National biodiversity Institute (SANBI) for the quarter degree grid 2629BA.
- The IUCN Red List Category for plant species, as well as supplementary information on habitats and distribution, was obtained from the SANBI Threatened Species Programme (Red List of South African Plants, http://redlist.sanbi.org).

Regional plans

- The Mpumalanga Biodiversity Sector Plan (MBSP) retrieved from the SANBI BGIS website (https://bgis.sanbi.org/MBCP). Information on this map is found in Lötter & Ferrar (2006) and Ferrar & Lötter (2007).
- South Africa Protected Areas Database (SAPAD_OR_2021_Q2) retrieved from the Department of Forestry, Fisheries and the Environment website (https://egis.environment.gov.za/data_egis/data_download/current).
- Information from the National Protected Areas Expansion Strategy (NPAES) was consulted for possible inclusion of the site into a protected area in future (available on http://bgis.sanbi.org).

Aerial imagery

- Recent satellite imagery (courtesy of Google Earth Pro). Google Earth Pro also provides historical imagery for a period up to 15 years ago, which aided in the determination of certain vegetation types.

Habitat sensitivity

The purpose of producing a habitat sensitivity map is to provide information on the location of potentially sensitive features in the study area. This was compiled by taking the following into consideration:

1. The general status of the vegetation of the study area was derived by compiling a landcover data layer for the study area (*sensu* Fairbanks *et al*., 2000) using available satellite imagery and aerial photography. From this, it can be seen which areas are transformed versus those that are still in a natural status.
2. Various provincial, regional or national level conservation planning studies have been undertaken in the area, e.g. the National Spatial Biodiversity Assessment (NSBA). The mapped results from these were taken into consideration in compiling the habitat sensitivity map.
3. Habitats in which various species of plants or animals occur that may be protected or are considered to have high conservation status are sensitive.

Field surveys

The study area was visited and assessed to confirm patterns identified from the desktop assessment. Vegetation was in a good state following good rains over the previous three months. Many plant species could be identified, and habitats were generally in a good state to assess. This means that botanical diversity and species composition were possible to assess. The site visit was therefore considered to be successful, as well as representative of the study area. Specific features of potential concern were investigated in the field, including the following:

- General vegetation status, i.e. whether the vegetation was natural, disturbed/secondary or transformed;
- Presence of habitats of conservation concern in terms of high biodiversity, presence of species of conservation concern, specific sensitivities, e.g. wetlands, and any other factors that would indicate an elevated biodiversity or functional value that could not be determined from the desktop assessment;
- Presence of protected trees; and
- Potential presence of species of conservation concern, including observation of individual plants found on site or habitats that are suitable for any of the species identified from the desktop assessment.

Key parts of the development site were visited during the reconnaissance site visit in such a way as to ensure all major variation was covered and that any unusual habitats or features were observed. A preliminary checklist of species occurring on site was collected during the survey (Appendix 3, highlighted in green). Plant names follow the South African National Plant Checklist (www.newposa.co.za). The season of the survey was favourable, and there is high confidence that many of species present on site were identifiable at the time of the survey. The survey was of adequate duration and intensity to characterise the flora of the development site as per the regulations.

Impact assessment methodology

A standard risk assessment methodology is used for the ranking of the identified environmental impacts pre-and post-mitigation (i.e., residual impact). The significance of environmental aspects is determined and ranked by considering the criteria presented in Table 1.

Table 1: Impact Assessment Criteria and Scoring System

CRITERIA	SCORE 1	SCORE 2	SCORE 3	SCORE 4	SCORE 5
Impact Magnitude (M) The degree of alteration of the affected environmental receptor	Very low: No impact on processes	Low: Slight impact on processes	Medium: Processes continue but in a modified way	High: Processes temporarily cease	Very High: Permanent cessation of processes
Impact Extent (E) The geographical extent of the impact on a given environmental receptor	Site: Site only	Local: Inside activity area	Regional: Outside activity area	National: National scope or level	International: Across borders or boundaries
Impact Reversibility (R) The ability of the environmental receptor to rehabilitate or restore after the activity has caused environmental change	Reversible: Recovery without rehabilitation		Recoverable: Recovery with rehabilitation		Irreversible: Not possible despite action
Impact Duration (D) The length of permanence of the impact on the environmental receptor	Immediate: On impact	Short term: 0-5 years	Medium term: 5-15 years	Long term: Project life	Permanent: Indefinite
Probability of Occurrence (P) The likelihood of an impact occurring in the absence of pertinent environmental management measures or mitigation	Improbable	Low Probability	Probable	Highly Probability	Definite

CRITERIA	SCORE 1	SCORE 2	SCORE 3	SCORE 4	SCORE 5
Significance (S) is determined by combining the above criteria in the following formula:	$[S = (E + D + R + M) \times P]$ $Significance = (Extent + Duration + Reversibility + Magnitude) \times Probability$				
IMPACT SIGNIFICANCE RATING					
Total Score	**4 to 15**	**16 to 30**	**31 to 60**	**61 to 80**	**81 to 100**
Environmental Significance Rating (Negative (-))	**Very low**	**Low**	**Moderate**	**High**	**Very High**
Environmental Significance Rating (Positive (+))	**Very low**	**Low**	**Moderate**	**High**	**Very High**

RELEVANT LEGISLATIVE AND PERMIT REQUIREMENTS

Relevant legislation is provided in this section to provide a description of the key legal considerations of importance to the proposed project. The applicable legislation is listed below.

Convention on Biodiversity (CBD)

South Africa became a signatory to the United Nations Convention on Biological Diversity (CBD) in 1993, which was ratified in 1995. The CBD requires signatory states to implement objectives of the Convention, which are the conservation of biodiversity; the sustainable use of biological resources and the fair and equitable sharing of benefits arising from the use of genetic resources. According to Article 14 (a) of the CBD, each Contracting Party, as far as possible and as appropriate, must introduce appropriate procedures, such as environmental impact assessments of its proposed projects that are likely to have significant adverse effects on biological diversity, to avoid or minimize these effects and, where appropriate, to allow for public participation in such procedures.

National Environmental Management Act, Act No. 107 of 1998 (NEMA)

NEMA is the framework environmental management legislation, enacted as part of the government's mandate to ensure every person's constitutional right to an environment that is not harmful to his or her health or wellbeing. It is administered by the Department of Forestry, Fisheries and the Environment (DFFE) but several functions have been delegated to the provincial environment departments. One of the purposes of NEMA is to provide for co-operative environmental governance by establishing principles for decision-making on matters affecting the environment. The Act further aims to provide for institutions that will promote cooperative governance and procedures for coordinating environmental functions exercised by organs of state and to provide for the administration and enforcement of other environmental management laws.

NEMA requires, inter alia, that:

- "development must be socially, environmentally, and economically sustainable",
- "disturbance of ecosystems and loss of biological diversity are avoided, or, where they cannot be altogether avoided, are minimised and remedied",
- "a risk-averse and cautious approach is applied, which takes into account the limits of current knowledge about the consequences of decisions and actions",

NEMA states that "the environment is held in public trust for the people, the beneficial use of environmental resources must serve the public interest and the environment must be protected as the people's common heritage."

This report considers the Environmental Impact Assessment (EIA) Regulations of 2014 (NEMA, 2014) as amended in 2021 (NEMA, 2021), under the NEMA. According to these Regulations under Listing Notice 1 (GRN No. 983, as amended), Listing Notice 2 (GRN No 984, as amended) and Listing Notice 3 (GRN No 985, as amended), the activities listed are identified as activities that require Environmental Authorisation prior to commencement of that activity and to identify competent authorities in terms of sections 24(2) and 24D of the Act.

National Environmental Management: Biodiversity Act (Act No 10 of 2004) (NEMBA)

As the principal national act regulating biodiversity protection, NEMBA, which is administered by DFFE, is concerned with the management and conservation of biological diversity, as well as the use of indigenous biological resources in a sustainable manner. The term biodiversity according to the Convention on Biodiversity (CBD) refers to the variability among living organisms from all sources including, inter alia terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity in genes, species and ecosystems.

In terms of NEMBA, the developer has a responsibility for:

- The conservation of endangered ecosystems and restriction of activities according to the categorisation of the area (not just by listed activity as specified in the EIA regulations).
- Promote the application of appropriate environmental management tools in order to ensure integrated environmental management of activities thereby ensuring that all development within the area are in line with ecological sustainable development and protection of biodiversity.
- Limit further loss of biodiversity and conserve endangered ecosystems.

Chapter 4 of the Act relates to threatened or protected ecosystems or species. According to Section 57 of the Act, "Restricted activities involving listed threatened or protected species":

- (1) A person may not carry out a restricted activity involving a specimen of a listed threatened or protected species without a permit issued in terms of Chapter 7.

Such activities include any that are “of a nature that may negatively impact on the survival of a listed threatened or protected species”.

Alien and Invasive Species

Chapter 5 of NEMBA relates to species and organisms posing a potential threat to biodiversity. The Act defines alien species and provides lists of invasive species in regulations. The Alien and Invasive Species (AIS) Regulations, in terms of Section 97(1) of NEMBA, was published in Government Notice R598 in Government Gazette 37885 in 2014 (NEMBA, 2014). The Alien and Invasive Species (AIS) lists were subsequently published in Government Notice R 864 of 29 July 2016 (NEMBA, 2016).

NEMBA regulates all invasive organisms in South Africa, including a wide range of fauna and flora. Chapter 5 of the Act relates to species and organisms posing a potential threat to biodiversity. The purpose of Chapter 5 is:

a) to prevent the unauthorized introduction and spread of alien species and invasive species to ecosystems and habitats where they do not naturally occur;
b) to manage and control alien species and invasive species to prevent or minimize harm to the environment and to biodiversity in particular;
c) to eradicate alien species and invasive species from ecosystems and habitats where they may harm such ecosystems or habitats;

According to Section 65 of the Act, "Restricted activities involving alien species":

1) A person may not carry out a restricted activity involving a specimen of an alien species without a permit issued in terms of Chapter 7. Restricted activities include the following:
    a. Importing into the Republic, including introducing from the sea, any specimen of a listed invasive species.
    b. Having in possession or exercising physical control over any specimen of a listed invasive species.
    c. Growing, breeding or in any other way propagating any specimen of a listed invasive species, or causing it to multiply.
    d. Conveying, moving or otherwise translocating any specimen of a listed invasive species.
    e. Selling or otherwise trading in, buying, receiving, giving, donating or accepting as a gift, or in any other way acquiring or disposing of any specimen of a listed invasive species.
    f. Spreading or allowing the spread of any specimen of a listed invasive species.
    g. Releasing any specimen of a listed invasive species.
    h. Additional activities that apply to aquatic species.
2) A permit referred to in subsection (1) may be issued only after a prescribed assessment of risks and potential impacts on biodiversity is carried out.

An "**alien species**" is defined in the Act as:

a) a species that is not an indigenous species; or
b) an indigenous species translocated or intended to be translocated to a place outside its natural distribution range in nature, but not an indigenous species that has extended its natural distribution range by means of migration or dispersal without human intervention.

According to Section 71 of the Act, "Restricted activities involving listed invasive species":

1) A person may not carry out a restricted activity involving a specimen of a listed invasive species without a permit issued in terms of Chapter 7.
2) A permit referred to in subsection (1) may be issued only after a prescribed assessment of risks and potential impacts on biodiversity is carried out.

An "**invasive species**" is defined in the Act as any species whose establishment and spread outside of its natural distribution range:

a) threaten ecosystems, habitats or other species or have demonstrable potential to threaten ecosystems, habitats or other species; and
b) may result in economic or environmental harm or harm to human health.

A "**listed invasive species**" is defined in the Act as any invasive species listed in terms of section 70(1).

According to Section 73 of the Act, "Duty of care relating to listed invasive species":

2) A person who is the owner of land on which a listed invasive species occurs must-
    a) notify any relevant competent authority, in writing, of the listed invasive species occurring on that land;
    b) take steps to control and eradicate the listed invasive species and to prevent it from spreading; and
    c) take all the required steps to prevent or minimize harm to biodiversity.

According to Section 75 of the Act, "Control and eradication of listed invasive species":

- (1) Control and eradication of a listed invasive species must be carried out by means of methods that are appropriate for the species concerned and the environment in which it occurs.
- (2) Any action taken to control and eradicate a listed invasive species must be executed with caution and in a manner that may cause the least possible harm to biodiversity and damage to the environment.
- (3) The methods employed to control and eradicate a listed invasive species must also be directed at the offspring, propagating material and re-growth of such invasive species in order to prevent such species from producing offspring, forming seed, regenerating or re-establishing itself in any manner.

Government Notice No. 1002 of 2011: National List of Ecosystems that are Threatened and in need of protection
This act, published under Section 52(1)(a) of NEMBA, provides for the listing of threatened or protected ecosystems based on national criteria. The list of threatened terrestrial ecosystems supersedes the information regarding terrestrial ecosystem status in the National Spatial Biodiversity Assessment (2004).

GNR 151: Critically Endangered, Endangered, Vulnerable and Protected Species List
Published under Section 56(1) of NEMBA.

GNR 1187: Amendment of Critically Endangered, Endangered, Vulnerable and Protected Species List
Published under Section 56(1) of NEMBA.

Government Notice No. 40733 of 2017: Draft National Biodiversity Offset Policy
Published under NEMA. The aim of the Policy is to ensure that significant residual impacts of developments are remedied as required by NEMA, thereby ensuring sustainable development as required by section 24 of the Constitution of the Republic of South Africa, 1996. This policy should be taken into consideration with every development application that still has significant residual impact after the Mitigation Sequence has been followed. The mitigation sequence entails the consecutive application of avoiding or preventing loss, then at minimizing or mitigating what cannot be avoided, rehabilitating where possible and, as a last resort, offsetting the residual impact. The Policy specifies that one impact that has come across consistently as unmitigable is the rapid and consistent transformation of certain ecosystems and vegetation types, leading to the loss of ecosystems and extinction of species. The Policy specifically targets ecosystems where the ability to reach protected area targets is lost or close to being lost. However, the Policy states that "*[w]here ecosystems remain largely untransformed, intact and functional, an offset would not be required for developments that lead to transformation, provided they have not been identified as a biodiversity priority*". Biodivesity offsets should be considered to remedy residual negative impacts on biodiversity of 'medium' to 'high' significance. Residual impacts of 'very high' significance are a fatal flaw for development and residual biodiversity impacts of 'low' significance would usually not require offsets. The Policy indicates that impacts should preferably be

avoided in protected areas, Critical Biodiversity Areas (CBA), verified wetland and river features and areas earmarked for protected area expansion.

National Forests Act (Act no 84 of 1998)

Protected trees
According to this act, the Minister may declare a tree, group of trees, woodland or a species of trees as protected. The prohibitions provide that 'no person may cut, damage, disturb, destroy or remove any *protected tree*, or collect, remove, transport, export, purchase, sell, donate or in any other manner acquire or dispose of any protected tree, except under a licence granted by the Minister'.

Forests
Prohibits the destruction of indigenous trees in any natural forest without a licence.

National Water Act (Act 36 of 1998)

Wetlands, riparian zones and watercourses are defined in the Water Act as a water resource and any activities that are contemplated that could affect the water resource require authorisation (Section 21 of the National Water Act of 1998). A "watercourse" in terms of the National Water Act (Act 36 of 1998) means:

- River or spring;
- A natural channel in which water flows regularly or intermittently;
- A wetland, lake or dam into which, or from which, water flows; and
- Any collection of water which the Minister may, by notice in the gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.

Conservation of Agricultural Resources (Act No. 43 of 1983) as amended in 2001

Declared Weeds and Invaders in South Africa are categorised according to one of the following categories:

- Category 1 plants: are prohibited and must be controlled.
- Category 2 plants: (commercially used plants) may be grown in demarcated areas providing that there is a permit and that steps are taken to prevent their spread.
- Category 3 plants: (ornamentally used plants) may no longer be planted; existing plants may remain, as long as all reasonable steps are taken to prevent the spreading thereof, except within the floodline of watercourses and wetlands.

National Veld and Forest Fire Act (Act No. 101 of 1998)

Provides requirements for veldfire prevention through firebreaks and required measures for fire-fighting. Chapter 4 of the Act places a duty on landowners to prepare and maintain firebreaks. Chapter 5 of the Act places a duty on all landowners to acquire equipment and have available personnel to fight fires.

Mpumalanga Nature Conservation Act, No. 10 of 1998

This Act provides for the sustainable utilisation of wild animals, aquatic biota and plants; provides for the implementation of the Convention on International Trade in Endangered Species of Wild Fauna and Flora; provides for offences and penalties for contravention of the Act; provides for the appointment of nature conservators to implement the provisions of the Act; and provides for the issuing of permits and other authorisations. Amongst other regulations, the following may apply to the current project:

- Various species are protected;
- The owner of land upon which an invasive species is found (plant or animal) must take the necessary steps to eradicate or destroy such species.

The Act provides lists of protected species for the Province. According to the Mpumalanga Nature Conservation Act, a permit is required for the removal of any species on this list.

National Environmental Management Protected Areas Act, No. 57 of 2003

The National Environmental Management: Protected Areas Act 57 of 2003 has the following objectives:

- to provide for the protection and conservation of ecologically viable areas representative of South Africa's biological diversity and its natural landscapes and seascapes;
- to provide for the establishment of a national register of all national, provincial and local protected areas;
- to provide for the management of those areas in accordance with national norms and standards;
- to provide for intergovernmental co-operation and public consultation in matters concerning protected areas; and
- to provide for matters in connection therewith.

It has been amended several times:

- National Environmental Management: Protected Areas Amendment Act 21 of 2014
- National Environmental Management: Protected Areas Amendment Act 15 of 2009
- National Environmental Management: Protected Areas Amendment Act 15 of 2009
- National Environmental Laws Amendment Act 14 of 2009
- National Environmental Management: Protected Areas Amendment Act 31 of 2004

Other Acts

Other Acts that may apply to biodiversity issues, but which are considered to not apply to the current site are as follows:

- Marine Living Resources Act (Act No. 18 of 1998)
- Sea Birds and Seals Protection Act (Act No. 46 of 1973)
- Lake Areas Development Act (Act No. 39 of 1975)
- Mountain Catchment Areas Act (Act No. 63 of 1970)
- Integrated Coastal Zone Management Act (Act No. 24 of 2008)

SENSITIVITIES IDENTIFIED FROM DFFE ONLINE SCREENING TOOL

Terrestrial Biodiversity theme

The National Web based Environmental Screening Tool was queried in relation to the following infrastructure:

Infrastructure|Localised infrastructure|Storage|Dangerous Goods|Chemicals

There are three project options. A Screening Tool output is available for each of the three. The information presented below is for Option 3, which spans the largest number of sensitivities. The terrestrial biodiversity theme indicates that the site is within one sensitivity class, namely **VERY HIGH** (Figure 2).

Sensitivity features are indicated as follows:

Sensitivity	Feature(s)	Project options
Critical biodiversity area 1	Very High	3
Critical biodiversity area 2	Very High	1, 2, 3
Protected Areas Expansion Strategy	Very High	1, 2, 3
Vulnerable ecosystem	Very High	1, 2, 3

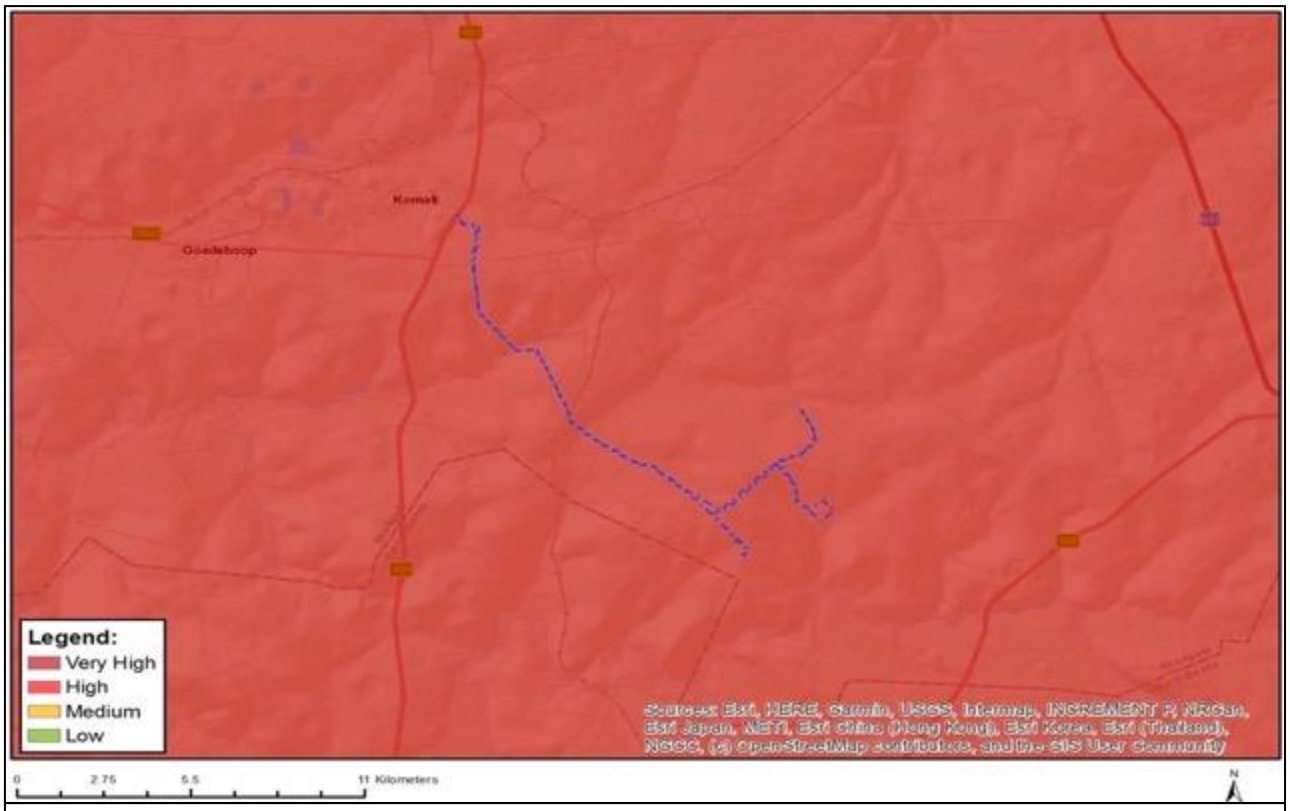

Figure 2: DFFE Screening Tool extract: terrestrial biodiversity theme for Alternative 3.

DESCRIPTION OF STUDY AREA

Location

The Project is located 17km west of Hendrina, in the Steve Tshwete Local Municipality of the Nkangala District Municipality, Mpumalanga Province (Figure 3). It is located approximately halfway between Hendrina and Kriel and about 45 km south-east of eMalahleni. The Olifants River is located 2 km south of the site, Komati Power Station is north-west and there are scattered opencast and underground coal mines in the vicinity of the site.

Site conditions

The proposed infrastructure is within a grassland area with undulating topography. Within the study area are significant parts that are either currently or previously cultivated, the exception being wetland areas and areas of grassland with shallow soils that are not suitable for cultivation. Within the general area, there are various secondary roads leading from the main access roads, and several homestead complexes. There are groves of exotic trees scattered throughout the study area, but mostly clustered around homesteads and farm infrastructure, where they act as shelter and windbreaks. The vegetation in the study area is used primarily for livestock grazing and is affected to some degree by this usage, but not to the extent that any severe degradation was noted on site. Except for cultivated areas and infrastructure, the remaining vegetation and habitats in the study area appear to be what would be expected according to the natural relationship between the physical environment and the vegetation.

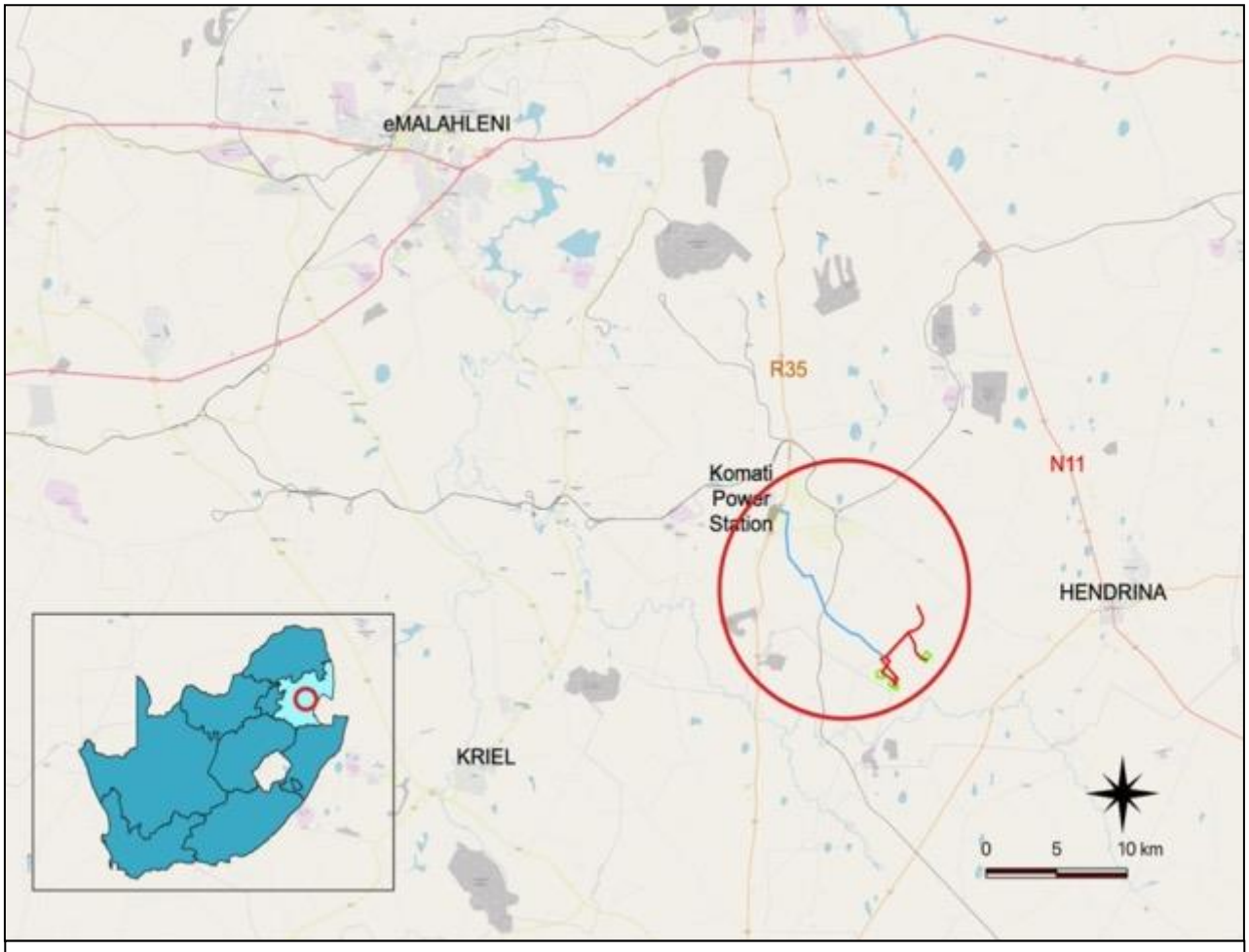

Figure 3: Location of the proposed infrastructure.

Topography and drainage

The study area is situated close to (within 2 km of) the floodplain of the Olifants River, as well as on the undulating plains and slopes north of the river. The site therefore includes moderately sloping topography in combination with undulating terrain.

The elevation on site varies from 1594 to 1692 m above sea level, an elevation difference of approximately 100 m across a distance of over 8 km. The highest point in the study area is along the powerline route between the infrastructure location options. The lowest point is in a drainage line close to Komati Power Station.

The general study area is drained by various drainage lines, and the Olifants River.

Regional vegetation patterns

There is one regional vegetation type occurring in the study area, namely Eastern Highveld Grassland (Figure 4). There is one additional unit that occurs in nearby areas, namely Eastern Temperate Freshwater Wetlands. It is probable that terrestrial vegetation patterns reflect the major vegetation type, namely Eastern Highveld Grassland. The vegetation types that occur in the study area and nearby areas are briefly described below. The description below is from Mucina & Rutherford, extracted from the SANBI BGIS website (http://bgis.sanbi.org/vegmap).

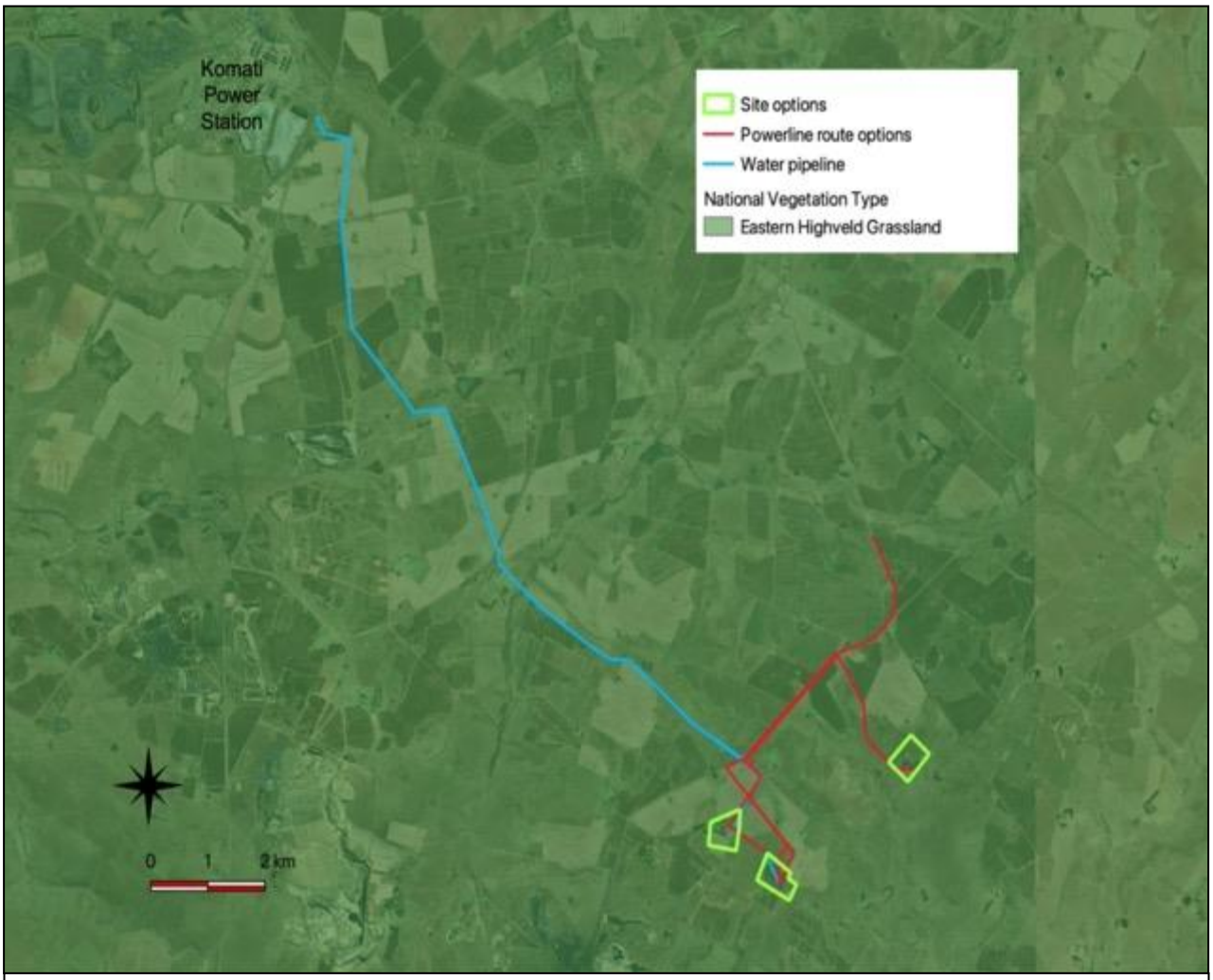

Figure 4: Regional vegetation types of the study area.

Eastern Highveld Grassland

Distribution

Found in Mpumalanga and Gauteng Provinces, on the plains between Belfast in the east and the eastern side of Johannesburg in the west and extending southwards to Bethal, Ermelo and west of Piet Retief. The vegetation type occurs at an altitude of between 1 520–1 780 m.

Vegetation & Landscape Features

The vegetation occurs on slightly to moderately undulating plains, including some low hills and pan depressions. The vegetation is short dense grassland dominated by the usual highveld grass composition (*Aristida*, *Digitaria*, *Eragrostis*, *Themeda*, *Tristachya*, etc.) with small, scattered rocky outcrops with wiry, sour grasses and some woody species (*Acacia caffra*, *Celtis africana*, *Diospyros lycioides* subsp *lycioides*, *Parinari capensis*, *Protea caffra*, *P. welwitschii* and *Searsia magalismontanum*).

Geology & Soils

Red to yellow sandy soils of the Ba and Bb land types found on shales and sandstones of the Madzaringwe Formation (Karoo Supergroup). Land types Bb (65%) and Ba (30%).

Climate

Strongly seasonal summer rainfall, with very dry winters. MAP 650–900 mm (overall average: 726 mm), MAP relatively uniform across most of this unit, but increases significantly in the extreme southeast. The coefficient of variation in MAP is 25% across most of the unit, but drops to 21% in the east and southeast. Incidence of frost from 13–42 days, but higher at higher elevations.

Important Taxa

Low Shrubs	*Anthospermum rigidum* subsp. *pumilum*, *Stoebe plumosa*.
Herbs	*Berkheya setifera* (d), *Haplocarpha scaposa* (d), *Justicia anagalloides* (d), *Pelargonium luridum* (d), *Acalypha angustata*, *Chamaecrista mimosoides*, *Dicoma anomala*, *Euryops gilfillanii, E. transvaalensis* subsp. *setilobus, Helichrysum aureonitens*, *H. caespititium*, *H. callicomum*, *H. oreophilum*, *H. rugulosum*, *Ipomoea crassipes*, *Pentanisia prunelloides* subsp. *latifolia*, *Selago densiflora*, *Senecio coronatus*, *Vernonia oligocephala*, *Wahlenbergia undulata*.
Geophytic Herbs	*Gladiolus crassifolius*, *Haemanthus humilis* subsp. *hirsutus*, *Hypoxis rigidula* var. *pilosissima*, *Ledebouria ovatifolia*.
Succulent Herbs	*Aloe ecklonis*
Graminoids	*Aristida aequiglumis* (d), *A. congesta* (d), *A. junciformis* subsp. *galpinii* (d), *Brachiaria serrata* (d), *Cynodon dactylon* (d), *Digitaria monodactyla* (d), *D. tricholaenoides* (d), *Elionurus muticus* (d), *Eragrostis chloromelas* (d), *E. curvula* (d), *E. plana* (d), *E. racemosa* (d), *E. sclerantha* (d), *Heteropogon contortus* (d), *Loudetia simplex* (d), *Microchloa caffra* (d), *Monocymbium ceresiiforme* (d), *Setaria sphacelata* (d), *Sporobolus africanus* (d), *S. pectinatus* (d), *Themeda triandra* (d), *Trachypogon spicatus* (d), *Tristachya leucothrix* (d), *T. rehmannii* (d), *Alloteropsis semialata* subsp. *eckloniana*, *Andropogon appendiculatus*, *A. schirensis*, *Bewsia biflora*, *Ctenium concinnum*, *Diheteropogon amplectens*, *Eragrostis capensis*, *E. gummiflua*, *E. patentissima*, *Harpochloa falx*, *Panicum natalense*, *Rendlia altera*, *Schizachyrium sanguineum*, *Setaria nigrirostris*, *Urelytrum agropyroides*.

Eastern Temperate Freshwater Wetlands

Distribution

Northern Cape, Eastern Cape, Free State, North-West, Gauteng, Mpumalanga and KwaZulu-Natal Provinces as well as in neighbouring Lesotho and Eswatini: Around water bodies with stagnant water (lakes, pans, periodically flooded vleis, edges of calmly flowing rivers) and embedded within the Grassland Biome. Altitude ranging from 750–2 000 m.

Vegetation & Landscape Features

Flat landscape or shallow depressions filled with (temporary) water bodies supporting zoned systems of aquatic and hygrophilous vegetation of temporarily flooded grasslands and ephemeral herb-lands.

Geology & Soils

Found on younger Pleistocene to recent sediments overlying fine-grained sedimentary rocks of the Karoo Supergroup (on sediments of both Ecca and Beaufort Groups due to the large extent of the area of occurrence) as well as of the much older dolomites of the Malmani Subgroup of the Transvaal Supergroup in the northwest. Especially the areas built by Karoo Supergroup sediments are associated with the occurrence of Jurassic Karoo dolerite dykes having a profound influence on run-off. Soils are peaty (Champagne soil form) to vertic (Rensberg soil form). The vleis form where flow of

water is impeded by impermeable soils and/or by erosion resistant features, such as dolerite intrusions. Many vleis and pans of this type of freshwater wetlands are inundated and/or saturated only during the summer rainfall season, and for some months after this into the middle of the dry winter season, but they may remain saturated all year round. Surface water inundation may be present at any point while the wetland is saturated and some plant species will be present only under inundated conditions, or under permanently saturated conditions. The presence of standing water should not be taken as a sign of permanent wet conditions.

Climate

Exclusively summer-rainfall region (MAP range 421–915 mm). Cool-temperate pattern with MAT ranging between 12.6°C and 16.7°C. Due to high elevation, frost is a frequent phenomenon

Important Taxa

Megagraminoids	*Cyperus congestus* (d), *Phragmites australis* (d), *Schoenoplectus corymbosus* (d), *Typha capensis* (d), *Cyperus immensus*.
Graminoids	*Agrostis lachnantha* (d), *Carex acutiformis* (d), *Eleocharis palustris* (d), *Eragrostis plana* (d), *E. planiculmis* (d), *Fuirena pubescens* (d), *Helictotrichon turgidulum* (d), *Hemarthria altissima* (d), *Imperata cylindrica* (d), *Leersia hexandra* (d), *Paspalum dilatatum* (d), *P. urvillei* (d), *Pennisetum thunbergii* (d), *Schoenoplectus decipiens* (d), *Scleria dieterlenii* (d), *Setaria sphacelata* (d), *Andropogon appendiculatus*, *A. eucomus*, *Aristida aequiglumis*, *Ascolepis capensis, Carex austro-africana*, *Carex cernua, C. schlechteri*, *Cyperus cyperoides*, *C. distans*, *C. longus*, *C. marginatus*, *Echinochloa holubii*, *Eragrostis micrantha*, *Ficinia acuminata*, *Fimbristylis complanata*, *F. ferruginea*, *Hyparrhenia dregeana*, *H. quarrei, Ischaemum fasciculatum*, *Kyllinga erecta*, *Panicum schinzii*, *Pennisetum sphacelatum*, *Pycreus macranthus*, *P. nitidus*, *Setaria pallide-fusca*, *Xyris gerrardii*.
Herbs	*Centella asiatica* (d), *Ranunculus multifidus* (d), *Berkheya radula*, *B. speciosa*, *Berula erecta* subsp. *thunbergii*, *Centella coriacea*, *Chironia palustris*, *Equisetum ramosissimum*, *Falckia oblonga, Haplocarpha lyrata, Helichrysum difficile*, *H. dregeanum*, *H. mundtii*, *Hydrocotyle sibthorpioides, H. verticillata*, *Lindernia conferta*, *Lobelia angolensis, L. flaccida*, *Marsilea farinosa* subsp. *farinosa, Mentha aquatica*, *Monopsis decipiens*, *Pulicaria scabra*, *Pycnostachys reticulata*, *Rorippa fluviatilis* var. *fluviatilis*, *Rumex lanceolatus*, *Senecio inornatus*, *S. microglossus*, *Sium repandum*, *Thelypteris confluens*, *Wahlenbergia banksiana*.
Carnivorous herb	*Utricularia inflexa*.
Geophytic Herbs	*Cordylogyne globosa*, *Crinum bulbispermum*, *Gladiolus papilio*, *Kniphofia ensifolia*, *K. fluviatilis*, *K. linearifolia*, *Neobolusia tysonii, Nerine gibsonii* (only in Eastern Cape), *Satyrium hallackii* subsp. *Hallackii*
Aquatic Herbs	*Aponogeton junceus*, *Ceratophyllum demersum*, *Lagarosiphon major*, *L. muscoides*, *Marsilea capensis*, *Myriophyllum spicatum, Nymphaea lotus*, *N. nouchali* var. *caerulea*, *Nymphoides thunbergiana*, *Potamogeton thunbergii*.

Endemic Taxa

Herbs	*Disa zuluensis, Kniphofia flammula* (northern KwaZulu-Natal), *Nerine platypetala*
Succulent herb	*Crassula tuberella*

Conservation status of regional vegetation types

Based on a scientific approach used at national level by SANBI (Driver *et al*., 2005), vegetation types can be categorised according to their conservation status which is, in turn, assessed according to the degree of transformation relative to the expected extent of each vegetation type. The status of a habitat or vegetation type is based on how much of its original area remains intact relative to various thresholds. The original extent of a vegetation type is as presented in the most recent national vegetation map (Mucina, Rutherford & Powrie 2005) and is the extent of the vegetation type in the absence of any historical human impact. On a national scale the thresholds are as depicted in Table 4 below, as determined by best available scientific approaches (Driver *et al*., 2005). The level at which an ecosystem becomes Critically Endangered differs from one ecosystem to another and varies from 16% to 36% (Driver *et al*., 2005).

Determining ecosystem status (Driver *et al*., 2005). *BT = biodiversity target (the minimum conservation requirement).

Habitat remaining (%)			
	80–100	least threatened	LT
	60–80	vulnerable	VU
	*BT–60	endangered	EN
	0–*BT	critically endangered	CR

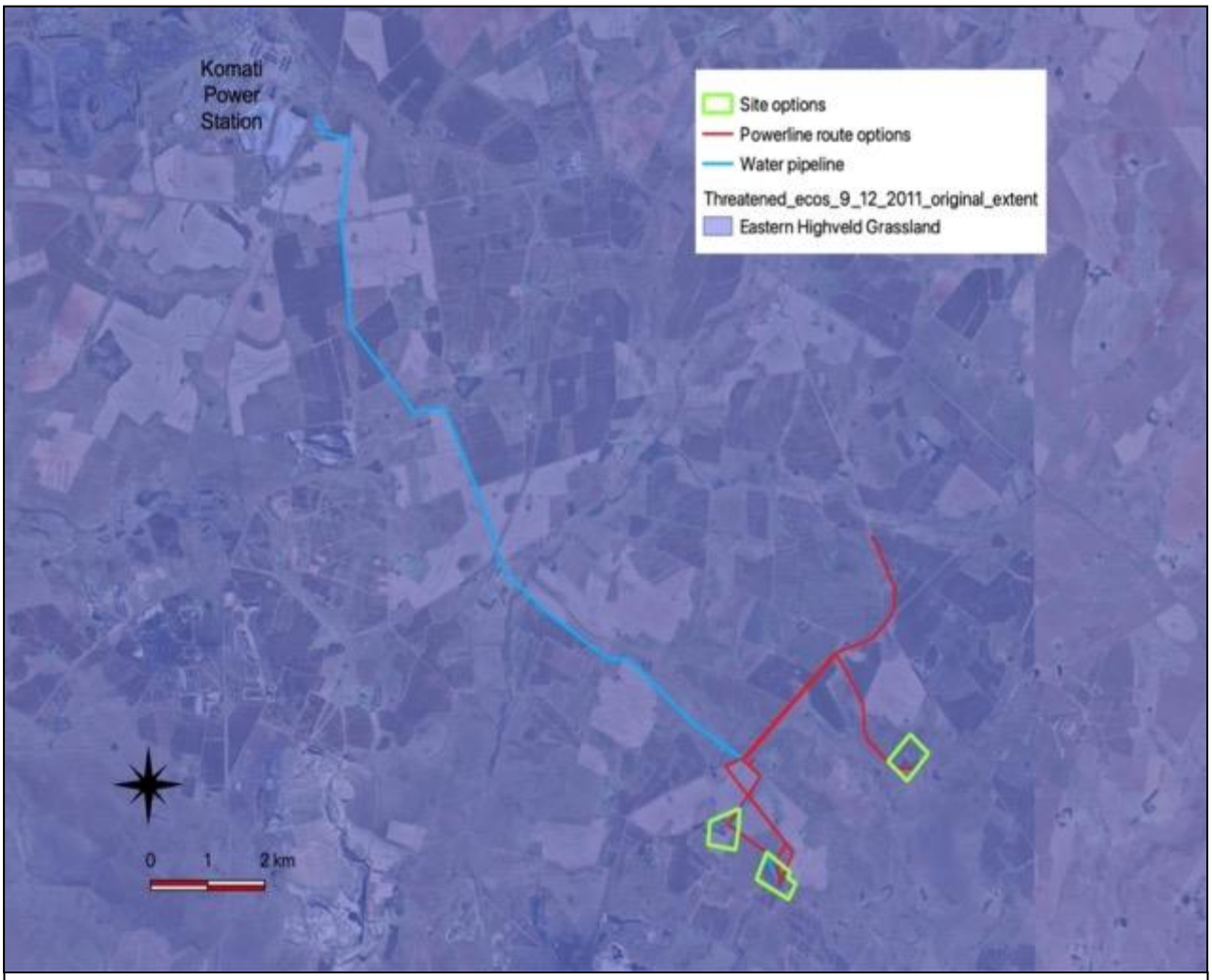

Figure 5: Threatened ecosystems of the study area.

Conservation status of different vegetation types occurring in the study area.

Vegetation Type	Target (%)	Conserved (%)	Transformed (%)	Conservation status	
				Driver *et al*. 2005; Mucina *et al*., 2006	National Ecosystem List (NEMBA)
Eastern Highveld Grassland	24	0.3	44	Endangered	Vulnerable
Eastern Temperate Freshwater Wetlands	24	5	15	Least threatened	Vulnerable

According to scientific literature (Driver *et al*., 2005; Mucina *et al*., 2006), Eastern Highveld Grassland is listed as Endangered and Eastern Temperate Freshwater Wetlands as Least Threatened.

The National List of Ecosystems that are Threatened and need of protection (GN1002 of 2011), published under the NEMBA, lists national vegetation types that are afforded protection on the basis of rates of transformation. The thresholds for listing in this legislation are higher than in the scientific literature, which means there are fewer ecosystems listed in the National Ecosystem List versus in the scientific literature. Both national vegetation types are listed as Vulnerable in the National List of Ecosystems that are Threatened and need of protection (GN1002 of 2011).

Biodiversity Conservation Plans

The Mpumalanga Biodiversity Sector Plan (MBSP) (Mpumalanga Parks and Tourism Agency 2014) classifies the natural vegetation of the province according to the following categories:

1. Protected Areas (sub-divided into three categories);
2. Critical Biodiversity Areas (CBA), which is sub-divided into “Irreplaceable” and “Optimal”.
3. Other natural areas.
4. Ecological Support Area (sub-divided into four categories); and
5. Modified (sub-divided into Heavily or Moderately modified).

Figure 6 shows a map of features within the study area within four of these classes, as follows:

1. Critical Biodiversity Areas (CBA): Irreplaceable: Significant portions of the eastern part of the site are within a “CBA: Irreplaceable” area. These categorized areas are associated with the Olifants River and a drainage valley leading into it, and all natural areas adjacent to these two areas.
2. Critical Biodiversity Areas (CBA): Optimal: The entire grassland area in the southern part of the site is within a “CBA: Optimal” area, as well as other smaller patches adjacent to the CBA: Irreplaceable area.
3. Other Natural Areas (ONA): There are patches in the western part of the site mapped as ONA.
4. Ecological Support Area: There is a patch in the centre of the eastern half of the site that is mapped as ESA: Local Corridor.
5. Heavily or moderately modified: Remaining areas on site, associated primarily with cultivation.

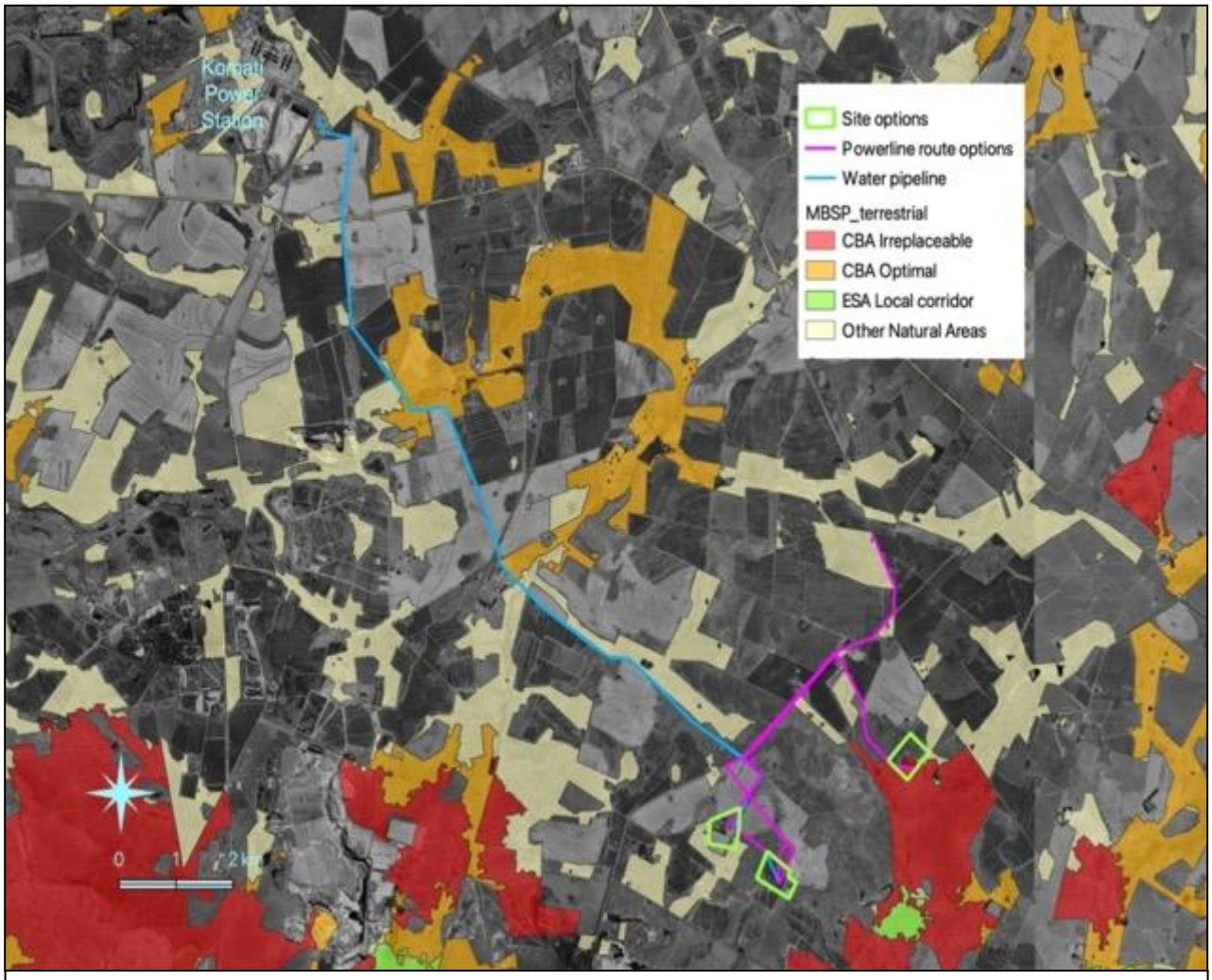

Figure 6**: Mpumalanga CBA map for the study area.**

According to the description for the MBSP Terrestrial Assessment categories, Critical Biodiversity Areas are areas that are required to meet biodiversity targets (for biodiversity pattern and ecological process features). The policy is that they should remain in a natural state. CBAs are areas of high biodiversity value which are usually at risk of being lost and usually identified as important in meeting biodiversity targets, except for Critically Endangered Ecosystems or Critical Linkages.

Proposed protected areas

According to the National Protected Areas Expansion Strategy 2008 (NPAES2008), there are no areas within the study area that have been identified as priority areas for inclusion in future protected areas. The study area is therefore outside the NPAES focus area. A draft National Protected Areas Expansion Strategy was published for public comment in 2018, but is not available as a spatial dataset. It does, however, reference the Mpumalanga Protected Area Expansion Strategy, in which priority areas are identified in terms of High, Medium nd Low priorities. A map within this PDF document shows areas around Hendrina within the Low priority class that may include the site, but a spatial dataset to confirm this could not be sourced at the time of producing this report. On the basis of the Screening Tool output, which identifies "Protected Areas Expansion Strategy" as a factor within the study area, it is assumed that natural areas within the study area fall within this category (Low Priority - Mpumalanga Protected Area Expansion Strategy).

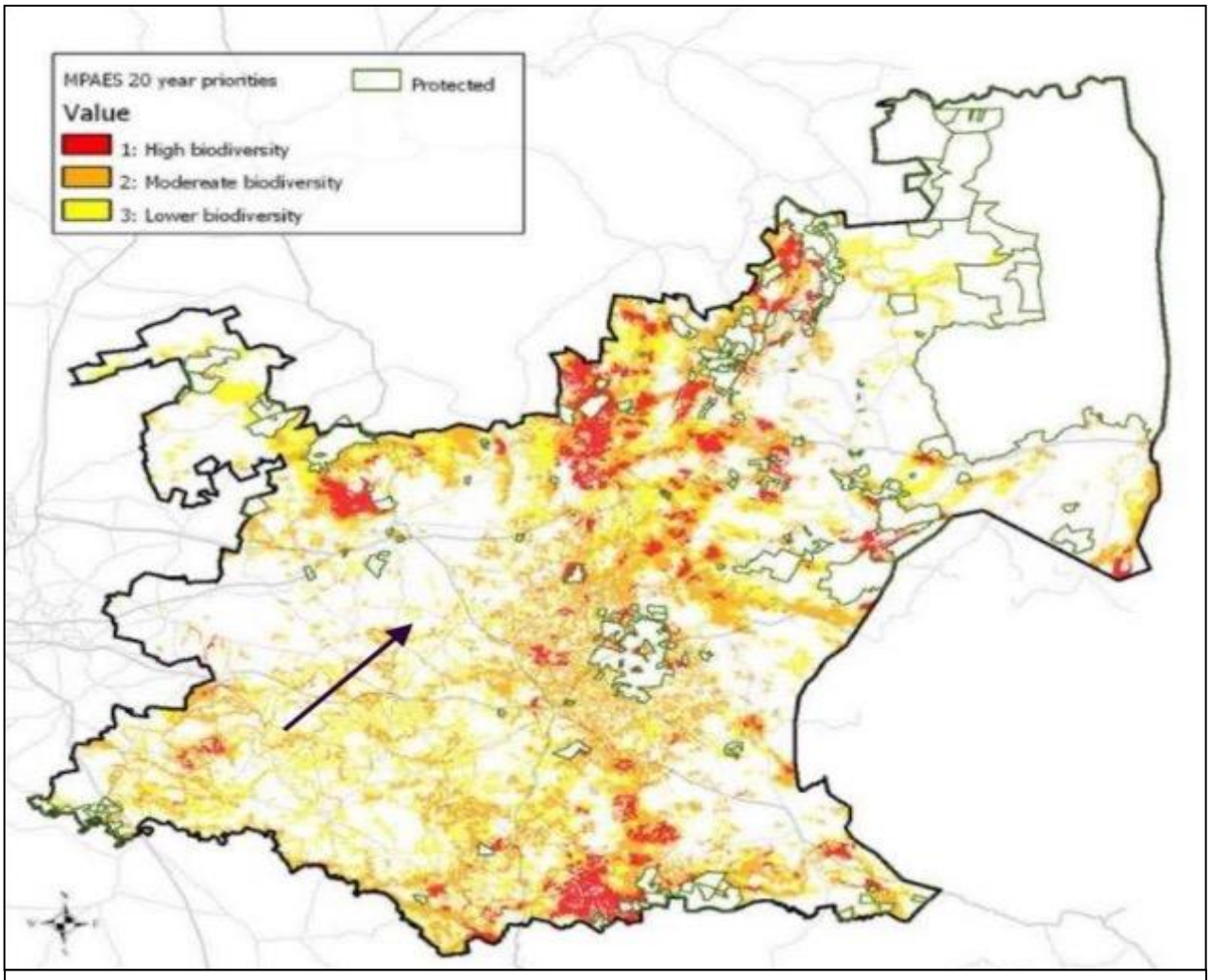

Figure 7: Mpumalanga Protected Area Expansion Strategy (Lotter 2015) arrow points to site.

Habitats on site

A map of habitats within the study area is provided in Figure 8. The site is within an area of natural grassland but degraded (from heavily to light). The grassland contains variation due to changes in topography, slope inclination, surface rockiness and the influence of water-flow and water retention in the landscape. A broad classification of the habitat units on site, which also reflects relatively uniform plant species compositional units, is as follows:

Natural habitats:

1. **Natural grassland** (open grassland on undulating plains – the condition is not indicated in the habitat map although there is a gradient from heavily grazed poor condition to moderate condition);
2. **Wetlands** (permanent and seasonal wetlands in drainage valleys, including channels, where they occur);

Transformed and degraded areas:

3. **Old lands** (secondary grasslands on previously cultivated areas);
4. **Exotic trees** (stands of exotic trees);
5. **Degraded areas** (disturbed areas with bare ground, weeds or waste ground).
6. **Current cultivation** (areas currently cultivated and fallow lands);
7. **Transformed** (areas such as roads and buildings where there is no vegetation).

A map of intact natural habitats within the study area and adjacent areas is provided in Figure 8.

Note that the mapping of any wetland-related habitats on site is based on vegetation characteristics and plant species composition and is not a wetland delineation according to the soil-based methodology required according to the National Water Act. For example, there are several facultative wetland species that occur in seasonal and temporary wetlands that do not occur in terrestrial grasslands (see description below for "Wetlands"). The habitats in which these wetland-related species occur are recognizable on aerial images and were mapped accordingly.

NATURAL VERSUS SECONDARY GRASSLAND	
Natural grassland	Areas of original vegetation in which the soil has not been mechanically disturbed, including areas that are in poor condition due to **overgrazing**, **trampling**, **invasion** by weeds or alien invasive species, **inappropriate fire regimes**, or any other factor that drives natural change in species composition or vegetation structure. The key factor is that the original plants continue to exist, often resprouting after defoliation from sub-surface stems or other storage organs.
Secondary grassland	Areas of vegetation where the original grassland vegetation has been lost through direct **disturbance of the soil** that results in physical removal of the original plants, the most common cause of which is ploughing, but could be other mechanical factors. The vegetation that develops is a result of recolonisation of the area through propagation.

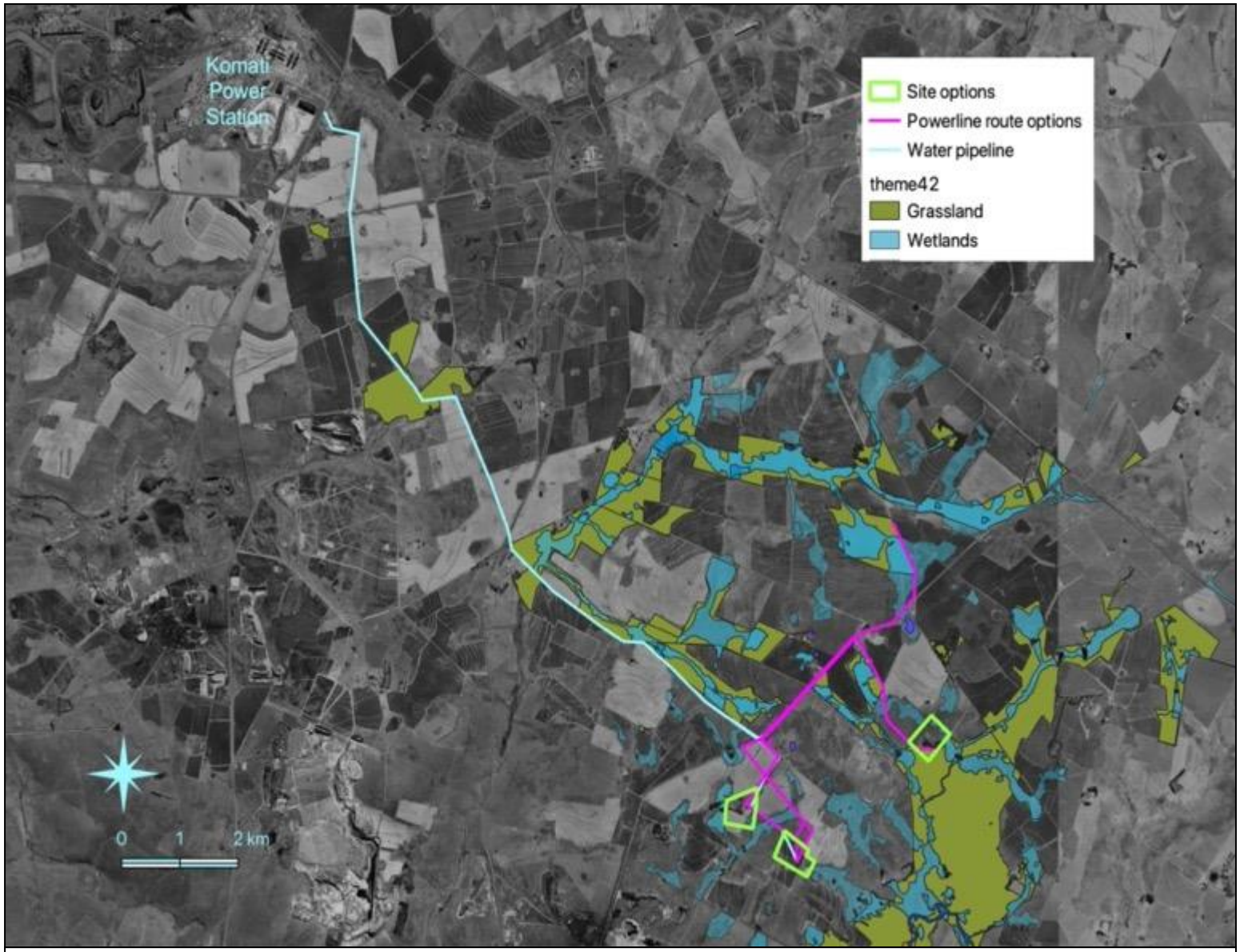

Figure 8**: Main habitats of the study area.**

Grassland
The natural vegetation of the study area is characterized by an open grassland on undulating hills and plains. It is generally a short to moderate height tussock grassland with closed canopy cover. The soil depth varies, as does the amount of surface rock cover. A typical view of this vegetation, as found on site, is shown in Figure 9. This was the most widespread vegetation community on site, occurring on all the relatively flat plains areas. These plains are also the area that has been most subject to cultivation.

The general floristic character of this vegetation on site is fairly uniform across wide areas, often dominated by the same suite of species, including the grasses, *Alloteropsis semialata, Aristida diffusa, Aristida junciformis, Bewsia biflora, Brachiaria serrata, Diheteropogon amplectens, Elionurus muticus, Eragrostis capensis, Eragrostis chloromelas, Eragrostis plana, Eragrostis racemosa, Harpochloa falx, Heteropogon contortus, Microchloa caffra, Panicum natalense, Setaria sphacelata var. torta, Themeda triandra,* and *Tristachya leucothrix*, and the forbs, *Acalypha angustata, Anthospermum rigidum subsp. rigidum, Berkheya setifera, Chaetacanthus costatus, Commelina africana, Crabbea acaulis, Cucumis hirsutus, Cucumis zeyheri, Cyanotis speciosa, Gerbera viridifolia, Haplocarpha scaposa, Helichrysum rugulosum, Hemizygia pretoriae, Hermannia transvaalensis, Hibiscus aethiopicus, Hypoxis obtusa, Hypoxis rigidula, Indigofera comosa, Ipomoea ommaneyi, Justicia anagalloides, Kohautia amatymbica, Ledebouria ovatifolia, Monsonia attenuata, Nidorella hottentotta, Pentanisia angustifolia, Pollichia campestris, Scabiosa columbaria, Selago densiflora, Seriphium plumosum, Vernonia galpinii, Vernonia oligocephala,* and *Zornia milneana*. Overall diversity in this habitat is high and includes a full list of over 100 species. Local species richness is also high at 56 species per 400m^2 sampling area. This rivals the local richness of some of the most species-rich grasslands anywhere in the country.

Wetlands
There are various valley bottom wetlands in the study area. Valley bottom wetlands in this general area around Hendrina are generally dominated by a variety of grasses, sedges and herbaceous plants, including the graminoids, *Kyllinga erecta*, *Leersia hexandra*, *Agrostis lachnantha*, *Andropogon appendiculatus*, *Helictotrichon turgidulum*, *Scirpoides burkei*, *Cyperus teneristolon*, *Cyperus macranthus*, *Typha capensis*, *Agrostis erianthe*, *Hemarthria altissima*, *Panicum schinzii*, *Cyperus rigidifolius* and *Arundinella nepalensis*, the herbs, *Centella asiatica*, *Senecio polyodon*, *Senecio erubescens*, *Haplocarpha scaposa*, *Pelargonium luridum*, *Commelina africana*, *Lobelia flaccida*, *Monopsis decipiens*, and *Helichrysum aureonitens*. The species composition depends on the hydrological characteristics of the site, with a greater number of obligate wetland species occurring in more permanently damp areas, whereas dryer areas resemble more closely the terrestrial grassland in species composition.

The drainage areas are important habitat for animals, providing refuge and shelter, water, when it is available, palatable vegetation, when surrounding areas are in drought, and softer and deeper soils for burrowing animals. The habitat is also an important flood-attenuation component of the landscape, and a reservoir for soil water.

Habitat sensitivity

To determine ecological sensitivity in the study area, local and regional factors were considered. There are some habitats in the study area that have been described as sensitive, irrespective of regional assessments. This includes primarily the valley bottom wetlands. A detailed assessment of these areas is being undertaken by an aquatic specialist, and they are only considered here in terms of being important habitat for flora and fauna.

At a regional level, the CBA map for Mpumalanga indicates various parts of the study area as being important for conservation. There are parts of the study area that fall within CBAs (Figure 6). Much of the remainder of the study area is heavily modified. The CBA map therefore corresponds with the distribution of remaining natural habitat on site.

In terms of other species of concern, including both plants and animals, the preferred habitat of each of these can be determined or has been described. They are, however, distributed amongst different habitats on site, which means that no single habitat is primarily important as habitat for species of concern.

A summary of sensitivities that occur on site and that may be vulnerable to damage from the proposed project are as follows:

1. CBA “Irreplaceable” areas: The Mpumalanga Biodiversity Sector Plan (MBSP) (Mpumalanga Parks and Tourism Agency 2014) shows areas on site within various conservation planning categories, including areas designated as “CBA: Irreplaceable”. These are areas that are required to meet biodiversity targets (for biodiversity pattern and ecological process features), the implication being that there are no other areas that meet the biodiversity criteria for meeting these conservation planning objectives. The Provincial policy is that they should remain in a natural state. Where possible, impacts on these areas should be minimised.

2. Wetlands: These are described here only in terms of being a unique botanical habitat and not in the sense of a formal wetland delineation, which is normally assessed in a separate specialist study. The wetlands must be delineated according to “DWAF, 2003: A Practical Guideline Procedure for the Identification and Delineation of Wetlands and Riparian Zones”. Restrictions in terms of infrastructure within these areas should be according to the National Water Act (Act 36 of 1998), except where the wetlands fall within a CBA “Irreplaceable” area, in which case they should be considered to be “No-Go” areas.

3. Listed ecosystems: Eastern Highveld Grassland and Eastern Temperate Freshwater Wetlands are both listed as Vulnerable in the National List of Ecosystems that are Threatened and need of protection (GN1002 of 2011). All remaining natural habitat on site falls within one of these two listed ecosystems.

4. Grasslands: Grassland vegetation, in a general sense has been identified as threatened nationally as a habitat type. Indications are that loss of any grassland habitat is permanent in an ecological and biodiversity sense, and it is not possible to restore grassland to a natural state after they have been disturbed. They should therefore be treated as sensitive and all efforts made to minimize impacts on any area of grassland. If possible, the footprint of any proposed infrastructure should be kept to a minimum within any natural grasslands, especially those in a moderate to good condition.

Based on this information, a map of habitat sensitivity on site is provided in Figure 9. This shows main habitat sensitivity classes on site, as follows:

1. LOW for all transformed areas, including cultivated lands.
2. MEDIUM-LOW for secondary grasslands in previously cultivated areas.
3. MEDIUM for cultivated wetlands.
4. MEDIUM-HIGH for secondary wetlands in previously cultivated areas, as well as for all remaining natural areas on site.
5. HIGH for remaining natural habitat within “CBA: Irreplaceable” and “CBA: Optimal” areas.
6. VERY HIGH for intact natural wetlands.

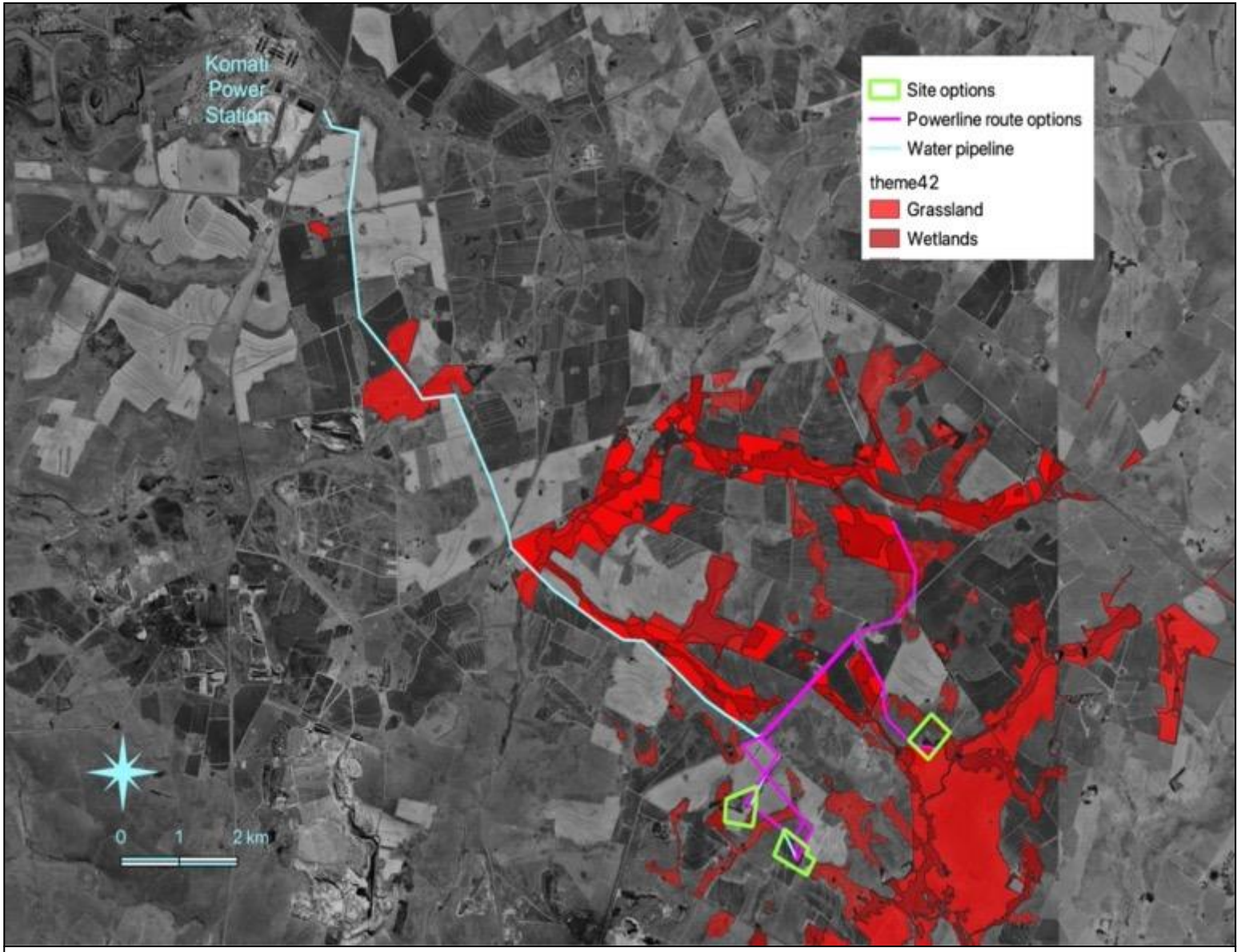

Figure 9: Habitat sensitivity of the study area, including CBAs.

SITE ECOLOGICAL IMPORTANCE

The Species Environmental Assessment Guidelines (SANBI 2020) require that a Site Ecological Importance is calculated for each habitat on site and provides methodology for making this calculation.

1. **Natural grassland** (open grassland on undulating plains, including moderately to heavily grazed areas);
2. **Wetlands** (seasonal wetlands in drainage valleys);
3. **Old lands** (secondary grasslands on old lands);
4. **Current cultivation** (areas currently cultivated and fallow lands);
5. **Exotic trees** (stands of exotic trees);
6. **Degraded areas** (disturbed areas with weeds or waste ground);
7. **Transformed areas** (no vegetation, due to complete removal and replacement with hard surface or structure).

As per the Species Environmental Assessment Guidelines (SANBI 2020), Site Ecological Importance (SEI) is calculated as a function of the Biodiversity Importance (BI) of the receptor and its resilience to impacts (SEI = BI + RR). The Biodiversity Importance (BI) in turn is a function of Conservation Importance (CI) and Functional Integrity (FI), i.e. BI = CI + FI.

Site ecological importance for habitats found on site:

Habitat	Conservation importance	Functional integrity	Receptor resilience	Site Ecological Importance (BI)
Natural grassland	High Small area (> 0.01% but < 0.1% of the total ecosystem type extent) of natural habitat of EN ecosystem type or large area (> 0.1%) of natural habitat of VU ecosystem type.	Medium Mostly minor current negative ecological impacts with some major impacts (e.g. established population of alien and invasive flora) and a few signs of minor past disturbance. Moderate rehabilitation potential.	Very low Habitat that is unable to recover from major impacts	High (BI = Medium)
Wetlands	High Any area of natural habitat of threatened ecosystem type with status of VU.	Medium (> 5 ha but < 20 ha) semi-intact area for any conservation status of ecosystem type or > 20 ha for VU ecosystem types	Low Habitat that is unlikely to be able to recover fully after a relatively long period: > 15 years required to restore less than 50% of the original species composition and functionality	High (BI = Medium)
Old lands	Low No confirmed or highly likely populations of SCC or range-restricted species.	Very low Several major current negative ecological impacts.	High Habitat that can recover relatively quickly (5-10 years) to restore >75% to restore the original species composition and functionality	Very low (BI = Very low)
Current cultivation	Very low No confirmed or highly likely populations of SCC or range-restricted species. No natural habitat remaining.	Very low Several major current negative ecological impacts.	Very high Habitat that can recover rapidly	Very low (BI = Very low)

Exotic trees	Very low No confirmed or highly likely populations of SCC or range-restricted species. No natural habitat remaining.	Very low Several major current negative ecological impacts.	Very high Habitat that can recover rapidly	Very low (BI = Very low)
Degraded	Very low No confirmed or highly likely populations of SCC or range-restricted species. No natural habitat remaining.	Very low Several major current negative ecological impacts.	Very high Habitat that can recover rapidly	Very low (BI = Very low)
Transformed	Very low No confirmed or highly likely populations of SCC or range-restricted species. No natural habitat remaining.	Very low Several major current negative ecological impacts.	Very high Habitat that can recover rapidly	Very low (BI = Very low)

The calculation of Site Ecological Importance matches the sensitivity classification given in the previous section of this report but includes an explicit recognition of the ability of each ecosystem to tolerate and recover from disturbance. Guidelines for development activities within different importance levels are given in the table below.

Guidelines for interpreting SEI in the context of the proposed development activities:

Site ecological importance	**Interpretation in relation to proposed development activities**
Very high	Avoidance mitigation – no destructive development activities should be considered. Offset mitigation not acceptable/ not possible (i.e. last remaining populations of species, last remaining good condition patches of ecosystems/ unique species assemblages). Destructive impacts for species/ecosystems where persistence target remains.
High	Avoidance mitigation wherever possible. Minimisation mitigation – changes to project infrastructure design to limit the amount of habitat impacted; limited development activities of low impact acceptable. Offset mitigation may be required for high impact activities.
Medium	Minimisation and restoration mitigation – development activities of medium impact acceptable followed by appropriate restoration activities.
Low	Minimisation and restoration mitigation – development activities of medium to high impact acceptable followed by appropriate restoration activities
Very low	Minimisation mitigation – development activities of medium to high impact acceptable and restoration activities may not be required.

POSSIBLE IMPACTS

Proposed infrastructure in relation to sensitivities

Infrastructure locations relative to mapped sensitivities are shown in Figure 10

Anticipated impacts

The main impacts associated with construction of the proposed infrastructure are anticipated to be as follows:

1. Direct loss of habitat within the footprint of the proposed infrastructure, and associated impacts on CBAs.
2. Impacts on specific habitats of biodiversity value.
3. Invasion by alien invasive plant species, leading to degradation of habitat. This could occur anywhere on site where disturbance is introduced, and alien plants are not specifically controlled. The reason is that they already occur in the area and would opportunistically colonise any area of soil where they are not vigorously controlled.

The main mitigation measures, other than required Management Plans for plant rescue, rehabilitation, and alien plant management, are related to infrastructure location, which is a planning phase measure.

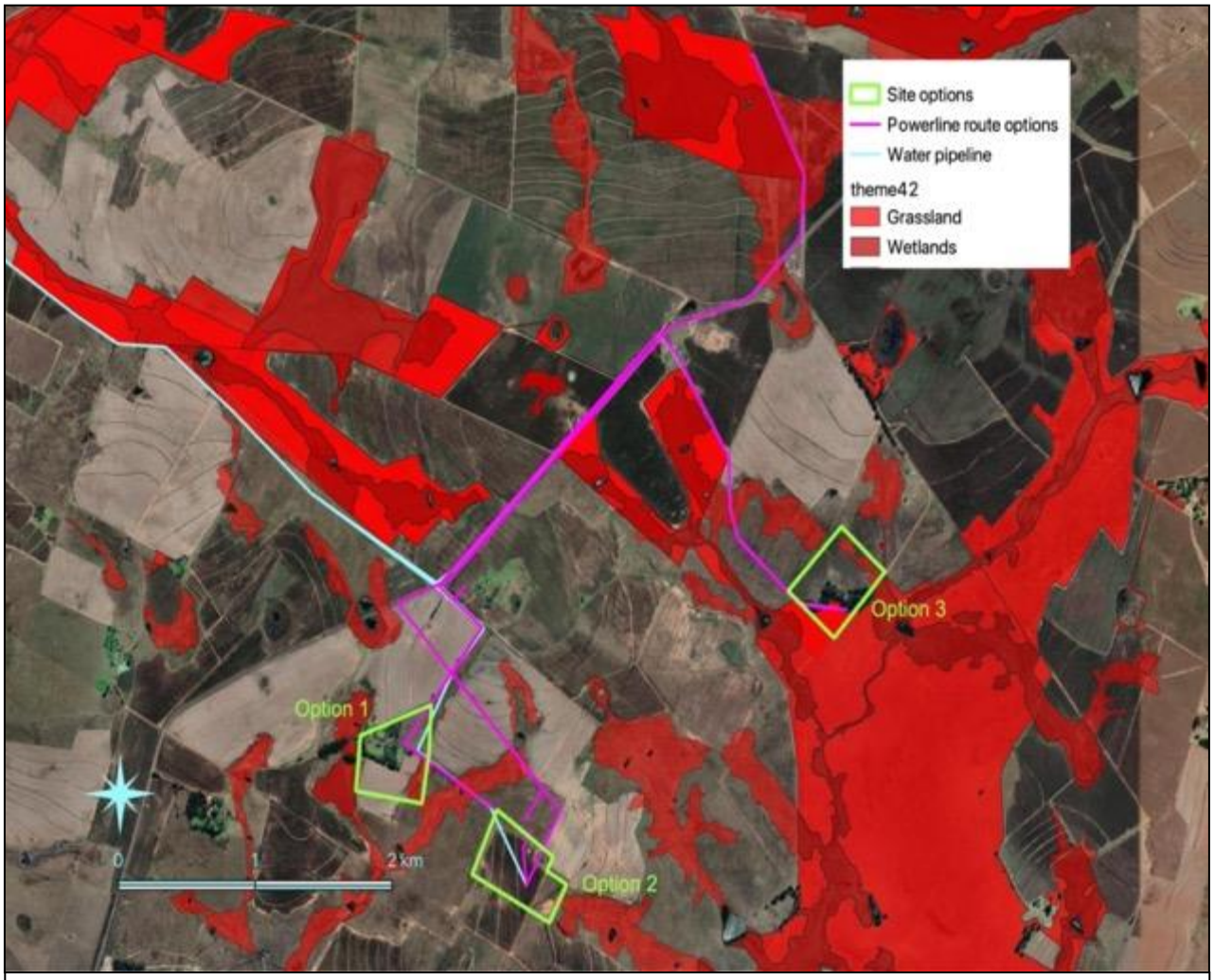

Figure 10: Plant location options in relation to sensitivities.

Construction Phase impacts

Direct impacts

Direct impacts include the following:

1. Loss and/or fragmentation of indigenous natural vegetation due to clearing.

Indirect impacts

Indirect impacts during the construction phase include the following:

1. Establishment and spread of alien invasive plants due to the clearing and disturbance of indigenous vegetation.
2. Increased runoff and erosion due to clearing of vegetation, construction of hard surfaces and compaction of surfaces, leading to soil erosion, followed by vegetation loss, in downslope areas.

Operational Phase Impacts

Direct impacts

Ongoing direct impacts will include the following:

1. Sporadic disturbance to natural habitats due to unforeseen events during general operational activities and maintenance (e.g., fires, driving off-road); and

Indirect impacts

These will include the following:

1. Continued establishment and spread of alien invasive plant species due to the presence of disturbance.
2. Continued erosion due to the presence of hard surfaces that change the infiltration and runoff properties of the landscape.

Decommissioning Phase Impacts

Direct impacts

These will include the following:

1. Loss and disturbance of natural vegetation due to the removal of infrastructure and need for working sites.
2. Effects on physiological functioning of vegetation due to dust deposition.

Indirect impacts

These will occur due to renewed disturbance due to decommissioning activities, as follows:

1. Continued establishment and spread of alien invasive plant species due to the presence of migration corridors and disturbance vectors.

Cumulative impacts

These include the following:

1. Cumulative impacts on indigenous natural vegetation due to clearing.
2. Cumulative impacts on ecological processes.
3. Cumulative impacts due to establishment and spread of alien invasive plant species

ASSESSMENT OF SIGNIFICANCE OF ECOLOGICAL IMPACTS

Design Phase Impacts

No negative impacts occur during the Design Phase of the project since no physical construction activities take place. Nevertheless, measures taken during the Design Phase of the project can potentially have a significant positive effect on the nature, extent and intensity of impacts experienced during the Construction Phase. This is usually as a response to identified issues, leading to design modifications to avoid negative impacts.

Construction Phase Impacts

Loss of indigenous natural vegetation due to clearing

The regional vegetation type in the broad study area is Eastern Highveld Grassland, classified in the scientific literature as Endangered (Mucina *et al.*, 2008) and listed as Vulnerable in the National List of Ecosystems that are Threatened and need of protection (GN1002 of 2011). Any areas of natural habitat (specifically natural grassland, as described above) within this regional vegetation type are therefore considered to have high conservation value.

Vegetation on site is within the Grassland Biome. Mesic grasslands in South Africa have a life-form composition that includes a high number of resprouting sub-terranean species that constitute more than 50% of the species richness at any single location and a higher proportion, if counted across a wider area. Secondary grassland that develops in previously cleared areas (for example, cultivated lands) usually develop a perennial grass cover, but the resprouting component of the flora almost never recovers. This means that any clearing of grassland vegetation, even if temporary, results in permanent loss of the local species composition. Clearing of natural grassland is therefore a permanent impact.

Habitat loss refers to physical disturbance of habitats through clearing, grading and other permanent to semi-permanent loss or degradation. Loss of habitat on site could lead to loss of biodiversity as well as habitat important for the survival of populations of various species.

Impact 1	Loss of indigenous natural vegetation	
Issue	Clearing of natural habitat for construction	
Description of Impact		
Construction activities will require clearing of natural habitat, to be replaced by the infrastructure. This will result in permanent local loss of habitat.		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Construction	
Criteria	**Without Mitigation**	**With Mitigation**
Extent	1	1
Duration	5	4
Reversibility	3	3
Magnitude (severity of impact)	1	1
Probability	4	4
Significance	40 (MODERATE)	36 (MODERATE)
Mitigation actions		

The following measures are recommended:	1. Restrict impact to development footprint only and limit disturbance in surrounding areas. 2. Prior to commencement of construction, compile a Rehabilitation Plan including monitoring specifications, to be included into the EMPr during final approval. 3. Prior to commencement of construction, compile an Alien Plant Management Plan, to be included into the EMPr during final approval.
Monitoring	
The following monitoring is recommended:	As per management plans.

Establishment and spread of declared weeds and alien invader plants due to the clearing and disturbance of indigenous vegetation

Major factors contributing to invasion by alien invader plants includes *inter alia* high disturbance (such as clearing for construction activities) and negative grazing practices. Exotic species are often more prominent near infrastructural disturbances than further away. Consequences of this may include:

1. loss of indigenous vegetation.
2. change in vegetation structure leading to change in various habitat characteristics.
3. change in plant species composition.
4. change in soil chemical properties.
5. loss of sensitive habitats.
6. loss or disturbance to individuals of rare, endangered, endemic and/or protected species.
7. fragmentation of sensitive habitats.
8. change in flammability of vegetation, depending on alien species.
9. hydrological impacts due to increased transpiration and runoff; and
10. impairment of wetland function.

Low existing populations of alien plants were seen on site, but areas of farm infrastructure were not investigated in detail during the field survey. There is a high possibility that alien plants could be introduced to areas within the footprint of the proposed activities from surrounding areas in the absence of control measures. The potential consequences may be of moderate seriousness for affected natural habitats. Control measures could prevent the impact from occurring. These control measures are relatively standard and well-known. Known alien invasive species recorded in the general geographical area that includes the site are as follows (in order of frequency observed):

- *Campuloclinium macrocephalum*
- *Acacia mearnsii*
- *Verbena bonariensis*
- *Solanum mauritianum*
- *Datura stramonium*
- *Cirsium vulgare*
- *Rumex acetosella*
- *Acacia dealbata*
- *Solanum sisymbriifolium*
- *Cortaderia selloana*
- *Arundo donax*
- *Sesbania punicea*
- *Ipomoea purpurea*
- *Melia azedarach*
- *Nicotiana glauca*
- *Eucalyptus camaldulensis*
- *Solanum elaeagnifolium*
- *Phytolacca octandra*
- *Robinia pseudoacacia*
- *Ailanthus altissima*

- *Xanthium spinosum*
- *Myriophyllum aquaticum*
- *Araujia sericifera*
- *Nasturtium officinale*
- *Verbena rigida*
- *Acacia melanoxylon*
- *Xanthium strumarium*
- *Azolla filiculoides*
- *Pinus taeda*
- *Alisma plantago-aquatica*
- *Rubus niveus*
- *Agave americana*
- *Acacia podalyriifolia*
- *Carduus nutans*
- *Ligustrum lucidum*
- *Ageratum houstonianum*
- *Spathodea campanulata*
- *Verbena brasiliensis*
- *Salvia tiliifolia*
- *Solanum pseudocapsicum*
- *Argemone ochroleuca*
- *Pinus patula*
- *Paspalum quadrifarium*
- *Austrocylindropuntia subulata*
- *Rumex usambarensis*

Impact 2	Establishment and spread of declared weeds and alien invader plants	
Issue	Establishment and spread of declared weeds and alien invader plants	
Description of Impact		
Establishment and spread of declared weeds and alien invader plants		
Type of Impact	Indirect	
Nature of Impact	Negative	
Phases	Construction	
Criteria	**Without Mitigation**	**With Mitigation**
Extent	2	1
Duration	1	1
Reversibility	3	3
Magnitude (severity of impact)	2	1
Probability	3	2
Significance	24 (LOW)	12 (VERY LOW)
Mitigation actions		
The following measures are recommended:	1. Prior to commencement of construction, compile and implement an alien management plan, which highlights control priorities and areas and provides a programme for long-term control, including monitoring specifications. 2. Undertake regular monitoring to detect alien invasions early so that they can be controlled. 3. Implement control measures.	
Monitoring		

The following monitoring is recommended:	As per management plans

Operational Phase impacts

Continued disturbance to natural habitats due to general operational activities and maintenance

During the operational phase of the project, there will be continuous activity on site, including normal operational activities, maintenance and monitoring. There may also be minor additional construction. Rehabilitation of various sites, such as the construction camps, will also take place. These activities all have the potential to cause additional direct and/or indirect damage to natural habitat and vegetation.

Impact 3	Continued disturbance to natural habitats due to general operational activities and maintenance	
Issue	Sporadic unforeseen disturbance to natural habitats e.g. accidental fires, driving off-road, dumping etc. during general operational activities and maintenance.	
Description of Impact		
Continued disturbance to natural habitats due to general operational activities and maintenance		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Operation	
Criteria	**Without Mitigation**	**With Mitigation**
Extent	1	1
Duration	5	5
Reversibility	3	3
Magnitude (severity of impact)	1	1
Probability	3	2
Significance	30 (LOW)	20 (LOW)
Mitigation actions		
The following measures are recommended:	As per impact 1	
Monitoring		
The following monitoring is recommended:	As per management plans	

Continued establishment and spread of alien invasive plant species due to the presence of migration corridors and disturbance vectors

The presence of disturbed surfaces on site creates ecological edges and corridors along which alien species can travel and become established.

Impact 4	Establishment and spread of declared weeds and alien invader plants	
Issue	Establishment and spread of declared weeds and alien invader plants	
Description of Impact		
Establishment and spread of declared weeds and alien invader plants		
Type of Impact	Indirect	
Nature of Impact	Negative	
Phases	Operation	
Criteria	**Without Mitigation**	**With Mitigation**

Extent	2	1
Duration	4	2
Reversibility	3	3
Magnitude (severity of impact)	3	1
Probability	3	2
Significance	36 (MODERATE)	14 (VERY LOW)
Mitigation actions		
The following measures are recommended:	1. Prior to commencement of Operation , compile and implement an alien management plan, which highlights control priorities and areas and provides a programme for long-term control. 2. Undertake regular monitoring to detect alien invasions early so that they can be controlled. 3. Implement control measures.	
Monitoring		
The following monitoring is recommended:	As per management plans	

Runoff and erosion due to the presence of hard surfaces that change the infiltration and runoff properties of the landscape

Increased erosion (water and wind) and water run-off will be caused by the clearing of indigenous vegetation, creation of new hard surfaces and compaction of soil. Increased run-off and erosion could affect hydrological processes in the area and will change water and silt discharge into drainage lines and streams.

Impact 5	Continued runoff and erosion	
Issue	Continued runoff and erosion	
Description of Impact		
Increased runoff and erosion due to clearing of vegetation, construction of hard surfaces and compaction of surfaces, leading to changes in downslope areas		
Type of Impact	Indirect	
Nature of Impact	Negative	
Phases	Operation	
Criteria	**Without Mitigation**	**With Mitigation**
Extent	1	1
Duration	5	5
Reversibility	3	3
Magnitude (severity of impact)	1	1
Probability	3	2
Significance	30 (LOW)	20 (LOW)
Mitigation actions		
The following measures are recommended:	1. Prior to commencement of Operation, compile and implement a stormwater management plan including monitoring specifications. 2. Monitor surfaces for erosion, repair and/or upgrade, where necessary.	
Monitoring		
The following monitoring is recommended:	As per management plans	

Decommissioning Phase impacts

It is expected that the project will operate for a minimum of twenty to twenty-five years (a typical planned lifespan for a project of this nature). Decommissioning will probably require a series of steps resulting in the removal of equipment from the site and rehabilitation of footprint areas. It is possible that the site could be returned to a rural nature, but it is unlikely that natural vegetation would become established at disturbed locations on site for a very long time thereafter. The reality is that it is not possible to determine at this stage whether rehabilitation measures will be implemented or not or what the future for the site would be nor is it possible at this stage to determine what surrounding land pressures would be. These uncertainties make it difficult to undertake any assessment to determine possible impacts of decommissioning. It is recommended that a closure and rehabilitation plan be compiled near to the decommissioning stage but in advance of when decommissioning is planned, and that this would be required to be implemented prior to closure of the project. The closure and rehabilitation plan must follow the regulatory requirements at the time of decommissioning. Possible impacts are described below.

Loss and disturbance of natural vegetation due to the removal of infrastructure and need for working sites
During the decommissioning phase of the project, there will be a flurry of activity on site over a period, similar to during the construction phase, including dismantling and removal of equipment and rehabilitation. There may also be minor additional construction. Rehabilitation of various sites will also take place. These activities all have the potential to cause additional direct and/or indirect damage to natural habitat and vegetation.

Impact 6	Loss and/or disturbance of indigenous natural vegetation during removal of infrastructure	
Issue	Disturbance of natural habitat during infrastructure removal	
Description of Impact		
Decommissioning activities may cause disturbance of natural habitat. This may result in permanent local loss of habitat.		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Decommissioning	
Criteria	**Without Mitigation**	**With Mitigation**
Extent	1	1
Duration	5	5
Reversibility	3	3
Magnitude (severity of impact)	1	1
Probability	2	2
Significance	20 (LOW)	20 (LOW)
Mitigation actions		
The following measures are recommended:	1. Prior to decommissioning commencing, compile a Rehabilitation Plan in compliance with the regulatory requirements at the time of decommissioning.	
Monitoring		
The following monitoring is recommended:	As per management plans.	

Continued establishment and spread of alien invasive plant species due to the presence of migration corridors and disturbance vectors
The presence of disturbed surfaces on site creates ecological edges and corridors along which alien species can travel and become established.

Impact 7	Establishment and spread of declared weeds and alien invader plants

Issue	Establishment and spread of declared weeds and alien invader plants	
Description of Impact		
Establishment and spread of declared weeds and alien invader plants		
Type of Impact	Indirect	
Nature of Impact	Negative	
Phases	Operation	
Criteria	**Without Mitigation**	**With Mitigation**
Extent	2	1
Duration	4	4
Reversibility	3	3
Magnitude (severity of impact)	2	1
Probability	4	3
Significance	44 (MODERATE)	27 (LOW)
Mitigation actions		
The following measures are recommended:	1. Rehabilitate disturbed areas in accordance with the specifications of a Rehabilitation Plan.	
Monitoring		
The following monitoring is recommended:	As per management plans	

Cumulative impacts

Significance values for these impacts are included in the assessment of impacts in the sections above for Construction, Operation and Decommisioning, under the section for "Cumulative impacts".

Cumulative impacts on indigenous natural vegetation

The regional terrestrial vegetation type in the broad study area is listed as Vulnerable and is impacted across its range by historical activities. Loss of habitat will occur for the project, which will be a small area in comparison to the total area of the vegetation type. However, the total loss of habitat due to several projects together will be greater than for any single project, so a cumulative effect will occur. The area lost in total will be very small compared to the total area of the vegetation type concerned. The cumulative effect will therefore be low for vegetation loss.

Extent	The impact will affect natural vegetation on site and is rated as **site**. For a combination of projects, it affects a wider area and is rated as **regional**.
Probability	Loss and/or disturbance of vegetation is **definite**.
Reversibility	In all projects, loss of vegetation is effectively **irreversible** within the immediate footprint of permanent infrastructure since construction of roads and other hard surfaces completely removes vegetation and modifies the substrate upon which it grows. For all the projects, in other areas (crane pads, construction camp and disturbed areas adjacent to construction activities) the impact is partially reversible in the sense that secondary vegetation in disturbed areas will probably never resemble the original vegetation found on site.
Duration	Within the immediate footprint of the permanent infrastructure (turbine foundations, roads and substation) the impact will be **Permanent** (mitigation either by man or natural process will not occur in such a way or such a time span that the impact can be considered transient). In other areas (crane pads, construction camp and disturbed areas adjacent to construction activities) the impact will be of long-term duration. The assessment here is for the permanently affected areas.

Impact 8	Cumulative impacts on indigenous natural vegetation	
Issue	Clearing of natural habitat for construction	
Description of Impact		
Construction activities will require clearing of natural habitat, to be replaced by the infrastructure. This will result in permanent local loss of habitat, multiplied across multiple projects.		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Construction	
Criteria	**Current project**	**Combination of projects**
Extent	1	3
Duration	4	5
Reversibility	3	3
Magnitude (severity of impact)	1	2
Probability	4	5
Significance	36 (MODERATE)	65 (HIGH)

Cumulative impacts on ecological processes

There are various ecological processes that may be affected at a landscape level by the presence of multiple projects. This includes population processes, such as migration (movement of species through the landscape), pollination (can be disrupted if insect pollinators are blocked from movement)and dispersal, but also more difficult to interpret factors,

such as spatial heterogeneity (the diversity of habitats and their spatial relationship to one another), community composition (the species that occur in the landscape) and environmental gradients, that can become disrupted when landscapes are disturbed at a high level. Disturbance can alter the pattern of variation in the structure or function of ecosystems. Fragmentation is the breaking up of a habitat, ecosystem, or land-use type into smaller parcels. An important consequence of repeated, random clearing is that contiguous cover can break down into isolated patches. This happens when the area cleared exceed a critical level and landscapes start to become disconnected. Spatially heterogenous patterns can be interpreted as individualistic responses to environmental gradients and lead to natural patterns in the landscape. Disrupting gradients and creating disturbance edges across wide areas is very disruptive of natural processes and will lead to fundamental changes in ecosystem function.

The current project has been designed to mostly occupy areas that are already disturbed. Where infrastructure is located in natural areas, it is near to edges or follows existing roads. There are few places where it intrudes significantly into natural areas.

Extent	The extent of the combined projects taken together make this a regional effect.
Probability	Based on the number and the nature of the projects (mostly wind-energy projects), the impact may possibly happen.
Reversibility	Partly reversible, where disruptions to specific processes can be identified and rectified.
Irreplaceable loss of resources	Significant loss of resources could potentially occur, but it is more likely that marginal loss of resources will happen.
Duration	The impact will be long-term to permanent, depending on the process and the specific impact.
Intensity/magnitude	Based on the nature and number of projects and the ecological process affected, the impact is most likely to be of medium intensity.

Impact 9	Cumulative impacts on ecological processes	
Issue	Disruption of ecological processes at landscape level	
Description of Impact		
Construction activities will require clearing of natural habitat, to be replaced by the infrastructure. This will result in possible regional disruption of ecological processes.		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Construction	
Criteria	**Current project**	**Combination of projects**
Extent	1	3
Duration	4	4
Reversibility	3	3
Magnitude (severity of impact)	2	3
Probability	3	4
Significance	30 (LOW)	52 (MODERATE)

Cumulative impacts due to spread of declared weeds and alien invader plants

There is a moderate possibility that alien plants could be introduced to areas within the footprint of the proposed infrastructure from surrounding areas in the absence of control measures. The greater the number of projects, the more likely this effect will happen; therefore, the effect is cumulative. For the current site, the impact is predicted to be low due to the current absence of invasive species on site and the high ability to control any additional impact. The significance will therefore be low, especially if control measures are implemented. However, the increased overall disturbance of the landscape will create opportunities and, if new invasions are not controlled, can create nodes that spread to new locations due to the heightened disturbance levels.

Extent	Habitat in the general area of all RE projects being considered will be affected, rated as regional.
Probability	The impact will probably happen in the absence of control measures.
Reversibility	Partly reversible in the absence of control measures. Completely reversible if mitigation measures applied. Preventative measures will stop the impact from occurring.
Irreplaceable loss of resources	Marginal to significant loss of resources will occur. Uncontrolled invasion can affect all nearby natural habitats.
Duration	The impact will be long-term. With no control measures it could effectively be permanent, or alternatively, have impacts of high intensity.
Intensity/magnitude	Medium. Severe invasion can alter the functioning of natural ecosystems.

Impact 10	Cumulative impacts due to establishment and spread of declared weeds and alien invader plants	
Issue	Establishment and spread of declared weeds and alien invader plants	
Description of Impact		
Establishment and spread of declared weeds and alien invader plants		
Type of Impact	Indirect	
Nature of Impact	Negative	
Phases	Operation	
Criteria	**Current project**	**Combination of projects**
Extent	1	3
Duration	2	4
Reversibility	3	3
Magnitude (severity of impact)	1	3
Probability	2	4
Significance	14 (VERY LOW)	52 (MODERATE)

Assessment of No-Go alternative

If the project does not proceed, then the current *status quo* will continue. This will involve continued use of the land for cultivation and livestock production, as well as the possibility of future mining. Historical aerial imagery shows that cultivation patterns have not changed much in recent history. This is probably because most areas that were viable for crop production were already cultivated in the early 1900s and that there is no benefit to cultivating any new areas, usually due to soil depth limitations. Within the project area, there is very little grassland remaining that has not been cultivated.

In terms of livestock production, the agricultural specialist report indicated that the long-term grazing capacity of the general area is high at 4.5 hectares per large stock unit (DAFF, 2018). Current stocking rates are much higher than this (around double). Therefore, the land is heavily overstocked, which is reflected in the condition of the grasslands on site. These are obviously overgrazed, and the site is on a long-term over-grazing trajectory. This implies that stocking rates, and therefore profitability, will need to be reduced to avert land degradation, putting financial strain on producers. An alternative income stream associated with financial benefits from hosting renewable energy projects is likely to improve the financial viability of any land manager, which in turn reduces the pressure to carry unsustainable stock numbers. This reduces pressure on the land, which reduces the likelihood of grazing-induced degradation.

In summary, the No-Go option will increase the rate of land degradation due to over-grazing, especially under adverse future climate scenarios, whereas there is a possibility of this effect being lessened in the case of the project promoting local economic diversity. There is also a moderate to high risk of loss of natural areas due to expansion of coal mining.

Summary of mitigation measures

The following mitigation measures are recommended to address known potential impacts:

- Restrict impact to development footprint only and limit disturbance in surrounding areas.
- Prior to commencement of construction, compile a Rehabilitation Plan including monitoring specifications, to be included into the EMPr during final approval.
- Prior to commencement of construction, compile an Alien Plant Management Plan, to be included into the EMPr during final approval.
- Prior to commencement of construction, compile and implement an alien management plan, which highlights control priorities and areas and provides a programme for long-term control, including monitoring specifications.
- Undertake regular monitoring to detect alien invasions early so that they can be controlled.
- Prior to commencement of construction, compile and implement a stormwater management plan including monitoring specifications.
- Monitor surfaces for erosion, repair and/or upgrade, where necessary.
- Prior to decommissioning commencing, compile a Rehabilitation Plan in compliance with the regulatory requirements at the time of decommissioning.

Summary of monitoring recommendations

Specific monitoring recommendations should be provided in the Alien Invasive Management Plan, and the Rehabilitation Plan. The following are broad recommendations:

Alien Invasive Species:

- Monitor for early detection, to find species when they first appear on site. This should be as per the frequency specified in the management plan and should be conducted by the ECO Early detection should provide a list of species and locations where they have been detected. Summer (vegetation maximum growth period) is usually the most appropriate time, but monitoring can be adaptable, depending on local conditions – this must be specified in the management plan.
- Monitor for the effect of management actions on target species, which provides information on the effectiveness of management actions. Such monitoring depends on the management actions taking place. It should take place after each management action.
- Monitor for the effect of management actions on non-target species and habitats.

Rehabilitated areas:

- Rehabilitation Plan must be compiled by an approved ecologist prior to achieving COD and prior to the start of decommissioning.
- All management actions associated with rehabilitation must be recorded after each management action has taken place.
- All rehabilitated areas should be monitored to assess vegetation recovery. This should be for a minimum of three years after post-construction rehabilitation but depends on the assessed trajectory of rehabilitation (whether it is following a favourable progression of vegetation establishment or not – this depends on the total vegetation cover present, and the proportion that consists of perennial growth of desired species). For each monitoring site, an equivalent comparative site in adjacent undisturbed vegetation should be similarly monitored. Monitoring data collection should include the following:
    - total vegetation cover and height, as well as for each major growth form.
    - species composition, including relative dominance.

    - soil stability and/or development of erosion features.
    - representative photographs should be taken at each monitoring period.
- Monitoring of rehabilitated areas should take place at the frequency and for the duration determined in the rehabilitation plan, or until vegetation stability has been achieved.

Project option preferences

Hydrogen and ammonia plant

Option 1 affects a very small area of habitat mapped as "wetland", but this is poor quality and probably previously ploughed. Option 2 affects no natural habitat. Option 3 affects an area of natural habitat that is just under 4 ha in size. This area of habitat also falls within CBA "Irreplaceable". Although quite small in a regional context, this makes Option 3 the least preferred. The preference is therefore as follows:

1. Option 2: preferred
2. Option 1: acceptable
3. Option 3: least favoured

Powerlines

There are three powerline options for each project option. All of them are feasible with none affecting habitat in any significant way. However, in principle, the shortest route is ecologically the best. This makes powerline option 2 (all three project options) the least favourable. It also makes project option 3 the one with the longest average length of powerline, irrespective of which powerline option is selected. In general, the following is the order of preference (taking into account that none are flawed):

1. Project option 1: Powerline option 1: Favourable
2. Project option 1: Powerline option 2: Least favoured
3. Project option 1: Powerline option 3: Favourable / preferred
4. Project option 2: Powerline option 1: Favourable
5. Project option 2: Powerline option 2: Least favoured
6. Project option 2: Powerline option 3: Favourable / preferred
7. Project option 3: Powerline option 1: Least favoured
8. Project option 3: Powerline option 2: Least favoured
9. Project option 3: Powerline option 3: Least favoured

Water pipeline

For all three plant options, the water pipeline follows the same route to Komati Power Station along most of its length, except at the southern end, where it is routed to the plant. The water pipeline option selected therefore depends on the plant option selected and is not significantly different between the three options.

DISCUSSION

The DFFE online screening tool identifies Terrestrial Biodiversity as a theme of very high sensitivity. Reasons on site for this sensitivity Critical biodiversity area 1 (Project Option 3 only), Critical biodiversity area 2, Vulnerable Ecosystem, and Protected Areas Expansion Strategy. The theme indicates almost the entire study area as being in the Very High sensitivity category, but there are significant areas that have been cultivated that do not warrant this classification. However, remaining natural areas are sensitive and of high biodiversity value.

The project study area for the proposed project consists largely of cultivated areas with some remnant natural habitat within a rural area.

Currently, the rates of transformation within the vegetation in this general region is moderately high. The regional vegetation type that occurs on site, Eastern Highveld Grassland (as well Eastern Temperate Freshwater Wetlands), is listed as Vulnerable in the National List of Ecosystems that are Threatened and need of protection (GN1002 of 2011), published under the National Environmental Management: Biodiversity Act (Act No. 10, 2004). Any remaining natural habitat on site therefore has high biodiversity value, which is reflected in the Provincial Conservation Plan assessment of the area. The proposed project will therefore potentially have impacts on areas of natural habitat that have potentially high biodiversity value, including CBA1 and CBA2 areas. The specific locations of potentially affected areas are described in detail in the section above where impacts are discussed.

The proposed project consists of a hydrogen and ammonia plant, powerlines to link to the grid, and a pipeline from Komati Power Station. There are three plant location options, and various pipeline and powerline options for each of these. From a landscape perspective, construction of the infrastructure will lead to relatively localized impacts.

An impact assessment identified the following impacts as potentially of concern for the project:

1. Loss and/or fragmentation of indigenous natural vegetation (HIGH, MODERATE after mitigation).
2. Impacts on Critical Biodiversity Areas (HIGH, MODERATE after mitigation).
3. Continued disturbance to natural habitats due to general operational activities and maintenance (MODERATE, LOW after mitigation)
4. Establishment and spread of declared weeds and invader plants (MODERATE; LOW after mitigation).
5. Cumulative impacts on indigenous natural vegetation (high significance after mitigation).
6. Cumulative impacts on Critical Biodiversity Areas (high significance after mitigation).

Various mitigation measures are proposed to minimise identified impacts.

Due to the small area of CBA1 affected by Option 3, this is the least preferred project option. Option 1 and Option 2 are both favourable. For the powerline and pipeline routes, there is not any major difference between any of the various options and they can all be considered as potential options.

CONCLUSIONS

Desktop information, field data collection and mapping from aerial imagery provides the following verifications of patterns for the terrestrial biodiversity theme:

1. The vegetation type that occurs on site, Eastern Highveld Grassland, is listed as Vulnerable. The entire site is therefore within a listed ecosystem. All areas of natural vegetation are therefore representative of this listed ecosystem. These specific parts of the site have High sensitivity in terms of the Terrestrial Biodiversity Theme.
2. Most remaining natural areas of vegetation on the site are within Critical Biodiversity Areas (CBA1 and CBA2), or within an Ecological Support Area. All areas of natural vegetation within CBAs must therefore be treated as having high sensitivity. These specific parts of the site have High sensitivity in terms of the Terrestrial Biodiversity Theme.
3. Most of the site consists of secondary and/ or degraded areas, including areas heavily invaded by alien invasive shrubs. Significant parts of the site therefore have very low sensitivity. Construction of project components is not problematic in these areas.
4. The project is supported if impacts on remaining natural areas on site can be minimised, as suggested.
5. Alternative 1 and Alternative 2 are preferred over Alternative 3, simply because they affect almost no natural areas. However, all options are feasible.

BIBLIOGRAPHY AND REFERENCES:

DRIVER, A., MAZE, K., ROUGET, M., LOMBARD, A.T., NEL, J., TURPIE, J.K., COWLING, R.M., DESMET, P., GOODMAN, P., HARRIS, J., JONAS, Z., REYERS, B., SINK, K. & STRAUSS, T. 2005. National Spatial Biodiversity Assessment 2004: priorities for biodiversity conservation in South Africa. Strelitzia 17. South African National Biodiversity Institute, Pretoria.

FAIRBANKS, D.H.K., THOMPSON, M.W., VINK, D.E., NEWBY, T.S., VAN DEN BERG, H.M & EVERARD, D.A. 2000. The South African Land-Cover Characteristics Database: a synopsis of the landscape. *S.Afr.J.Science* 96: 69-82.

FERRAR, A.A. & LÖTTER, M.C. 2007. Mpumalanga Biodiversity Conservation Plan Handbook. Mpumalanga Tourism & Parks Agency, Nelspruit

IUCN (2001). *IUCN Red Data List categories and criteria: Version 3.1*. IUCN Species Survival Commission: Gland, Switzerland.

LÖTTER, M.C. & FERRAR, A.A. 2006. Mpumalanga Biodiversity Conservation Plan Map. Mpumalanga Tourism & Parks Agency, Nelspruit

LOTTER, M. (2015) Spatial Assessment informing the Mpumalanga Protected Area Expansion Strategy - 20 and 5 year spatial priorities. Mpumalanga Tourism & Parks Agency, Mbombela (Nelspruit).

MUCINA, L. AND RUTHERFORD, M.C. (editors) 2006. Vegetation map of South Africa, Lesotho and Swaziland: an illustrated guide. *Strelitzia* 19, South African National Biodiversity Institute, Pretoria.

MUCINA, L., RUTHERFORD, M.C. AND POWRIE, I.W. (editors) 2005. Vegetation map of South Africa, Lesotho and Swaziland, 1:1 000 000 SCALE SHEET MAPS South African National Biodiversity Institute, Pretoria.

RUTHERFORD, M.C. AND WESTFALL., R.H. 1994. Biomes of Southern Africa. An objective characterisation. Memoirs of the Botanical Survey of South Africa 63, 1-94.

RUTHERFORD, M.C., MUCINA, L. AND POWRIE, L.W. 2006. Biomes and Bioregions of Southern Africa. In: L. Mucina and M.C. Rutherford (Eds). The vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19, pp. 30-51. South African National Biodiversity Institute, Pretoria.

APPENDICES:

Appendix 1: Curriculum vitae: Dr David Hoare

Education
Matric - Graeme College, Grahamstown, 1984
BSc (majors: Botany, Zoology) - Rhodes University, 1991-1993
BSc (Hons) (Botany) - Rhodes University, 1994 with distinction
MSc (Botany) - University of Pretoria, 1995-1997 with distinction
PhD (Botany) – Nelson Mandela Metropolitan University, Port Elizabeth

Main areas of specialisation

- Vegetation ecology, primarily in grasslands, thicket, coastal systems, wetlands.
- Plant biodiversity and threatened plant species specialist.
- Alien plant identification and control / management plans.
- Remote sensing, analysis and mapping of vegetation.
- Specialist consultant for environmental management projects.

Membership
Professional Natural Scientist, South African Council for Natural Scientific Professions, 16 August 2005 – present. Reg. no. 400221/05 (Ecology, Botany)
Member, International Association of Vegetation Scientists (IAVS)
Member, Ecological Society of America (ESA)
Member, International Association for Impact Assessment (IAIA)
Member, Herpetological Association of Africa (HAA)

Employment history
1 December 2004 – present, Director, David Hoare Consulting (Pty) Ltd. Consultant, specialist consultant contracted to various companies and organisations.
1 January 2009 – 30 June 2009, Lecturer, University of Pretoria, Botany Dept.
1 January 2013 – 30 June 2013, Lecturer, University of Pretoria, Botany Dept.
1 February 1998 – 30 November 2004, Researcher, Agricultural Research Council, Range and Forage Institute, Private Bag X05, Lynn East, 0039. Duties: project management, general vegetation ecology, remote sensing image processing.

Experience as consultant
Ecological consultant since 1995. Author of over 380 specialist ecological consulting reports. Wide experience in ecological studies within grassland, savanna and fynbos, as well as riparian, coastal and wetland vegetation.

Publication record:

Refereed scientific articles (in chronological order):

Journal articles:

HOARE, D.B. & BREDENKAMP, G.J. 1999. Grassland communities of the Amatola / Winterberg mountain region of the Eastern Cape, South Africa. *South African Journal of Botany* 64: 44-61.

HOARE, D.B., VICTOR, J.E., LUBKE, R.A. & MUCINA, L., 2000. Vegetation of the coastal fynbos and rocky headlands south of George, South Africa. *Bothalia* 30: 87-96.

VICTOR, J.E., **HOARE, D.B.** & LUBKE, R.A., 2000. Checklist of plant species of the coastal fynbos and rocky headlands south of George, South Africa. *Bothalia* 30: 97-101.

MUCINA, L, BREDENKAMP, G.J., **HOARE, D.B** & MCDONALD, D.J. 2000. A National Vegetation Database for South Africa *South African Journal of Science* 96: 1-2.

HOARE, D.B. & BREDENKAMP, G.J. 2001. Syntaxonomy and environmental gradients of the grasslands of the Stormberg / Drakensberg mountain region of the Eastern Cape, South Africa.. *South African Journal of Botany* 67: 595 – 608.

LUBKE, R.A., **HOARE, D.B.**, VICTOR, J.E. & KETELAAR, R. 2003. The vegetation of the habitat of the Brenton blue butterfly, Orachrysops niobe (Trimen), in the Western Cape, South Africa. *South African Journal of Science* 99: 201–206.

HOARE, D.B & FROST, P. 2004. Phenological classification of natural vegetation in southern Africa using AVHRR vegetation index data. *Applied Vegetation Science* 7: 19-28.

FOX, S.C., HOFFMANN, M.T. and HOARE, D. 2005. The phenological pattern of vegetation in Namaqualand, South Africa and its climatic correlates using NOAA-AVHRR NDVI data. South African Geographic Journal, 87: 85–94.

Pfab, M.F., Compaan, P.C., Whittington-Jones, C.A., Engelbrecht, I., Dumalisile, L., Mills, L., West, S.D., Muller, P., Masterson, G.P.R., Nevhutalu, L.S., Holness, S.D., **Hoare, D.B.** 2017. The Gauteng Conservation Plan: Planning for biodiversity in a rapidly urbanising province. Bothalia, Vol. 47:1. a2182. https://doi.org/10.4102/abc.v47i1.2182.

Book chapters and conference proceedings:

HOARE, D.B. 2002. Biodiversity and performance of grassland ecosystems in communal and commercial farming systems in South Africa. Proceedings of the FAO's Biodiversity and Ecosystem Approach in Agriculture, Forestry and Fisheries Event: 12–13 October, 2002. Food and Agriculture Organisation of the United Nations, Viale delle Terme di Caracalla, Rome, Italy. pp. 10 - 27.

STEENKAMP, Y., VAN WYK, A.E., VICTOR, J.E., **HOARE, D.B.**, DOLD, A.P., SMITH, G.F. & COWLING, R.M. 2005. Maputaland-Pondoland-Albany Hotspot. In: Mittermeier, R.A., Gil, P.R., Hoffmann, M., Pilgrim, J., Brooks, T., Mittermeier, C.G., Lamoreux, J. & Fonseca, G.A.B. da (eds.) *Hotspots revisited.* CEMEX, pp.218–229. ISBN 968-6397-77-9

STEENKAMP, Y., VAN WYK, A.E., VICTOR, J.E., **HOARE, D.B.**, DOLD, A.P., SMITH, G.F. & COWLING, R.M. 2005. Maputaland-Pondoland-Albany Hotspot. http://www.biodiversityhotspots.org/xp/hotspots/maputaland/.

HOARE, D.B., MUCINA, L., RUTHERFORD, M.C., VLOK, J., EUSTON-BROWN, D., PALMER, A.R., POWRIE, L.W., LECHMERE-OERTEL, R.G., PROCHES, S.M., DOLD, T. and WARD, R.A. *Albany Thickets.* in Mucina, L. and Rutherford, M.C. (eds.) 2006. The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19, South African National Biodiversity Institute, Pretoria.

MUCINA, L., **HOARE, D.B.**, LÖTTER, M.C., DU PREEZ, P.J., RUTHERFORD, M.C., SCOTT-SHAW, C.R., BREDENKAMP, G.J., POWRIE, L.W., SCOTT, L., CAMP, K.G.T., CILLIERS, S.S., BEZUIDENHOUT, H., MOSTERT, T.H., SIEBERT, S.J., WINTER, P.J.D., BURROWS, J.E., DOBSON, L., WARD, R.A., STALMANS, M., OLIVER, E.G.H., SIEBERT, F., SCHMIDT, E., KOBISI, K., KOSE, L. 2006. *Grassland Biome.* In: Mucina, L. & Rutherford, M.C. (eds.) The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19. South African National Biodiversity Institute, Pretoria.

RUTHERFORD, M.C., MUCINA, L., LÖTTER, M.C., BREDENKAMP, G.J., SMIT, J.H.L., SCOTT-SHAW, C.R., **HOARE, D.B.**, GOODMAN, P.S., BEZUIDENHOUT, H., SCOTT, L. & ELLIS, F., POWRIE, L.W., SIEBERT, F., MOSTERT, T.H., HENNING, B.J., VENTER, C.E., CAMP, K.G.T., SIEBERT, S.J., MATTHEWS, W.S., BURROWS, J.E., DOBSON, L., VAN ROOYEN, N., SCHMIDT, E., WINTER, P.J.D., DU PREEZ, P.J., WARD, R.A., WILLIAMSON, S. and HURTER, P.J.H. 2006. *Savanna Biome.* In: Mucina, L. & Rutherford, M.C. (eds.) The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19. South African National Biodiversity Institute, Pretoria.

MUCINA, L., RUTHERFORD, M.C., PALMER, A.R., MILTON, S.J., SCOTT, L., VAN DER MERWE, B., **HOARE, D.B.**, BEZUIDENHOUT, H., VLOK, J.H.J., EUSTON-BROWN, D.I.W., POWRIE, L.W. & DOLD, A.P. 2006. *Nama-Karoo Biome.* In: Mucina, L. & Rutherford, M.C. (eds.) The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19. South African National Biodiversity Institute, Pretoria.

MUCINA, L., SCOTT-SHAW, C.R., RUTHERFORD, M.C., CAMP, K.G.T., MATTHEWS, W.S., POWRIE, L.W. and **HOARE, D.B.** 2006. *Indian Ocean Coastal Belt.* In: Mucina, L. & Rutherford, M.C. (eds.) The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19. South African National Biodiversity Institute, Pretoria.

Conference Presentations:

HOARE, D.B. & LUBKE, R.A. *Management effects on diversity at Goukamma Nature Reserve, Southern Cape*; Paper presentation, Fynbos Forum, Bienne Donne, July 1994

HOARE, D.B., VICTOR, J.E. & LUBKE, R.A. *Description of the coastal fynbos south of George, southern Cape*; Paper presentation, Fynbos Forum, Bienne Donne, July 1994

HOARE, D.B. & LUBKE, R.A. *Management effects on fynbos diversity at Goukamma Nature Reserve, Southern Cape*; Paper presentation, South African Association of Botanists Annual Congress, Bloemfontein, January 1995

HOARE, D.B. & BOTHA, C.E.J. *Anatomy and ecophysiology of the dunegrass Ehrharta villosa var. maxima*; Poster presentation, South African Association of Botanists Annual Congress, Bloemfontein, January 1995

HOARE, D.B., PALMER, A.R. & BREDENKAMP, G.J. 1996. *Modelling grassland community distributions in the Eastern Cape using annual rainfall and elevation*; Poster presentation, South African Association of Botanists Annual Congress, Stellenbosch, January 1996

HOARE, D.B. Modelling vegetation on a past climate as a test for palaeonological hypotheses on vegetation distributions; Paper presentation, Randse Afriakaanse Universiteit postgraduate symposium, 1997

HOARE, D.B., VICTOR, J.E. & BREDENKAMP, G.J. *Historical and ecological links between grassy fynbos and afromontane fynbos in the Eastern Cape*; Paper presentation, South African Association of Botanists Annual Congress, Cape Town, January 1998

LUBKE, R.A., HOARE, D.B., VICTOR, J.E. & KETELAAR, R. *The habitat of the Brenton Blue Butterfly*. Paper presentation, South African Association of Botanists Annual Congress, Cape Town, January 1998

HOARE, D.B. & PANAGOS, M.D. Satellite stratification of vegetation – structure or floristic composition? Poster presentation at the 34th Annual Congress of the Grassland Society of South Africa, Warmbaths, 1-4 February 1999.

HOARE, D.B. & WESSELS, K. Conservation status and threats to grasslands of the northern regions of South Africa, Poster presentation at the South African Association of Botanists Annual Congress, Potchefstroom, January 2000.

HOARE, D.B. Phenological dynamics of Eastern Cape vegetation. Oral paper presentation at the South African Association of Botanists Annual Congress, Grahamstown, January 2002.

HOARE, D.B., MUCINA, L., VAN DER MERWE, J.P.H. & PALMER, A.R. Classification and digital mapping of grasslands of the Eastern Cape Poster presentation at the South African Association of Botanists Annual Congress, Grahamstown, January 2002.

HOARE, D.B. Deriving phenological variables for Eastern Cape vegetation using satellite data Poster presentation at the South African Association of Botanists Annual Congress, Grahamstown, January 2002.

MUCINA, L., RUTHERFORD, M.C., HOARE, D.B. & POWRIE, L.W. 2003. VegMap: The new vegetation map of South Africa, Lesotho and Swaziland. In: Pedrotti, F. (ed.) Abstracts: Water Resources and Vegetation, 46th Symposium of the International Association for Vegetation Science, June 8 to 14 – Napoli, Italy.

HOARE, D.B. 2003. Species diversity patterns in moist temperate grasslands of South Africa. Proceedings of the VIIth International Rangeland Congress, 26 July – 1 August 2003, Durban South Africa. African Journal of Range and Forage Science. 20: 84.

Unpublished technical reports:

PALMER, A.R., HOARE, D.B. & HINTSA, M.D., 1999. Using satellite imagery to map veld condition in Mpumalanga: A preliminary report. Report to the National Department of Agriculture (Directorate Resource Conservation). ARC Range and Forage Institute, Grahamstown.

HOARE, D.B. 1999. The classification and mapping of the savanna biome of South Africa: methodology for mapping the vegetation communities of the South African savanna at a scale of 1:250 000. Report to the National Department of Agriculture (Directorate Resource Conservation). ARC Range and Forage Institute, Pretoria.

HOARE, D.B. 1999. The classification and mapping of the savanna biome of South Africa: size and coverage of field data that exists on the database of vegetation data for South African savanna. Report to the National Department of Agriculture (Directorate Resource Conservation). ARC Range and Forage Institute, Pretoria.

THOMPSON, M.W., VAN DEN BERG, H.M., NEWBY, T.S. & HOARE, D.B. 2001. Guideline procedures for national land-cover mapping and change monitoring. Report no. ENV/P/C 2001-006 produced for Department of Water Affairs and Forestry, National Department of Agriculture and Department of Environment Affairs and Tourism. Copyright: Council for Scientific and Industrial Research (CSIR) and Agricultural Research Council (ARC).

HOARE, D.B. 2003. Natural resource survey of node O R Tambo, using remote sensing techniques, Unpublished report and database of field data for ARC Institute for Soil, Climate & Water, ARC Range and Forage Institute, Grahamstown.

HOARE, D.B. 2003. Short-term changes in vegetation of Suikerbosrand Nature Reserve, South Africa, on the basis of resampled vegetation sites. Gauteng Department of Agriculture, Conservation, Environment and Land Affairs, Conservation Division.

BRITTON, D., SILBERBAUER, L., ROBERTSON, H., LUBKE, R., HOARE, D., VICTOR, J., EDGE, D. & BALL, J. 1997. The Life-history, ecology and conservation of the Brenton Blue Butterfly (*Orachrysops niobe*) (Trimen)(*Lycaenidea*) at Brenton-on-Sea. Unpublished report for the Endangered Wildlife Trust of Southern Africa, Johannesburg. 38pp.

HOARE, D.B., VICTOR, J.E. & MARNEWIC, G. 2005. Vegetation and flora of the wetlands of Nylsvley River catchment as component of a project to develop a framework for the sustainable management of wetlands in Limpopo Province.

Consulting reports:

Total of over 380 specialist consulting reports for various environmental projects from 1995 – present.

Workshops / symposia attended:

International Association for Impact Assessment Annual Congress, Durban, 16 – 19 May 2018.

Workshop on remote sensing of rangelands presented by Paul Tueller, University of Nevada Reno, USA, VIIth International Rangeland Congress, 26 July – 1 August 2003, Durban South Africa.

VIIth International Rangeland Congress, 26 July – 1 August 2003, Durban South Africa.

BioMap workshop, Stellenbosch, March 2002 to develop strategies for studying vegetation dynamics of Namaqualand using remote sensing techniques

South African Association of Botanists Annual Congress, Grahamstown, January 2002.

28th International Symposium on Remote Sensing of Environment, Somerset West, 27-31 March 2000.

Workshop on Vegetation Structural Characterisation: Tree Cover, Height and Biomass, 28th International Symposium on Remote Sensing of Environment, Strand, 26 March 2000.

South African Association of Botanists Annual Congress, Potchefstroom, January 2000

National Botanical Institute Vegmap Workshop, Kirstenbosch, Cape Town, 30 September-1 October 1999.

Sustainable Land Management – Guidelines for Impact Monitoring, Orientation Workshop: Sharing Impact Monitoring Experience, Zithabiseni, 27-29 September 1999.

WWF Macro Economic Reforms and Sustainable Development in Southern Africa, Environmental Economic Training Workshop, development Bank, Midrand, 13-14 September 1999.

34th Annual Congress of the Grassland Society of South Africa, Warmbaths, 1-4 February 1999

Expert Workshop on National Indicators of Environmental Sustainable Development, Dept. of Environmental Affairs and Tourism, Roodevallei Country Lodge, Roodeplaat Dam, Pretoria, 20-21 October 1998.

South African Association of Botanists Annual Congress, Cape Town, January 1998

Randse Afriakaanse Universiteit postgraduate symposium, 1997.

South African Association of Botanists Annual Congress, Bloemfontein, January 1995.