Appendix D:

Specialist Reports (including terms of reference)

Appendix D1: Biodiversity and Wetland Impact Assessment

Appendix D2: Soils and Agricultural Impact Assessment

Appendix D3: Heritage Impact Assessment

Appendix D4: Visual Impact Assessment

Appendix D5: Social Impact Assessment

Appendix D6: Avifauna Impact Assessment

Report on the ecological and wetland assessment for the proposed Harmony Central Plant PV solar development situated in Virginia, Free State Province.

June 2022

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DECLARATION OF INDEPENDENCE

DPR Ecologists and Environmental Services is an independent company and has no financial, personal or other interest in the proposed project, apart from fair remuneration for work performed in the delivery of ecological services. There are no circumstances that compromise the objectivity of the study.

Report Version	**Draft 1.1**		
Title	**Report on the ecological and wetland assessment for the proposed Harmony Central Plant PV solar development situated in Virginia, Free State Province.**		
Author	**DP van Rensburg (Pr.Sci.Nat)**		**Jun'22**

Executive Summary

The study area is situated approximately 2 km north of the small town of Virginia and to the east of the settlement of Saaiplaas (Appendix A: Map 1). The study area is fairly large but is dominated by grassland plains without prominent slopes and has an approximate extent of 200 hectares. The majority of this area has however already been transformed by both previous agricultural cropfields as well as structures and infrastructure associated with mining operations. Mining structures have been removed and the areas rehabilitated though it is clearly still transformed.

From the description of the area given above it is clear that the majority of the site has been transformed by agricultural and mining operations (Appendix A: Map 1). The natural vegetation type in this area, Vaal-Vet Sandy Grassland is also currently under severe transformation pressure. Consequently, any remaining natural patches would therefore be regarded as having a very high conservation value. These patches has also been listed as Critical Biodiversity Area 1 (CBA 1) which confirms this (Appendix A: Map 2). These areas should therefore be avoided by the development. The borders of these natural areas have also been refined by the current site survey (Appendix A: Map 4).

Should development of the solar facility be able to remain within transformed areas, this will greatly decrease the anticipated impacts. However, should the development encroach into adjacent remnant patches of natural grassland this will entail a high impact. Being a mining area, this results in transformation and degradation of large portions of land. The cumulative impact of development and mining in this area is therefore high. The proposed solar development should therefore first consider the development of areas considered as already transformed and of low sensitivity. These include the old ploughed fields and areas which previously consisted of buildings and structures. Only if no remaining options remain available should the development consider encroaching into natural areas. However, in that instance it will result in high impacts. Likewise the remaining natural wetland areas in the southern portion of the site will also have a high level of sensitivity and should be avoided by development but will be discussed in greater detail in the wetland assessment section of the report.

Signs and tracks of mammals are present on the site but notably diminished when compared to natural areas. Natural vegetation has a high carrying capacity for mammals which decreases significantly where agriculture and mining transforms this natural vegetation and in such areas the mammal population is normally represented by a generalist mammal population. This was also notably the situation on the site which is dominated by generalist species while being largely modified from the natural mammal population. Rare and endangered mammals are often reclusive and avoid areas in close proximity to human activities and are also dependant on habitat in pristine condition. Such habitats are absent from the area and consequently it is unlikely that such species of high conservation value will still occur in this area. Species identified on the site also indicate a generalist mammal population adapted to transformed and disturbed habitats and is exactly what would be expected of this area. A similar mammal population is anticipated to re-establish in the solar development footprint after construction has taken place.

The surface water features of the study area is dominated by a large seepage system in the southern portion of the site (Appendix A: Map 3). A smaller seepage area is also located to the east of this system and though heavily modified, is considered a natural wetland area. A few shallow excavations as well as surface obstructions (berms, roads and ditches) also promote

the accumulation of surface water and consequent formation of artificial wetland areas but since they are undoubtedly artificial and do not form part of the natural drainage pattern, they will not be assessed and only discussed in overview.

The seepage wetlands were delineated by use of topography (land form and drainage pattern) and obligate wetland vegetation with limited soil sampling (Appendix C). Due to time constraints and the extent of the study area soil samples were only taken along a few transects of the seepage wetlands to confirm the presence of wetland conditions. The vegetation survey indicated that obligate wetland vegetation occurs within both wetland areas and was dominated by several obligate wetland sedges and grasses. This was also confirmed by soils samples in the wetland areas which indicated at least seasonal saturation of the soils and the formation of wetland systems (Appendix A: Map 3). The large wetland system and smaller wetland area to the east of it in the study area can be categorised as seepage wetlands (SANBI 2009).

The determination of the condition of the wetlands on the site will be confined to the large seepage system in the southern portion of the site. This will also incorporate the smaller seepage wetland to the east which also drains into this larger system. A WET-Health determination will be done for this large seepage system occurring on the site and should give an accurate indication of the current condition of the system and its vulnerability to impacts of the development. The WET-Health will be taken as representative of the Present Ecological State (PES) of this system (Appendix D).

The catchment of the wetland is dominated by previously ploughed fields and a large portion previously consisting of buildings and structures but now dominated by degraded land. The wetland itself is largely still intact though a few drainage ditches occur within it which will also have a high impact on the functioning of it. The seepage wetland system is affected by numerous impacts which result in a significant level of modification. The associated wetland area to the east was also included within this assessment. A WET-Health determination was undertaken for the seepage wetland to determine its current condition given the impacts affecting it (Appendix D). The results of the WET-Health indicated an overall Present Ecological State of Category C: Moderately Modified. This is considered relatively accurate given the largely transformed catchment and impacts within the wetland. The EI&S of the seepage wetland system has been rated as being Moderate.

A Risk Assessment for the proposed solar facility which will affect the seepage wetland areas in the southern portion of the site has been undertaken according to the Department of Water & Sanitation's requirements for risk assessment and the provisional Risk Assessment Matrix for Section 21(c) & (i) water use (Appendix E). Aspects of the development that may have an impact on the surface water features of the site include, impacts on the large main seepage system and its buffer zone and impacts on the smaller seepage area to the east of it.

The large main seepage wetland system has clearly been identified as the main wetland system on the site and is considered as still providing several essential functions and is therefore considered as highly sensitive and being of high conservation value (Appendix A: Map 3). The wetland should therefore be completely excluded by the development and in order to ensure no further impacts on it occur, a 20 meter buffer zone should also be maintained around the edge of the wetland. As long as this is implemented successfully, the anticipated risk on the wetland should remain low.

The smaller seepage wetland approximately 200 meters to the east of the main wetland is quite heavily modified but still functions in terms of the surface water drainage of the area (Appendix A: Map 3). It also forms part of an area of remaining natural vegetation which also contributes towards its conservation value. Any impacts that the development will have on this smaller wetland would inevitably also affect the larger wetland system. The development should therefore consider excluding this wetland area from development. Should the development manage to exclude this area the risk will also be retained as low.

The impact significance has been determined and should development take place without mitigation it is anticipated that several moderate-high to high impacts will occur. The impact on remaining natural patches of grassland as well as the wetland systems in the southern portion of the site will especially be heavily affected. However, should adequate mitigation be implemented as described these can all be reduced to moderate and low-moderate impacts. This is however subject to the development footprint being retained within areas of low sensitivity and avoiding any patches of remaining natural grassland as well as the wetland systems on the site (Appendix A: Map 4).

Table of contents

Ecological and wetland assessment.
Declaration of Independence
Executive Summary

1. Introduction 8
- 1.1 Background
- 1.2 The value of biodiversity
- 1.3 Value of wetlands and watercourses
- 1.4 Details and expertise of specialist

2. Scope and limitations 12
- 2.1 Vegetation
- 2.2 Fauna
- 2.3 Wetlands and watercourses
- 2.4 Limitations

3. Methodology 14
- 3.1 Desktop study
- 3.2 Survey
- 3.3 Criteria used to assess sites
- 3.3.1 Vegetation characteristics
- 3.3.2 Vegetation condition
- 3.3.3 Faunal characteristics
- 3.4 Biodiversity sensitivity rating (BSR)

4. Ecological overview of the site 21
- 4.1 Overview of ecology and vegetation types 21
- 4.2 Overview of terrestrial fauna 29
- 4.3 Wetland and Watercourses Assessment 32
- 4.3.1 Introduction 32
- 4.3.2 Wetland indicators 33
- 4.3.3 Classification of wetland systems 34
- 4.3.4 Condition and importance of the affected watercourses 34
- 4.3.5 Description of watercourses and wetlands 39
- 4.3.6 Buffer zone determination 44
- 4.3.7 Risk Assessment Matrix 45

5. Anticipated impacts 47

6. Biodiversity sensitivity rating (BSR) 57

7. Biodiversity sensitivity rating (BSR) interpretation 59

8. Discussion and conclusions 60

9. Recommendations 65

10. References 67

Annexure A: Maps 71

Annexure B: Species list 76

Annexure C: Soil samples 78

Annexure D: Index of Habitat Integrity (IHI)/WET-Health 80

Annexure E: Risk Assessment Matrix 82

Annexure F: Buffer Zone Determination 84

Appendix G: Impact methodology 87

<u>Ecological and wetland assessment.</u>

1. INTRODUCTION

1.1 Background

Natural vegetation is an important component of ecosystems. Some of the vegetation units in a region can be more sensitive than others, usually as a result of a variety of environmental factors and species composition. These units are often associated with water bodies, water transferring bodies or moisture sinks. These systems are always connected to each other through a complex pattern. Degradation of a link in this larger system, e.g. tributary, pan, wetland, usually leads to the degradation of the larger system. Therefore, degradation of such a water related system should be prevented.

Though vegetation may seem to be uniform and low in diversity it may still contain species that are rare and endangered. The occurrence of such a species may render the development unviable. Should such a species be encountered the development should be moved to another location or cease altogether.

South Africa has a large amount of endemic species and in terms of plant diversity ranks third in the world. This has the result that many of the species are rare, highly localised and consequently endangered. It is our duty to protect our diverse natural resources.

South Africa's water resources have become a major concern in recent times. As a water scarce country, we need to manage our water resources sustainably in order to maintain a viable resource for the community as well as to preserve the biodiversity of the system. Thus, it should be clear that we need to protect our water resources so that we may be able to utilise this renewable resource sustainably. Areas that are regarded as crucial to maintain healthy water resources include wetlands, streams as well as the overall catchment of a river system.

In order to better manage our water resources several guidelines and research sources have been developed. Amongst these are the National Freshwater Ecosystem Priority Areas for South Africa 2011 (NFEPA).

The human population has become a power-hungry system where non-renewable resources are being utilised at an alarming rate. These resources are nearing depletion and are often associated with some form of pollution (air-, water-, atmospheric pollution). The unlimited use of these non-renewable resources is not sustainable. In recent times people have become aware of this and are attempting to alleviate this by using renewable energy sources. This has become increasingly popular and are commonplace in many first world countries. Recently it has come to light that South Africa is optimally situated for solar power production. The use of solar power will alleviate the pressure experienced by Eskom, will reduce carbon emissions and will promote the use of renewable energies. The development of solar facilities should be encouraged. Solar parks do have their disadvantages. These include the use of fertile soil for power production rather than food supply and the disturbance and removal of natural vegetation.

The study area is situated approximately 2 km north of the small town of Virginia and to the east of the settlement of Saaiplaas (Appendix A: Map 1). The study area is fairly large but is dominated by grassland plains without prominent slopes and has an approximate extent of 200 hectares. The majority of this area has however already been transformed by both previous agricultural cropfields as well as structures and infrastructure associated with mining operations. Mining structures have been removed and the areas rehabilitated though it is clearly still transformed. Natural areas are almost completely absent and represented by only a few remaining patches which are also fairly degraded. A few areas also contain saturated soils and clearly form wetland systems.

A site visit was conducted on 24 May 2022. The entire footprint of the proposed development area, including terrestrial and riparian areas, was surveyed over the period of one day. The site survey was conducted during late autumn and though vegetation was in the process of going dormant, late rains and no frost to date did allow for adequate vegetation identification and an active hydrological

For the above reasons it is necessary to conduct an ecological and wetland assessment of an area proposed for development.

The report together with its recommendations and mitigation measures should be used to minimise the impact of the proposed solar development.

1.2 The value of biodiversity

The diversity of life forms and their interaction with each other and the environment has made Earth a uniquely habitable place for humans. Biodiversity sustains human livelihoods and life itself. Although our dependence on biodiversity has become less tangible and apparent, it remains critically important.

The balancing of atmospheric gases through photosynthesis and carbon sequestration is reliant on biodiversity, while an estimated 40% of the global economy is based on biological products and processes.

Biodiversity is the basis of innumerable environmental services that keep us and the natural environment alive. These services range from the provision of clean water and watershed services to the recycling of nutrients and pollution. These ecosystem services include:

- Soil formation and maintenance of soil fertility.
- Primary production through photosynthesis as the supportive foundation for all life.
- Provision of food, fuel and fibre.
- Provision of shelter and building materials.
- Regulation of water flows and the maintenance of water quality.
- Regulation and purification of atmospheric gases.
- Moderation of climate and weather.
- Detoxification and decomposition of wastes.
- Pollination of plants, including many crops.
- Control of pests and diseases.
- Maintenance of genetic resources.

1.3 Value of wetlands and watercourses

Freshwater ecosystems provide valuable natural resources, which contributes toward economic, aesthetic, spiritual, cultural and many recreational values. Yet the integrity of freshwater ecosystems in South Africa is rapidly declining in recent times. This crisis is largely a consequence of a variety of challenges that are practical (managing vast areas of land to maintain connectivity between freshwater ecosystems), socio-economic (the need to utilise these recourses between different stakeholders, i.e. individuals, communities, corporate and industrial) and institutional (Implementing appropriate governance and management). Water affects every activity and aspiration of human society and sustains all ecosystems.

Freshwater ecosystems provide many of our fundamental needs, enable important regulating ecosystem services, supports functional faunal and floral communities:

- Water for drinking and irrigation
- Food such as fish and water plants.
- Building material such as clay and reeds.
- Preventing floods and easing the impacts of droughts.
- Remove excess nutrients and toxic substances from water
- Rivers, wetlands and groundwater systems maintain water supplies and buffer the effects of storms, reducing the loss of life and property to floods.
- Riverbanks help to trap sediments, stabilise
- river banks and break down pollutants draining from the surrounding land.

1.4 Details and expertise of specialist

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South African Council for Natural Scientific Professions No. (400284/13) (Ecological Science).

Membership with relevant societies and associations:

- South African Society of Aquatic Scientists (SASAQS0091)
- South African Association of Botanists
- South African Wetlands Society (3SLY4IG4)

Expertise:

- Qualifications: B.Sc. (Hons) Botany (2008), M.Sc. in Vegetation Ecology (2012) with focus on ephemeral watercourses.
- Vegetation ecologist with over 10 years experience of conducting ecological assessments.

- Founded DPR Ecologists & Environmental Services (Pty) Ltd in 2016.
- Has conducted over 200 ecological and wetland assessments for various developments.
- Regularly attend conferences and courses in order to stay up to date with current methods and trends:

  2017: Kimberley Biodiversity Symposium.
  2018: South African Association of Botanists annual conference.
  2018: National Wetland Indaba Conference.
  2019: SASS5 Aquatic Biomonitoring Training.
  2019: Society for Ecological Restoration World Congress 2019.
  2019: Wetland rehabilitation: SER 2019 training course.
  2020: Tools For Wetlands (TFW) training course.

2. SCOPE AND LIMITATIONS

- To evaluate the present state of the vegetation and ecological functioning of the area proposed for the solar development.
- To identify possible negative impacts that could be caused by the proposed clearing of vegetation and establishment of solar development.
    - Severity relates to the nature of the event, aspect or impact to the environment and describes how severe the aspects impact on the ecosystem.
    - Duration refers to the amount of time that the environment will be affected by the event, risk or impact, if no intervention e.g. remedial action takes place.
    - Extent refers to the spatial influence of an impact.
    - Frequency refers to how often the specific activity, related to the event, aspect or impact, is undertaken.
    - Probability refers to how often the activity/event or aspect has an impact on the environment.
- To provide a description of watercourses, wetlands and riparian vegetation included within the study area.
- Identify watercourses including rivers, streams, pans and wetlands and determine the presence of wetland conditions within these systems.
- Where wetland conditions have been identified the classification of the wetland system will be given.
- To evaluate the present state of the wetlands and riparian vegetation in close proximity to the site. The importance of the ecological function and condition will also be assessed.
- Determine the Present Ecological State (PES) and Ecological Importance & Sensitivity (EIS) for the watercourses in close proximity to operations.
- Conduct a risk assessment and determine the likelihood that watercourses and wetlands will be adversely affected by the development.

2.1 Vegetation

Aspects of the vegetation that will be assessed include:

- The vegetation types of the region with their relevance to the proposed site.
- The overall status of the vegetation on site.
- Species composition with the emphasis on dominant-, rare- and endangered species.

The amount of disturbance present on the site assessed according to:
- The amount of grazing impacts.
- Disturbance caused by human impacts.
- Other disturbances.

2.2 Fauna

Aspects of the fauna that will be assessed include:

- A basic survey of the fauna occurring in the region using visual observations of species as well as evidence of their occurrence in the region (burrows, excavations, animal tracks, etc.).

- The overall condition of the habitat.

2.3 Wetlands and watercourses

Aspects of the wetlands that will be assessed include:

- Identification and delineation of watercourses including rivers, streams, pans and wetlands.
- Determine the presence of wetland conditions and riparian vegetation using obligate wetland and riparian species.
- Describe watercourses and wetlands and importance relative to the larger system.
- Conduct habitat integrity assessment of perennial systems to inform the condition and status of watercourses.

2.4 Limitations

- Due to the season of the survey several bulbs, seasonal herbs and subterranean succulents may have been overlooked as leaves and flowers may be absent due to their seasonal or deciduous nature.
- Although a comprehensive survey of the site was done it is still likely that several species were overlooked.
- Smaller drainage lines may have been overlooked where a distinct channel or riparian vegetation is absent.
- Due to previous transformation and mining activities this may have altered soil layers and the morphology of drainage areas which would complicate the delineation of wetland and riparian areas.
- Due to time constraints only limited surveys of wetlands were done.
- Some animal species may not have been observed as a result of their nocturnal and/or shy habits.

3. METHODOLOGY

3.1 Several literature works were used for additional information.

General ecology:

- Red Data List (Raymondo *et al.* 2009).
- Vegetation types (Mucina & Rutherford 2006).
- NBA 2018: South African Inventory of Inland Aquatic Ecosystems (SAIIAE).
- NBA 2018 Technical Report: Inland Aquatic (Freshwater) Realm.
- NBA 2018 Technical Report Volume 1: Terrestrial Realm.
- National Freshwater Ecosystem Priority Areas 2011 (NFEPA).
- Strategic Water Source Areas 2018 (SWSA).
- SANBI (2011): List of threatened ecosystems.
- NEM:BA: List of threatened ecosystems and Threatened Or Protected Species (TOPS).
- Biodiversity Plan Free State Province (2018).

Vegetation:

- Red Data List (Raymondo *et al.* 2009).
- Vegetation types (Mucina & Rutherford 2006).
- Field guides used for species identification (Bromilow 1995, 2010, Coates-Palgrave 2002, Fish *et al* 2015, Gerber *et al* 2004, Gibbs-Russell *et al* 1990, Griffiths & Picker 2015, Manning 2009, Moffett 1997, Pooley 1998, 2003, Retief & Meyer 2017, Van Ginkel & Cilliers 2020, Van Ginkel *et al* 2011, Van Oudtshoorn 2004, Van Wyk & Malan 1998, Van Wyk & Van Wyk 1997, Venter & Joubert 1985).

Terrestrial fauna:

- Field guides for species identification (Smithers 1983, Child *et al* 2016, Cillié 2018).

Wetland methodology, delineation and identification:
Department of Water Affairs and Forestry 2004, 2005, 2008, Collins 2006, Duthie 1999, Kleynhans *et al* 2008, Marnewecke & Kotze 1999, Macfarlane, Ollis & Kotze 2020, Ollis *et al* 2013, Nel *et al* 2011, SANBI 2009.

3.2 Survey

The site was assessed by means of transects and sample plots. Observation w.r.t. the general ecology of the area includes:

- Noted species include rare and dominant species.
- The broad vegetation types present at the site were determined.
- The state of the environment was assessed in terms of condition, grazing impacts, disturbance by humans, erosion and presence of invader and exotic species.
- The state of the habitat was also assessed.

Ecological aspects surveyed and recorded includes:

- The overall ecology of an area including the diversity of species, uniformity or diversity of habitats and different vegetation communities.

- Identification and delineation of distinct vegetation communities ad habitats and the ecological drivers responsible for these distinct communities, i.e. soil, geology, topography, aspect, etc.
- A comprehensive plant species survey including the identification of protected, rare or threatened species.
- Any ecological process or function which is important to the ecosystem including ecological drivers such as fire, frost, grazing, browsing, etc. and any changes to these processes.

Animal species were also noted as well as the probability of other species occurring on or near the site according to their distribution areas and habitat requirements.
The state of the habitat was also assessed.

In order to provide a visually representative overview of the results obtained from the survey, site sensitivity mapping will also be done. This should indicate the relative importance of different ecological elements on the site as obtained from the survey. In general, these levels of sensitivity will include:

- Low Sensitivity – normally confined to areas that are completely transformed from the natural condition or degraded to such an extent that they are no longer representative of the natural ecosystem. Such areas will also no longer contain any ecological processes of importance relative to the surrounding areas, i.e. in some instances such as watercourses which are completely transformed but still provide important ecological functions, a low level of sensitivity will not apply.

- Moderate Sensitivity – normally applicable to areas that are still natural and therefore does still have some ecological importance but which do not contain elements of high conservation value and are not essential to the continued functioning of surrounding areas. Areas of Moderate Sensitivity usually require some mitigation but can be developed without resulting in high impacts.

- High Sensitivity – areas of high sensitivity contain one or more ecological elements which are considered of high conservation value. Such areas are normally preferred to be excluded from a development but where this is not possible, will require comprehensive mitigation and is also likely to result in high impacts.

- Very High Sensitivity – these areas are critical to the continued functioning of the ecosystem on and around the site. Development of such areas normally represent a fatal flaw and should be excluded from development. No manner of mitigation is able to decrease the anticipated impact in these areas.

All rivers, streams, pans and wetlands were identified and surveyed where they occurred in the study area. These systems were determined by use of topography (land form and drainage pattern) and riparian vegetation with limited soil sampling (Appendix B & C). The following outlines the process applied during the on-site survey in order to obtain all required data:

- Perform desktop overview of the study area utilising available resources (Section 3.1). From the desktop overview identify the different landscape forms, possible wetland areas, watercourses and their relative flow patterns. Using this information, identify transects and sample plots for possible on-site survey. This should be both representative of the wetland or watercourse as a whole but should also include any prominent or significantly unique features.

- Possible sites identified during the desktop overview should be surveyed on-site. Where access is not possible or where desktop features are considered poor representatives of the wetland or watercourse the survey site or transect should be moved to another location, without compromising a comprehensive overview of the system.
- Where a lateral transect is taken of a watercourse this is done from the water's edge, across the marginal, lower and upper zones and extended across the floodplain until the edge of the riparian zone is reached.
- Where a transect is taken of a wetland system, this should preferably be taken across the entire wetland at its widest part or where it is most relevant to the proposed development, from the terrestrial surroundings, across the temporary, seasonal and perennial zones across the wetland.
- Soil samples are taken at 10 meter intervals along the survey transect, or where a distinct transition into a different zone is observed.
- A survey of the plant species within each distinct riparian or wetland zone is undertaken and includes the identification of obligate wetland species, riparian species, terrestrial species, exotic species and the general species composition and vegetation structure which allows for an accurate description of the watercourse or wetland.
- Visual survey of the general topography which substantiates the presence of riparian zones and wetland forms.
- Other general observations include any impacts observed, the overall ecosystem function, presence of fauna, surrounding land uses and the overall condition of the watercourse or wetland.
- Data is recorded by means of photographs with GPS coordinates taken at all relevant soil sampling sites and borders of riparian and wetland zones.

Data obtained during the on-site survey is utilised to provide the following information on the system:

- Desktop overview and assimilation of information on the likely impacts and functioning of the wetland system.
    - Review all available spatial data and resources in order to provide an estimate of the likely impacts and condition of the wetland or watercourse system.
- Confirm the presence of the wetland or watercourse system and provide an estimate of its borders.
    - The border of wetland conditions or the edge of the riparian zone will be confirmed by using soil sampling, obligate wetland vegetation and topography. This will also include the delineation of any temporary, seasonal or perennial zones of wetness along wetlands and the marginal, lower, upper and riparian zones along watercourses.
- Provide a description of the wetland or watercourse.
    - Provide the hydrogeomorphic setting of the wetland, a longitudinal profile which will aid in determining the erodibility of the wetland and provide an overall description of the wetland and impacts affecting it.
    - Provide a general description of the lateral zonation of the watercourse banks including the marginal, lower, upper and riparian zones and a description of the riparian vegetation along the banks of the watercourse. This will also include the description of any impacts or modification of the watercourse.

- Assess the current condition of the wetland or watercourse.
    - Utilising information obtained from the assessments listed above, determine the condition of this portion of the wetland by applying the WET-Health 2 tool.
    - Utilising information obtained from the assessments listed above, determine the condition of the relevant section of the watercourse by applying the Index of Habitat Integrity (IHI) tool.
- Utilising all of the information obtained from the assessment, provide recommendations to mitigate anticipated impacts that the development will have.

The following guidelines and frameworks were also used to determine the presence of the rivers, streams, pans and wetlands in the study area:

- Department of Water Affairs and Forestry. 2005. A practical field procedure for identification and delineation of wetlands and riparian areas. Edition 1. Department of Water Affairs and Forestry, Pretoria.
- Marnewecke & Kotze 1999. Appendix W6: Guidelines for delineation of wetland boundary and wetland zones. In: MacKay (Ed.), H. Resource directed measures for protection of water resources: wetland ecosystems. Department of Water Affairs and Forestry, Pretoria.

The following guidelines and frameworks were used to determine the sensitivity or importance of these identified watercourses or wetlands in the study area:

- Nel *et al.* (2011). Technical Report for the National Freshwater Ecosystem Priority Areas project. WRC Report No. K5/1801.

- Government of South Africa. 2008. National Protected Area Expansion Strategy for South Africa 2008: Priorities for expanding the protected area network for ecological sustainability and climate change adaptation. Government of South Africa, Pretoria.

- Duthie, A. 1999. Appendix W5: IER (floodplain and wetlands) determining the Ecological Importance and Sensitivity (EIS) and Ecological Management Class (EMC). In: MacKay (Ed.), H. Resource directed measures for protection of water resources: wetland ecosystems. Department of Water Affairs and Forestry, Pretoria.

These guidelines provide the characteristics which can be utilised to determine if a wetland or watercourse is present and also aids in determining the boundary of these systems.

The following were utilised to inform the condition and status of watercourses:

- Kleynhans, C.J., Louw, M.D. & Graham, M. 2008. Module G: EcoClassification and EcoStatus determination in River EcoClassification: Index of Habitat Integrity. Joint Water Research Commission and Department of Water Affairs and Forestry report. WRC Report No. TT 377-08.

The following were utilised to inform the condition and status of wetlands:

- Macfarlane, D.M., Ollis, D.J. & Kotze, D.C. 2020. WET-Health (Version 2.0): a refined suite of tools for assessing the present ecological state of wetland ecosystems. WRC Report No. TT 820/20.

A Risk Assessment will be conducted for the proposed development in or near watercourses and wetlands in accordance with the Department of Water & Sanitation's requirements for risk assessment and the provisional Risk Assessment Matrix for Section 21(c) & (i) water use.

3.3 Criteria used to assess sites

The following criteria is also applied during the site survey to further inform the general sensitivity and conservation value of the site or specific elements on the site. These criteria were used to assess the site and determine the overall status of the environment.

3.3.1 Vegetation characteristics

Characteristics of the vegetation in its current state. The diversity of species, sensitivity of habitats and importance of the ecology as a whole.

Habitat diversity and species richness: normally a function of locality, habitat diversity and climatic conditions.
Scoring: Wide variety of species occupying a variety of niches – 1, Variety of species occupying a single nich – 2, Single species dominance over a large area containing a low diversity of species – 3.

Presence of rare and endangered species: The actual occurrence or potential occurrence of rare or endangered species.
Scoring: Occurrence actual or highly likely – 1, Occurrence possible – 2, Occurrence highly unlikely – 3.

Ecological function: All plant communities play a role in the ecosystem. The ecological importance of all areas though, can vary significantly e.g. wetlands, drainage lines, ecotones, etc.
Scoring: Ecological function critical for greater system – 1, Ecological function of medium importance – 2, No special ecological function (system will not fail if absent) – 3.

Degree of rarity/conservation value:
Scoring: Very rare and/or in pristine condition – 1, Fair to good condition and/or relatively rare – 2, Not rare, degraded and/or poorly conserved – 3.

3.3.2 Vegetation condition

The sites are compared to a benchmark site in a good to excellent condition. Vegetation management practises (e.g. grazing regime, fire, management, etc.) can have a marked impact on the condition of the vegetation.

Percentage ground cover: Ground cover is under normal and natural conditions a function of climate and biophysical characteristics. Under poor grazing management, ground cover is one of the first signs of vegetation degradation.
Scoring: Good to excellent – 1, Fair – 2, Poor – 3.

Vegetation structure: This is the ratio between tree, shrub, sub-shrubs and grass layers. The ratio could be affected by grazing and browsing by animals.

Scoring: All layers still intact and showing specimens of all age classes – 1, Sub-shrubs and/or grass layers highly grazed while tree layer still fairly intact (bush partly opened up) – 2, Mono-layered structure often dominated by a few unpalatable species (presence of barren patches notable) – 3.

Infestation with exotic weeds and invader plants or encroachers:
Scoring: No or very slight infestation levels by weeds and invaders – 1, Medium infestation by one or more species – 2, Several weed and invader species present and high occurrence of one or more species – 3.

Degree of grazing/browsing impact:
Scoring: No or very slight notable signs of browsing and/or grazing – 1, Some browse lines evident, shrubs shows signs of browsing, grass layer grazed though still intact – 2, Clear browse line on trees, shrubs heavily pruned and grass layer almost absent – 3.

Signs of erosion: The formation of erosion scars can often give an indication of the severity and/or duration of vegetation degradation.
Scoring: No or very little signs of soil erosion – 1, Small erosion gullies present and/or evidence of slight sheet erosion – 2, Gully erosion well developed (medium to large dongas) and/or sheet erosion removed the topsoil over large areas – 3.

3.3.3 Faunal characteristics

Presence of rare and endangered species: The actual occurrence or potential occurrence of rare or endangered species on a proposed site plays a large role on the feasibility of a development. Depending on the status and provincial conservation policy, presence of a Red Data species or very unique and sensitive habitats can potentially be a fatal flaw.
Scoring: Occurrence actual or highly likely – 1, Occurrence possible – 2, Occurrence highly unlikely.

3.4 Biodiversity sensitivity rating (BSR)

The total scores for the criteria discussed in section 3.3 were used to determine the biodiversity sensitivity ranking for the sites. On a scale of 0 – 30, five different classes are described to assess the biodiversity of the study area. The different classes are described in the Table 1:

Table 1: Biodiversity sensitivity ranking

BSR	BSR general floral description	Floral score equating to BSR class
Totally transformed (5)	Vegetation is totally transformed or in a highly degraded state, generally has a low level of species diversity, no species of concern and/or has a high level of invasive plants. The area has lost its inherent ecological function. The area has no conservation value and potential for successful rehabilitation is very low.	29 – 30
Advanced Degraded (4)	Vegetation is in an advanced state of degradation, has a low level of species diversity, no species of concern and/or has a high level of invasive plants. The area's ecological function is seriously hampered, has a very low conservation value and the potential for successful rehabilitation is low.	26 – 28
Degraded (3)	Vegetation is notably degraded, has a medium level of species diversity although no species of concern are present. Invasive plants are present but are still controllable. The area's ecological function is still intact but may be hampered by the current levels of degradation. Successful rehabilitation of the area is possible. The conservation value is regarded as low.	21 – 25
Good Condition (2)	The area is in a good condition although signs of disturbance are present. Species diversity is high and species of concern may be present. The ecological function is intact and very little rehabilitation is needed. The area is of medium conservation importance.	11 – 20
Sensitive/Pristine (1)	The vegetation is in a pristine or near pristine condition. Very little signs of disturbance other than those needed for successful management are present. The species diversity is very high with several species of concern known to be present. Ecological functioning is intact and the conservation importance is high.	0 - 10

4. ECOLOGICAL OVERVIEW OF THE SITE

For the purpose of this report the terrestrial ecology of the study area will first be discussed followed by a discussion of the watercourses and wetland systems.

4.1 Overview of ecology and vegetation types

Refer to the list of species encountered on the site in Appendix B.

According to Mucina & Rutherford (2006) the area consists of Vaal-Vet Sandy Grassland (Gh 10) This vegetation type is currently listed as Endangered (EN) under the National List of Threatened Ecosystems (Notice 1477 of 2009) (National Environmental Management Biodiversity Act, 2004) (Appendix A: Map 1). Any remaining patches of natural grassland would therefore be regarded as being of very high conservation value. The vegetation type is currently heavily affected by extensive transformation by agriculture, urban expansion and mining operations.

The Free State Province Biodiversity Management Plan (2015) has been published and has identified areas which are essential to meeting conservation targets for specific vegetation types, i.e. Critical Biodiversity Areas. The site in question is predominately listed as a Degraded area and is a result of extensive transformation of the majority of the site by previous ploughing as well as mining structures and infrastructure (Appendix A: Map 2). These areas would also largely be of low conservation value. A few small patches on the site are however listed as Critical Biodiversity Area 1 (CBA 1) as these represent remnant patches of the threatened Vaal-Vet Sandy Grassland. These areas remain essential to maintaining the conservation targets for this vegetation type and they should all be regarded as having a very high conservation value. These areas regarded as CBA 1 should be excluded from the development and should be completely avoided by any associated activities.

The study area is situated approximately 2 km north of the small town of Virginia and to the east of the settlement of Saaiplaas (Appendix A: Map 1). The study area is fairly large but is dominated by grassland plains without prominent slopes and has an approximate extent of 200 hectares. The majority of this area has however already been transformed by both previous agricultural cropfields as well as structures and infrastructure associated with mining operations. Mining structures have been removed and the areas rehabilitated though it is clearly still transformed. Natural areas are almost completely absent and represented by only a few remaining patches which are also fairly degraded. A few areas also contain saturated soils and clearly form wetland systems.

As previously stated, the majority of the study area has already been transformed by agricultural land use and mining activities. This is also confirmed by the National Biodiversity Assessment (2018) (Appendix A: Map 1). The largest portions of the site has been transformed by previous ploughing for agricultural crop production. The survey has also confirmed that these areas are completely transformed from the natural vegetation type and though a grass layer has been able to re-establish it is clearly dominated by pioneer species bearing no resemblance to the natural vegetation type. This vegetation is therefore of secondary establishment and will not be able to sustain a viable ecosystem.

Figure 1: Previously ploughed areas have been able to re-establish a grass layer but which is clearly dominated by pioneer species and does not represent the natural vegetation type of the area.

Another large portion of the site, mainly in the south east has also been transformed by structures and infrastructure associated with mining operations. These buildings have since been demolished and the area cleared and rehabilitated though it is quite clear that these areas are heavily degraded and will not contribute toward the ecology of the area.

Figure 2: Buildings had been cleared from the south eastern portion of the site and is now dominated by a transformed vegetation layer dominated by pioneer grasses and weeds.

A few remnant patches of vegetation remain in the southern, western and northern corners of the site (Appendix A: Map 1 & 2). These areas are also quite degraded, mostly by overgrazing by livestock but is clearly still dominated by natural vegetation and still fit within the characteristics of the natural vegetation type, Vaal-Vet Sandy Grassland. Since this vegetation type is listed as Endangered (EN) these patches will be regarded as having a very high conservation value and should be excluded from development. Since these areas are small and located along the borders it should not be difficult to exclude them.

Figure 3: Remnant patches of natural grassland though degraded are still considered to be of very high conservation value.

In the southern portion of the site a few areas occur that clearly contain saturated soil conditions on a seasonal basis and has developed wetland conditions (Appendix A: Map 1 & 3). The largest of these is clearly a natural system while surrounding smaller wetland areas may also be a result of poor drainage and accumulation of surface water associated with previous land uses. These areas will all be assessed in detail in the wetland assessment section of the report.

Figure 4: A large wetland area occurs in the south of the site which is dominated by wetland grasses.

As indicated, historical ploughing for crop production and the activities associated with this is considered the main impact in this area (Appendix A: Map 1). Though these ploughed areas have been able to re-establish a grass layer it is clearly of secondary establishment and does not represent the natural vegetation type. The historical mining structures and infrastructure is the second most prominent impact. These buildings and structures have since been removed but is clear that this area is transformed and contains a high amount of exotic weeds. These areas have also altered the surface runoff patterns of this area which results in the formation of a few artificial wetland areas. Other general disturbances include a woodlot of exotic trees, shallow excavations, an existing electrical substation, an extensive dirt track network and pipelines associated with the mining areas.

The natural topography of the area has also been altered to a significant degree. Previous ploughing has modified the soil surface and has also influenced the surface runoff patterns. The area which had contained buildings and structures and which has since been cleared has been levelled though the surface drainage patterns are extensively modified and this also contributes to the formation of artificial wetland areas. Several shallow excavations also contribute toward the modification of the surface topography. The general topography is dominated by a fairly flat plain with a slight slopes toward the south and toward the natural wetland area.

The site and the surrounding area is situated in a region experiencing moderate rainfall, with cold, dry winters and warm summers. Climate for the site can be extrapolated from rainfall and evaporation data from the weather station C4E009 (Zeebrugge@Sand-Vet). The site is located in an area with a rainfall of between 500 mm and 600 mm per annum with an average of 508.7 mm per year. Rainfall occurs largely as summer rainfall with a mean annual evaporation of between 1600 and 1799 mm/annum. The surface water runoff in the area is therefore not significantly high which results in a relatively low runoff for the area of between 20 - 50 mm according to a study by the Water Research Commission.

The study area is situated on geology associated with the Adelaide Subgroup. The Adelaide Subgroup of the Beaufort Group in the vicinity of Virginia is dominated by underlying mudrock. However, the site and surroundings are dominated by quite fine sand and silt soils. This is also one of the main drivers of the vegetation composition of the area.

As previously indicated, the terrestrial component of the study area, can roughly be divided into three distinct areas, based on the degree of transformation. These are the previously ploughed areas, the previous mining structures portion and those small remnants of natural grassland. These will be discussed separately in the below paragraphs and elements of conservation value indicated where these were observed.

Ploughed Plains (Grass layer dominated by pioneer species)

The largest portion of the site, including the western and northern portions have been transformed by previous ploughing and is subsequently transformed from the natural condition (Appendix A: Map 1). The soil profile has been transformed and though an indigenous grass layer has been able to re-establish this is dominated by pioneer species and is not characteristic of the natural vegetation type. Several exotic weeds and pioneer shrubs have also established in these areas.

The vegetation composition in these areas also confirm that the natural vegetation type has been completely transformed in these areas. The grass layer is dominated by pioneer grasses and herbs while exotic weeds are also common. The grass layer consists almost exclusively of pioneer grasses common in transformed areas. These include *Chloris virgata, Aristida congesta, Cynodon dactylon, Aristida bipartita, Hyparrhenia hirta* and *Cymbopogon pospischillii*. The herbaceous layer is also dominated by pioneer species and include *Solanum incanum, Salvia verbenaca, Berkheya onopordifolia, Arctotis venusta, Conyza podocephala* and *Gomphocarpus fruticosus*. The dwarf shrub, *Stoebe plumosus* is also a reliable indicator of degraded grassland and is common in this area. Exotic weeds are also abundant and include *Alternanthera pungens, Datura ferox, Emex australis* and *Schinus molle.* Species being associated with the natural vegetation type is almost completely absent and include rare specimens of *Lotononis listii* and *Delosperma cooperi*.

From the vegetation description of these previously ploughed areas they are clearly transformed from the natural vegetation type and can no longer be regarded as representative of the Vaal-Vet Sandy Grassland vegetation type (Appendix A: Map 1). These areas are also utilised as communal grazing and is affected by fairly high levels of overgrazing by livestock. Given that the soil profile had also been transformed by previous ploughing it is highly unlikely that they would ever be able to re-attain a similar composition to the natural vegetation type. They are consequently regarded as having a low conservation value and would be ideal for the proposed development.

Figure 5: Previously ploughed areas are characterised by a pioneer grass layer with scattered shrubs and not representative of the natural vegetation type in this area.

Mining structures, buildings and infrastructure (dominated by pioneers and weeds)

The large portion in the south of the site as well as a smaller portion in the north previously consisted of a variety of buildings, structures and infrastructure (Appendix A: Map 1). These have subsequently been demolished and the materials removed and the area rehabilitated. It is however clear that the surface is completely transformed and now forms an artificial habitat dominated by indigenous pioneer species and exotic weeds. Invasive trees are also common in this area.

The vegetation composition in these areas also confirm that the natural vegetation type has been completely transformed in these areas. The grass layer is dominated by only a few pioneer species such as *Cynodon dactylon, Aristida congesta, Chloris virgata* and *Eragrostis lehmanniana*. Exotic weeds are also abundant and dominate some portions and these include *Flaveria bidentis, Tagetes minuta, Salsola kali, Laggera decurrens* and *Melilotus alba*. Several invasive tree species are also abundant and include *Pinus pinaster, Tipuana tipa, Tamarix chinensis* and *Nerium oleander*. The invasive grass, *Pennisetum setaceum* is also abundant, especially in the northern portion of the site. Several of these are also considered serious invaders and may spread into surrounding areas.

From the vegetation description of these areas which previously consisted of buildings and structures the area is completely transformed and heavily degraded (Appendix A: Map 1). It was also notable that weeds and invasive species are common and this will also require clearing and adequate disposal during construction. The proposed development will also have to implement a comprehensive monitoring and eradication programme. These areas are however completely transformed, are regarded as having a low conservation value and would be ideal for the proposed development.

Figure 6: The portion previously consisting of buildings and structure are clearly transformed and quite degraded.

Figure 7: Invasive tree species are also abundant in this area and have begun spreading into the surroundings.

Figure 8: Though a grass layer has been able to establish in some areas where buildings were situated, it is dominated by pioneer grasses with exotic weeds also being abundant.

Patches of remaining natural grassland (consisting of sandy soils)

A few small patches of natural grassland remain in the area in the northern corner, the western corner and the southern corner (Appendix A: Map 1). These patches are all fairly small, they are in varying degrees of disturbance though still retain sufficiently representative vegetation to be regarded as part of the natural vegetation type in this area. This vegetation type, Vaal-Vet Sandy Grassland is also an Endangered ecosystem and therefore any remaining patches would be regarded as having a high conservation value. Though not in a particularly good condition, these patches are still dominated by a variety of climax grasses, dwarf shrubs and herbs while exotic weeds are also common and are indicative of significant disturbance.

The vegetation composition in these areas confirm that they are still representative of the natural vegetation type though also contain significant levels of disturbance. The grass layer is dominated by climax grasses though pioneer species are also abundant indicating a natural grass layer but with significant disturbance. Climax grasses include *Themeda triandra, Digitaria eriantha, Eragrostis obtusa* and *Eragrostis superba* while pioneer species include *Pogonarthria squarrosa, Eragrostis gummiflua* and *Trichoneura grandiglumis*. Other dwarf shrubs and herbs which are characteristic of this vegetation type also include *Nolletia ciliaris, Berkheya macrocephala, Rosenia humilis, Sebaea exigua, Pentzia incana, Dicoma macrocephala, Nenax microphylla, Crabbea acaulis* and *Pollichia campestris*. However, the pioneer herb, *Nidorella resedifolia* is also abundant and is an indicator of disturbance. A few geophytic plants are also present, *Colchicum longipes* and *Massonia jasminiflora*. These are both characteristic of the natural vegetation type in this area. Notable disturbance in the remnant patches as well as their somewhat isolated nature also promotes the establishment of exotic weeds such as *Opuntia humifusa, Tagetes minuta, Bidens bipinnata* and *Conyza bonariensis*. No protected or endangered species could be identified in these areas though it remains possible that some may be present.

These patches of remnant Vaal-Vet Sandy Grassland are still representative of the natural vegetation but is also notably disturbed as a result of their limited extent, surrounding degraded areas, overgrazing by livestock and relative isolation (Appendix A: Map 1). However, this vegetation type is under severe development pressure and almost all remaining portions are regarded as essential for reaching conservation targets. These remnant patches are therefore also listed as Critical Biodiversity Area 1 (CBA 1) (Appendix A: Map 2). They therefore have a very high conservation value and should be retained in their current condition. These areas should therefore be avoided by the development. The borders of these natural areas have also been refined by the current site survey (Appendix A: Map 1).

Conclusions

From the description of the area given above it is clear that the majority of the site has been transformed by agricultural and mining operations (Appendix A: Map 1). The natural vegetation type in this area, Vaal-Vet Sandy Grassland is also currently under severe transformation pressure. Consequently, any remaining natural patches would therefore be regarded as having a very high conservation value. These patches have also been listed as Critical Biodiversity Area 1 (CBA 1) which confirms this (Appendix A: Map 2). These areas should therefore be avoided by the development. The borders of these natural areas have also been refined by the current site survey (Appendix A: Map 1). From aerial imagery it is also evident how the area has progressively been transformed (Google Earth 2011 - 2021).

Figure 9: Historical imagery dating from 2011 (Google Earth) indicate a largely transformed site (red) with agricultural fields and building, structures and infrastructure clearly visible.

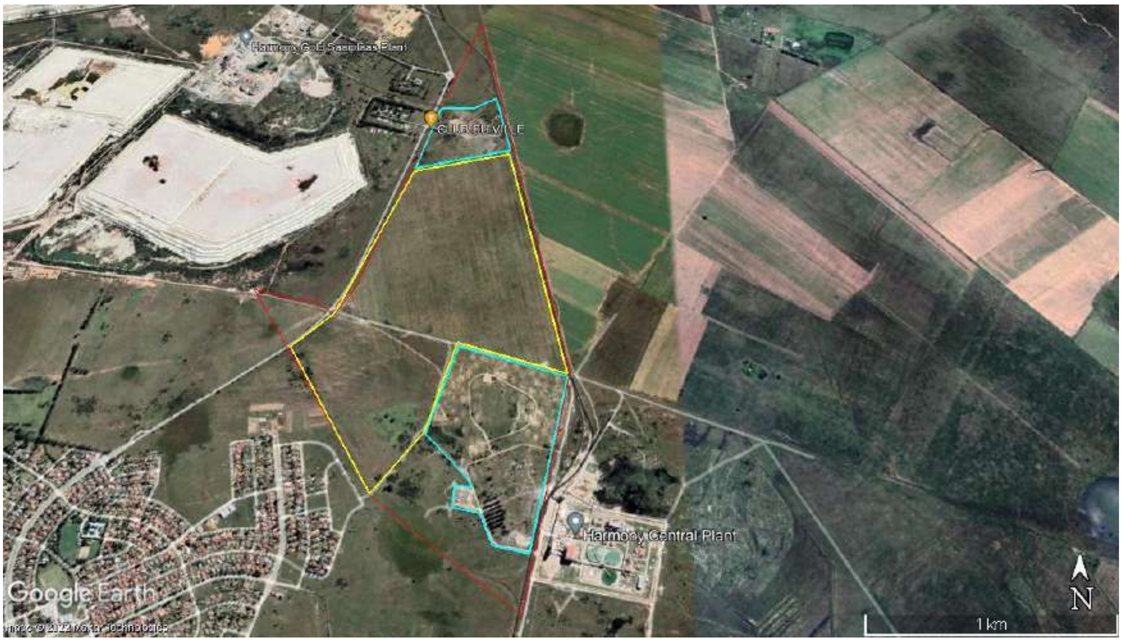

Figure 10: Aerial view of the recent condition of the study area (Google Earth 2022) which clearly indicates the large scale transformation of the area. The approximate extent of transformed areas are indicated: Yellow – ploughed fields, Blue – buildings and structures.

Should development of the solar facility be able remain within transformed areas, this will greatly decrease the anticipated impacts. However, should the development encroach into adjacent remnant patches of natural grassland this will entail a high impact. Being a mining area, this results in transformation and degradation of large portions of land. The cumulative impact of development and mining in this area is therefore high. The proposed solar development should therefore first consider the development of areas considered as already transformed and of low sensitivity. These include the old ploughed fields and areas which previously consisted of buildings and structures. Only if no remaining options remain should the development consider encroaching into remaining natural areas. However, in this instance it will result in high impacts. Likewise the remaining natural wetland areas in the southern portion of the site will also have a high level of sensitivity and should be avoided by development but will be discussed in greater detail in the wetland assessment section of the report.

Due to the largely transformed nature of the development area, no protected or endangered plant species were noted. Although the possibility remains that may be present in those patches of remaining natural grassland, the likelihood is considered fairly low. The area does however contain quite a substantial infestation of invasive trees and this will pose a risk of spreading into surrounding natural areas, especially as construction of the solar development will increase disturbance in the area (Appendix B). The proposed development will also have to implement a comprehensive monitoring and eradication programme to ensure that invasive plant species are removed from the area and prevented from re-establishing.

4.2 Overview of terrestrial fauna (actual & possible)

Signs and tracks of mammals are present on the site but notably diminished when compared to natural areas. Natural vegetation has a high carrying capacity for mammals which decreases significantly where agriculture and mining transforms this natural vegetation and in such areas the mammal population is normally represented by a generalist mammal population. This was also notably the situation on the site which is dominated by generalist species while being largely modified from the natural mammal population. Rare and endangered mammals are often reclusive and avoid areas in close proximity to human activities and are also dependant on habitat in pristine condition. Such habitats are absent from the area and consequently it is unlikely that such species of high conservation value will still occur in this area.

Wetland and riparian habitats also generally provide a higher abundance of resources and subsequently are also able to sustain a diverse and large mammal population (Appendix A: Map 3). This will also be the case for the natural system in the southern portion of the site. Though these areas are also disturbed to a significant extent and coupled with the close proximity of human activities, these wetlands will still be able to sustain a higher bio-load which in turn supports a larger mammal population. This also substantiates the need to avoid these wetland areas and exclude them from development.

The mammal survey of the site was conducted by means of active searching and recording any tracks or signs of mammals and actual observations of mammals. From the survey the following actual observations of mammals were recorded:

- Soil mounds of the Common Molerat (*Cryptomys hottentotus*) were common in most areas of the study area. This is a widespread species which has even become adapted to urban areas. It is a generalist species anticipated to occur in this area.

- Extensive colonies of Ground Squirrel (*Xerus inauris*) and Yellow Mongoose (*Cynictis penicillata*) occur in the study area. These are companion species which are widespread and common and found in most natural or disturbed habitats.

- Tracks of a large canid carnivore were observed which is almost certainly that of a domestic dog associated with herding of livestock in this area. Herding dogs are also known to have a detrimental impact on the mammal population and will also have an additional impact on the already modified mammal population in the area.

These species identified on the site indicate a generalist mammal population adapted to transformed and disturbed habitats and is exactly what would be expected of this area. A similar mammal population is anticipated to re-establish in the solar development footprint after construction has taken place.

The most significant impact on mammals anticipated on the site itself is primarily concerned with the loss and fragmentation of available habitat. Transformation of the natural vegetation on the site will result in a decrease in the population size as available habitat decreases. Since the area is already largely transformed, the mammal population will already be heavily modified and the impact caused by the proposed development should be fairly low. Additional measures which will further mitigate these impacts include the exclusion of remnants of natural grassland and the exclusion of natural wetland areas in the southern portion of the site.

It is also considered likely that several mammal species were overlooked during the survey though it is highly unlikely that any rare or endangered species would occur.

Construction itself may also affect the mammal population and care should therefore be taken to ensure none of the faunal species on site is harmed. The hunting, capturing or harming in any way of mammals on the site should not be allowed. Voids and excavations may also act as pitfall traps to fauna and these should continuously be monitored and any trapped fauna removed and released in adjacent natural areas.

Mammals species likely to occur on the site has been determined by means of FitzPatrick Institute of African Ornithology (2022).

Table 2: Red Listed mammals occurring or likely to occur in the study area (Child *et al* 2016).

Common name	Scientific name	Status
African White-tailed Rat	*Mystromys albicaudatus*	**Vulnerable (VU)**

The survey has indicated that the mammal population will consist largely of widespread, generalist species and it is considered unlikely that any endangered species will still occur in this area.

Table 3: Likely mammal species in the region.

Family	Scientific name	Common name	Status
Bathyergidae	Cryptomys hottentotus	Southern African Mole-rat	
Bovidae	Raphicerus campestris	Steenbok	
Herpestidae	Cynictis penicillata	Yellow Mongoose	
	Herpestes sanguineus	Slender Mongoose	
	Suricata suricatta	Meerkat	
Leporidae	Lepus saxatilis	Scrub Hare	
Muridae	Aethomys namaquensis	Namaqua Rock Mouse	
Nesomyidae	Mystromys albicaudatus	African White-tailed Rat	**Vulnerable (VU)**
Sciuridae	Xerus inauris	South African Ground Squirrel	

Suidae	Phacochoerus africanus	Common Warthog	
Viverridae	Genetta genetta	Common Genet	

From historical records (Table 3) it is confirms that the area generally consists of a generalist mammal population. However, one endangered mammal, African White-tailed Rat has been recorded in this area and there is a slight possibility that it may still occur in remnant patches of grassland. The exclusion of these remaining natural grassland areas should however avoid any impact on it should there still be specimens of these mammals left.

A note should also be made of the Sungazer Lizard (*Smaug giganteus*). This is a highly endangered reptile known to occur in the sandy grassland habitats of this region. The survey also specifically targeted this species but was found to be absent from the area. This is also to be expected given the largely transformed condition of the area.

Figure 11: Tracks and signs of mammals on the site include from top to bottom; soil mound of the Common molerat (*Cryptomys hottentotus*), Ground squirrels (*Xerus inauris*), Yellow Mongoose (*Cenictus penicillata*) and tracks of what is almost certainly a domestic dog.

4.3 Wetland Assessment

4.3.1 Introduction

The surface water features of the study area are dominated by a large seepage system in the southern portion of the site (Appendix A: Map 3). A smaller seepage area is also located to the east of this system and though heavily modified, is considered a natural wetland area. A few shallow excavations as well as surface obstructions (berms, roads and ditches) also promote the accumulation of surface water and consequent formation of artificial wetland areas but since they are undoubtedly artificial and do not form part of the natural drainage pattern, they will not be assessed and only discussed in overview. The assessment will focus on the large seepage system, clearly being the most important, though will also include the seepage wetland area to the east.

As indicated, the southern portion of the site contains a large seepage wetland of which a significant portion falls within the borders of the development area (Appendix A: Map 3). The wetland is clearly only seasonal and will only contain surface water for short periods during the rainy season. The wetland is fed by a catchment to the north where the solar development will be situated and runoff generated by the development is therefore still likely to have some affect on it. Though the wetland is significantly affected by the surrounding land uses it contains extensive wetland habitat which will be an important ecosystem for this area and will provide several ecosystem functions such as flood attenuation, bioremediation and water transportation.

To the east of this seepage wetland (approximately 200 meters) a smaller seepage area is also present. It drains toward the larger seepage wetland (Appendix A: Map 3). Though considered to be a natural system it is evidently quite heavily modified by trenches and berms which dewater and modify the flow regime. This was most likely also done to promote drainage from this area. Wetland conditions are however still clearly present both in terms of soil wetness indicators and obligate wetland vegetation. Due to the proximity of the development, it is likely that this wetland will be negatively affected by it.

A few areas occur that are clearly not natural watercourses or wetlands but may have formed artificial wetland conditions due to the accumulation of surface runoff. Such areas include a few shallow excavations, where water accumulates along dirt tracks and berms and areas where storm water generated by the previous buildings discharge into the surroundings. These areas are all artificial and are consequently of negligible conservation value. They will be noted in the report but will not form part of the discussions.

The term watercourse refers to a river, stream, wetland or pan. The National Water Act (NWA, 1998) includes rivers, streams, pans and wetlands in the definition of the term watercourse. This definition follows:

Watercourse means:

- A river or spring.
- A natural channel in which water flows regularly or intermittently.
- A wetland, lake or dam into which water flows.
- 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.

The classification of stream orders from 1 to 3 can be illustrated by means of the Strahler 1952 classification:

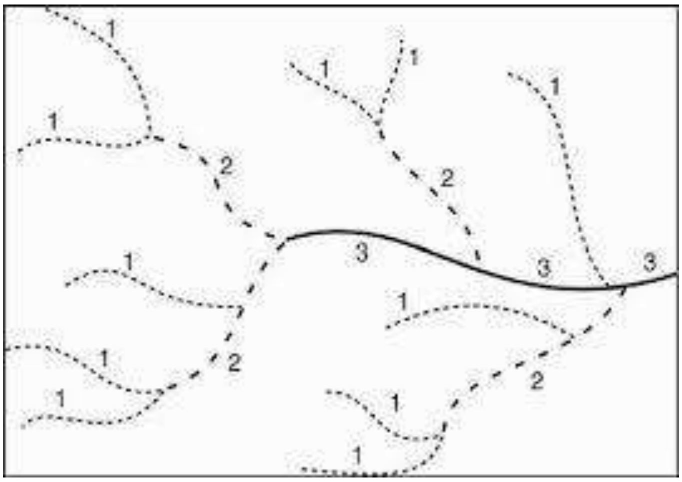

Figure 12: The classification of stream orders from 1 to 3 (Strahler 1952).

4.3.2 Wetland indicators

Riparian habitat is an accepted indicator of watercourses used to delineate the extent of wetlands, rivers, streams and pans (Department of Water Affairs and Forestry 2005). The seepage wetlands were delineated by use of topography (land form and drainage pattern) and obligate wetland vegetation with limited soil sampling (Appendix C). Due to time constraints and the extent of the study area soil samples were only taken along a few transects of the seepage wetlands to confirm the presence of wetland conditions. The following guidelines and frameworks were used to determine and delineate the watercourses and wetlands in the study area:

- Department of Water Affairs and Forestry. 2005. A practical field procedure for identification and delineation of wetlands and riparian areas. Edition 1. Department of Water Affairs and Forestry, Pretoria.
- Marnewecke & Kotze 1999. Appendix W6: Guidelines for delineation of wetland boundary and wetland zones. In: MacKay (Ed.), H. Resource directed measures for protection of water resources: wetland ecosystems. Department of Water Affairs and Forestry, Pretoria.

Obligate wetland vegetation was utilised to determine the presence and border of wetland conditions (Appendix B). Due to time constraints soil samples were only taken within sample points within the smaller seepage wetland area and along two lateral transects of the larger wetland system to confirm the presence or absence of wetland conditions. Soil samples were investigated for the presence of anaerobic evidence which characterises wetland soils (Appendix C).

The vegetation survey indicated that obligate wetland vegetation occurs is within both wetland areas and was dominated by several obligate wetland sedges and grasses. This was also confirmed by soils samples in the wetland areas which indicated at least seasonal saturation of the soils and the formation of a wetland systems (Appendix A: Map 3). Because the topography is fairly flat in this region, coupled with a moderate rainfall and shallow soils, pan and wetland systems are abundant in this area. These wetland systems on the site are also a consequence of this. Due to extensive mining activities in this area the surface drainage patterns has been heavily modified. This also affects wetlands in the area and any remaining wetlands will therefore also be regarded as having a high conservation value and will also increase their value in terms of the surface water drainage of the area.

4.3.3 Classification of wetland systems

The wetland conditions identified within the two seepage wetland areas in the study area can be classified into a specific wetland type.

The large wetland system and smaller wetland area to the east of it in the study area can be categorised as seepage wetlands (SANBI 2009):

"Hillslope seep: a wetland area located on (gently to steeply) sloping land, which is dominated by the colluvial (i.e. gravity-driven), unidirectional movement of material down-slope. Water inputs are primarily from groundwater or precipitation that that enters the wetland from an up-slope direction in the form of subsurface flow. Water movement through the wetland is mainly in the form of interflow, with diffuse overland flow ('sheetwash') often being significant during and after rainfall events. Water leaves a 'hillslope seep with channelled outflow' mostly by means of concentrated surface flow, whereas water leaves a 'hillslope seep without channelled outflow' by means of a combination of diffuse surface flow, interflow, evaporation and infiltration."

This description fits quite well with these wetland areas which are situated along a gentle slope from north to south. Water movement is clearly unidirectional along this slope and water also exits this system as a series is poorly defined wetland areas.

4.2.4 Description of watercourses and wetlands

The study area contains the main, seepage wetland system, a smaller seepage area to the east of it and a few artificial excavations and wetlands (Appendix A: Map 3). A short description of each of these will be provided below.

Obligate wetland vegetation was also used to determine the presence of wetland conditions. Obligate wetland species are confined to wetlands and are only able to occur in wetlands. They are therefore reliable indicators of wetland conditions. Field observations over time as well as the following sources were used to determine FW and OW species:

- Marnewecke, G. & Kotze, D. 1999. Appendix W6: Guidelines for delineation of wetland boundary and wetland zones. In: MacKay (Ed.), H. Resource directed measures for protection of water resources: wetland ecosystems. Department of Water Affairs and Forestry, Pretoria.

- DWAF. 2008. Updated manual for the identification and delineation of wetlands and riparian areas, prepared by M.Rountree, A.L. Batchelor, J. MacKenzie and D. Hoare. Stream Flow Reduction Activities, Department of Water Affairs and Forestry, Pretoria, South Africa.

- Van Ginkel, C.E. & Cilliers, C.J. 2020. Aquatic and wetland plants of Southern Africa. Briza Publications, Pretoria.

Table 2: Description of the individual watercourses and wetlands which forms part of the study area (Appendix A: Map 3) (FW – Facultative wetland species, OW – Obligate wetland species, * - Exotic species).

Watercourse name: #1 Seepage wetland – Main wetland in the south of the site	**Coordinates of sampling:** S 28.060238°, E 26.880505° S 28.059307°, E 26.879937°	**Flow regime:** Seasonal
Description of watercourse: The largest and most significant surface water feature in the area. This seepage wetland is quite large, with an approximate diameter of 300 meters and is clearly the largest wetland feature in the area. The wetland does not have a defined, channelled outflow but flow is clearly unidirectional along the gentle slope from north to south. The wetland is also largely fed by groundwater inflow from the north. The proposed development will therefore likely have a direct affect on it in terms of runoff generated by it and which will enter this system. Though this is a natural system it is clearly affected by several large impacts. The wetland itself contain a shallow drain which will have a large impact on the hydrology of it and which will contribute toward dewatering of the system. The catchment of the wetland is also completely transformed and this will undoubtedly also have an impact on the pan. Together with berms, ditches and surface modification of the catchment this has had a further modification of the hydrology of the wetland. The condition of the wetland would therefore seem to be poor. The wetland is fairly flat but may form a slight depression in the landscape with a slight incline along its northern border also aiding in accurate delineation of the system. Vegetation within the wetland is dominated by a few obligate wetland grasses and sedges which also confirm the presence of saturated soils. Terrestrial plants may also be abundant and this also indicates the seasonal nature of the wetland. Soil samples also reliably confirm the presence of wetland conditions which indicate a seasonal zone of wetness within the wetland.		
Dominant plant species: Seepage wetland: *Polygala hottentotta, Selago densifora, Diplachne fusca* (OW), *Cyperus longus* (OW), *Cycnium tubulosum* subsp. *tubulosum, Lotononis listii*. Wetland border: *Searsia lancea, *Cestrum laevigatum, Vachellia karroo, *Schkuhria pinata, Themeda triandra, *Bidens bipinata, Moraea pallida.*		
Protected plant species: None observed.		
Soil sample:		

The seepage wetland is quite extensive and be visible as a slight depression in the landscape.

The wetland is domionated by obligate wetland grasses and sedges.

A dreainage trench through the wetland also provide a visual indication of the saturation of soils and the shallow groundwater.

Watercourse name:	Coordinates of sampling:	Flow regime:
#2 Seepage wetland – smaller wetland to east of the main wetland	S 28.060514°, E 26.883067°	Seasonal

Description of watercourse:

A much smaller wetland area that is situated approximately 200 meters to the east of the main seepage wetland. It is quite small with a diameter of approximately 50 meters. The wetland is poorly defined but clearly drains from north east to south west and towards the main wetland system. The wetland is also largely fed by groundwater inflow from the north. The proposed development will therefore likely have a direct affect on it in terms of runoff generated by it and which will enter this system. Though this is a natural system it is clearly affected by several large impacts. The wetland has been heavily modified as a result of a drainage channel to the west and a road acting as flow obstruction to the north. The condition of the wetland would therefore seem to be poor.

The wetland is fairly flat but may form a slight depression in the landscape with a slight slope from north east to south west. It is not well defined, also a consequence of its modified condition, which also makes accurate delineation difficult. Vegetation within the wetland is dominated by a few obligate wetland grasses and sedges which also confirm the presence of saturated soils. Exotic weeds are also abundant and confirm the modified condition. Soil samples also reliably confirm the presence of wetland conditions which indicate a seasonal zone of wetness within the wetland.

Dominant plant species:

Cyperus longus (OW), *Diplachne fusca* (OW), *Cyperus eragrostis* (OW), **Tegetes minuta, *Bidens bipinnata.*

Protected plant species:

None observed.

Soil sample:


The wetland is not well defined but may be discerned as shallow depressions, dominated by wetland vegetation.

Watercourse name: #10 Artificial wetlands	**Coordinates of sampling:** S 28.057284°, E 26.879543° S 28.055119°, E 26.878540°	**Flow regime:** Artificial

Description of watercourse:
The following two areas have been identified as being formed by artificial, human induced modifications in the landscape and are not regarded as forming either natural watercourses or wetlands. Due to surface modifications, they may contain surface water for some periods which may form artificial wetland conditions. These artificial wetland areas consist of the following:

- An elongated and shallow excavation forms a depression in the landscape and collects surface water runoff. As a consequence, a few artificial wetland areas has formed. They are not considered to play any role in the surface drainage pattern of the site and are therefore not considered to be of consequence to the development. They are however simply listed here to confirm that they have been surveyed and confirmed to be of low sensitivity in terms of the development.

- A series of storm water outlets discharge into the surrounding area where the buildings and structures previously required storm water discharge. These areas have formed indistinct and poorly defined wetland areas. These areas do indicate poor storm water management in the area and should the development take place, a comprehensive storm water management system will have to be implemented which should also prevent these areas of poor drainage forming.

A shallow excavation which accumulates surface water and now forms artificial wetland conditions.

Areas where storm water discharges form poorly defined artificial wetland patches.

4.3.5 Condition and importance of the affected wetland

The determination of the condition of the wetlands on the site will be confined to the large seepage system in the southern portion of the site. This will also incorporate the smaller seepage wetland to the east which also drains into this larger system. The seepage wetland and associated smaller seepage area is clearly the most important surface water feature here, and as a whole, will be the most likely affected by the solar development. The determination of the condition of this seepage system, including the smaller wetland area is therefore also of importance. Therefore, a WET-Health determination will be done for this large seepage system occurring on the site and should give an accurate indication of the current condition of the system and its vulnerability to impacts of the development. The WET-Health will be taken as representative of the Present Ecological State (PES) of this system (Appendix D).

Table 4 refers to the determination and categorisation of the Present Ecological State (PES; health or integrity) of various biophysical attributes of rivers relative to the natural or close to the natural reference condition. The purpose of the EcoClassification process is to gain insights and understanding into the causes and sources of the deviation of the PES of biophysical attributes from the reference condition. This provides the information needed to derive desirable and attainable future ecological objectives for the river (Kleynhans & Louw 2007).

Table 5 refers to the Ecological Importance and Sensitivity (EIS) of wetlands. "Ecological importance" of a water resource is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales. "Ecological sensitivity" refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred. The Ecological Importance and Sensitivity (EIS) provides a guideline for determination of the Ecological Management Class (EMC).

Table 4: Ecological categories for Present Ecological Status (PES).

Ecological Category	Description
A	Unmodified, natural
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominately unchanged.
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem function has occurred.
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
F	Critically/Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.

Table 5: Ecological importance and sensitivity categories.

Ecological Importance and Sensitivity Category (EIS)	Range of Median	Recommended Ecological Management Class
Very High Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications.	>3 and <=4	A
High Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications.	>2 and <=3	B
Moderate Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications.	>1 and <=2	C
Low/marginal		D

Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications.	>0 and <=1	

According to previous desktop assessments (Kleynhans 2000, Van Deventer *et al* 2018) the large pan situated in the central portion of the site is considered to have a PES of Category A/B: Natural to Largely Natural. The current survey has however determined that this is significantly overestimated. The seepage wetland is clearly quite modified and degraded, mostly as a result of the transformation of the catchment but also in-wetland modifications such as drains. Despite this modified condition, the wetland remains a sensitive system and any additional impacts on it should be prevented. The proposed development will occur in close proximity to it but should avoid both this larger seepage wetland as well as the smaller wetland areas to the east. A comprehensive storm water management system will also have to be implemented in order to prevent runoff from the development from having any further negative effect on it. Should this be implemented it will significantly reduce the likelihood of the development having any significant impacts on the wetland system.

As indicated above, the seepage wetland has been modified by numerous significant impacts. A summary of the impacts will be provided in the following paragraphs.

The catchment of the wetland is dominated by previously ploughed fields and a large portion previously consisting of buildings and structures but now dominated by degraded land. These areas would have a much lower surface vegetation coverage than normal and would therefore have a significant influence on surface runoff and erosion which will influence sediment deposition in the wetland. These areas have also caused significant modification of the surface topography and this would then alter the inflow into the wetland which consequently will modify its hydrology. The catchment is also notable for many dirt roads and tracks, none of which have adequate drainage and also numerous furrows and storm water ditches of which the function was most probably to evacuate surface runoff as fast as possible and into the wetland system. These all lead to further modification of the surface drainage and will have a further impact on the hydrology of the wetland.

The wetland itself is largely still intact though a few drainage ditches occur within it which will also have a high impact on the functioning of it. Wetlands function as sponges, they received and contain a large volume of water which is then slowly released to the downstream areas. This results in several unique functions which include the attenuation of floods in downstream areas (a function which has become quite apparent during recent flooding events), because they release water slowly, they also have a purifying effect which helps to improve water quality and through this whole process they also provide unique habitat to a range of fauna and flora. When a drain is excavated through a wetland this results in the faster evacuation of water through the wetland which heavily impacts on these unique functions and therefore has a high impact on the hydrology of the system. Such drains are normally intentionally installed to promote dewatering of wetland areas.

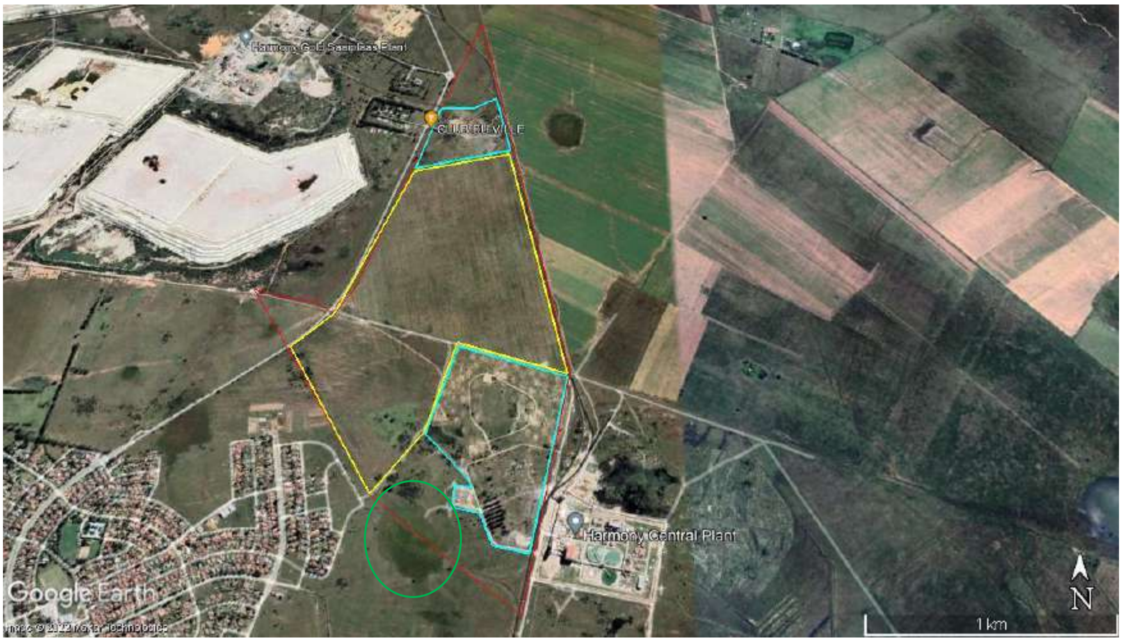

Figure 13: A recent aerial image of the wetland (Green) which also indicates the prominent impacts in the catchment (Google Earth 2022). The catchment is dominated by ploughed fields (yellow) and heavily modified, previously built-up areas (blue). The heavily modified surface topography is also clearly evident.

Figure 14: The catchment is largely transformed which results in higher velocity runoff and in turn promotes erosion

Figure 15: Large portions of the catchment are generally degraded and contain significant surface modification which will also alter the surface drainage patterns.

Figure 16: Surface infrastructure such as pipelines, dirt roads and ditches all act as obstruction to surface flow and will also contribute toward the modification of surface runoff patterns.

Figure 17: The wetland is largely intact though a surface drain will have a significant impacts on the hydrology of the system.

From the above described impacts it should be clear that the seepage wetland system is affected by numerous impacts which result in a significant level of modification. The associated wetland area to the east was also included within this assessment. A WET-Health determination was undertaken for the seepage wetland to determine its current condition given the impacts affecting it (Appendix D). The results of the WET-Health indicated an overall Present Ecological State of Category C: Moderately Modified. This is considered relatively accurate given the largely transformed catchment and impacts within the wetland.

The EI&S of the seepage wetland system has been rated as being Moderate: Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications. This is mostly a result of the already degraded condition of the wetland, though since it is a large system still providing several important functions the EI&S remains Moderate.

4.3.6 Buffer zone determination

As indicated in previous sections, the seepage wetland system is still largely intact and though at least moderately modified, it still provides many essential functions. The long mining history of this region and indiscriminate loss of wetland areas has clearly illustrated how this progressively leads to large problems with surface drainage, flooding and poor water quality. It is therefore highly recommended that the proposed development completely avoid this wetland system as well as the smaller adjacent wetland area. These seepage wetland areas should be treated as no-go areas and no construction or operational activities including stockpiling, clearing, laydown areas, vehicle movement or any other associated activities should occur in or near these wetland areas.

In addition, a suitable buffer for the main seepage wetland systems can be provided by using the Buffer Zone Tool for the Determination of Aquatic Impact Buffers and Additional Setback Requirements for Wetland Ecosystems (2014) (Appendix F). This determination was also done in conjunction with Macfarlane *et al* (2014). It should be noted however that the buffers determined by this model only caters for wetland systems and impacts associated with diffuse-source surface runoff. By using the above tools a suitable buffer of 20 meters from the edge of the wetland has been determined (Appendix A: Map 3).

4.3.7 Risk Assessment

A Risk Assessment for the proposed solar facility which will affect the seepage wetland areas in the southern portion of the site has been undertaken according to the Department of Water & Sanitation's requirements for risk assessment and the provisional Risk Assessment Matrix for Section 21(c) & (i) water use (Appendix E). Aspects of the development that may have an impact on the surface water features of the site include, impacts on the large main seepage system and its buffer zone and impacts on the smaller seepage area to the east of it.

The large main seepage wetland system has clearly been identified as the main wetland system on the site and is considered as still providing several essential functions and is therefore considered as highly sensitive and being of high conservation value (Appendix A: Map 3). The wetland should therefore be completely excluded by the development and in order to ensure no further impacts on it occur, a 20 meter buffer zone should also be maintained around the edge of the wetland. The wetland and buffer zone should also be regarded as no-go areas and no construction or operational activities including stockpiling, clearing, laydown areas, vehicle movement or any other associated activities should occur in or near this wetland system. As long as this is implemented successfully, the anticipated risk on the wetland should remain low. Furthermore, the catchment of the wetland lies largely within the proposed development footprint and will therefore have a significant impact on the runoff generated and inflow into the wetland. However, this is subject to the development implementing a comprehensive storm water management system which should ensure that the surface runoff patterns are retained as is, especially pertaining to solar panels, and that the development does not contribute toward increased surface flow, erosion and any impacts on downslope areas.

The smaller seepage wetland approximately 200 meters to the east of the main wetland is quite heavily modified but still functions in terms of the surface water drainage of the area (Appendix A: Map 3). It also forms part of an area of remaining natural vegetation which also contributes towards its conservation value. Any impacts that the development will have on this smaller wetland would inevitably also affect the larger wetland system. The development should therefore consider excluding this wetland area from development. Should the development manage to exclude this area the risk will also be retained as low.

Low Risks: Acceptable as is or consider requirement for mitigation. Impact to watercourses and resource quality small and easily mitigated.

Mitigation as recommended as well as any additional mitigation recommended by other specialist studies should be implemented in order to alleviate the risks on the two seepage wetland systems.

For the complete risk assessment please refer to Appendix E.

No.	Phases	Activity	Aspect	Impact	Risk Rating	Confidence level	Control measures
1	Mostly Construction Phase but also during operation	Construction of a solar facility	A large seepage system with high conservation value may be affected by the proposed development	The construction of the facility may encroach into the wetland which will directly affect or may also impact on the catchment of the wetland which will then have an indirect impact on it.	**L**	**80**	Provided that recommendations are implemented and that the wetland system as well as the 20 meter buffer zone is excluded from the development and is treated as no-go areas, the anticipated risk should remain low. As the development may still occur in relatively close proximity to it, it will also be important to implement a comprehensive storm water management system.
	Mostly Construction Phase but also during operation	Construction of a solar facility	A smaller seepage area occur to the ast of the main wetland and will also likely be affected by the development	The solar facility will exclude the smaller wetland area from the development footprint but may still have an indirect impact in terms of surface runoff.	**L**	**80**	Should the development be able to exclude the smaller seepage wetland area from development the risk will be retained as low. It will still be necessary to ensure the upslope development does not contribute to adverse impact on this area though given that the storm water management system will be implemented there the runoff from the development should not result in significant impacts on this area.

5. ANTICIPATED IMPACTS

Anticipated impacts that the development will have is primarily concerned with the loss of habitat and species diversity but will also include impacts on the seepage wetland systems forming part of the study area (Appendix A: Map 1 - 4).

The following impacts on the ecosystem, ecology and biodiversity will be assessed:

- Loss of vegetation and consequently habitat and species diversity as a result.
- Loss of protected, rare or threatened plant species.
- Impacts on watercourses, wetlands or the general catchment.
- The impact that the development will have on exotic weeds and invasive species, both current and anticipated conditions.
- Any increased erosion that the development may cause.
- Fragmentation of habitat, disruption of ecological connectivity and -functioning in terms of the surrounding areas.
- Impacts that will result on the mammal population on and around the site.
- Any significant cumulative impacts that the development will contribute towards.

Solar PV developments usually entail the removal of surface vegetation and may also involve modification of the surface topography. This therefore has a large impact in terms of the loss of vegetation, vegetation type and consequently habitat. As indicated from the discussion of the study area, the majority of the area has already been transformed by agricultural and mining operations (Appendix A: Map 1). These areas will have a low level of sensitivity and since these areas have already been transformed the anticipated impact should remain low. However, small patches of remaining natural grassland consists of Vaal-Vet Sandy Grassland which is listed as Endangered (EN) and will therefore have a very high conservation value. This is also confirmed by the Free State Province Biodiversity Management Plan (2015) which regards the majority of these remaining natural areas as Critical Biodiversity Area 1 (CBA 1) and which is consequently of very high sensitivity (Appendix A: Map 2). As long as the development footprint is retained within areas of low sensitivity and these patches of remaining natural grassland are avoided, the anticipated impact should remain fairly low.

Given the largely transformed condition of the site no protected or endangered plant species were noted (Appendix B). Although the possibility remains that may be present in those patches of remaining natural grassland, the likelihood is considered fairly low. The anticipated impact on the loss of protected or endangered plant species is therefore fairly low.

The survey of the site has identified the presence of a large seepage wetland as well as a smaller wetland to the east of it (Appendix A: Map 3). These systems will most probably be affected by the proposed development. Solar developments are well known to have significant impacts on surface water features as a result of the rain shadow caused by the panels and the coupled runoff and infiltration patterns, erosion caused by these runoff patterns and disruption of surface watercourses. These identified wetland areas should therefore be excluded from the development and the necessary mitigation implemented to ensure no indirect impacts affect the wetland systems. Development within 500 meters of these wetland areas will require authorisation from DWS. Refer to the risk assessment (Section 4.3.7) for a more detailed discussion on the likely risks and impacts that the development will have on these wetland areas. Should these wetland areas be excluded from the development and measures as indicated implemented the anticipate impact should remain low.

As was observed during the survey of the study area it contains several exotic weed and invader species (Appendix B). In addition, development (especially construction) will increase disturbance and exacerbate conditions susceptible to the establishment of exotic weeds and invaders. Without mitigation this will significantly increase the establishment of exotics and is likely to spread into the surrounding areas. It is therefore recommended that weed control be judiciously and continually practised. Monitoring of weed establishment should form a prominent part of management of the development area. Where category 1 and 2 weeds occur, they require removal by the property owner according to the Conservation of Agricultural Resources Act, No. 43 of 1983 and National Environmental Management: Biodiversity Act, No. 10 of 2004.

As indicated, because solar PV developments result in the removal of vegetation, this reduces infiltration and promotes runoff. Coupled with the rain shadow caused by panels and the resulting dripline, this increases runoff and erosion. This may also have a moderate impact on the wetland systems adjacent to the site. In order to reduce this impact, the development should implement a comprehensive storm water management system which should ensure that the surface runoff patterns are retained as is, especially pertaining to solar panels, and that the development does not contribute toward increased surface flow, erosion and any impacts on downslope areas.

The majority of this area is already transformed to a large extent and is therefore greatly affected by habitat fragmentation and the disruption of ecosystem processes. Therefore, should the development encroach into any remaining natural areas this will have significant additional impacts in terms of habitat fragmentation. However, as indicated, the area is largely transformed and should the development be able to avoid remaining natural patches of grassland the impact on habitat fragmentation and the loss of ecosystem processes would remain low.

The most significant impact on mammals anticipated on the site itself is primarily concerned with the loss and fragmentation of available habitat. Transformation of the natural vegetation on the site will result in a decrease in the population size as available habitat decreases. Since the area is already largely transformed, the mammal population will already be heavily modified and the impact caused by the proposed development should be fairly low. Additional measures which will further mitigate these impacts include the exclusion of remnants of natural grassland and the exclusion of natural wetland areas in the southern portion of the site. Construction itself may also affect the mammal population and care should therefore be taken to ensure none of the faunal species on site is harmed. The hunting, capturing or harming in any way of mammals on the site should not be allowed. Voids and excavations may also act as pitfall traps to fauna and these should continuously be monitored and any trapped fauna removed and released in adjacent natural areas.

As previously indicated, the area has a long history of transformation by mining, agriculture and urban expansion and the cumulative impact that this has had is extensive. Therefore, should the proposed development further encroach into natural areas it will have a high cumulative impact. However, since transformation is already so extensive the proposed development has the opportunity to make use of these transformed areas and should the development be able to remain within these transformed areas should therefore not contribute significantly toward the cumulative impacts in this area.

The impact significance has been determined and should development take place without mitigation it is anticipated that several moderate-high to high impacts will occur. The impact on remaining natural patches of grassland as well as the wetland systems in the southern portion of the site will especially be heavily affected. However, should adequate mitigation be implemented as described these can all be reduced to moderate and low-moderate impacts. This is however subject to the development footprint being retained within areas of low sensitivity and avoiding any patches of remaining natural grassland as well as the wetland systems on the site (Appendix A: Map 4).

Please refer to Appendix G for the impact methodology.

<table>
<tr><td colspan="4">Nature:
Loss of vegetation and consequently habitat and species diversity as a result.</td></tr>
<tr><td colspan="4">Impact description: Solar PV developments usually entail the removal of surface vegetation and may also involve modification of the surface topography. This therefore has a large impact in terms of the loss of vegetation, vegetation type and consequently habitat. As indicated from the discussion of the study area, the majority of the area has already been transformed by agricultural and mining operations (Appendix A: Map 1). These areas will have a low level of sensitivity and since these areas have already been transformed the anticipated impact should remain low. However, small patches of remaining natural grassland consists of Vaal-Vet Sandy Grassland which is listed as Endangered (EN) and will therefore have a very high conservation value. This is also confirmed by the Free State Province Biodiversity Management Plan (2015) which regards the majority of these remaining natural areas as Critical Biodiversity Area 1 (CBA 1) and which is consequently of very high sensitivity (Appendix A: Map 2).</td></tr>
<tr><td></td><td>Rating</td><td>Motivation</td><td>Significance</td></tr>
<tr><td colspan="4">Prior to Mitigation</td></tr>
<tr><td>Duration</td><td>5</td><td>Permanent transformation of vegetation</td><td rowspan="4">High Negative (85)</td></tr>
<tr><td>Extent</td><td>2</td><td>Limited development footprint</td></tr>
<tr><td>Magnitude</td><td>10</td><td>Loss of a Threatened Ecosystem</td></tr>
<tr><td>Probability</td><td>5</td><td>Impact is unavoidable</td></tr>
<tr><td colspan="4">Mitigation/Enhancement Measures</td></tr>
<tr><td colspan="4">Mitigation:
As long as the development footprint is retained within areas of low sensitivity and these patches of remaining natural grassland are avoided, the anticipated impact should remain fairly low.</td></tr>
<tr><td colspan="4">Post Mitigation/Enhancement Measures</td></tr>
<tr><td>Duration</td><td>5</td><td>Permanent transformation of vegetation</td><td rowspan="4">Low Negative (16)</td></tr>
<tr><td>Extent</td><td>1</td><td>Decreased development extent maintained within transformed areas</td></tr>
<tr><td>Magnitude</td><td>2</td><td>Development limited to areas of transformation</td></tr>
<tr><td>Probability</td><td>2</td><td>Impact probability is low since development is limited to already transformed areas</td></tr>
<tr><td colspan="4">Cumulative impacts:
The area has a long history of transformation by mining, agriculture and urban expansion and</td></tr>
</table>

the cumulative impact that this has had is extensive. Therefore, should the proposed development further encroach into natural areas it will have a high cumulative impact. However, since transformation is already so extensive the proposed development has the opportunity to make use of these transformed areas and should the development be able to remain within these transformed areas should therefore not contribute significantly toward the cumulative impacts in this area.
Residual Risks: As long as the development footprint is retained within areas of low sensitivity and these patches of remaining natural grassland are avoided, the anticipated impact should remain fairly low.

Nature: **Loss of protected, rare or threatened plant species.**			
Impact description: Given the largely transformed condition of the site no protected or endangered plant species were noted (Appendix B). Although the possibility remains that may be present in those patches of remaining natural grassland, the likelihood is considered fairly low. The anticipated impact on the loss of protected or endangered plant species is therefore fairly low.			
	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	5	Permanent loss of protected species	**Low Negative (18)**
Extent	2	Limited development footprint	
Magnitude	2	Unlikely loss of protected species	
Probability	2	Occurrence of protected species unlikely and therefore probability is low	
Mitigation/Enhancement Measures			
Mitigation: None required			
Post Mitigation/Enhancement Measures			
Duration	5	Permanent loss of protected species	**Low Negative (8)**
Extent	1	Decreased development extent maintained within transformed areas	
Magnitude	2	Unlikely loss of protected species	
Probability	1	Occurrence of protected species unlikely and therefore probability is low	
Cumulative impacts: The area has a long history of transformation by mining, agriculture and urban expansion and the cumulative impact that this has had is extensive. Therefore, should the proposed development further encroach into natural areas it will have a high cumulative impact including any impact on protected species. However, since transformation is already so extensive the proposed development has the opportunity to make use of these transformed areas and should the development be able to remain within these transformed areas should therefore not contribute significantly toward the cumulative impacts in this area including any cumulative impacts on protected species.			

Residual Risks: Given the largely transformed condition of the site no protected or endangered plant species were noted (Appendix B). Although the possibility remains that may be present in those patches of remaining natural grassland, the likelihood is considered fairly low. The anticipated impact on the loss of protected or endangered plant species is therefore fairly low.

Nature: **Impacts on watercourses, wetlands or the general catchment.**			
Impact description: The survey of the site has identified the presence of a large seepage wetland as well as a smaller wetland to the east of it (Appendix A: Map 3). These systems will most probably be affected by the proposed development. Solar developments are well known to have significant impacts on surface water features as a result of the rain shadow caused by the panels and the coupled runoff and infiltration patterns, erosion caused by these runoff patterns and disruption of surface watercourses. These identified wetland areas should therefore be excluded from the development and the necessary mitigation implemented to ensure no indirect impacts affect the wetland systems. Development within 500 meters of these wetland areas will require authorisation from DWS. Refer to the risk assessment (Section 4.3.7) for a more detailed discussion on the likely risks and impacts that the development will have on these wetland areas. Should these wetland areas be excluded from the development and measures as indicated implemented the anticipate impact should remain low.			
	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	5	Permanent transformation of wetland areas	**High Negative (90)**
Extent	3	Spill over of impacts into downstream areas	
Magnitude	10	Direct wetland loss	
Probability	5	Impact is unavoidable	
Mitigation/Enhancement Measures			
Mitigation: Should these wetland areas be excluded from the development and measures as indicated implemented the anticipate impact should remain low. Refer to the risk assessment (Section 4.3.7) for a more detailed discussion on the likely risks and impacts that the development will have on these wetland areas.			
Post Mitigation/Enhancement Measures			
Duration	5	Permanent transformation of wetland areas	**Low Negative (20)**
Extent	1	Wetlands excluded from development footprint	
Magnitude	4	Impacts on wetland still significant	
Probability	2	Impact probability is low	
Cumulative impacts: The area has a long history of transformation by mining, agriculture and urban expansion and the cumulative impact that this has had is extensive, including the impacts on wetlands in the area. Therefore, should the proposed development further encroach into natural areas (including wetlands) it will have a high cumulative impact. However, since transformation is already so extensive the proposed development has the opportunity to make use of these transformed areas and should the development be able to remain within these transformed areas and exclude wetland areas, it should therefore not contribute significantly toward the			

cumulative impacts in this area (including wetlands).
Residual Risks: Should these wetland areas be excluded from the development and measures as indicated implemented the anticipated impact should remain low.

<table>
<tr><td colspan="4">Nature:
The impact that the development will have on exotic weeds and invasive species, both current and anticipated conditions.</td></tr>
<tr><td colspan="4">Impact description: As was observed during the survey of the study area it contains several exotic weed and invader species (Appendix B). In addition, development (especially construction) will increase disturbance and exacerbate conditions susceptible to the establishment of exotic weeds and invaders. Without mitigation this will significantly increase the establishment of exotics and is likely to spread into the surrounding areas. It is therefore recommended that weed control be judiciously and continually practised. Monitoring of weed establishment should form a prominent part of management of the development area. Where category 1 and 2 weeds occur, they require removal by the property owner according to the Conservation of Agricultural Resources Act, No. 43 of 1983 and National Environmental Management: Biodiversity Act, No. 10 of 2004.</td></tr>
<tr><td></td><td>Rating</td><td>Motivation</td><td>Significance</td></tr>
<tr><td colspan="4">Prior to Mitigation</td></tr>
<tr><td>Duration</td><td>4</td><td>Long-term infestation</td><td rowspan="4">High Negative (70)</td></tr>
<tr><td>Extent</td><td>3</td><td>Spreading of infestation into neighbouring areas</td></tr>
<tr><td>Magnitude</td><td>8</td><td>Infestation of a Threatened Ecosystem</td></tr>
<tr><td>Probability</td><td>5</td><td>Impact is unavoidable</td></tr>
<tr><td colspan="4">Mitigation/Enhancement Measures</td></tr>
<tr><td colspan="4">Mitigation:
It is recommended that weed control be judiciously and continually practised. Monitoring of weed establishment should form a prominent part of management of the development area. Where category 1 and 2 weeds occur, they require removal by the property owner according to the Conservation of Agricultural Resources Act, No. 43 of 1983 and National Environmental Management: Biodiversity Act, No. 10 of 2004.</td></tr>
<tr><td colspan="4">Post Mitigation/Enhancement Measures</td></tr>
<tr><td>Duration</td><td>3</td><td>Limited duration if monitoring and eradication is maintained</td><td rowspan="4">Moderate Negative (30)</td></tr>
<tr><td>Extent</td><td>1</td><td>Limiting extent through monitoring and eradication</td></tr>
<tr><td>Magnitude</td><td>6</td><td>Limited but unavoidable infestation</td></tr>
<tr><td>Probability</td><td>3</td><td>Moderate probability remains</td></tr>
<tr><td colspan="4">Cumulative impacts:
The area has a long history of transformation by mining, agriculture and urban expansion which increases the cumulative impact of increased infestation by exotics. Therefore, should the proposed development further encroach into natural areas and contribute to increased infestation it will have a high cumulative impact. However, since transformation is already so extensive the proposed development has the opportunity to make use of these transformed areas and should the development be able to remain within these transformed areas should therefore not contribute significantly toward the cumulative impacts associated with increased exotic vegetation infestation.</td></tr>
</table>

Residual Risks: Without mitigation this will significantly increase the establishment of exotics and is likely to spread into the surrounding areas.

Nature: **Any increased erosion that the development may cause.**			
Impact description: As indicated, because solar PV developments result in the removal of vegetation, this reduces infiltration and promotes runoff. Coupled with the rain shadow caused by panels and the resulting dripline, this increases runoff and erosion. This may also have a moderate impact on the wetland systems adjacent to the site. In order to reduce this impact, the development should implement a comprehensive storm water management system which should ensure that the surface runoff patterns are retained as is, especially pertaining to solar panels, and that the development does not contribute toward increased surface flow, erosion and any impacts on downslope areas.			
	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	5	Permanent modification of surface topography	**Moderate Negative (56)**
Extent	3	Spreading of erosion into neighbouring areas	
Magnitude	6	Limited magnitude due to the flat topography	
Probability	4	Highly likely to take place	
Mitigation/Enhancement Measures			
Mitigation: In order to reduce this impact, the development should implement a comprehensive storm water management system which should ensure that the surface runoff patterns are retained as is, especially pertaining to solar panels, and that the development does not contribute toward increased surface flow, erosion and any impacts on downslope areas.			
Post Mitigation/Enhancement Measures			
Duration	5	Permanent modification of surface topography	**Low Negative (20)**
Extent	1	Limiting extent through storm water management	
Magnitude	4	Limited magnitude due to the flat topography	
Probability	2	Unlikely to occur as long as storm water management is maintained	
Cumulative impacts: The area has a long history of transformation by mining, agriculture and urban expansion and the cumulative impact (including surface erosion) that this has had is extensive. Therefore, should the proposed development further encroach into natural areas it will have a high cumulative impact (including surface erosion). However, since transformation is already so extensive the proposed development has the opportunity to make use of these transformed areas and should the development be able to remain within these transformed areas and successfully implement a storm water management system it should not contribute significantly toward the cumulative erosion in this area.			
Residual Risks: Erosion may also have a significant impact on the wetland systems adjacent to the site.			

<table>
<tr><td colspan="4">Nature:
Fragmentation of habitat, disruption of ecological connectivity and -functioning in terms of the surrounding areas.</td></tr>
<tr><td colspan="4">Impact description: The majority of this area is already transformed to a large extent and is therefore greatly affected by habitat fragmentation and the disruption of ecosystem processes. Therefore, should the development encroach into any remaining natural areas this will have significant additional impacts in terms of habitat fragmentation. However, as indicated, the area is largely transformed and should the development be able to avoid remaining natural patches of grassland the impact on habitat fragmentation and the loss of ecosystem processes would remain low.</td></tr>
<tr><td></td><td>Rating</td><td>Motivation</td><td>Significance</td></tr>
<tr><td colspan="4">Prior to Mitigation</td></tr>
<tr><td>Duration</td><td>5</td><td>Permanent loss and fragmentation of habitat</td><td rowspan="4">Moderate Negative (60)</td></tr>
<tr><td>Extent</td><td>2</td><td>Limited loss of natural areas</td></tr>
<tr><td>Magnitude</td><td>8</td><td>High impact due to fragmentation of a Threatened Ecosystem</td></tr>
<tr><td>Probability</td><td>4</td><td>Highly likely to take place</td></tr>
<tr><td colspan="4">Mitigation/Enhancement Measures</td></tr>
<tr><td colspan="4">Mitigation:
The area is largely transformed and should the development be able to avoid remaining natural patches of grassland the impact on habitat fragmentation and the loss of ecosystem processes would remain low.</td></tr>
<tr><td colspan="4">Post Mitigation/Enhancement Measures</td></tr>
<tr><td>Duration</td><td>5</td><td>Permanent loss and fragmentation of habitat</td><td rowspan="4">Low Negative (8)</td></tr>
<tr><td>Extent</td><td>1</td><td>Limiting extent by excluding remaining natural areas</td></tr>
<tr><td>Magnitude</td><td>2</td><td>Limited magnitude due to limiting development to already transformed areas</td></tr>
<tr><td>Probability</td><td>1</td><td>Low probability as long as development is limited to already transformed areas</td></tr>
<tr><td colspan="4">Cumulative impacts:
As previously indicated, the area has a long history of transformation by mining, agriculture and urban expansion and the cumulative impact that this has had is extensive. Therefore, should the proposed development further encroach into natural areas it will have a high cumulative impact. However, since transformation is already so extensive the proposed development has the opportunity to make use of these transformed areas and should the development be able to remain within these transformed areas should therefore not contribute significantly toward the cumulative impacts in this area.</td></tr>
<tr><td colspan="4">Residual Risks:
The area is largely transformed and should the development be able to avoid remaining natural patches of grassland the impact on habitat fragmentation and the loss of ecosystem processes would remain low.</td></tr>
</table>

Nature: **Impacts that will result on the mammal population on and around the site.**			
Impact description: The most significant impact on mammals anticipated on the site itself is primarily concerned with the loss and fragmentation of available habitat. Transformation of the natural vegetation on the site will result in a decrease in the population size as available habitat decreases. Since the area is already largely transformed, the mammal population will already be heavily modified and the impact caused by the proposed development should be fairly low. Additional measures which will further mitigate these impacts include the exclusion of remnants of natural grassland and the exclusion of natural wetland areas in the southern portion of the site. Construction itself may also affect the mammal population and care should therefore be taken to ensure none of the faunal species on site is harmed.			
	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	4	Limited to a semi-permanent impact if some vegetation re-establishes within the development	**Low Negative (24)**
Extent	2	Limited loss of natural areas	
Magnitude	4	Moderate given the already modified mammal population	
Probability	2	Moderate given the already modified mammal population	
Mitigation/Enhancement Measures			
Mitigation: Additional measures which will further mitigate these impacts include the exclusion of remnants of natural grassland and the exclusion of natural wetland areas in the southern portion of the site. Construction itself may also affect the mammal population and care should therefore be taken to ensure none of the faunal species on site is harmed. The hunting, capturing or harming in any way of mammals on the site should not be allowed. Voids and excavations may also act as pitfall traps to fauna and these should continuously be monitored and any trapped fauna removed and released in adjacent natural areas.			
Post Mitigation/Enhancement Measures			
Duration	4	Limited to a semi-permanent impact if some vegetation re-establishes within the development	**Low Negative (24)**
Extent	2	Limited loss of natural areas	
Magnitude	4	Moderate given the already modified mammal population	
Probability	2	Moderate given the already modified mammal population	
Cumulative impacts: The area has a long history of transformation by mining, agriculture and urban expansion and the cumulative impact that this has had on the mammal population is extensive. Therefore, should the proposed development further encroach into natural areas it will have a further increased cumulative impact on the mammal population. However, since transformation is already so extensive the proposed development has the opportunity to make use of these transformed areas and should the development be able to remain within these transformed areas should therefore not contribute significantly toward the cumulative impacts on the local mammal population.			
Residual Risks:			

Transformation of the indigenous vegetation on the site will result in a decrease in the mammal population size as available habitat decreases.

Cumulative impact:

Any significant cumulative impacts that the development will contribute towards. As previously indicated, the area has a long history of transformation by mining, agriculture and urban expansion and the cumulative impact that this has had is extensive. Therefore, should the proposed development further encroach into natural areas it will have a high cumulative impact. However, since transformation is already so extensive the proposed development has the opportunity to make use of these transformed areas and should the development be able to remain within these transformed areas should therefore not contribute significantly toward the cumulative impacts in this area.		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	2	3
Duration	5	4
Magnitude	10	8
Probability	5	5
Significance	**High (85)**	**High (70)**
Status (positive or negative)	Negative	Negative
Reversibility	Irreversible	Irreversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes	Yes
Confidence in findings: High		
Mitigation: Since transformation is already so extensive the proposed development has the opportunity to make use of these transformed areas and should the development be able to remain within these transformed areas should therefore not contribute significantly toward the cumulative impacts in this area.		

6. BIODIVERSITY SENSITIVITY RATING (BSR)

Habitat diversity and species richness:
The natural vegetation types in the study area has been extensively transformed by agricultural and mining operations. In addition, remaining natural areas are fairly uniform with a low diversity of habitats (Appendix A: Map 4). As a consequence of this, the study area only has a moderate species diversity as well (Appendix B)

Presence of rare and endangered species:
Given the largely transformed condition of the site no protected or endangered plant species were noted (Appendix B). Although the possibility remains that may be present in those patches of remaining natural grassland, the likelihood is considered fairly low.

Ecological function:
The ecological function of the site has been altered to a significant degree. The site functions as habitat for a variety of fauna, supports specific vegetation types and the wetlands systems forming part of the site also provides vital functions in terms of water transportation, wetland and aquatic habitats and bio-remediation. The vegetation type on the site has been transformed to a large degree and the resultant habitat provided to fauna is also altered and unable to sustain the natural population (Appendix A: Map 1). The functioning of the wetland areas has been shown to be moderately modified but is still considered a highly sensitive system. Overall the ecological function of the study is therefore regarded as moderately modified.

Degree of rarity/conservation value:
According to Mucina & Rutherford (2006) the area consists of Vaal-Vet Sandy Grassland (Gh 10) This vegetation type is currently listed as Endangered (EN) under the National List of Threatened Ecosystems (Notice 1477 of 2009) (National Environmental Management Biodiversity Act, 2004) (Appendix A: Map 2). Any remaining patches of natural grassland would therefore be regarded as being of very high conservation value.

The Free State Province Biodiversity Management Plan (2015) has been published and has identified areas which are essential to meeting conservation targets for specific vegetation types, i.e. Critical Biodiversity Areas. The site in question is predominately listed as a Degraded area and is a result of extensive transformation of the majority of the site by previous ploughing as well as mining structures and infrastructure. These areas would also largely be of low conservation value. A few small patches on the site are however listed as Critical Biodiversity Area 1 (CBA 1) as these represent remnant patches of the threatened Vaal-Vet Sandy Grassland (Appendix A: Map 2). These areas remain essential to maintaining the conservation targets for this vegetation type and they should all be regarded as having a very high conservation value.

Although degraded the wetland areas still play a vital role in water transport and is therefore considered to have a high conservation value (Appendix A: Map 4).

Overall the site is therefore considered as having a moderate conservation value with areas of low conservation value dominating while areas of high conservation value are also still present.

Percentage ground cover:
Overall, the percentage vegetation cover is regarded as largely modified. The majority of the site has been transformed by previous ploughing and built-up areas and consequently now these areas are dominated by rather sparse pioneer species.

Vegetation structure:
The area forms part of the Grassland Biome and should naturally therefore contain a well-developed grass layer and without any significant tree or shrub component being present. Due to previous transformation by ploughing and buildings the majority of the site has now developed a significant shrub component, with invasive tree species also being prominent.

Infestation with exotic weeds and invader plants:
Numerous exotic weeds and invasive tree species are present on the site (Appendix B). They are abundant and may also form dominant patches, that will continue to spread over time. These include *Alternanthera pungens, Datura ferox, Emex australis, Schinus molle, Flaveria bidentis, Tagetes minuta, Salsola kali, Laggera decurrens, Melilotus alba, Pinus pinaster, Tipuana tipa, Tamarix chinensis, Nerium oleander*, *Opuntia humifusa, Bidens bipinnata* and *Conyza bonariensis*. Several of these are considered serious invasive species and it is important that a comprehensive eradication and monitoring programme be implemented.

Degree of grazing/browsing impact:
The area is being utilised as communal grazing and browsing for domestic livestock and there is therefore no structured grazing regime or stocking levels and this results in high levels of overgrazing.

Signs of erosion:
Signs of erosion is common, though not yet extensive and gulley formation is not yet prominent.

Terrestrial animals:
Signs and tracks of mammals are present on the site but notably diminished when compared to natural areas. Natural vegetation has a high carrying capacity for mammals which decreases significantly where agriculture and mining transforms this natural vegetation and in such areas the mammal population is normally represented by a generalist mammal population. This was also notably the situation on the site which is dominated by generalist species while being largely modified from the natural mammal population. Rare and endangered mammals are often reclusive and avoid areas in close proximity to human activities and are also dependant on habitat in pristine condition. Such habitats are absent from the area and consequently it is unlikely that such species of high conservation value will still occur in this area.

Wetland and riparian habitats also generally provide a higher abundance of resources and subsequently are also able to sustain a diverse and large mammal population (Appendix A: Map 3). This will also be the case for the natural system in the southern portion of the site. Though these areas are also disturbed to a significant extent and coupled with the close proximity of human activities, these wetlands will still be able to sustain a higher bio-load which in turn supports a larger mammal population. This also substantiates the need to avoid these wetland areas and exclude them from development.

Table 6: Biodiversity Sensitivity Rating for the proposed solar development.

	Low (3)	Medium (2)	High (1)
Vegetation characteristics			
Habitat diversity & Species richness		2	
Presence of rare and endangered species	3		
Ecological function		2	
Uniqueness/conservation value		2	
Vegetation condition			
Percentage ground cover	3		
Vegetation structure	3		
Infestation with exotic weeds and invader plants or encroachers	3		
Degree of grazing/browsing impact	3		
Signs of erosion		2	
Terrestrial animal characteristics			
Presence of rare and endangered species	3		
Sub total	18	8	0
Total		26	

7. BIODIVERSITY SENSITIVITY RATING (BSR) INTERPRETATION

Table 7: Interpretation of Biodiversity Sensitivity Rating.

Site	Score	Site Preference Rating	Value
Harmony Central PV Solar	26	Advanced Degraded	4

8. DISCUSSION AND CONCLUSION (Appendix A: Map 1 - 4)

The site proposed for PV solar development has been rated as being Advanced Degraded. This is mostly a result of the extensive transformation by previous ploughing and built-up areas. It is however notable that the characteristics still contain elements of value such as remnants of endangered vegetation and wetland areas while the vegetation condition indicate the degraded condition of the area. Therefore, as long as areas of high conservation value (remnant grassland patches and wetland areas) are avoided the impact of the development should remain low.

The study area is situated approximately 2 km north of the small town of Virginia and to the east of the settlement of Saaiplaas (Appendix A: Map 1). The study area is fairly large but is dominated by grassland plains without prominent slopes and has an approximate extent of 200 hectares. The majority of this area has however already been transformed by both previous agricultural cropfields as well as structures and infrastructure associated with mining operations. Mining structures have been removed and the areas rehabilitated though it is clearly still transformed. Natural areas are almost completely absent and represented by only a few remaining patches which are also fairly degraded. A few areas also contain saturated soils and clearly form wetland systems.

According to Mucina & Rutherford (2006) the area consists of Vaal-Vet Sandy Grassland (Gh 10) This vegetation type is currently listed as Endangered (EN) under the National List of Threatened Ecosystems (Notice 1477 of 2009) (National Environmental Management Biodiversity Act, 2004) (Appendix A: Map 1). Any remaining patches of natural grassland would therefore be regarded as being of very high conservation value. The vegetation type is currently heavily affected by extensive transformation by agriculture, urban expansion and mining operations.

The Free State Province Biodiversity Management Plan (2015) has been published and has identified areas which are essential to meeting conservation targets for specific vegetation types, i.e. Critical Biodiversity Areas. The site in question is predominately listed as a Degraded area and is a result of extensive transformation of the majority of the site by previous ploughing as well as mining structures and infrastructure (Appendix A: Map 2). These areas would also largely be of low conservation value. A few small patches on the site are however listed as Critical Biodiversity Area 1 (CBA 1) as these represent remnant patches of the threatened Vaal-Vet Sandy Grassland. These areas remain essential to maintaining the conservation targets for this vegetation type and they should all be regarded as having a very high conservation value. These areas regarded as CBA 1 should be excluded from the development and should be completely avoided by any associated activities.

As previously stated, the majority of the study area has already been transformed by agricultural land use and mining activities. This is also confirmed by the National Biodiversity Assessment (2018) (Appendix A: Map 1). The largest portions of the site has been transformed by previous ploughing for agricultural crop production. The survey has also confirmed that these areas are completely transformed from the natural vegetation type and though a grass layer has been able to re-establish it is clearly dominated by pioneer species bearing no resemblance to the natural vegetation type. This vegetation is therefore of secondary establishment and will not be able to sustain a viable ecosystem.

Another large portion of the site, mainly in the south east has also been transformed by structures and infrastructure associated with mining operations (Appendix A: Map 1). These buildings have since been demolished and the area cleared and rehabilitated though it is quite clear that these areas are heavily degraded and will not contribute toward the ecology of the area.

A few remnant patches of vegetation remain in the southern, western and northern corners of the site (Appendix A: Map 1 & 2). These areas are also quite degraded, mostly by overgrazing by livestock but is clearly still dominated by natural vegetation and still fit within the characteristics of the natural vegetation type, Vaal-Vet Sandy Grassland. Since this vegetation is listed as Endangered (EN) these patches will be regarded as having a very high conservation value and should be excluded from development. Since these areas are small and located along the borders it should not be difficult to exclude them.

In the southern portion of the site a few areas occur that clearly contain saturated soil conditions on a seasonal basis and has developed wetland conditions (Appendix A: Map 3). The largest of these is clearly a natural system while surrounding smaller wetland areas may also be a result of poor drainage and accumulation of surface water associated with previous land uses. These areas will all be assessed in detail in the wetland assessment section of the report.

From the description of the area given above it is clear that the majority of the site has been transformed by agricultural and mining operations (Appendix A: Map 1). The natural vegetation type in this area, Vaal-Vet Sandy Grassland is also currently under severe transformation pressure. Consequently, any remaining natural patches would therefore be regarded as having a very high conservation value. These patches has also been listed as Critical Biodiversity Area 1 (CBA 1) which confirms this (Appendix A: Map 2). These areas should therefore be avoided by the development. The borders of these natural areas have also been refined by the current site survey (Appendix A: Map 4).

Should development of the solar facility be able to remain within transformed areas, this will greatly decrease the anticipated impacts. However, should the development encroach into adjacent remnant patches of natural grassland this will entail a high impact. Being a mining area, this results in transformation and degradation of large portions of land. The cumulative impact of development and mining in this area is therefore high. The proposed solar development should therefore first consider the development of areas considered as already transformed and of low sensitivity. These include the old ploughed fields and areas which previously consisted of buildings and structures. Only if no remaining options remain available should the development consider encroaching into natural areas. However, in that instance it will result in high impacts. Likewise the remaining natural wetland areas in the southern portion of the site will also have a high level of sensitivity and should be avoided by development but will be discussed in greater detail in the wetland assessment section of the report.

Due to the largely transformed nature of the development area, no protected or endangered plant species were noted. Although the possibility remains that some may be present in those patches of remaining natural grassland, the likelihood is considered fairly low. The area does however contain quite a substantial infestation of invasive trees and this will pose a risk of spreading into surrounding natural areas, especially as construction of the solar development will increase disturbance in the area (Appendix B). The proposed development will also have to implement a comprehensive monitoring and eradication programme to ensure that invasive plant species are removed from the area and prevented from re-establishing.

Signs and tracks of mammals are present on the site but notably diminished when compared to natural areas. Natural vegetation has a high carrying capacity for mammals which decreases significantly where agriculture and mining transforms this natural vegetation and in such areas the mammal population is normally represented by a generalist mammal population. This was also notably the situation on the site which is dominated by generalist species while being largely modified from the natural mammal population. Rare and endangered mammals are often reclusive and avoid areas in close proximity to human activities and are also dependant on habitat in pristine condition. Such habitats are absent from the area and consequently it is unlikely that such species of high conservation value will still occur in this area. Species identified on the site also indicate a generalist mammal population adapted to transformed and disturbed habitats and is exactly what would be expected of this area. A similar mammal population is anticipated to re-establish in the solar development footprint after construction has taken place.

The most significant impact on mammals anticipated on the site itself is primarily concerned with the loss and fragmentation of available habitat. Transformation of the natural vegetation on the site will result in a decrease in the population size as available habitat decreases. Since the area is already largely transformed, the mammal population will already be heavily modified and the impact caused by the proposed development should be fairly low. Additional measures which will further mitigate these impacts include the exclusion of remnants of natural grassland and the exclusion of natural wetland areas in the southern portion of the site.

The surface water features of the study area is dominated by a large seepage system in the southern portion of the site (Appendix A: Map 3). A smaller seepage area is also located to the east of this system and though heavily modified, is considered a natural wetland area. A few shallow excavations as well as surface obstructions (berms, roads and ditches) also promote the accumulation of surface water and consequent formation of artificial wetland areas but since they are undoubtedly artificial and do not form part of the natural drainage pattern, they will not be assessed and only discussed in overview.

As indicated, the southern portion of the site contains a large seepage wetland of which a significant portion falls within the borders of the development area (Appendix A: Map 3). The wetland is clearly only seasonal and will only contain surface water for short periods during the rainy season. The wetland is fed by a catchment to the north where the solar development will be situated and runoff generated by the development is therefore still likely to have some affect on it. Though the wetland is significantly affected by the surrounding land uses it contains extensive wetland habitat which will be an important ecosystem for this area and will provide several ecosystem functions such as flood attenuation, bioremediation and water transportation.

To the east of this seepage wetland (approximately 200 meters) a small seepage area is also present (Appendix A: Map 3). It drains toward the larger seepage wetland. Though considered to be a natural system it is evidently quite heavily modified by trenches and berms which dewater and modify the flow regime. This was most likely also done to promote drainage from this area. Wetland conditions are however still clearly present both in terms of soil wetness indicators and obligate wetland vegetation. Due to the proximity of the development, it is likely that this wetland will be negatively affected by it.

A few areas occur that are clearly not natural watercourses or wetlands but may have formed artificial wetland conditions due to the accumulation of surface runoff. Such areas include a few shallow excavations, where water accumulates along dirt tracks and berms and areas where storm water generated by the previous buildings discharge into the surroundings. These areas are all artificial and are consequently of negligible conservation value. They will be noted in the report but will not form part of the discussions.

The seepage wetlands were delineated by use of topography (land form and drainage pattern) and obligate wetland vegetation with limited soil sampling (Appendix C). Due to time constraints and the extent of the study area soil samples were only taken along a few transects of the seepage wetlands to confirm the presence of wetland conditions. The vegetation survey indicated that obligate wetland vegetation occurs within both wetland areas and was dominated by several obligate wetland sedges and grasses. This was also confirmed by soils samples in the wetland areas which indicated at least seasonal saturation of the soils and the formation of wetland systems (Appendix A: Map 3). The large wetland system and smaller wetland area to the east of it in the study area can be categorised as seepage wetlands (SANBI 2009).

The determination of the condition of the wetlands on the site will be confined to the large seepage system in the southern portion of the site. This will also incorporate the smaller seepage wetland to the east which also drains into this larger system. A WET-Health determination will be done for this large seepage system occurring on the site and should give an accurate indication of the current condition of the system and its vulnerability to impacts of the development. The WET-Health will be taken as representative of the Present Ecological State (PES) of this system (Appendix D).

The catchment of the wetland is dominated by previously ploughed fields and a large portion previously consisting of buildings and structures but now dominated by degraded land. The wetland itself is largely still intact though a few drainage ditches occur within it which will also have a high impact on the functioning of it. The seepage wetland system is affected by numerous impacts which result in a significant level of modification. The associated wetland area to the east was also included within this assessment. A WET-Health determination was undertaken for the seepage wetland to determine its current condition given the impacts affecting it (Appendix D). The results of the WET-Health indicated an overall Present Ecological State of Category C: Moderately Modified. This is considered relatively accurate given the largely transformed catchment and impacts within the wetland. The EI&S of the seepage wetland system has been rated as being Moderate.

A Risk Assessment for the proposed solar facility which will affect the seepage wetland areas in the southern portion of the site has been undertaken according to the Department of Water & Sanitation’s requirements for risk assessment and the provisional Risk Assessment Matrix for Section 21(c) & (i) water use (Appendix E). Aspects of the development that may have an impact on the surface water features of the site include, impacts on the large main seepage system and its buffer zone and impacts on the smaller seepage area to the east of it.

The large main seepage wetland system has clearly been identified as the main wetland system on the site and is considered as still providing several essential functions and is therefore considered as highly sensitive and being of high conservation value (Appendix A: Map 3). The wetland should therefore be completely excluded by the development and in order to ensure no further impacts on it occur, a 20 meter buffer zone should also be maintained around the edge of the wetland. As long as this is implemented successfully, the anticipated risk on the wetland should remain low.

The smaller seepage wetland approximately 200 meters to the east of the main wetland is quite heavily modified but still functions in terms of the surface water drainage of the area (Appendix A: Map 3). It also forms part of an area of remaining natural vegetation which also contributes towards its conservation value. Any impacts that the development will have on this smaller wetland would inevitably also affect the larger wetland system. The development should therefore consider excluding this wetland area from development. Should the development manage to exclude this area the risk will also be retained as low.

The impact significance has been determined and should development take place without mitigation it is anticipated that several moderate-high to high impacts will occur. The impact on remaining natural patches of grassland as well as the wetland systems in the southern portion of the site will especially be heavily affected. However, should adequate mitigation be implemented as described these can all be reduced to moderate and low-moderate impacts. This is however subject to the development footprint being retained within areas of low sensitivity and avoiding any patches of remaining natural grassland as well as the wetland systems on the site (Appendix A: Map 4).

9. RECOMMENDATIONS

- The survey has indicated several areas that are considered highly sensitive and with a high conservation value and should be excluded from development as far as possible (Appendix A: Map 4):

    - Remnants of endangered Vaal-Vet Sandy Grassland situated in the northern, western and southern corners of the site should be excluded from development and retained in their current condition.
    - The larger seepage wetland system in the southern portion of the site should be excluded from development and a 20 meter buffer around it also maintained (Appendix A: Map 3).
    - A smaller wetland area approximately 200 meters to the east of the larger wetland should also be excluded and avoided by development.

- The following recommendations and mitigation measures should be implemented in order to manage impacts on the seepage wetland systems on the site (Appendix A: Map 3):
    - Both wetland systems as delineated should be completely excluded from the development footprint in order to ensure no impacts on them occur (Appendix A: Map 3).
    - These wetland areas should be regarded as no-go areas and no construction or operational activities including stockpiling, clearing, laydown areas, vehicle movement or any other associated activities should occur in or near these systems.
    - The development should design and implement a comprehensive storm water management system in order to manage runoff and prevent erosion which will affect the wetland systems.
    - The storm water management system should include design of erosion prevention structures such as soakaways, attenuation areas and dissipation structures.
    - All structures and mitigation measures should be maintained throughout the lifetime of the development.
    - It will be important to implement a monitoring programme so that any changes to the surrounding wetlands can be identified quickly before it leads to irreversible changes. This monitoring programme should include, at least during the construction phase, a bi-annual biomonitoring of the affected wetlands. This should be conducted by a suitable qualified wetland specialist.
    - The necessary authorisations should be obtained from the Department of Water and Sanitation (DWS).

- Construction may affect the mammal population and care should therefore be taken to ensure none of the faunal species on site is harmed. The hunting, capturing or harming in any way of mammals on the site should not be allowed.

- Voids and excavations may also act as pitfall traps to fauna and these should continuously be monitored and any trapped fauna removed and released in adjacent natural areas. This should include mammals, reptiles and amphibians.

- In the event of poisonous snakes or other dangerous animals encountered on the site an experienced and certified snake handler or zoologist must remove these animals from the site and re-locate them to a suitable area.

- Due to the susceptibility of disturbed areas, it is recommended that weed control be judiciously and continually practised. Monitoring of weed establishment should form a prominent part of management of the development area and should be extended into the operational phase.

- Adequate monitoring of weed establishment and their continued eradication must be maintained (Appendix B). Where category 1 and 2 weeds occur, they require removal by the property owner according to the Conservation of Agricultural Resources Act, No. 43 of 1983 and National Environmental Management: Biodiversity Act, No. 10 of 2004.

- No littering must be allowed and all litter must be removed from the site.

- Construction should be confined to the site footprint and should not encroach into adjacent areas.

- After construction has ceased all construction waste should be removed from the area.

- Monitoring of construction including weed establishment and erosion should take place.

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Annexure A: Maps

Locality map for the proposed Harmony Central Plant PV solar development situated in Virginia, Free State Province.

Preparred for:
Savannah Environmental (Pty) Ltd
P.O. Box 148
Sunninghill
2157

Legend:

- Study area
- Watercourses
- NFEPA Wetlands
- Vaal-Vet Sandy Grassland

Map Information

Spheroid: WGS 84

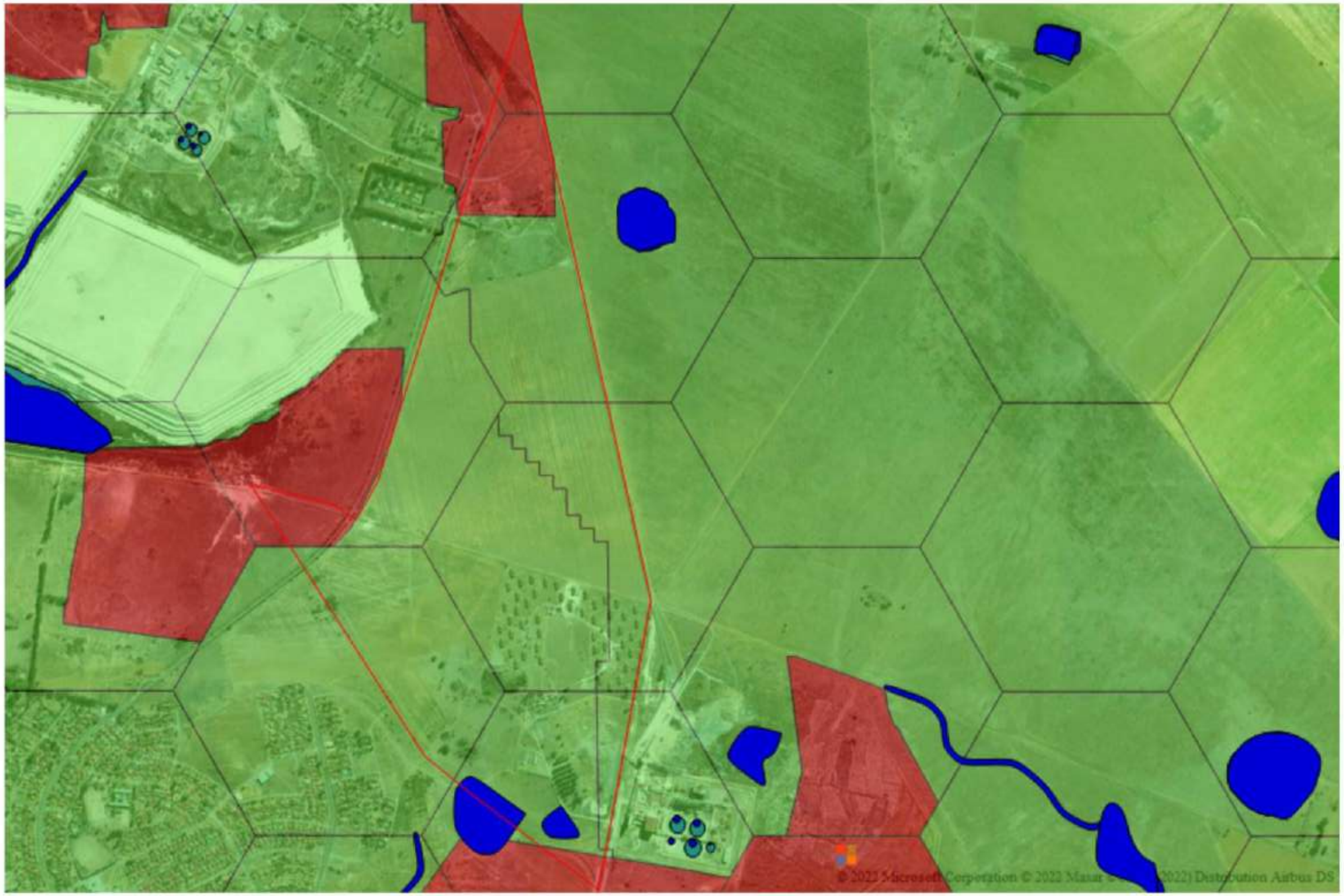
Quantum GIS

Scale: 1:25 000

DPR Ecologists
Contact Darius van Rensburg at:
darius@dprecologists.co.za
P.O. Box 12726, Brandhof, 9324
Tel: 083 410 0770

Map 1: Locality map of the proposed Harmony Central Plant PV solar development near the town of Virginia. Those portions of remaining and intact natural vegetation are indicated and it is clear that the majority of the study area has been transformed by agriculture and mining activities. Remaining natural areas also form part of the Endangered (EN) Vaal-Vet Sandy Grassland which is considered to have a high conservation value. Locations of NFEPA and probable identified wetland areas are also indicated. Note however that these may not be accurate and on-site delineation should be used for the location of wetlands (Map 3).

Free State Biodiversity Plan map for the proposed Harmony Central Plant PV solar development situated in Virginia, Free State Province.



Map 2: Free State Biodiversity Plan map of the proposed Harmony Central Plant PV solar development near the town of Virginia. The area is largely being regarded as Degraded and also indicates the largely transformed condition of the natural vegetation. Small portions of Critical Biodiversity Area 1 occur in the northern, western and southern corners of the site and indicate remnant patches of the Endangered Vaal-Vet Sandy Grassland which is considered essential for meeting conservation targets for this vegetation type.

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Legend:

- Study area
- Watercourses
- NFEPA Wetlands
- Critical Biodiversity Area 1
- Critical Biodiversity Area 2
- Ecological Support Area 1
- Ecological Support Area 2
- Degraded
- Other

Map Information

Spheroid: WGS 84

Quantum GIS

Scale: 1:25 000

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Wetland delineation map for the proposed Harmony Central Plant PV solar development situated in Virginia, Free State Province.

Map 3: Wetland delineation map of the proposed Harmony Central Plant PV solar development near the town of Virginia. A large wetland system is situated in the southern portion of the site. To the west of this wetland, a smaller seepage wetland area is also indicated. Both of these wetland areas should be excluded from development while a 20-meter buffer should also be retained around the larger wetland system. The wetland sampling points are also indicated.

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Sunninghill
2157

Legend:

- Study area
- Watercourses
- Delineated Wetland Areas
- 20-meter buffer
- Wetland sampling points

Map Information

Spheroid: WGS 84

Quantum GIS

Scale: 1:25 000

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Sensitivity map for the proposed Harmony Central Plant PV solar development situated in Virginia, Free State Province.

Preparred for:
Savannah Environmental (Pty) Ltd
P.O. Box 148
Sunninghill
2157

Legend:

- Study area
- Watercourses
- NFEPA Wetlands
- Very High Sensitivity
- High Sensitivity
- Moderate Sensitivity
- Low Sensitivity

Map Information

Spheroid: WGS 84

Quantum GIS

Scale: 1:25 000

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Map 4: Sensitivity map of the proposed Harmony Central Plant PV solar development near the town of Virginia. Areas which have been listed as CBA 1 areas represent portions of remaining Endangered grassland and should therefore be afforded a Very High level of sensitivity. Likewise the two wetland systems in the southern portion of the site should also be regarded as having a Very High level of sensitivity. A portion of remaining natural grassland in the southern portion of the site is not listed as a CBA 1 but still represents portions of remaining Endangered grassland which should therefore be regarded as having at least a High level of sensitivity. The remainder of the area consists of previously ploughed fields and built-up, but now rehabilitated, areas which, although indigenous grasses have been able to re-estalish is clearly degraded and transformed from the natural vegetation type.

Appendix B: Species list

Species indicated with an * are exotic.

Protected species are coloured orange and Red Listed species red.

Species	Growth form
**Agave americana*	Succulent
**Alternanthera pungens*	Herb
**Argemone ochroleuca*	Herb
**Arundo donax*	Reed
**Bidens bipinnata*	Herb
**Cestrum laevigatum*	Shrub
**Conyza bonariensis*	Herb
**Cyllindropuntia subalata*	Succulent
**Datura ferox*	Herb
**Echinopsis schikendantzii*	Succulent
**Emex australis*	Herb
**Eucalyptus camaldulensis*	Tree
**Flaveria bidentis*	Herb
**Gleditsia triacanthos*	Tree
**Laggera decurrens*	Herb
**Melia azedarach*	Tree
**Melilotus alba*	Herb
**Nerium oleander*	Shrub
**Opunti ficus-indica*	Succulent
**Opuntia humifusa*	Succulent
**Pennisetum setaceum*	Grass
**Pinus pinaster*	Tree
**Salsoli kali*	Herb
**Schinus molle*	Tree
**Schkuhria pinata*	Herb
**Tagetes minuta*	Herb
**Tamarix chinensis*	Tree
**Tipuana tipu*	Tree
**Verbena tenuisecta*	Herb
**Xanthium spinosum*	Herb
Androcymbium longipes	Geophyte
Arctotis venusta	Herb
Aristida bipartita	Grass
Aristida congesta	Grass
Berkehya onopordifolia	Herb
Berkheya macrocephala	Herb
Bulbine narcissifolia	Geophyte
Chloris virgata	Grass
Conyza podocephala	Herb
Crabbea acaulis	Herb

Cucumis myriocarpus	Creeper
Cycnium tubulosum subsp. *tubulosum*	Herb
Cymbopogon pospischillii	Grass
Cynodon dactylon	Grass
Cyperus congestus	Sedge
Cyperus longus	Sedge
Delosperma cooperi	Succulent
Dicoma macrocephala	Herb
Digitaria eriantha	Grass
Diplachne fusca	Grass
Eragrostis gummiflua	Grass
Eragrostis lehmanniana	Grass
Eragrostis obtusa	Grass
Eragrostis superba	Grass
Gazania krebsiana	Herb
Gomphocarpus fruticosus	Herb
Helichrysum caespititum	Herb
Hyparrhenia hirta	Grass
Lotononis listii	Herb
Massonia jasminiflora	Geophyte
Monsonia angustifolia	Herb
Moraea pallida	Geophyte
Nenax microphylla	Herb
Nidorella resedifolia	Herb
Nolletia ciliaris	Dwarf shrub
Paspalum distichum	Grass
Pentzia incana	Dwarf shrub
Pogonarthria squarrosa	Grass
Pollichia campestris	Herb
Polygala hottentotta	Herb
Rosenia humilis	Dwarf shrub
Salvia verbenaca	Herb
Schoenoplectus corymbosus	Sedge
Searsia lancea	Tree
Sebaea exigua	Herb
Selago densiflora	Herb
Solanum incanum	Herb
Stoebe plumosus	Dwarf shrub
Themeda triandra	Grass
Trichoneuris grandiglumis	Grass
Vachellia karroo	Tree

Appendix C: Soil Samples

Obligate wetland vegetation was utilised to determine the presence and border of wetlands. Soil samples were used to confirm the wetland conditions in the study area. Soil samples were taken at approximately 10 meter intervals. Soil samples were investigated for the presence of anaerobic evidence which characterises wetland soils.

Within wetlands the hydrological regime differs due to the topography and landscape. For instance; a valley bottom wetland would have a main channel that is below the water table and consequently permanently saturated, i.e. permanent zone of wetness. As you move away from the main channel the wetland would become dependent on flooding in order to be saturated. As a result along this hydrological regime areas of permanent saturation, seasonal and temporary saturation would occur. At some point along this gradient the saturation of the soil would be insufficient to develop reduced soil conditions and therefore will not be considered as wetland.

Within wetland soils the pores between soil particles are filled with water instead of atmosphere. As a result available oxygen is consumed by microbes and plantroots and due to the slow rate of oxygen diffusion oxygen is depleted and biological activity continues in anaerobic conditions and this causes the soil to become reduced.

Reduction of wetland soils is a result of bacteria decomposing organic material. As bacteria in saturated soils deplete the dissolved oxygen they start to produce organic chemicals that reduce metals. In oxidised soils the metals in the soil give it a red, brown, yellow or orange colour. When these soils are saturated and metals reduced the soil attains a grey matrix characteristic of wetland soils.

Within this reduction taking place in the wetland soils there may be reduced matrix, redox depletions and redox concentrations. The reduced matrix is characterised by a low chroma and therefore a grey soil matrix. Redox depletions result in the grey bodies within the soil where metals have been stripped out. Redox concentrations result in mottles within the grey matrix with variable shape and are recognised as blotches or spots, red and yellow in colour.

Soil wetness indicator is used as the primary indicator of wetlands. The colour of various soil components are often the most diagnostic indicator of hydromorphic soils. Colours of these components are strongly influenced by the frequency and duration of soil saturation. Generally, the higher the duration and frequency of saturation in a soil profile, the more prominent grey colours become in the soil matrix.

Coloured mottles, another feature of hydromorphic soils, are usually absent in permanently saturated soils and are at their most prominent in seasonally saturated soils, becoming less abundant in temporarily saturated soils until they disappear altogether in dry soils (Collins 2005).

The following soil wetness indicators can be used to determine the permanent, seasonal and temporary wetness zones. The boundary of the wetland is defined as the outer edge of the temporary zone of wetness and is characterised by a minimal grey matrix (<10%), few high chroma mottles and short periods of saturation (less than three months per year). The seasonal zone of wetness is characterised by a grey matrix (>10%), many low chroma mottles and significant periods of wetness (at least three months per year). The permanent zone of wetness is characterised by a prominent grey matrix, few to high chroma mottles, wetness all year round and sulphuric odour (rotten egg smell).

According to convention hydromorphic soil must display signs of wetness within 50 cm of the soil surface (DWAF 2005).

Appendix D: Index of Habitat Integrity (IHI)/WET-Health Summary

For the complete WET-Health please contact the author of this report.

Wetland Attributes	
The information in this sheet must be captured before continuing with any other aspects of the assessment. Not capturing all the information required will lead to errors in the spreadsheet calculations, which will prevent a final outcome being obtained.	
Wetland Name	Harmony Central
Assessment Unit Name / No.	1
Assessor	DP van Rensburg
Date of Assessment	24/05/2022
HGM Type (Basic)	Seep SEEP
HGM Type (Refined)	Seep SEEP
Conceptual model	Water and sediment inputs from the topographically defined catchment are assumed to emanate largely from lateral inputs, with limited inputs from the catchment upstream of the wetland. For the the purposes of geomorphic and water quality assesments, a weighting of 80% is therefore allocated to impacts associated with lateral inputs whilst impacts associated with the upstream catchment only contribute 20% to final catchment impact scores. For the hydrological assessment, weightings are based on the relative extent of contributing areas rather than default weightings.
Wetland size (Ha)	8
Upslope catchment size (Ha)	154.5
Quaternary Catchment[1]	C42J
MAR (Mm3)	13.0
MAR per unit area (m3/Ha)	195.0
MAP (mm)	521
PET (mm)	1600
MAP:PET ratio	0.3
Vulnerability Factor	1.0
Hydrogeological Type Setting[2]	Other
Connectivity of wetland to a regional aquifer	No connection
Change in groundwater levels in the regional aquifer	
Water quality of regional aquifer	
Channel characteristics (if present)	
Natural wetness regimes	Dominated by seasonally saturated soils
Broad vegetation attributes	Dominated by wetland grasses and sedges.
Number of dams in the catchment	0
Average surface area of dams (m2)	0
Perimeter of wetland (m)	1075
Perimeter-to-area ratio (m/ha)	134.4
Down-slope length of wetland (m)	320
Elevation change over length (m)	1
Longitudinal Slope (%)	0.3%
Propensity to erode (Category)[3]	Very low
Propensity to erode (Score)	1.0
Dominant sediment accumulation process	Clastic

	Wetland PES Summary			
Wetland name	**Harmony Central**			
Assessment Unit	**1**			
HGM type	Seep			
Areal extent (Ha)	8.0 Ha			
Unadjusted (modelled) Scores				
PES Assessment	**Hydrology**	**Geomorphology**	**Water Quality**	**Vegetation**
Impact Score	4.6	3.8	1.5	5.0
PES Score (%)	54%	62%	85%	50%
Ecological Category	**D**	**C**	**B**	**D**
Combined Impact Score	3.8			
Combined PES Score (%)	62%			
Combined Ecological Category	**C**			
Hectare Equivalents	4.9 Ha			
Confidence (modelled results)	RATE-TO-HIGH: Field-based assessment including information about the regional a			
Final (adjusted) Scores				
PES Assessment	**Hydrology**	**Geomorphology**	**Water Quality**	**Vegetation**
Impact Score	4.6	3.8	1.5	5.0
PES Score (%)	54%	62%	85%	50%
Ecological Category	**D**	**C**	**B**	**D**
Trajectory of change				
Confidence (revised results)	Not rated	Not rated	Not rated	Not rated
Combined Impact Score	3.8			
Combined PES Score (%)	62%			
Combined Ecological Category	**C**			
Hectare Equivalents	4.9 Ha			

Appendix E: Risk Assessment Matrix

RISK MATRIX (Based on DWS 2015 publication: Section 21 c and I water use Risk Assessment Protocol)

Risk to be scored for construction and operational phases of the project. MUST BE COMPLETED BY SACNASP REGISTERED PROFESSIONAL MEMBER REGISTERED IN AN APPROPRIATE FIELD OF EXPERTISE

					Severity																	
No.	Phases	Activity	Aspect	Impact	Flow Regime	Physico & Chemical (Water Quality)	Habitat (Geomorph+Vegetation)	Biota	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Confidence level	Control Measures
1	Mostly Construction Phase but also during operation	Construction of a solar facility	A large seepage system with high conservation value may be affected by the proposed development	The construction of the facility may encroach into the wetland which will directly affect or may also impact on the catchment of the wetland which will then have an indirect impact on it.	3	2	1	1	1.75	1	1	3.75	2	3	5	3	13	48.75	L	80	Provided that recommendations are implemented and that the wetland system as well as the 20 meter buffer zone is excluded from the development and is treated as no-go areas, the anticipated risk should remain low. As the development may still occur in relatively close proximity to it, it will also be important to implement a comprehensive storm water management system.
	Mostly Construction Phase but also during operation	Construction of a solar facility	A smaller seepage area occur to the ast of the main wetland and will also likely be affected by the development	The solar facility will exclude the smaller wetland area from the development footprint but may still have an indirect impact in terms of surface runoff.	2	2	1	1	1.5	1	1	3.5	2	3	5	3	13	45.5	L	80	Should the development be able to exclude the smaller seepage wetland area from development the risk will be retained as low. It will still be necessary to ensure the upslope development does not contribute to adverse impact on this area though given that the storm water management system will be implemented there the runoff from the development should not result in significant impacts on this area.

Appendix F: Buffer Zone Determination

Name of Assessor	Darius van Rensburg	Project Details	Harmony Central Solar Facility	Date of Assessment	24/05/2022

Step 1: Define objectives and scope of assessment and determine the most appropriate level of assessment

Level of assessment	Site-based

Step 2: Map and categorize water resources in the study area

Approach used to delineate the wetland boundary?	Site-based delineation	Wetland type	Seep

Step 3: Refer to the DWA management objectives for mapped water resources or develop surrogate objectives

Present Ecological State	C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.
Ecological importance & sensitivity	Medium	Features that are considered to be ecologically important and sensitive at a local scale. The functioning and/or biodiversity of these features is not usually sensitive to anthropogenic disturbances. They typically play a small role in providing ecological services at the local scale.
Management Objective	Maintain	

Step 4: Assess the risks from proposed developments and define mitigation measures necessary for protecting mapped water resources in the study area

Assess threats of planned activities on water resources and determine desktop buffer requirements

Proposed development / activity	Sector	Service infrastructure	Land use relating to the provision of all necessary utility services such as communication, municipal waste handling facilities and associated transfer pipeline infrastructure for fuels and water.
	Sub-Sector	Above-ground communication/power (electricity) infrastructure	Above-ground infrastructure designed for the transfer of power (electricity cables) or data (telephone lines).

Climatic factors	MAP Class	401 - 600mm	Rainfall Intensity	Zone 2

Overall size	**Size of the wetland relative to (as a percentage of) its catchment**	**Average slope of the wetland's catchment**	**The inherent runoff potential of the soil in the wetland's catchment**	**The extent to which the wetland (HGM) setting is generally characterized by sub-surface water input**
(6-50) Intermediate	10-20%	<3%	Moderately low	High (Hillslope seepage)
Perimeter to area ratio	**Vulnerability of the HGM type to sediment accumulation**	**Vulnerability of the site to erosion given the site's slope and size**	**Extent of open water, particularly water that is naturally clear**	**Sensitivity of the vegetation to burial under sediment**
Moderately low	Hillslope seep, Valley head seep, Unchannelled valley bottom	Low (Vulnerability score <2)	Very low (<0.5%)	Moderately low
Peat versus mineral soils	**Inherent level of nutrients in the landscape: is the wetland and its catchment underlain by sandstone?**	**Sensitivity of the vegetation to increased availability of nutrients**	**Sensitivity of the vegetation to toxic inputs, changes in acidity & salinization**	**Natural wetness regimes**
Mineral	Partially	Moderately low	Moderately low	Dominated by seasonally saturated soils
Natural salinity levels	**Level of domestic use**	**Mean Annual Temperature**	Note: See the guideline document for further information on the rationale for indicator selection and how these attributes affect the sensitivity of wetlands to lateral inputs.	
Naturally low saline levels	Low	Zone 3 (16.9 - 18.2 Deg C)		
Buffer attributes	**Buffer Segment 1**	**Buffer Segment 2**	**Buffer Segment 3**	**Buffer Segment 4**
Slope of the buffer	Gentle (2.1 - 10%)			
Vegetation characteristics (Construction phase)	Moderately low: Moderately low density with moderate basal cover (e.g. Forests, shrub dominated vegetation / heavily grazed grassland)			
Vegetation characteristics (Operational phase)	Low: Sparse vegetation cover with large areas of bare soil			
Soil permeability	Moderate: Moderately textured soils (e.g. sandy loam).			
Topography of the buffer zone	Dominantly uniform topography: Dominantly smooth topography with few/minor concentrated flow paths to reduce interception.			
Site-based aquatic impact buffer requirements (without additional mitigation measures)				
Construction Phase	**20**	**Not Assessed**	**Not Assessed**	**Not Assessed**
Operational Phase	**15**	**Not Assessed**	**Not Assessed**	**Not Assessed**
	Buffer Segment 1	**Buffer Segment 2**	**Buffer Segment 3**	**Buffer Segment 4**
Final aquatic impact buffer requirements (including practical management considerations)				
Construction Phase	**20**	**Not Assessed**	**Not Assessed**	**Not Assessed**
Operational Phase	**15**	**Not Assessed**	**Not Assessed**	**Not Assessed**
Final aquatic impact buffer requirement	**20**	**Not Assessed**	**Not Assessed**	**Not Assessed**

Appendix G: Impact methodology

Direct, indirect and cumulative impacts associated with the projects must be assessed in terms of the following criteria:

- » The **nature**, which shall include a description of what causes the effect, what will be affected and how it will be affected.
- » The **extent**, wherein it will be indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 will be assigned as appropriate (with 1 being low and 5 being high):
- » The **duration**, wherein it will be indicated whether:
  - ∗ the lifetime of the impact will be of a very short duration (0–1 years) – assigned a score of 1;
  - ∗ the lifetime of the impact will be of a short duration (2-5 years) - assigned a score of 2;
  - ∗ medium-term (5–15 years) – assigned a score of 3;
  - ∗ long term (> 15 years) - assigned a score of 4; or
  - ∗ permanent - assigned a score of 5;
- » The **magnitude**, quantified on a scale from 0-10, where 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
- » The **probability** *of occurrence*, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale of 1–5, where 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).
- » the **significance**, which shall be determined through a synthesis of the characteristics described above and can be assessed as low, medium or high; and
- » the **status**, which will be described as either positive, negative or neutral.
- » the degree to which the impact can be reversed.
- » the degree to which the impact may cause irreplaceable loss of resources.
- » the *degree* to which the impact can be *mitigated.*

The **significance** is calculated by combining the criteria in the following formula:

S=(E+D+M)P

S = Significance weighting
E = Extent
D = Duration
M = Magnitude
P = Probability

The **significance weightings** for each potential impact are as follows:

- » < 30 points: Low (i.e. where this impact would not have a direct influence on the decision to develop in the area),

» 30-60 points: Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated),
» > 60 points: High (i.e. where the impact must have an influence on the decision process to develop in the area).

Assessment of impacts must be summarised in the following table format. The rating values as per the above criteria must also be included. Complete a table and associated ratings for **each** impact identified during the assessment.

***Example* of Impact table summarising the significance of impacts (with and without mitigation)**

<table>
<tr><td colspan="4">Nature:
[Outline and describe fully the impact anticipated as per the assessment undertaken]</td></tr>
<tr><td colspan="4">Impact description: The impact will occur due to added pressure on the availability of housing located in the local community. This may contribute to increased levels of competition in the temporary housing market.</td></tr>
<tr><td></td><td>Rating</td><td>Motivation</td><td>Significance</td></tr>
<tr><td colspan="4">Prior to Mitigation</td></tr>
<tr><td>Duration</td><td>Short-term (1)</td><td>The construction period will last for less than one year</td><td rowspan="4">Low Negative (18)</td></tr>
<tr><td>Extent</td><td>Local (1)</td><td>Pressure will only be added on the local municipality to provide housing for outsourced construction workers</td></tr>
<tr><td>Magnitude</td><td>Low (4)</td><td>The increase in demand for affordable accommodation should not be extensive as workers will primarily be sourced from the local communities.</td></tr>
<tr><td>Probability</td><td>Probable (3)</td><td>The possibility of the impact on the provision of affordable accommodation is very low</td></tr>
<tr><td colspan="4">Mitigation/Enhancement Measures</td></tr>
<tr><td colspan="4">Mitigation:
“Mitigation“, means to anticipate and prevent negative impacts and risks, then to minimise them, rehabilitate or repair impacts to the extent feasible.
Provide a description of how these mitigation measures will be undertaken keeping the above definition in mind.</td></tr>
<tr><td colspan="4">Post Mitigation/Enhancement Measures</td></tr>
<tr><td>Duration</td><td>Short-term (1)</td><td>Pressure will only be added on the local municipality to provide housing for outsourced construction workers.</td><td rowspan="3">Low Positive (8)</td></tr>
<tr><td>Extent</td><td>Local (1)</td><td>The increase in demand for affordable accommodation should be mitigated if external construction crews are provided with onsite accommodation.</td></tr>
<tr><td>Magnitude</td><td>Minor (2)</td><td>The possibility of the impact on the</td></tr>
</table>

		provision of affordable accommodation is very low.	
Probability	Improbable (2)	A reduced amount of pressure will be added on the local municipality to provide housing for outsourced construction workers.	
Cumulative impacts: "Cumulative Impact", in relation to an activity, means the past, current and reasonably foreseeable future impact of an activity, considered together with the impact of activities associated with that activity, that in itself may not be significant, but may become significant when added to existing and reasonably foreseeable impacts eventuating from similar or diverse activities.			
Residual Risks: "Residual Risk", means the risk that will remain after all the recommended measures have been undertaken to mitigate the impact associated with the activity (Green Leaves III, 2014).			

Assessment of Cumulative Impacts

As per requirements of the EIA Regulations, specialists are required to assess the cumulative impacts. In this regard, please refer to the methodology below that will need to be used for the assessment of Cumulative Impacts.

"Cumulative Impact", in relation to an activity, means the past, current and reasonably foreseeable future impact of an activity, considered together with the impact of activities associated with that activity, that in itself may not be significant, but may become significant when added to existing and reasonably foreseeable impacts eventuating from similar or diverse activities[1].

The role of the cumulative assessment is to test if such impacts are relevant to the proposed project in the proposed location (i.e. whether the addition of the proposed project in the area will increase the impact). This section should address whether the construction of the proposed development will result in:

» Unacceptable risk
» Unacceptable loss
» Complete or whole-scale changes to the environment or sense of place
» Unacceptable increase in impact

The specialist is required to conclude if the proposed development will result in any unacceptable loss or impact considering all the projects proposed in the area.

Example of a cumulative impact table:

Nature: Complete or whole-scale changes to the environment or sense of place (example)

Nature: **[Outline and describe fully the impact anticipated as per the assessment undertaken]**		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**

1 Unless otherwise stated, all definitions are from the 2014 EIA Regulations, as amended, GNR 326

Extent	Low (1)	Low (1)
Duration	Medium-term (3)	Long-term (4)
Magnitude	Minor (2)	Low (4)
Probability	Improbable (2)	Probable (3)
Significance	**Low (12)**	**Low (27)**
Status (positive or negative)	Negative	Negative
Reversibility	High	Low
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes	Yes
Confidence in findings: High.		
Mitigation: "Mitigation", means to anticipate and prevent negative impacts and risks, then to minimise them, rehabilitate or repair impacts to the extent feasible. Provide a description of how these mitigation measures will be undertaken keeping the above definition in mind.		

TerraAfrica
SOIL. AGRICULTURE. ENVIRONMENT.

Agricultural Agro-Ecosystem Assessment for proposed 14MWac Harmony Central Plant Solar PV Facility

Submitted by TerraAfrica Consult cc

Mariné Pienaar

09 August 2022

DOCUMENT AND QUALITY CONTROL

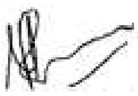
Client	Savannah Environmental (Pty) Ltd
Applicant	HARMONY GOLD MINING CO (LTD)
Document Title	Agricultural Agro-Ecosystem Report for the proposed 140MWac Harmony Central Plant Solar PV Facility
Document Version	Draft Report

Report Version	Responsible Person	Role/Responsibility	Signed	Date
Draft for Comment	Mariné Pienaar	Report Author		09/08/2022

Specialist Declaration

I, Mariné Pienaar , declare that –

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.



Mariné Pienaar

TerraAfrica Consult CC

09 August 2022

Table of Contents

1. Introduction 6
2. Project description 6
3. Details of the specialist 9
4. Purpose and objectives of the assessment 9
5. Legislative framework for the assessment 11
6. Agricultural Sensitivity 11
7. Assumptions, limitations and information gaps 14
8. Methodology 15
8.1 Desktop analysis of satellite imagery and other spatial data 15
8.2 Site assessment 16
9. Baseline description of the agro-ecosystem 19
9.1 Climate 19
9.2 Land type classification 21
9.3 Soil properties 23
9.3.2 Soil texture 25
9.3.3 Soil fertility parameters 26
9.4 Land capability and agricultural potential 26
9.5 Land use 29
10. Agricultural production and employment 29
10.1 Agricultural income and employment 29
10.2 Comparative benefit analysis 31
11. Agricultural sensitivity of the site 32
11.1 Sensitivity rating of current development footprint layout 32
11.2 Consideration of Alternatives 32
11.3 Allowable development limits 35
12. Impact assessment of additional environmental impacts 35
12.1 Project description 35
11.2 Impact significance rating 36
12 Cumulative Impacts 40
13 Mitigation and management measures 43
14 Acceptability statement 45
15. Reference list 46
APPENDIX 1 – CURRICULUM VITAE OF SPECIALIST 47

List of Figures

Figure 1 Locality of the proposed Harmony Central Plant solar PV facility development area 7

Figure 2 Layout map of the infrastructure of the proposed Harmony Central Plant solar PV facility 8

Figure 3 Relative Agricultural Sensitivity from DFFE's Screening Tool of the Harmony Central Plant solar PV Facility development area (generated by Savannah Environmental, 06 June 2022) 12

Figure 4 Position of High Agricultural Areas around the Harmony Central Plant solar PV Facility development area (data source: DALRRD, 2021) 13

Figure 5 Locality of the observation points within the development area 17

Figure 6 Climate data for Welkom (source: Meteoblue, 2022) 19

Figure 7 Climate capability rating of the Harmony Central Plant development area (source: DALRRD, 2017) 20

Figure 8 Terrain form sketch of Land Type Bd20 22

Figure 9 Land type classification of the Harmony Central development area 22

Figure 10 Soil map of the Harmony Central development area 23

Figure 11 Example of the Bainsvlei soils within the development area.. 24

Figure 12 Area with Technosols within the development area 25

Figure 13 Land capability map of the Harmony Central development area (DALRRD, 2016) 27

Figure 14 Agricultural potential of the Harmony Central development area... 28

Figure 15 Long-term grazing capacity of the Harmony Central development area 30

Figure 16 Agricultural sensitivity of the Harmony Central development area.. 34

Figure 17 Other renewable energy projects within a 50km radius of the Harmony Central solar PV facility development area (source: Savannah Environmental)... 41

List of Tables

Table 1 Summary of particle size distribution and soil texture classes of the soil samples analysed 25

Table 2 Gross livestock income forecast for the proposed development footprint.................................... 31

Table 3 Summary of the impact of the development footprint on the agricultural sensitivity of the site 32

Table 4 Calculated allowable development limits according to the confirmed project site sensitivity 35

Table 5 Assessment of cumulative impact of decrease in areas available for livestock farming 42

Table 6 Assessment of cumulative impact of areas susceptible to soil erosion 42

Table 7 Assessment of cumulative impact of increased risk of soil pollution 42

1. Introduction

Terra-Africa Consult cc was appointed by Savannah Environmental (Pty) Ltd (Savannah Environmental) to conduct the Agricultural Agro-Ecosystem Assessment for the proposed 14MWac Harmony Central Plant Solar PV Facility. The report is part of the studies required for the Basic Assessment process required for the Environmental Authorisation (EA) of renewable energy projects. The applicant of the project is HARMONY GOLD MINING CO (LTD). The proposed project will consist of the construction and operation of a $14MW_{ac}$ Photovoltaic (PV) and associated infrastructure as well as grid connection infrastructure that consists of an overhead line of up to 132 kV. The overhead line will tie-in to the Harmony North (6.6/44kV) substation.

A development site of up to 165 ha for Central Solar PV has been identified, of which approximately 33.6 ha will be utilized for the project footprint. The development site is located around 6km North east of the town of Virginia and 11km South east of the town of Welkom within the Matjhabeng Local Municipality and within the Lejweleputswa District Municipality of the Free State Province (refer to Figure **1**). The development site is located on the following land parcels:

- Portion 12 of Farm Saaiplaas 771
- Portion 1 of Farm Rustgevonden 564

2. Project description

The project entails the development of a Solar PV Energy Facility with a capacity of up to14MW. Infrastructure associated with the solar PV facility will include the following (see Figure 2 for the layout of the infrastructure):

- Solar PV array comprising bifacial PV modules and mounting structures, using single axis tracking technology. Once installed will stand up to 5m above ground level.
- Inverters and transformers a SCADA room, and maintenance room
- Cabling between the project components.
- Balance of Plant:
    - Existing spare switchgear panels upgraded switchgear circuit breakers or additional switchgear panels.
    - EK self-build works as defined in the CEL.
- On-site facility substation to facilitate the connection between the solar PV facility and Eskom electricity grid. The Size and Capacity of each of the on-site stations will be 40MW, 20MW, 40MW respectively
- An onsite Medium voltage (MV) switching station forming part of the collector substation
- Temporary Laydown areas.
- Access roads, internal roads and fencing around the development area.
- Up to 132kV Overhead Power Lines (OHPL) – maximum of 30m height with a 30m servitude width
- Underground LV cabling will be used on the PV site

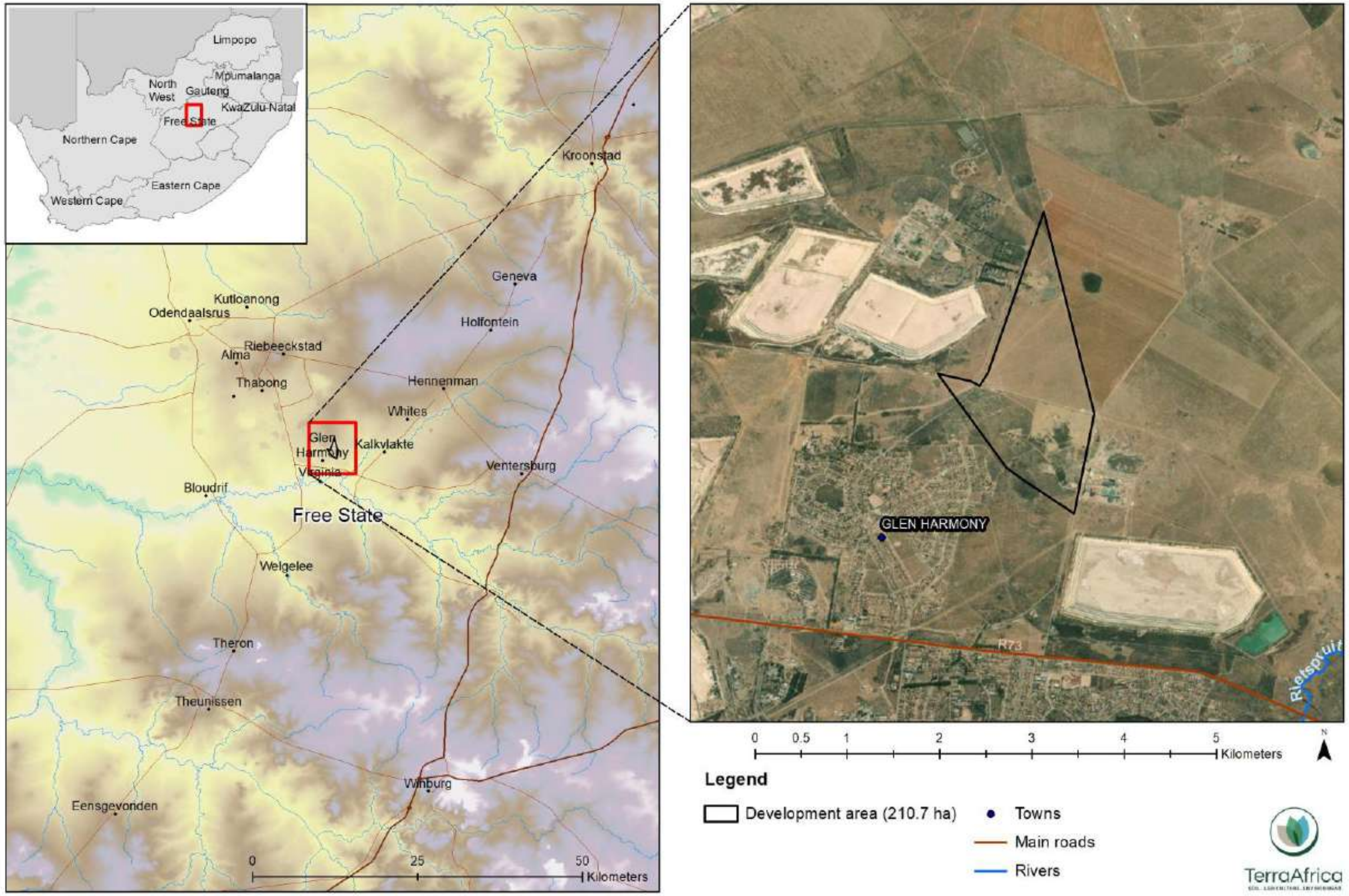


Figure 1 Locality of the proposed Harmony Central Plant solar PV facility development area

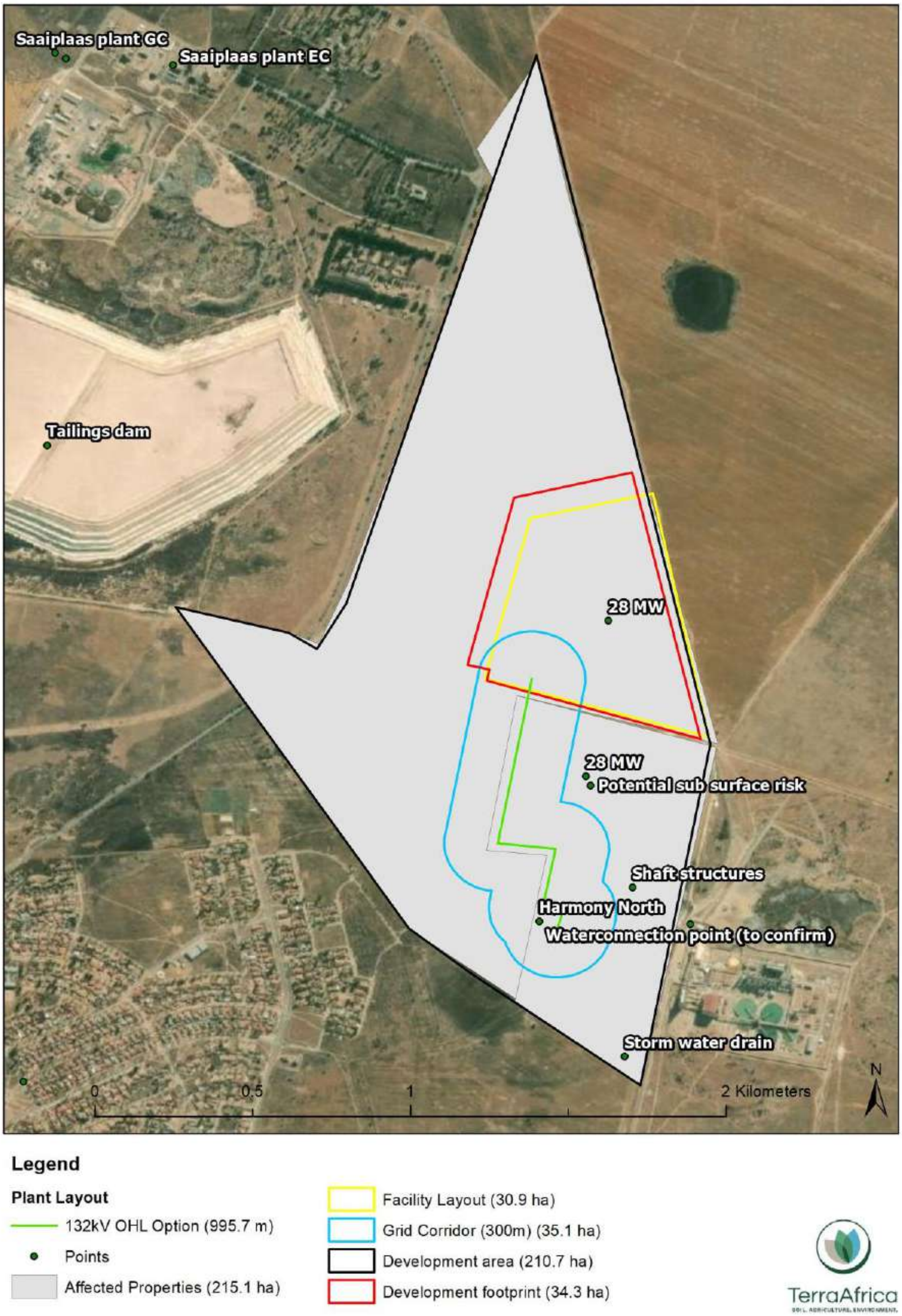


Figure 2 Layout map of the infrastructure of the proposed Harmony Central Plant solar PV facility

3. Details of the specialist

Mariné is a scientist registered with the South African Council for Natural Scientific Professions (SACNASP) and is specialised in the fields of Agricultural Science and Soil Science. Her SACNASP Registration Number is 400274/10. Mariné holds a BSc. degree in Agricultural Science (with specialisation in Plant Production) from the University of Pretoria and a MSc. Degree in Environmental Science from the University of the Witwatersrand. She has consulted in the subject fields of soil, agriculture, pollution assessment and land use planning for the environmental sector of several African countries including Botswana, Mozambique, Democratic Republic of Congo, Liberia, Ghana and Angola. She has also consulted on the soil and agricultural assessment of a gas infrastructure project in Afghanistan. Her contact details are provided in Appendices 1 and 2 attached.

4. Purpose and objectives of the assessment

The overarching purpose of the Agricultural Agro-Ecosystem Specialist Assessment (from here onwards also referred to as the Agricultural Assessment) that will be included in the final Environmental Impact Assessment Report, is to ensure that the sensitivity of the site to the proposed land use change (from agriculture to renewable energy generation) is sufficiently considered. Also, that the information provided in this report, enables the Competent Authority to come to a sound conclusion on the impact of the proposed project on the food production potential of the site. To meet this objective, site sensitivity verification must be conducted of which the results must meet the following objectives:

- It must confirm or dispute the current land use and the environmental sensitivity as was indicated by the National Environmental Screening Tool.
- It must contain proof of the current land use and environmental sensitivity pertaining to the study field.
- All data and conclusions are submitted together with the Basic Assessment report for the proposed Harmony Central Plant solar PV Facility.

According to GN320, the Agricultural Agro-Ecosystem Assessment that is submitted must meet the following requirements:

- It must identify the extent of the impact of the proposed development on the agricultural resources.
- It has to indicate whether or not the proposed development will have an unacceptable impact on the agricultural production capability of the site, and in the event where it does, whether such a negative impact is outweighed by the positive impact of the proposed development on agricultural resources.

The following checklist is supplied as per the requirements of GNR 320, detailing where in the report the various requirements have been addressed:

GNR 320 requirements of an Agricultural Agro-Ecosystem Statement (High to Very High Sensitivity)	Reference in this report
Details and relevant experience as well as the SACNASP registration number of the soil scientist or agricultural specialist preparing the assessment including a curriculum vitae;	Section 3 and Appendices 1 & 2
A signed statement of independence by the specialist;	Appendix 1
The duration, date and season of the site inspection and the relevance of the season to the outcome of the assessment;	Section 8.2
A description of the methodology used to undertake the on-site assessment inclusive of the equipment and models used, as relevant;	Section 8.2
A map showing the proposed development footprint (including supporting infrastructure) with a 50m buffered development envelope, overlaid on the agricultural sensitivity map generated by the screening tool;	Section 6, Figure 3
An indication of the potential losses in production and employment from the change of the agricultural use of the land as a result of the proposed development;	Section 10
An indication of possible long term benefits that will be generated by the project in relation to the benefits of the agricultural activities on the affected land;	Section 10.2
Additional environmental impacts expected from the proposed development based on the current status quo of the land including erosion, alien vegetation, waste, etc.;	Section 12
Information on the current agricultural activities being undertaken on adjacent land parcels;	Section 9.5
A motivation must be provided if there were development footprints that were identified as having a “medium” or “low” agriculture sensitivity and that were not considered appropriate;	Sections 11.1 and 11.2
Confirmation from the soil scientist or agricultural specialist that all reasonable measures have been considered in the micro-siting of the proposed development to minimise fragmentation and disturbance of agricultural activities;	Section 11
A substantiated statement from the soil scientist or agricultural specialist with regards to agricultural resources on the acceptability or not of the proposed development and a recommendation on the approval or not of the proposed development;	Section 14
Any conditions to which this statement is subjected;	Sections 12 and 14
Where identified, proposed impact management outcomes or any monitoring requirements for inclusion in the Environmental Management Programme (EMPr);	Section 13
A description of the assumptions made and any uncertainties or gaps in knowledge or data;	Section 7
Calculations of the physical development footprint area for each land parcel as well as the total physical development footprint area of the proposed development (including supporting infrastructure);	Table **3**
Confirmation whether the development footprint is in line with the allowable development limits set in Table 1 above, including where applicable any deviation from the set development limits and motivation to support the deviation, including: a) Where relevant, reasons why the proposed development footprint is required to exceed the limit;	Section 11.3, Table 4

b) Where relevant, reasons why this exceedance will be in the national interest; and c) Where relevant, reasons why there are no alternative options available including evidence of alternatives considered; and	
A map showing the renewable energy facilities within a 50km radius of the proposed development.	Section 13, **Error! Reference source not found.**

5. Legislative framework for the assessment

The report follows the protocols as stipulated for the Agricultural Assessment in Government Notice 320 of 2020 (GN320). This Notice provides the procedures and minimum criteria for reporting in terms of Sections 24(5)(a) and (h) and 44 of the National Environmental Management Act (No. 107 of 1998) (from here onwards referred to as NEMA). It replaces the previous requirements of Appendix 6 of the Environmental Impact Assessment Regulations of NEMA.

In addition to the specific requirements for this study, the following South African legislation is also considered applicable to the interpretation of the data and conclusions made with regards to environmental sensitivity:

- The Conservation of Agricultural Resources (Act 43 of 1983) states that the degradation of the agricultural potential of soil is illegal. This Act requires the protection of land against soil erosion and the prevention of water logging and salinisation of soils by means of suitable soil conservation works to be constructed and maintained. The utilisation of marshes, water sponges and watercourses are also addressed.
- Section 3 of the Subdivision of Agricultural Land Act 70 of 1970 may also relevant to the development.
- In addition to this, the National Water Act (Act 36 of 1998) deals with the protection of water resources, including wetlands. This legislation is considered for the purpose of identifying hydric soils with wetland functionality within the study area (should it be present).

6. Agricultural Sensitivity

For the purpose of the assessment, the development area of the Harmony Central Plant solar PV Facility, was screened for agricultural sensitivity using the National Environmental Screening Tool (www.screening.environment.gov.za). The screening report for the PV project site was generated by Savannah Environmental on 6 June 2022 and presented as Figure 3. The requirements of GN320 stipulates that a 50m buffered development envelope must be assessed with the screening tool. While the development area was used for the screening, the surrounding area is also visible in each map (which shows a buffered area of 1km or more around the development area boundary).

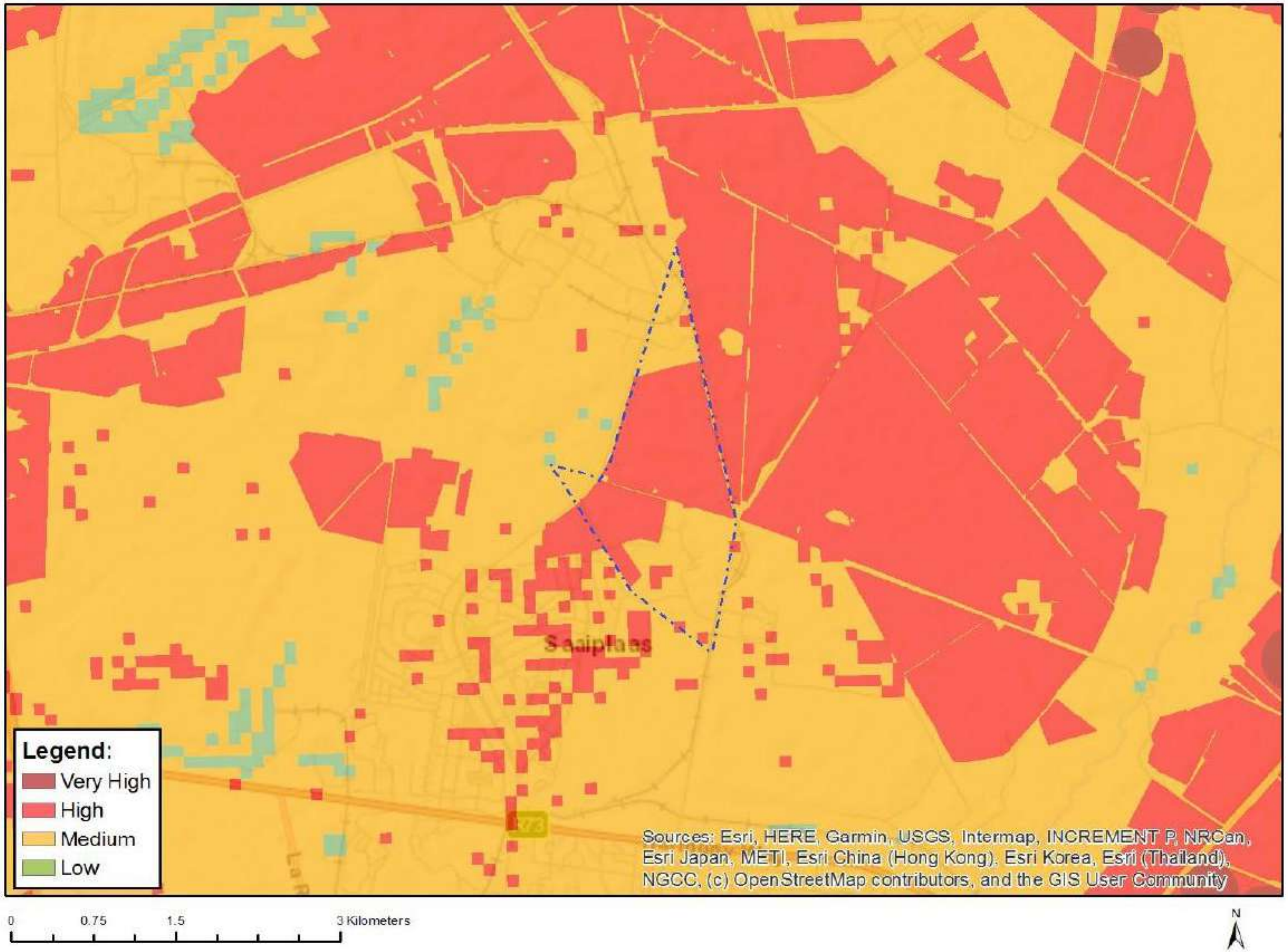


Figure 3 Relative Agricultural Sensitivity from DFFE's Screening Tool of the Harmony Central Plant solar PV Facility development area (generated by Savannah Environmental, 06 June 2022)

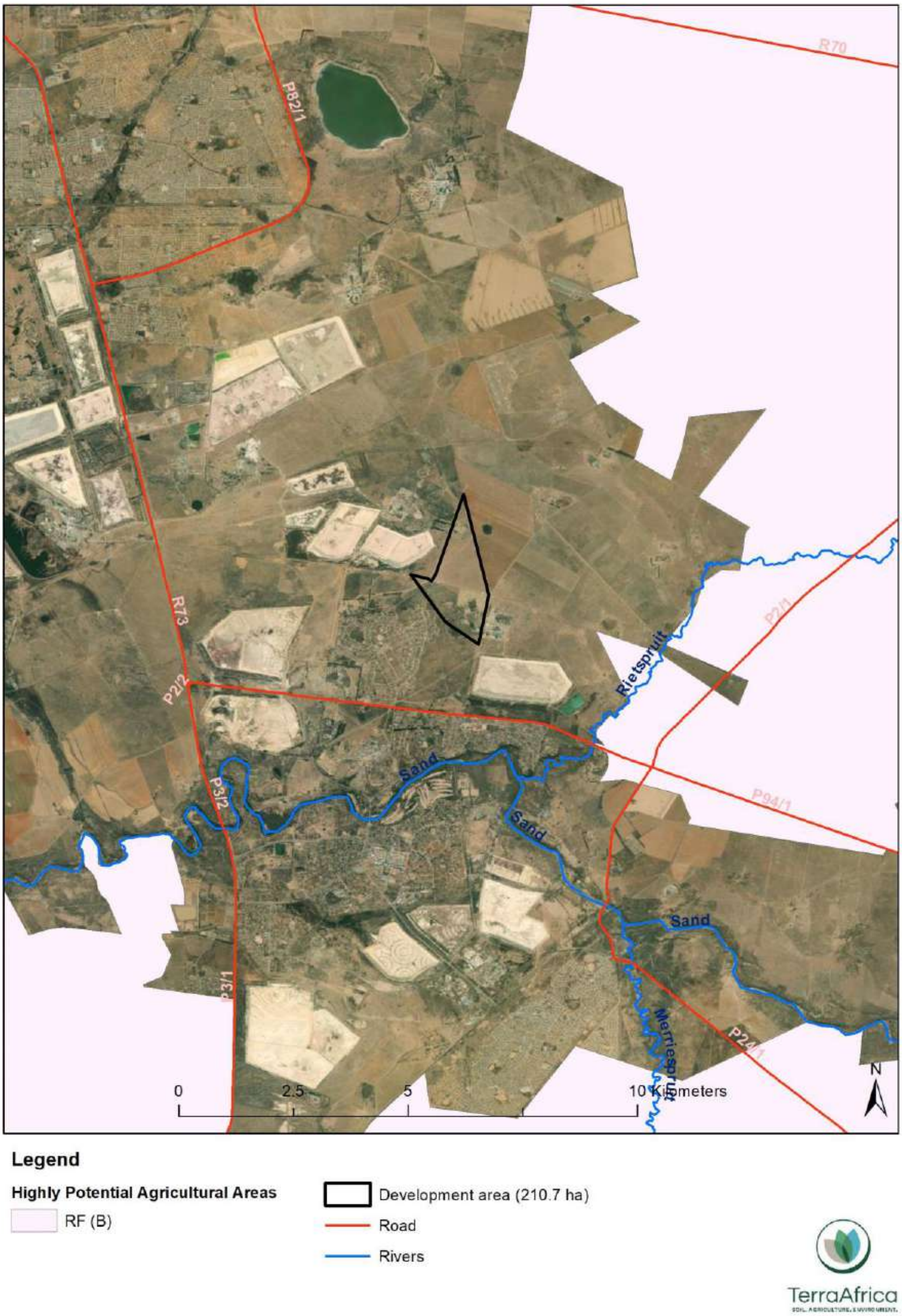


Figure 4 Position of High Agricultural Areas around the Harmony Central Plant solar PV Facility development area (data source: DALRRD, 2021)

According to Figure 3, approximately 60 to 65% of the development area consists of land with High agricultural sensitivity. The High sensitivity area occurs largely in a wide horizontal strip across the middle of the area while smaller isolated areas of High sensitivity are present along the southern and eastern boundaries of the area. The remaining areas within the development area, consist of land with Medium sensitivity.

Outside of the development area, the areas north west, south west and south east of the development area consists mainly of land with Medium agricultural sensitivity while the areas to the north east and the south west, consists mainly of land with High sensitivity. Approximately three-quarters of the area has High sensitivity while the most southern part has Medium sensitivity.

In alignment with the CARA, the Department of Agriculture, Land Reform and Rural Development (DALRRD) developed spatial data that depict High Potential Agricultural Areas (HPAAs) of the different provinces of South Africa (DALRRD, 2019). According to the DALRRD, these areas can be defined as: *"large, relative homogeneous portions of high value agricultural land that has the potential to sustainably, in the long-term, contribute significantly to the production of food.*"

In addition to the relative agricultural sensitivity of the area presented in Figure 3, the spatial data of the HPAAs of the Free State Province were evaluated (refer to Figure 4). According to this data, the entire development area falls is located outside any HPAA. The nearest HPAA, is a rainfed agricultural area with Category B priority rating (with Class A being the highest priority). This area is located between 5 and 7km to the east of the Harmony Central development area and the proposed development will therefore not affect the HPAA or result in fragmentation of it.

7. Assumptions, limitations and information gaps

The following assumptions are embedded within the results and discussions 0f this report:

- It is assumed that the development footprint will remain within the boundaries of the development area and be located where the development footprint of 34.3ha is indicated in Figure **2**.
- It is also assumed that the grid connection infrastructure will remain within the grid corridor that was assessed.
- it is assumed that the development footprint of the PV facility will be fenced off and excluded as land available for any future farming activities;
- it is assumed that the grid connection area will not be fenced off and that grazing around the powerline will be possible, and
- it is further assumed that the activities for the construction and operation of the infrastructure are limited to that typical for the construction and operation of a solar PV facility, inclusive of the infrastructure listed in Section 10.1.

The following limitation is part of the assessment:

- the anticipation and rating of impacts are based on the report author's knowledge and experience on the nature of construction and operation of PV facilities and grid connection infrastructure. Therefore, it is done as accurately as possible but must not be considered as absolute measures.

The following information gap regarding historical land use was identified:

- The current landowner (Harmony Gold) purchased the properties in 2014 and indicated that since the land was purchased, there were no agricultural production. While the new landowners indicated that there were agricultural activities on the properties when it was still owner by the previous landowner, they could not provide additional information on whether there was crop farming or livestock farming only.

No other information gaps or uncertainties are identified.

8. Methodology

8.1 Desktop analysis of satellite imagery and other spatial data

The most recent aerial photography of the area available from Google Earth was obtained. The satellite imagery was analysed prior to the site visit to determine any areas of existing impacts and land uses within the Harmony Central development area as well as the surrounding areas. It was also scanned for any areas where crop production and farming infrastructure may be present. To get a comprehensive overview of the natural resources that contribute to the agro-ecosystem of the proposed project site, the following spatial data was analysed:

- The National Land Capability Evaluation Raster Data Layer was obtained from the DAFF to determine the land capability classes of the project area according to this system. The data was developed using a spatial evaluation modelling approach (DAFF, 2017).
- The long-term grazing capacity for South Africa 2018 was analysed for the area and surrounding area of the project assessment zone. This data set includes incorporation of the RSA grazing capacity map of 1993, the Vegetation type of SA 2006 (as published by Mucina L. & Rutherford M.C.), the Land Types of South Africa data set as well as the KZN Bioresource classification data. The values indicated for the different areas represent long term grazing capacity with the understanding that the veld is in a relatively good condition.
- The Free State Field Crop Boundaries (November 2019) was analysed to determine whether the proposed project assessment zone falls within the boundaries of any crop production areas. The crop production areas may include rainfed annual crops, non-pivot and pivot irrigated annual crops, horticulture, viticulture, old fields, small holdings and subsistence farming.

8.2 Site assessment

The development area was visited twice. The first site visit was on 9 and 10 June 2022 (winter). The site assessment included a soil classification survey, the collection of soil samples as well as the collection of photographic evidence about the current land uses. The season has no effect on the outcome of the assessment. The soil profiles were examined to a maximum depth of 1.5 m or the point of refusal using a hand-held soil auger. Observations were made regarding soil texture, structure, colour and soil depth at each survey point. A cold 10% hydrochloric acid solution was used on site to test for the presence of carbonates in the soil. The soils are described using the S.A. Soil Classification: A Natural and Anthropogenic System for South Africa (Soil Classification Working Group, 2018).

For soil mapping of the development area, the soils were grouped into classes with relatively similar soil characteristics. The locality of each of the survey points, are indicated in Figure **5** below. Photographic evidence of soil properties, current land uses and other evidence were taken with a digital camera.

8.3 Analysis of samples

Four soil samples were collected at two of the observation points. At each of the two observation points, a topsoil and subsoil sample were collected. The soil was stored and sealed in clean sampling bags and submitted to Van's Lab in Bloemfontein for analysis. Samples were analysed for the following parameters:

- pH (using potassium chloride);
- Major cationic plant nutrients (calcium, magnesium, potassium, sodium) using ammonium acetate;
- Plant-available phosphorus (using Bray 1 extract); and
- Texture (using the three-sieve technique to determine the particle size distribution).

8.4. Agricultural income and employment

The landowner indicated that the development area has not been used for agricultural production from 2014 when they purchased the land. During the site visit, it was observed that cattle belonging to the locality community traverse through the area and it is likely that they use the area occasionally as grazing for their livestock. No crops have been cultivated within the development area since 2014. Therefore, the spatial data layer of the long-term grazing capacity of the area (DALRRD, 2018), was used for the calculations of the potential agricultural gross income of the land as well as the agricultural employment opportunities that it provides.

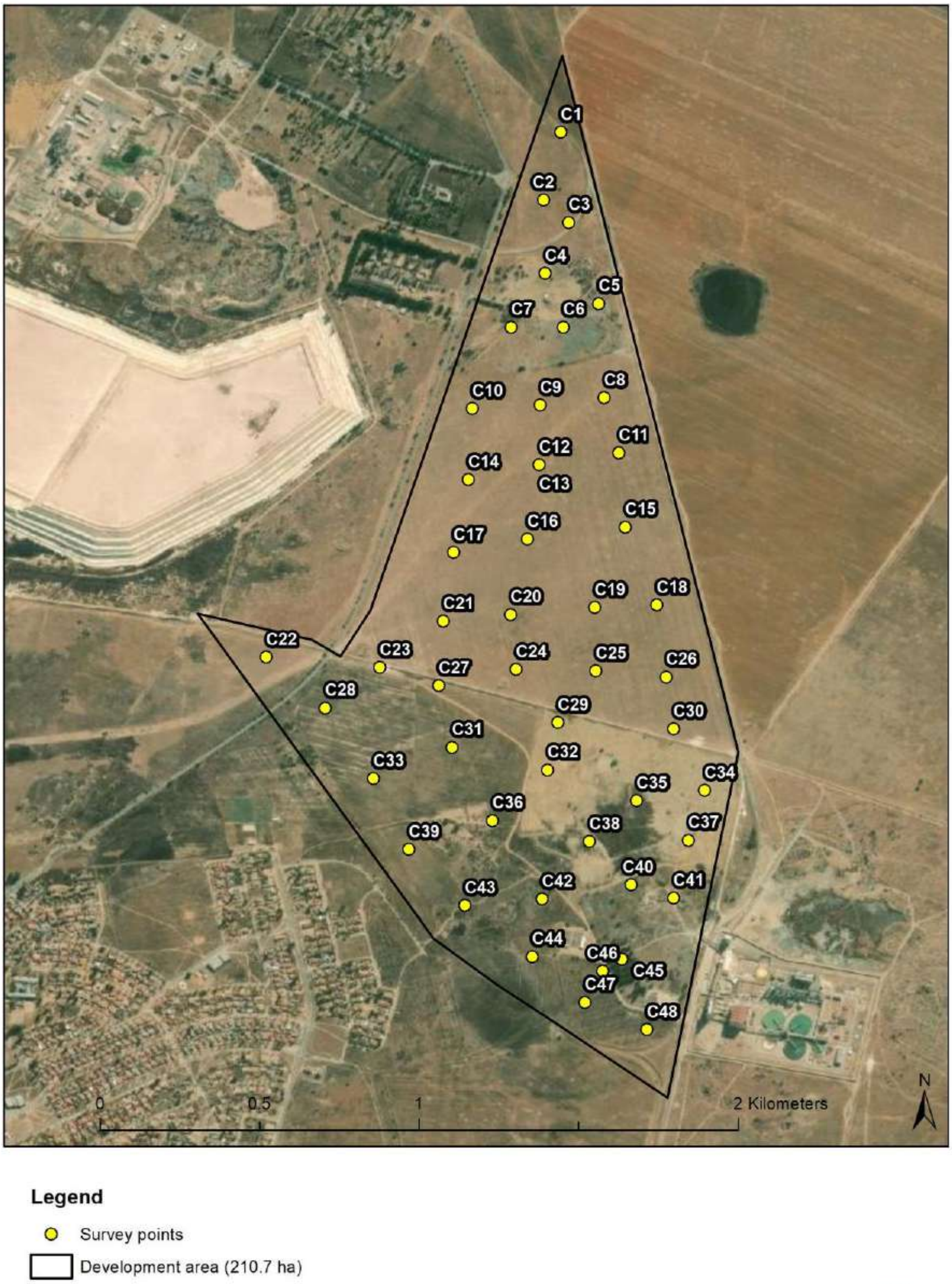


Figure 5 Locality of the observation points within the development area

8.5. Impact assessment methodology

Following the methodology prescribed by Savannah Environmental (Pty) Ltd., the direct, indirect and cumulative impacts associated with the project have been assessed in terms of the following criteria:

- The **nature**, which shall include a description of what causes the effect, what will be affected and how it will be affected.
- The **extent**, wherein it will be indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 will be assigned as appropriate (with 1 being low and 5 being high):
- The **duration**, wherein it will be indicated whether:
    - the lifetime of the impact will be of a very short duration (0–1 years) – assigned a score of 1;
    - the lifetime of the impact will be of a short duration (2-5 years) - assigned a score of 2;
    - medium-term (5–15 years) – assigned a score of 3;
    - long term (> 15 years) - assigned a score of 4; or
    - permanent - assigned a score of 5;
- The **magnitude**, quantified on a scale from 0-10, where 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
- The **probability** *of occurrence*, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale of 1–5, where 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).
- the **significance**, which shall be determined through a synthesis of the characteristics described above and can be assessed as low, medium or high; and
- the **status**, which will be described as either positive, negative or neutral.
- the degree to which the impact can be reversed.
- the degree to which the impact may cause irreplaceable loss of resources.
- the *degree* to which the impact can be *mitigated.*

The **significance** is calculated by combining the criteria in the following formula:

S=(E+D+M)P

S = Significance weighting
E = Extent
D = Duration

M = Magnitude
P = Probability

The **significance weightings** for each potential impact are as follows:

- < 30 points: Low (i.e. where this impact would not have a direct influence on the decision to develop in the area),
- 30-60 points: Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated),

60 points: High (i.e. where the impact must have an influence on the decision process to develop in the area).

9. Baseline description of the agro-ecosystem

9.1 Climate

The modelled climate data for Welom (as modelled and presented by Meteoblue, 2022) was used to describe the climate of the development area as Welkom is located approximately 20 km away. The climate data is depicted in Figure 6.

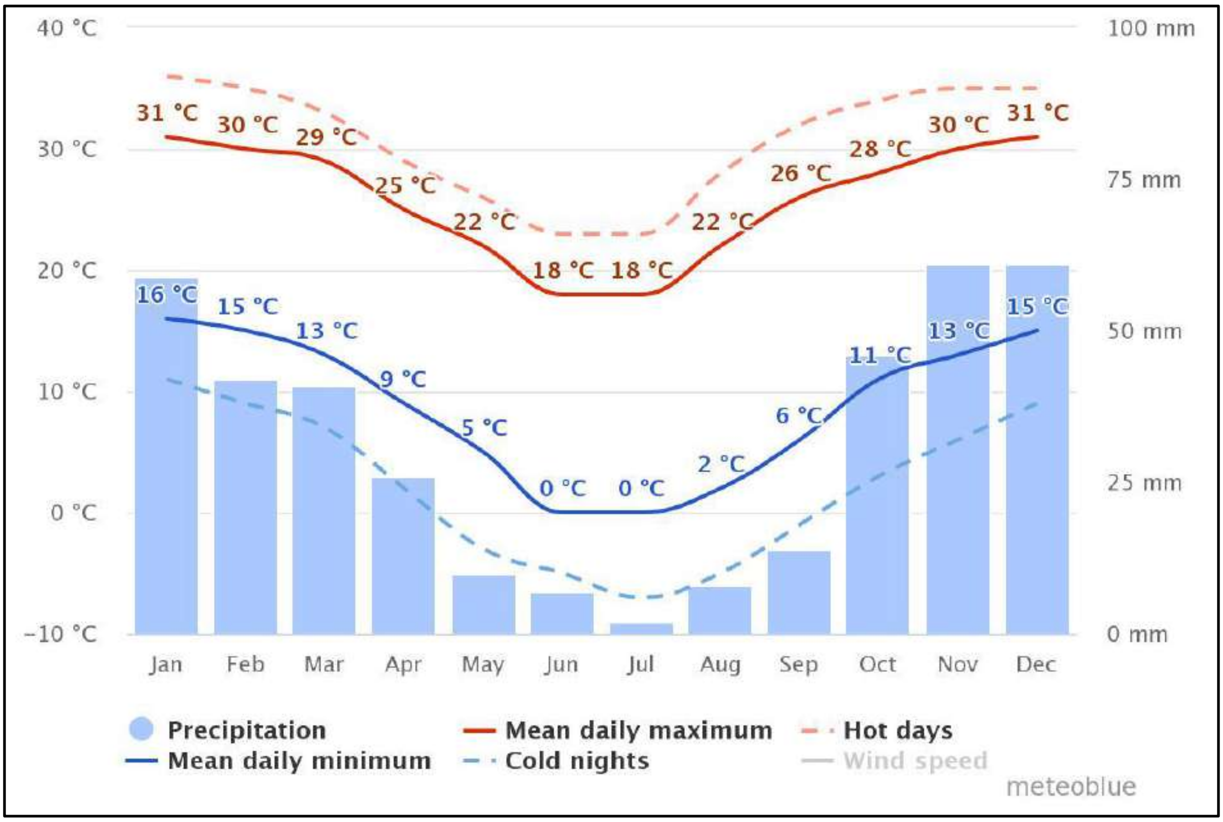


Figure 6 Climate data for Welkom (source: Meteoblue, 2022)

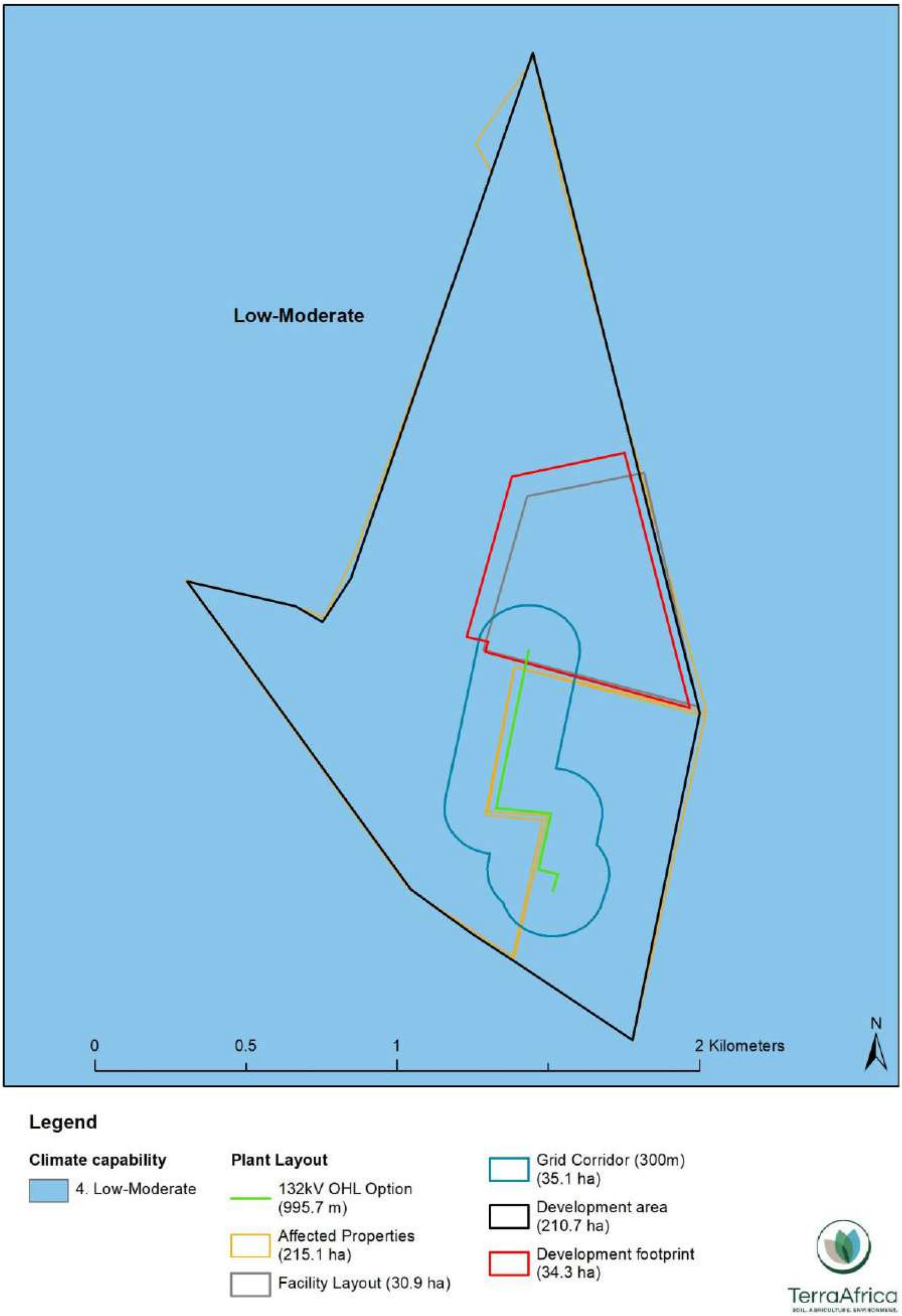


Figure 7 Climate capability rating of the Harmony Central Plant development area (source: DALRRD, 2017)

The mean daily maximum temperatures for Welkom ranges between 18°C June and 31°C in summer (the hottest months are December and January). The mean daily minimum temperatures range between 0°C in June and July and 16°C in December and January. The area has summer rainfall with the onset of the dry winter months from May through to September. The highest precipitation is in November and December with an average of 61 mm per month, with the month of January having the second highest average precipitation rate of 59 mm, respectively. The lowest average precipitation rate is from June to August with monthly averages of 2 to 8 mm.

The Department of Agriculture, Forestry and Fisheries (2017) compiled an updated description of the agricultural suitability of South African climatic conditions, accompanied by a raster data layer of the entire country. The description of climate capability refers to a definition by Strydom (2014) that defines it as the "capability of a geographic area to grow an agricultural crop under existing climatic conditions" (DAFF, 2017). The climate capability includes three parameters i.e., moisture supply capacity, physiological capacity, and climatic constraints. The climate capability classes range from 1 (the lowest or worst) to 9 (the highest or best climate for agricultural production).

According to the climate capability raster data, the entire development area has Low-Moderate (Class 04) climate capability (refer to **Error! Reference source not found.**). This indicates that the climate of the area is marginally suitable for rainfed crop production and climate limitations include periods of drought during the summer months, frost during winter months and the possibility of hail that presents hazards to rainfed crop production.

9.2 Land type classification

The entire development area as well as the area around it, consists of Land Type Bd20 (see Figure 9). This land type consists of four terrain units and the landscape can be described as flat to slightly undulating with the slope ranging between 1 and 2% (refer to Figure 8). The soil formed from sandstone, mudstone and shale of the Ecca and Beaufort Groups. The entire land type area consists of 55% crests (Terrain unit 1) and 40% mid-slopes (Terrain unit 3). The crests (Terrain unit 1) of deep Clovelly, Avalon and Hutton soil forms (mostly deeper than 1.2m). The texture of soil in this terrain unit is sandy-loam and sand-clay-loam.

The mid-slopes consist of a similar combination of soil forms with similar textures. While the foot-slopes consist of 50% Hutton soils deeper than 1m, it also includes soils with higher clay content and stronger structure such as the Valsrivier, Arcadia, Rensburg, Katspruit and Oakleaf forms. The valley bottoms consist exclusively of these soils with moderate to strong structure and higher clay content

The complete land type sheet of each land type is attached as Appendix 3.

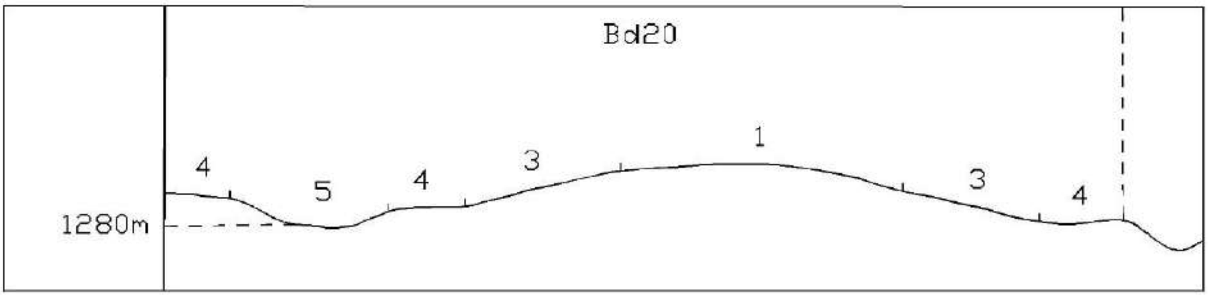


Figure 8 Terrain form sketch of Land Type Bd20

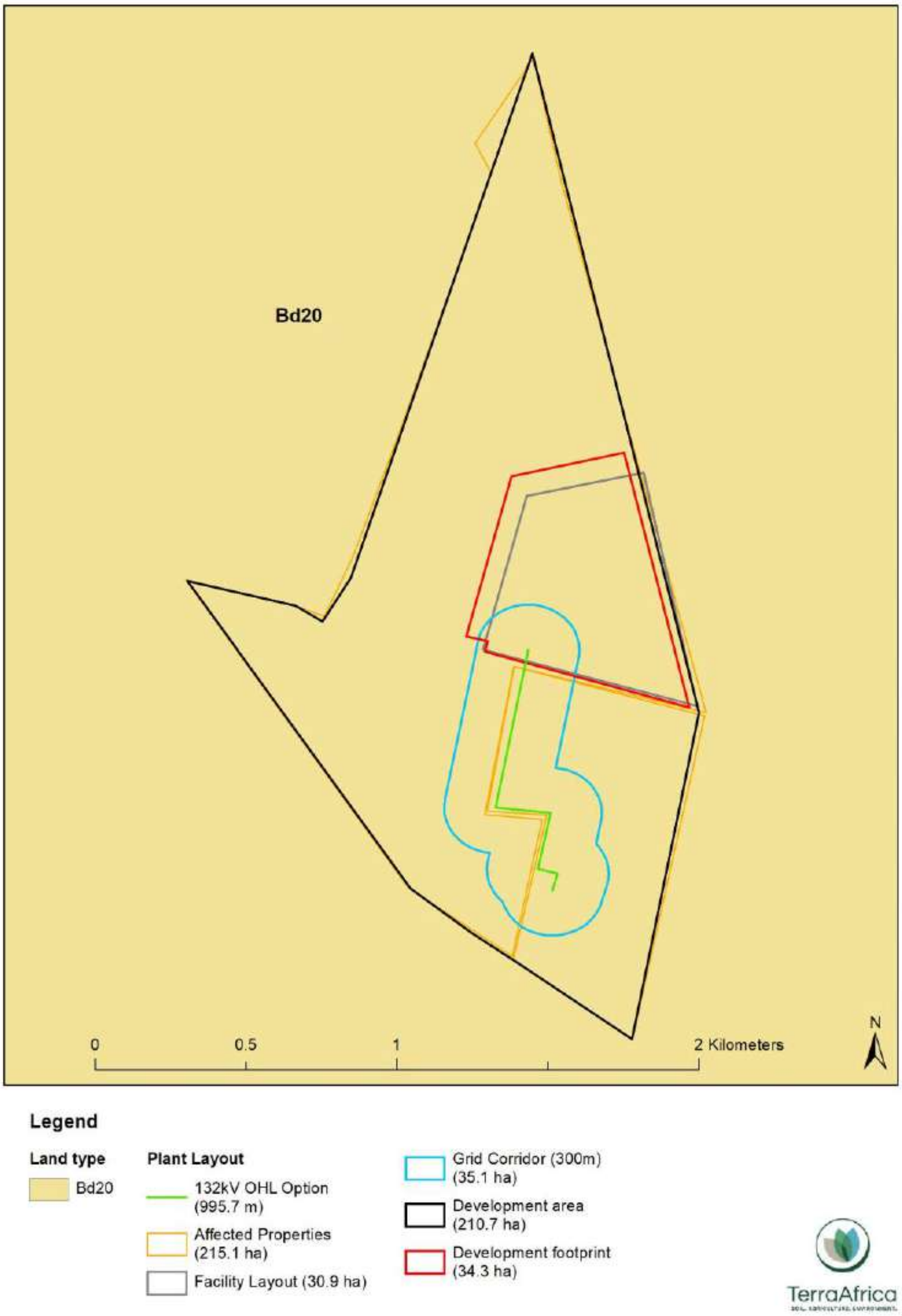


Figure 9 Land type classification of the Harmony Central development area

9.3 Soil properties

9.3.1 Soil forms

Three different soil forms are present within the Harmony Central development area (see **Error! Reference source not found.**). The two natural soil forms (Avalon and Bainsvlei) are grouped together as one mapping unit because of the similarity in horizon organization and effective soil depth.

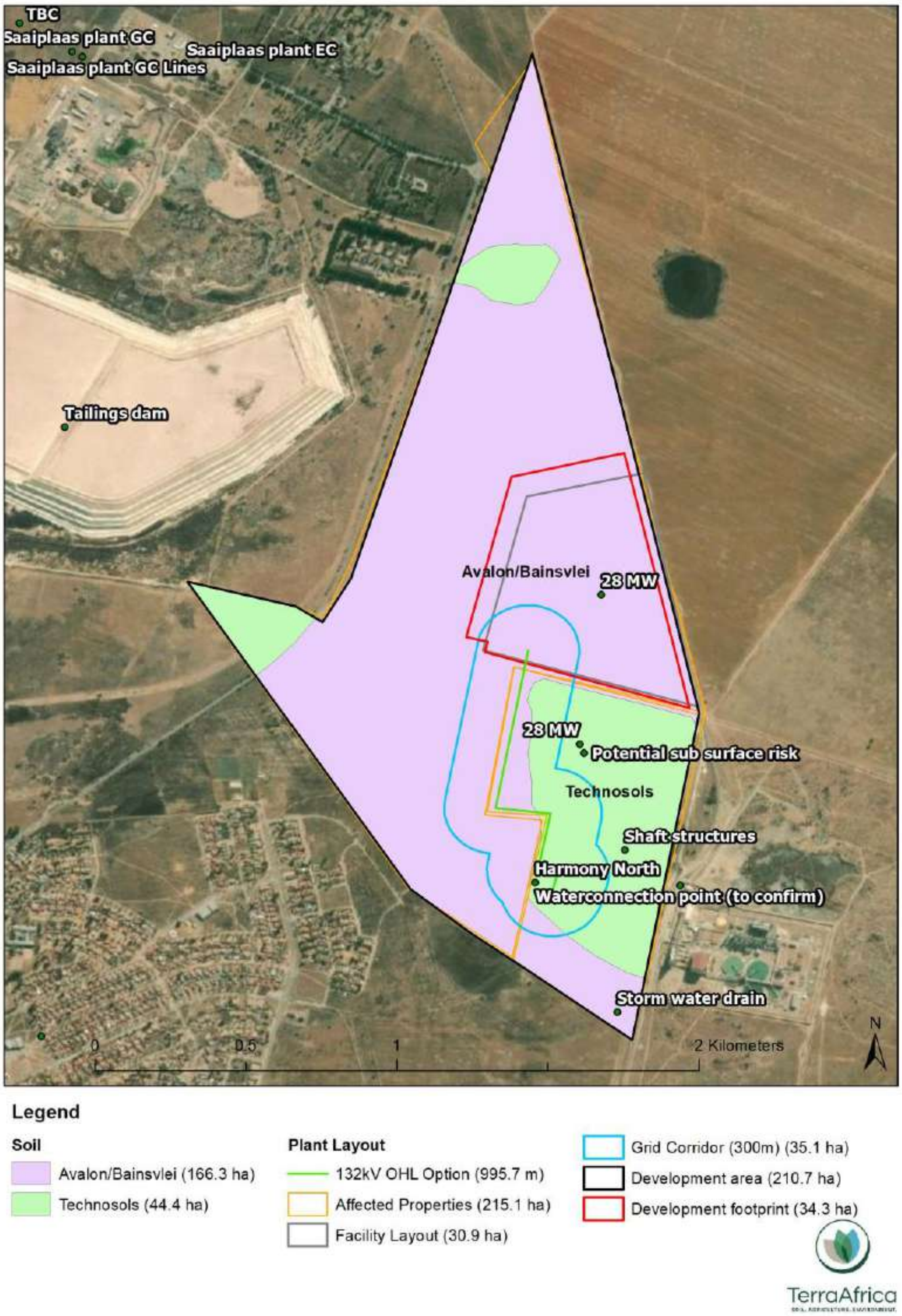


Figure 10 Soil map of the Harmony Central development area

Avalon/Bainsvlei soils

Avalon and Bainsvlei soils are present on 166.3 ha of the development area. The entire development area of 34.3 ha as well as the western part of the grid corridor, consists of Avalon and Bainsvlei soils. These soils consist of orthic topsoil that overlies apedal subsoil. The apedal subsoil is underlain by soft plinthic material that varies in thickness between 300 and 900mm. The effective depth of the soil profiles (topsoil and subsoil above the soft plinthic material) ranges between 300 and 800mm. The only difference between the Avalon and Bainsvlei soils, is the colour of the apedal horizon. Avalon soil profiles have yellow-brown apedal horizons with specified “yellow” colours (Soil Classification Working Group, 2018) while the red apedal horizon has “red” soil colours in both the moist and dry states.

Figure 11 Example of the Bainsvlei soils within the development area

Technosols

The remaining 44.4 ha of the development area consists of Technosols, located in three separate areas along the western and eastern boundaries. Technosols are defined as material from mining, industrial, construction or urban activities that supply parent materials for new anthropogenic soils (Soil Classification Working Group, 2018).

All three the areas of Technosols are in close proximity to existing mine infrastructure such as the tailings dam to the north west and the Central plant that is located east of the development area. The nature of the disturbance in the areas of the Technosols is a mixture of transported materials, areas of previous excavation and areas previously compacted by temporary infrastructure. The scope of this assessment does not include analysis of samples for soil contamination; therefore, it is not known whether there are any chemically polluted Technosols present on site.

Figure 12 Area with Technosols within the development area

9.3.2 Soil texture

The soil texture of the natural soil forms (Avalon and Bainsvlei) present within the proposed development area, was calculated by using the results of the particle size analysis for the soil texture triangle formulas as provided on the website of the United States Department of Agriculture's under Natural Resource Conservation Services (Soil) (www.nrcs.usda.gov). The results of the particle size analysis of the soil samples as well as the soil texture class into which results translate, are presented in Table 1 below. Following the results, the topsoils within the development area has Sandy Loam texture and the subsoils have Sandy Clay Loam texture, showing an increase in clay content with depth of the profiles.

Table 1 Summary of particle size distribution and soil texture classes of the soil samples analysed

Sample no:	**Particle size distribution (%)**			**Texture class**
	Sand	**Silt**	**Clay**	
C1 A (Topsoil)	73,2	9,2	17,6	Sandy Loam
C1 B (Subsoil)	68,2	11,0	21,2	Sandy Clay Loam
C8 A (Topsoil)	78,5	5,4	16,9	Sandy Loam
C8 B (Subsoil)	46,2	22,1	32,1	Sandy Clay Loam

9.3.3 Soil fertility parameters

From the perspective of the soil fertility parameters analysed, the soil does not have any limitations to crop production. The soil pH(KCl) values range between strongly acidic (pH 5.36 for sample C8 A) and moderately acidic (pH 5.74 for sample C8 B). For crop production, pH values above 4.5 is recommended to prevent aluminium toxicities, prevent phosphate fixation, and allow for optimal nutrient uptake by crop roots. However, should the soil have been used for crop production, the soil pH levels are suitable and can be raised through the addition of agricultural lime.

The calcium levels range between 599 mg/kg in sample C1 A and 2523.44 mg/kg in sample C8 B. The magnesium levels are the lowest in sample C8 A (137.83 mg/kg) and highest in sample C8 B (550.76 mg/kg). The potassium levels range between a low of 262.47 mg/kg in sample C8 A and 414.69 mg/kg in sample C8 B. The cation concentrations (calcium, magnesium and potassium) are present at sufficient concentrations should the soil have been used for crop production.

The plant-available phosphorus levels are low in all samples analysed and range between 3.38 mg/kg (sample C1 B) and 7.36 mg/kg (sample C1 A). The low phosphorus levels are an indication that any previous crop production within the project site has been abandoned a few years ago and that no phosphorus containing fertilizer has been applied in the area since then. Low soil phosphorus concentrations are typical of soils under natural vegetation (and without the addition of fertilizer) in South Africa.

9.4 Land capability and agricultural potential

9.4.1 Land capability

The land capability as determined by Department of Agriculture, Land Reform and Rural Development (DALRRD) through a spatial delineation process, was shown by overlying the project site boundary on the land capability raster data (DALRRD, 2016). According to DALRRD (2016), land capability is defined as the most intensive long-term use of land for purposed of **rainfed farming** determined by the interaction of climate, soil and terrain.

The largest area of the Harmony Central development area consists of land with Moderate (Class 08) land capability. This land capability class is predominantly present along the western, southern, and northern boundaries. Small, isolated areas with Moderate-High (Class 09) land capability and Low-Moderate (Classes 06 and 07) land capability are present between the land with Moderate (Class 08) land capability.

The area around the development area also consists mainly of land with Moderate (Class 08) land capability with an area of lower land capability situated north west of the development area and small areas with higher land capability located south west of the development area.

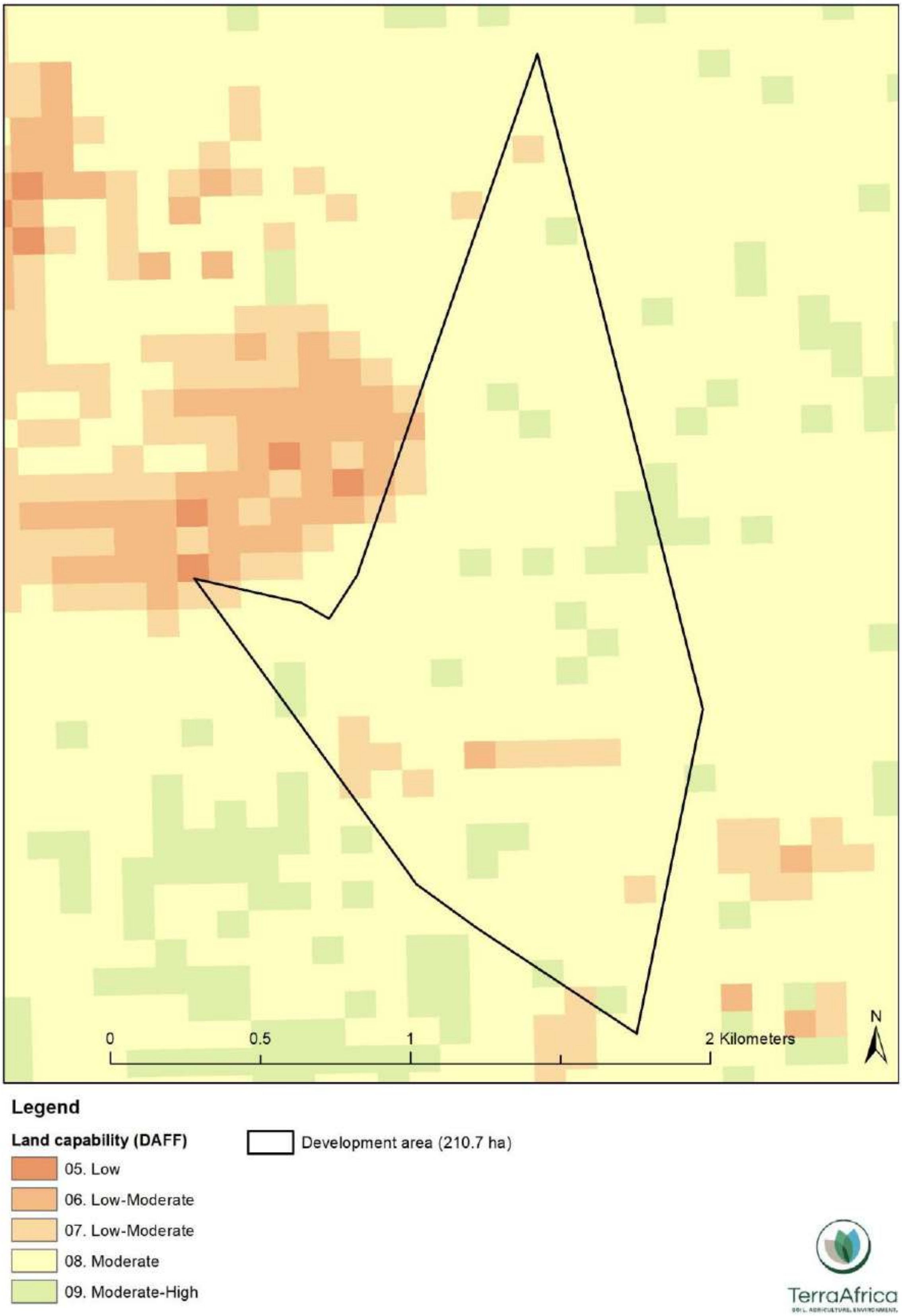


Figure 13 Land capability map of the Harmony Central development area (DALRRD, 2016)

9.4.2 Agricultural potential

Agricultural potential is defined as a measure of potential productivity per unit area and unit time achieved with specified management inputs and for a given crop or veld type and level of management, largely determined by the interaction of soil climate and terrain (DALRRD, 2016). For the proposed Harmony Central development area, the agricultural potential was derived from the soil classification of the site and its potential for rainfed production of grain crops. The delineation is shown in Figure 14.

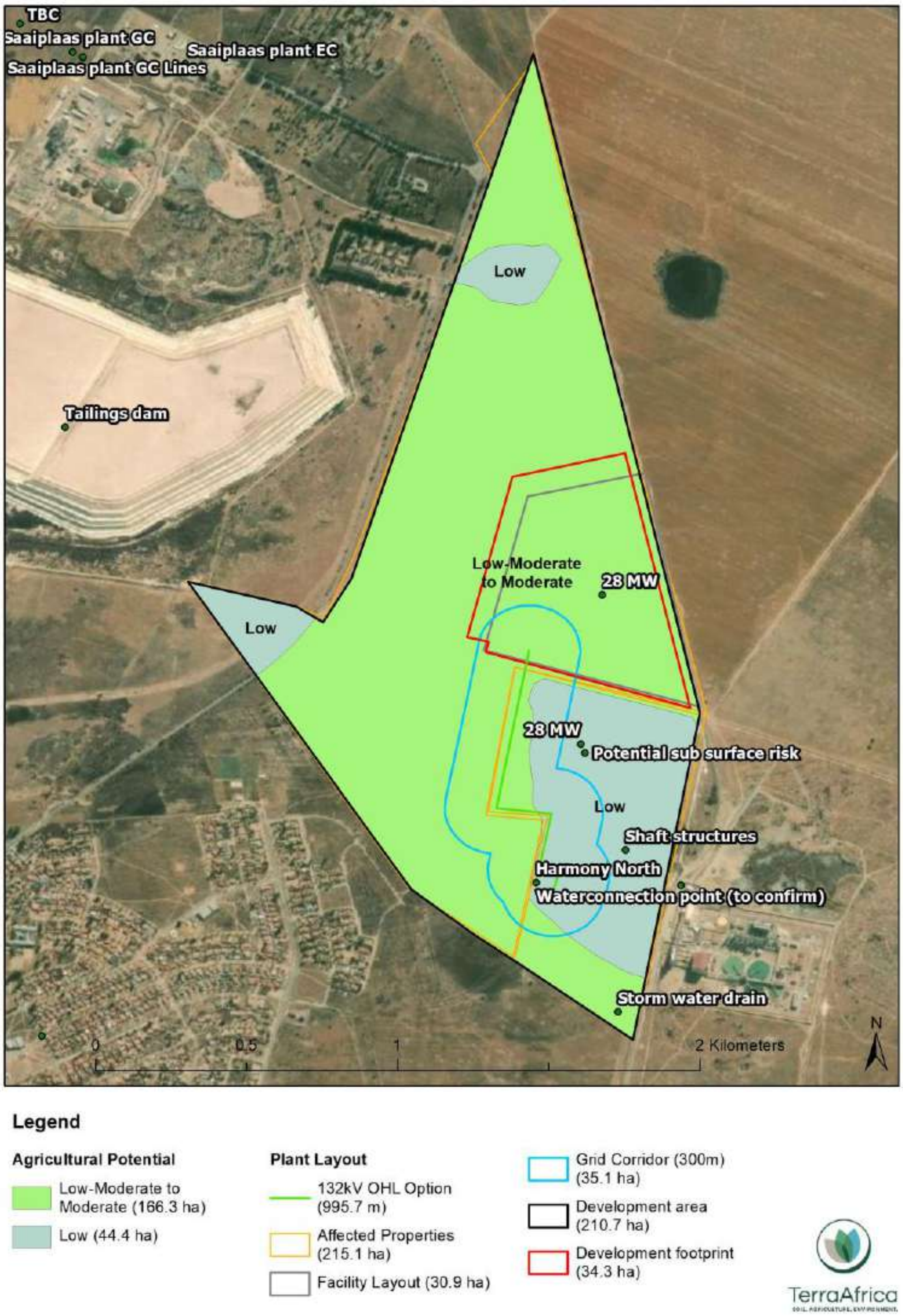


Figure 14 Agricultural potential of the Harmony Central development area

Within the development area, the areas where soil has been disturbed by activities associated with the nearby mining infrastructure, and that has been classified as Technosols, have Low agricultural potential. The areas are no longer suitable for rainfed crop production and has limited suitability for livestock farming because of the uneven terrain in these areas.

The rest of the development area has Low-Moderate to Moderate agricultural potential, depending on the effective depth of the Avalon and Bainsvlei profiles. The northern and western parts of the development area have shallower profiles and the yield potential of the soils are limited by a thick soft plinthic horizon present at depths between 300 and 500mm. The deeper profiles along the eastern side of the development area have better potential for rainfed agriculture with greater effective depth for root development and lower risk of water saturated conditions during wet years, such as the past year.

9.5 Land use

9.5.1 Current and historical land use of the development area

Harmony Gold (the current landowner) has indicated that there has been no agricultural production or activities within the development area since they purchased the land in 2014. No information could be provided regarding the types of agricultural land use of the area prior to the land sale. Historical Google Earth imagery shows that the crop fields that were present previously within the development area, had already been converted to grazing land prior to August 2010 (date of the imagery). The quality of aerial imagery prior to that, is not sufficient to derive any conclusions regarding land use.

While there have been no formal agricultural production activities by the landowner since 2014, the development area is not currently fenced off and livestock owners within the local community use this area for grazing occasionally and also traverse through this area with their cattle into other nearby areas. During the site visit, the cattle were herded through this area onto nearby land.

9.5.2 Surrounding land use

The surrounding land uses include mining, residential and agriculture. The mining areas are located northwest, east and southeast of the site and are centred around the Harmony Saaiplaas and Harmony Central plants. The residential areas are located southwest and further south and includes the town of Virginia. The agricultural areas consist of crop fields and grazing areas with livestock, located northeast and further east of the development area.

10. Agricultural production and employment

10.1 Agricultural income and employment

There are currently no formal agricultural production activities within the development area and the crop fields that were present, had been converted to grazing areas before 2014, when the land was sold to Harmony Gold. The area is currently grazed by livestock of the local community. The potential gross income that can therefore be generated from the land annually, with the current land use, was calculated by using the long-term average grazing capacity of the area that will be affected by the proposed project. The long-term grazing capacity of the entire development area is 6 ha/LSU (DALRRD, 2018) (refer to Figure 15).

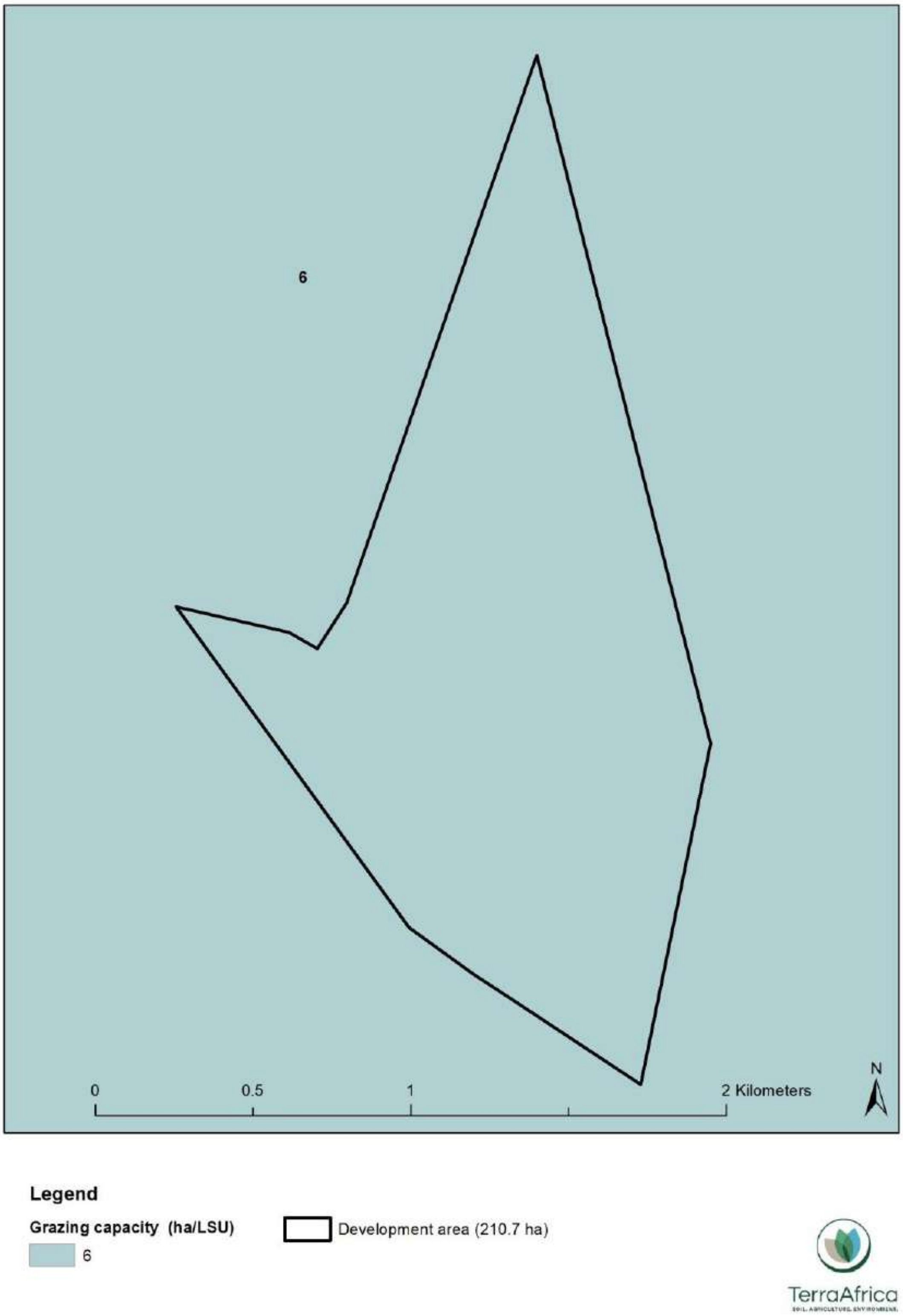


Figure 15 Long-term grazing capacity of the Harmony Central development area

The following assumptions have been made in the calculations:

- The construction of the Harmony Central Solar PV facility infrastructure will include fencing off the development footprint 34.3. This will exclude any cattle farming activities from the fenced-off area.
- The 132 kV overhead powerline will not be fenced off and once the construction phase has been completed, livestock will be able to graze in this area.
- At a long-term average grazing capacity of 6 hectare per Large Stock Unit (/ha/LSU) (DAFF, 2018), the development footprint of 34.3 ha, provide forage to a maximum of 6 head of cattle.
- If it is assumed that the livestock produce offspring at about a 70 to 80% weaning rate, four weaners will be available for sale each year. This is considered an optimistic figure and does not take any potential losses from stock theft into consideration.
- The average weight of a weaner is estimated at 220 kg and the average auction price for live weight (or "hoof weight") the past six months, was approximately R39.50/kg. The calculated total live weight that can be produced with the grazing available within the development footprint area, and sold annually, is 880 kg.

The total gross income that could possibly be generated by livestock farming in the area the past year, is therefore estimated to be R34 760.00 per annum.

Following the requirements of GN320, the potential gross income loss from agricultural activities in the area for five years, must be considered. For this estimation, it was assumed that there will be a price increase of 6% per annum for live weight of cattle. The estimates for four years as well as the total gross income lost from agricultural production, is presented in the table below.

Table 2 Gross livestock income forecast for the proposed development footprint

Year	Price of live weight (R/kg)	Gross annual income (R)
2022	39.50	R34 760.00
2023	41.87	R36 845.60
2024	44.38	R39 054.40
2025	47.04	R41 395.20
2026	49.86	R43 876.80
Estimated total gross income from livestock production between 2021 and 2026		**R195 932.00**

No information is available on the structure of community livestock farming in the area, but the estimated annual income of R34 760.00 is expected to contribute to the household income of one to two families. There is no formal employment associated with the development footprint currently.

10.2 Comparative benefit analysis

At this stage of the report (Draft for Comments by Applicant and EAP), no gross or nett income figures associated with the proposed Harmony Central Solar PV Facility, were provided. Therefore, no comparison between the financial benefits of the proposed renewable energy development and the existing land use (communal livestock farming), can be made. There are also no figures available on the employment opportunities that will be generated by the Harmony Central solar PV facility.

11. Agricultural sensitivity of the site

11.1 Sensitivity rating of current development footprint layout

Following the consideration of all the baseline and desktop data discussed in the sections above, the proposed Harmony Central Solar PV facility development area can be categorised as either Medium or Low sensitivity. The largest part of the development area has Medium sensitivity (166.3 ha or 79% of the project site), while the areas with Low sensitivity are present at 44.4 ha (or 21% of the project site). To illustrate the extent of the proposed land use change from agriculture to renewable energy, the development footprint (as received from the applicant), was superimposed on the agricultural sensitivity map and the areas measured that will be affected. The results are depicted in Figure **14** and summarised in Table 2.

Table 3 Summary of the impact of the development footprint on the agricultural sensitivity of the site

Sensitivity class	**Soil form**	**Area within the development area (ha)**	**Area that will be affected by development footprint (ha)**
Medium	Avalon, Bainsvlei	166.3	34.3
Low	Technosol	44.4	0

11.2 Consideration of Alternatives

11.2.1 Consideration of alternative infrastructure layouts and micro-siting

Only one layout for the development footprint's infrastructure has been provided at this stage for consideration (refer to Figure **14**). Since the current layout does not impact on land with high agricultural sensitivity, it is not anticipated that a change in layout will change the significance of the impacts on soil and agriculture. Any change in the layout will still affect soil with Medium agricultural sensitivity.

11.2.2 Consideration of the 'No-go' alternative

The 'No-go' alternative will not result in any land use change from communal livestock farming to the generation of renewable energy. There will be no additional impacts on soil properties and the current soil quality will remain as it is, permitting that the livestock grazing does not result in soil degradation.

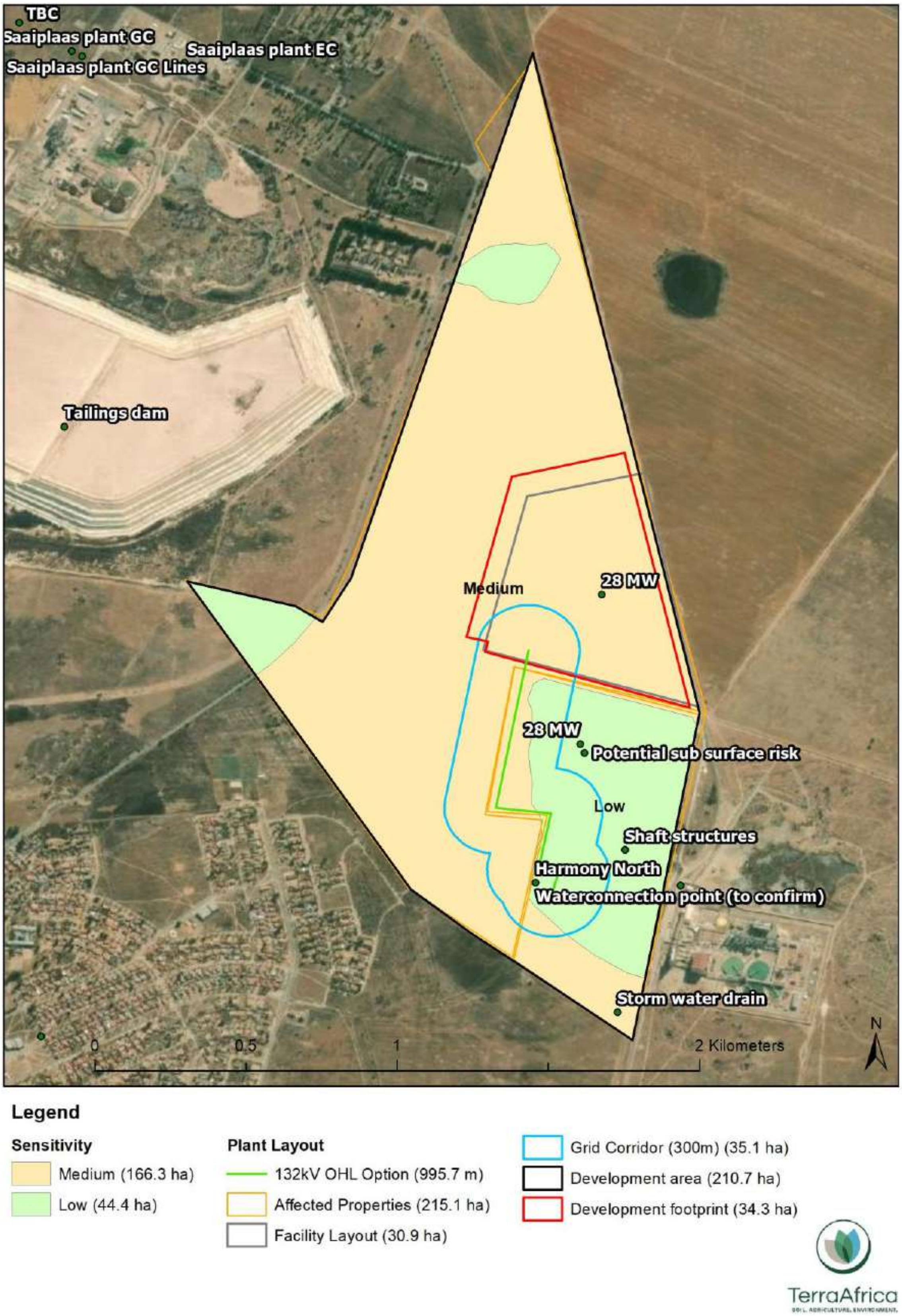


Figure 16 Agricultural sensitivity of the Harmony Central development area

11.3 Allowable development limits

Although the field crop data layer of DALRRD (DALRRD 2019) indicate that there are crop fields in the area, the data gather during the site visit, do not agree with these delineations. Following aerial imagery analysis as well as information from the current land owner (Harmony Gold), crop fields have already been converted to grazing veld earlier than 2014. The conversion to grazing was not an active process through the cultivation of planted pastures and instead, the fields were left uncultivated and pioneer species established themselves and over time, resulted in ecological succession. Since the project site do not have crop fields anymore and hasn't had crop fields for the past five years, the allowable development limit for areas outside of crop fields for land with Medium and Low Agricultural Sensitivity, will be used for the calculations. The results of the calculations are provided in Table 4 below.

Table 4 Calculated allowable development limits according to the confirmed project site sensitivity

Sensitivity class	**Area that will be affected by development footprint (ha)**	**Allowable limit (ha/MW)**	**Area allowed for a 14MW development (ha)**	**Area that exceeds allowable limit (ha)**
Medium	34.3	0.35	4.9	29.4
Low	0	2.50	35	0

12. Impact assessment of additional environmental impacts

12.1 Project description

The 14MW Harmony Central solar PV facility will consist of the following infrastructure:

- Solar PV array comprising bifacial PV modules and mounting structures, using single axis tracking technology. Once installed will stand up to 5m above ground level.
- Inverters and transformers a SCADA room, and maintenance room
- Cabling between the project components.
- Balance of Plant:
    - Existing spare switchgear panels upgraded switchgear circuit breakers or additional switchgear panels.
    - EK self-build works as defined in the CEL.
- On-site facility substation to facilitate the connection between the solar PV facility and Eskom electricity grid. The Size and Capacity of each of the on-site stations will be 40MW, 20MW, 40MW respectively
- An onsite Medium voltage (MV) switching station forming part of the collector substation
- Temporary Laydown areas.
- Access roads, internal roads and fencing around the development area.

- Up to 132kV Overhead Power Lines (OHPL) – maximum of 30m height with a 30m servitude width
- Underground LV cabling will be used on the PV site

11.2 Impact significance rating

The most significant impacts of the proposed Harmony Central solar PV facility project on soil and agricultural productivity, will occur during the construction phase when the vegetation is removed and the soil surface is prepared for infrastructure commissioning. During the operational phase, the risk remains that soil will be polluted by the waste generated during the operational phase or in the case of a spill incident. During the decommissioning phase, soil will be prone to erosion when the infrastructure is removed from the soil surface. Below follows a rating of the significance of each of the impacts.

11.2.1 Construction phase

Impact: Change in land use from livestock grazing to energy generation

Nature: Prior to construction of the thermal generation plant, the area will be fenced off and livestock farming will be excluded from 34.3ha of land. The area where infrastructure will be constructed will be stripped of vegetation and will no longer be suitable for livestock grazing.

	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Medium duration (3)	Medium duration (3)
Magnitude	Low (4)	Low (4)
Probability	Definite (4)	Definite (4)
Significance	**Medium (32)**	**Medium (28)**
Status (positive or negative)	Negative	Negative
Reversibility	Moderate	Moderate
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	No	N/A

Mitigation:

- Vegetation clearance must be restricted to areas where infrastructure is constructed.
- No materials removed from development area must be allowed to be dumped in nearby livestock farming areas.
- Prior arrangements must be made with the landowners to ensure that livestock and game animals are moved to areas where they cannot be injured by vehicles traversing the area.
- No boundary fence must be opened without the landowners' permission.
- All left-over construction material must be removed from site once construction on a land portion is completed.
- No open fires made by the construction teams are allowable during the construction phase.

Residual Impacts:
The residual impact from the construction and operation of the Harmony Central solar PV facility is considered medium.

Cumulative Impacts:
Any additional infrastructure development in support of the Harmony Central solar PV facility, will result in additional areas where grazing veld will be disturbed.

Impact: Soil erosion

Nature: All areas where vegetation is removed from the soil surface in preparation for the infrastructure construction, will result in exposed soil surfaces that will be prone to erosion. Both wind and water erosion are a risk and even though the project area is in the arid climate, the intensity of single rainstorm may result in soil particles being transported away.		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Medium-term (3)	Medium-term (3)
Magnitude	Moderate (6)	Low (4)
Probability	Probable (3)	Improbable (2)
Significance	**Medium (30)**	**Low (16)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes	N/A
Mitigation: • Land clearance must only be undertaken immediately prior to construction activities and only within the development footprint; • Unnecessary land clearance must be avoided; • Level any remaining soil removed from excavation pits that remained on the surface instead of allowing small stockpiles of soil to remain on the surface. • Where possible, conduct the construction activities outside of the rainy season.		
Residual Impacts: The residual impact from the construction and operation of the proposed Harmony Central solar PV facility Thermal Facility on the susceptibility to erosion is considered low.		
Cumulative Impacts: Any additional infrastructure development in support of the Harmony Central solar PV facility, will result in additional areas where exposed to soil erosion through wind and water movement.		

Impact: Soil compaction

Nature: The clearing and levelling of land for both the thermal plant infrastructure as well as the access road, will result in soil compaction. In the area where access roads will be constructed, topsoil will be removed and the remaining soil material will be deliberately compacted to ensure a stable road surface.		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Medium-term (3)	Medium-term (3)
Magnitude	Moderate (6)	Low (4)
Probability	Probable (3)	Improbable (2)
Significance	**Medium (30)**	**Low (16)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes	N/A
Mitigation: • Vehicles and equipment must travel within demarcated areas and not outside of the construction footprint; • Unnecessary land clearance must be avoided; • Where possible, conduct the construction activities outside of the rainy season; and • Vehicles and equipment must park in designated parking areas.		
Residual Impacts: The residual impact from the construction and operation of the proposed Harmony Central solar PV facility on soil compaction is considered low.		

Cumulative Impacts: Any additional infrastructure development in support of the Harmony Central solar PV facility, will result in additional areas exposed to soil compaction.

Impact: Soil pollution

During the construction phase, construction workers will access the land for the preparation of the terrain and the construction of the thermal plant and access road. Both potential spills and leaks from construction vehicles and equipment as well as waste generation on site, can result in soil pollution.

Nature: The following construction activities can result in the chemical pollution of the soil:

1. Petroleum hydrocarbon (present in oil and diesel) spills by machinery and vehicles during earthworks and the removal of vegetation as part of site preparation.
2. Spills from vehicles transporting workers, equipment, and construction material to and from the construction site.
3. The accidental spills from temporary chemical toilets used by construction workers.
4. The generation of domestic waste by construction workers.
5. Spills from fuel storage tanks during construction.
6. Pollution from concrete mixing.
7. Pollution from road-building materials.
8. Any construction material remaining within the construction area once construction is completed.
9. Containment breaches related to the battery units and any inadvertent chemical exposure therefrom.

	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Short-term (2)	Short-term (2)
Magnitude	Moderate (6)	Low (4)
Probability	Low (4)	Improbable (2)
Significance	**Medium (36)**	**Low (14)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes	N/A

Mitigation:

- Maintenance must be undertaken regularly on all vehicles and construction/maintenance machinery to prevent hydrocarbon spills;
- Any waste generated during construction, must be stored into designated containers and removed from the site by the construction teams.
- Any left-over construction materials must be removed from site.
- Ensure battery transport and installation by accredited staff / contractors.
- Compile (and adhere to) a procedure for the safe handling of battery cells during transport and installation.

Residual Impacts:
The residual impact from the construction and operation of the proposed project will be low to negligible.

Cumulative Impacts:
Any additional infrastructure that will be constructed to strengthen and support the operation of the Harmony Central solar PV facility and where waste is not removed to designated waste sites, will increase the cumulative impacts associated with soil pollution in the area.

11.2.2 Operational phase

Impact: Soil erosion

During the operational phase, staff and maintenance personnel will access the Harmony Central solar PV facility daily. This phase will have no additional impact on the livestock farming potential of the area. The following impacts on soil is expected for this phase:

Nature: The areas where vegetation was cleared, will remain at risk of soil erosion, especially during a rainfall event when runoff from the cleared surfaces will increase the risk of soil erosion in the areas directly surrounding the Harmony Central solar PV facility.		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Medium-term (3)	Medium-term (3)
Magnitude	Moderate (6)	Low (4)
Probability	Probable (3)	Improbable (2)
Significance	**Medium (30)**	**Low (16)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes	N/A
Mitigation: • The area around the development footprint must regularly be monitored to detect early signs of soil erosion on-set. • If soil erosion is detected, the area must be stabilised by the use of geo-textiles and facilitated re-vegetation.		
Residual Impacts: The residual impact from the operation of the proposed Harmony Central solar PV facility on the susceptibility to erosion is considered low.		
Cumulative Impacts: Any additional infrastructure that will be constructed to strengthen and support the operation of the Harmony Central solar PV facility, will result in additional areas where exposed to soil erosion through wind and water movement.		

Impact: Soil pollution

Nature: During the operational phase, potential spills and leaks from maintenance vehicles and equipment as well as waste generation on site, can result in soil pollution. Also, any failure of the fuel storage containers or equipment can be a source of soil pollution.		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Short-term (2)	Short-term (2)
Magnitude	Moderate (6)	Low (4)
Probability	Low (4)	Improbable (2)
Significance	**Medium (36)**	**Low (14)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes	N/A
Mitigation: • Maintenance must be undertaken regularly on all vehicles and maintenance machinery to prevent hydrocarbon spills; • No domestic and other waste must be left at the site and must be transported with the maintenance vehicles to an authorised waste dumping area.		

•
Residual Impacts: The residual impact from the operation of the proposed project will be low to negligible.
Cumulative Impacts: The operation of any additional infrastructure to strengthen and support the operation of the Harmony Central solar PV facility and where waste is not removed to designated waste sites, will increase the cumulative impacts associated with soil pollution in the area.

11.2.3 Decommissioning phase

The decommissioning phase will have the same impacts as the construction phase i.e. soil erosion, soil compaction and soil pollution. It is anticipated that especially the risk of soil erosion will remain until the vegetation growth has re-established in the area where the Harmony Central solar PV facility will be decommissioned.

12 Cumulative Impacts

"Cumulative Impact", in relation to an activity, means the past, current and reasonably foreseeable future impact of an activity, considered together with the impact of activities associated with that activity that in itself may not be significant, but may become significant when added to existing and reasonably foreseeable impacts eventuating from similar or diverse activities[1].

The role of the cumulative assessment is to test if such impacts are relevant to the proposed project in the proposed location (i.e. whether the addition of the proposed project in the area will increase the impact). This section should address whether the construction of the proposed development will result in:

- Unacceptable risk
- Unacceptable loss
- Complete or whole-scale changes to the environment or sense of place
- Unacceptable increase in impact

For the determination of cumulative impacts, all other renewable energy projects within a 50km radius from the Harmony Central solar PV facility development area, were considered. There are eleven other renewable energy projects within this area around the proposed Harmony Central solar PV facility. The position of these projects' areas are depicted in Figure **17**.

The cumulative impacts of the proposed project have been discussed in Section 11 above.

[1] Unless otherwise stated, all definitions are from the EIA Regulations 2014 (GNR 326).

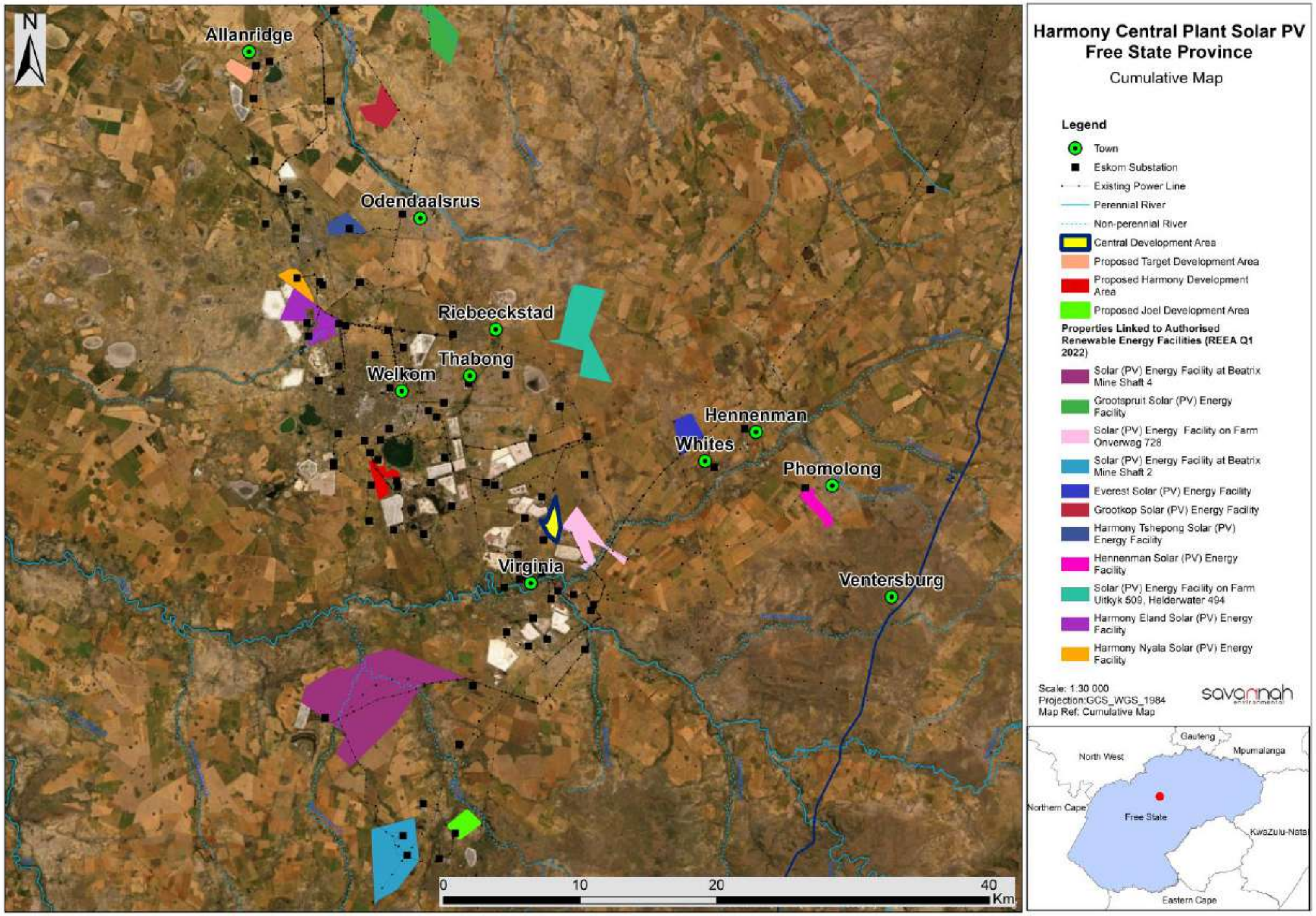


Figure 17 Other renewable energy projects within a 50km radius of the Harmony Central solar PV facility development area (source: Savannah Environmental)

Table 5 Assessment of cumulative impact of decrease in areas available for livestock farming

Nature: Decrease in areas with suitable land capability for cattle farming.		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	Local (1)	Regional (2)
Duration	Short duration - 2-5 years (2)	Long-term (4)
Magnitude	Low (4)	Low (4)
Probability	Highly likely (4)	Highly likely (4)
Significance	**Low (28)**	Medium (40)
Status (positive/negative)	Negative	Negative
Reversibility	High	Low
Loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes	No
Confidence in findings: High.		
Mitigation: The only mitigation measure for this impact is to keep the footprints of all renewable energy facilities as small as possible and to manage the soil quality by avoiding far-reaching soil degradation such as erosion.		

Table 6 Assessment of cumulative impact of areas susceptible to soil erosion

Nature: Increase in areas susceptible to soil erosion		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	Local (1)	Regional (2)
Duration	Medium-term (3)	Medium-term (3)
Magnitude	Moderate (6)	Moderate (6)
Probability	Probable (3)	Probable (3)
Significance	**Medium (30)**	**Medium (33)**
Status (positive/negative)	Negative	Negative
Reversibility	Low	Low
Loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes	No
Confidence in findings: High.		
Mitigation: Each of the projects should adhere to the highest standards for soil erosion prevention and management as defined in Section 11.2.2 above.		

Table 7 Assessment of cumulative impact of increased risk of soil pollution

Nature: Increase in areas susceptible to soil pollution		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	Local (1)	Regional (2)
Duration	Short-term (2)	Short-term (2)
Magnitude	Moderate (6)	Moderate (6)
Probability	Probable (3)	Probable (3)
Significance	**Low (27)**	**Medium (30)**
Status (positive/negative)	Negative	Negative

Reversibility	Low	Low
Loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes	No
Confidence in findings: High.		
Mitigation: Each of the projects should adhere to the highest standards for soil pollution prevention and management as defined in Section 11.2.3 above.		

13 Mitigation and management measures

The objective of the mitigation and management measures presented below are to reduce the risk of soil degradation that will in turn result in affect the ability of soils in within the project site to support the natural vegetation and provide ecosystem services.

Prevention and management of soil erosion:

Project component/s	• Construction of infrastructure • Construction of the access road
Potential Impact	Soil particles can be removed from the area through wind and water erosion
Activity/risk source	The removal of vegetation in areas where infrastructure will be constructed
Mitigation: Target/Objective	To avoid the onset of soil erosion that can spread into other areas

Mitigation: Action/control	**Responsibility**	**Timeframe**
• Limit vegetation clearance to only the areas where the surface infrastructure will be constructed. • Avoid parking of vehicles and equipment outside of designated parking areas. • Plan vegetation clearance activities for dry seasons (late autumn, winter and early spring). • Design and implement a Stormwater Management System where run-off from surfaced areas are expected. • Re-establish vegetation along the access road to reduce the impact of run-off from the road surface.	Environmental Control Officer / SHEQ division	During the entire construction, operational and decommissioning phases

Performance Indicator	No visible signs of soil erosion around the project infrastructure
Monitoring	• Regular inspections around the constructed infrastructure to detect early signs of soil erosion developing.

	• When signs of erosion is detected, the areas must be rehabilitated using a combination of geo-textiles and re-vegetation to prevent the eroded area(s) from expanding.

Prevention and management of soil pollution:

Project component/s	• Construction of infrastructure • Daily activities and maintenance during the operational phase
Potential Impact	Potential fuel and oil spills from vehicles as well as the generation of waste can cause soil pollution.
Activity/risk source	• Petroleum hydrocarbon (present in oil and diesel) spills by machinery and vehicles during earthworks and the removal of vegetation as part of site preparation. • Spills from vehicles transporting workers, equipment, and construction material to and from the construction site. • The accidental spills from temporary chemical toilets used by construction workers. • The generation of domestic waste by construction workers. • Spills from fuel storage tanks during construction. • Pollution from concrete mixing. • Pollution from road-building materials. • Any construction material remaining within the construction area once construction is completed. • Containment breaches related to the battery units and any inadvertent chemical exposure therefrom.
Mitigation: Target/Objective	To avoid soil pollution that can harm the surrounding environment and human health.

Mitigation: Action/control	**Responsibility**	**Timeframe**
• Maintenance must be undertaken regularly on all vehicles and construction/maintenance machinery to prevent hydrocarbon spills; • Any waste generated during construction, must be stored into designated containers and removed from the site by the construction teams. • Any left-over construction materials must be removed from site. • Ensure battery transport and installation by accredited staff / contractors. • Compile (and adhere to) a procedure for the safe handling of battery cells during transport and installation.	Environmental Control Officer / SHEQ division	During the entire construction, operational and decommissioning phases

Performance Indicator	• No visible signs of waste and spills within the project site.

	• No accumulation of contaminants in the soils of the project site.
Monitoring	• Regular inspections of vehicles and equipment that enter the project site. • Analysis of soil samples around high-risk areas to determine whether soil contaminants are present. • In the case that soil pollution is detected, immediate remediation must be done.

14 Acceptability statement

The soil and agricultural properties and sensitivities of the proposed Harmony Central solar PV facility development was the subject of the Agricultural Agro-Ecosystem Assessment conducted. The study found that the area consists of two different natural soil forms, i.e. Avalon and Bainsvlei, ranging from 0.3m to 0.9m in effective soil depth. The areas with existing soil disturbance, are classified as Technosols.

The largest portion of the development area has land with Moderate (Class 08) land capability that is suitable for dryland crop production. Small areas scattered in between has lower land capability (Class 06 and 07 – Low-Moderate) and higher land capability (Class 09 – High-Moderate). The sensitivity rating of the site was also based on the soil classification of the site as well as the current land use. Approximately 166.3 ha has Medium agricultural sensitivity and 44.4ha has Low sensitivity. The entire development footprint falls on land with Medium sensitivity. The proposed development footprint exceed the allowable limit with 29.4ha for the areas with Medium sensitivity.

It is anticipated that the construction and operation of the Harmony Central solar PV facility will have impacts that range from medium to low. Through the consistent implementation of the recommendation mitigation measures, most of impacts can all be reduced to low. Since the area around the development footprint will be fenced off, it is not anticipated that the impact on livestock grazing can be mitigated as this area will now be excluded from livestock farming.

Considering that the infrastructure components, including the proposed substation, will be placed in close proximity to each other, I confirm that as far as I know, all reasonable measures have been taken to avoid or minimize fragmentation and disturbance of agricultural activities, provided that the mitigation measures provided in this report are implemented.

It is my professional opinion that even though the development footprint include areas with Medium agricultural sensitivity that exceeds the allowable development limits, this application be considered favourably. The area has not been used for crop production since 2014 (according to the land owner) and aerial imagery has confirmed that the area has not been from 2010 onwards. The development is currently used for cattle grazing by the local community and this activity can supplement the income of one to two people’s families.

However, the project is considered acceptable permitting that the mitigation measures stipulated in this report are followed to prevent soil erosion and soil pollution and to minimise impacts on the veld quality of the farm portions that will be affected. The project infrastructure should also remain within the proposed footprint boundaries that will be fenced off.

15. Reference list

Crop Estimates Consortium, 2019. *Field crop boundary data layer (FS province)*, 2019. Pretoria. Department of Agriculture, Forestry and Fisheries.

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Department of Agriculture, Land Reform and Rural Development, 2021. *Protected agricultural areas – Spatial data layer, Free State province*. 2021. Pretoria.

Land Type Survey Staff, 1972 – 2006. *Land Types of South Africa data set*. ARC – Institute for Soil, Climate and Water. Pretoria.

South Africa (Republic), 2018. *Long-term grazing capacity for South Africa*: Data layer. Government Gazette Vol. 638, No. 41870. 31 August 2018. Regulation 10 of the Conservation of Agricultural Resources Act (CARA): Act 43 of 1983. Pretoria. Government Printing Works.

The Soil Classification Working Group, 2018. *Soil Classification – Taxonomic System for South Africa.* Dept. of Agric., Pretoria.

APPENDIX 1 – CURRICULUM VITAE OF SPECIALIST

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Wolmaransstad,
South Africa

EXPERTISE

Soil Quality Assessment

Soil Policy and Guidelines

Agricultural Agro-Ecosystem Assessment

Sustainable Agriculture

Data Consolidation

Land Use Planning

Soil Pollution

Hydropedology

EDUCATION

MASTER'S DEGREE
Environmental Science
University of Witwatersrand
2010 – 2018

BACHELOR'S DEGREE
Agricultural Science
University of Pretoria
2001 – 2004

PROFESSIONAL PROFILE

I contribute specialist knowledge on agriculture and soil management to ensure long-term sustainability of projects in Africa. For the past thirteen years, it has been my calling and I have consulted on more than 200 projects. My clients include environmental and engineering companies, mining houses, and project developers. I enjoy the multi-disciplinary nature of the projects that I work on and I am fascinated by the evolving nature of my field of practice. The next section provide examples of the range of projects completed. A comprehensive project list is available on request.

PROJECT EXPERIENCE

Global Assessment on Soil Pollution

Food and Agricultural Organisation (FAO) of the United Nations (UN)

Author of the regional assessment of Soil in Sub-Saharan Africa. The report is due for release in February 2021. The different sections included:

- Analysis of soil and soil-related policies and guidelines for each of the 48 regional countries
- Description of the major sources of soil pollution in the region
- The extent of soil pollution in the region and as well as the nature and extent of soil monitoring
- Case study discussions of the impacts of soil pollution on human and environmental health in the region
- Recommendations and guidelines for policy development and capacitation to address soil pollution in Sub-Saharan Africa

Data Consolidation and Amendment

Range of projects: Mining Projects, Renewal Energy

These projects included developments where previous agricultural and soil studies are available that are not aligned with the current legal and international best practice requirements such as the IFC Principles. Other projects are expansion projects or changes in the project infrastructure layout. Tasks on such projects include the incorporation of all relevant data, site verification, updated baseline reporting and alignment of management and monitoring measures.

Project examples:

- Northam Platinum's Booysendal Mine, South Africa
- Musonoi Mine, Kolwezi District, Democratic Republic of Congo
- Polihali Reservoir and Associated Infrastructure, Lesotho
- Kaiha 2 Hydropower Project, Liberia
- Aquarius Platinum's Kroondal and Marikana Mines

PROFESSIONAL MEMBERSHIP

South African Council for Natural Scientific Professions (SACNASP)

Soil Science Society of South Africa (SSSSA)

Soil Science Society of America (SSSA)

Network for Industrially Contaminated Land in Africa (NICOLA)

LANGUAGES

English (Fluent)

Afrikaans (Native)

French (Basic)

PRESENTATIONS

There is spinach in my fish pond
TEDx Talk
Available on YouTube

♦

Soil and the Extractive Industries
Session organiser and presenter
Global Soil Week, Berlin (2015)

♦

How to dismantle an atomic bomb
Conference presentation (2014)
Environmental Law Association (SA)

PROJECT EXPERIENCE (Continued)

Agricultural Agro-Ecosystem Assessments

Range of projects: Renewable Energy, Industrial and Residential Developments, Mining, Linear Developments (railways and power lines)

The assessments were conducted as part of the Environmental and Social Impact Assessment processes. The assessment process includes the assessment of soil physical and chemical properties as well as other natural resources that contributes to the land capability of the area.

Project examples:

- Mocuba Solar PV Development, Mozambique
- Italthai Railway between Tete and Quelimane, Mozambique
- Lichtenburg PV Solar Developments, South Africa
- Manica Gold Mine Project, Mozambique
- Khunab Solar PV Developments near Upington, South Africa
- Bomi Hills and Mano River Mines, Liberia
- King City near Sekondi-Takoradi and Appolonia City near Accra, Ghana
- Limpopo-Lipadi Game Reserve, Botswana
- Namoya Gold Mine, Democratic Republic of Congo

Sustainable Agriculture

Range of projects: Policy Development for Financial Institutions, Mine Closure Planning, Agricultural Project and Business Development Planning

Each of the projects completed had a unique scope of works and the methodology was designed to answer the questions. While global indicators of sustainable agriculture are considered, the unique challenges to viable food production in Africa, especially climate change and a lack of infrastructure, in these analyses.

Project examples:

- Measurement of sustainability of agricultural practices of South African farmers – survey design and pilot testing for the LandBank of South Africa
- Analysis of the viability of avocado and mango large-scale farming developments in Angola for McKinsey & Company
- Closure options analysis for the Tshipi Borwa Mine to increase agricultural productivity in the area, consultation to SLR Consulting
- Analysis of risks and opportunities for farm feeds and supplement suppliers of the Southern African livestock and dairy farming industries
- Sustainable agricultural options development for mine closure planning of the Camutue Diamond Mine, Angola

PROFESSIONAL DEVELOPMENT

Contaminated Land Management 101 Training
Network for Industrially Contaminated Land in Africa
2020

Intensive Agriculture in Arid & Semi-Arid Environments
CINADCO/MASHAV R&D Course, Israel
2015

World Soils and their Assessment Course
ISRIC – World Soil Information Centre, Netherlands
2015

Wetland Rehabilitation Course
University of Pretoria
2010

Course in Advanced Modelling of Water Flow and Solute Transport in the Vadose Zone with Hydrus
University of Kwazulu-Natal
2010

Environmental Law for Environmental Managers
North-West University Centre for Environmental Management
2009

PROJECT EXPERIENCE (Continued)

Soil Quality Assessments

Range of projects: Rehabilitated Land Audits, Mine Closure Applications, Mineral and Ore Processing Facilities, Human Resettlement Plans

The soil quality assessments included physical and chemical analysis of soil quality parameters to determine the success of land rehabilitation towards productive landscapes. The assessments are also used to understand the suitability for areas for Human Resettlement Plans

Project examples:

- Closure Planning for Yoctolux Colliery
- Soil and vegetation monitoring at Kingston Vale Waste Facility
- Exxaro Belfast Resettlement Action Plan Soil Assessment
- Soil Quality Monitoring of Wastewater Irrigated Areas around Matimba Power Station
- Keaton Vanggatfontein Colliery Bi-Annual Soil Quality Monitoring

REFERENCES

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LAND TYPE / *LANDTIPE* .... : **Bd20**

CLIMATE ZONE / *KLIMAATSONE* .... : 40S

Area / *Oppervlakte* .... : 97270 ha

Estimated area unavailable for agriculture

Beraamde oppervlakte onbeskikbaar vir landbou : 1570 ha

Occurrence (maps) and areas / *Voorkoms (kaarte) en oppervlakte :*

2726 Kroonstad (11240 ha) 2826 Winburg (86030 ha)

Inventory by / *Inventaris deur :*

J F Eloff

Modal Profiles / *Modale profiele :*

P485 P487 P488 P489

123 125 126 127

Terrain unit / *Terreineenheid* .... :	1	3	4	5
% of land type / *% van landtipe* .... :	55	40	3	2
Area / *Oppervlakte (ha)* .... :	53499	38908	2918	1945
Slope / *Helling (%)* .... :	1 - 2	1 - 2	1 - 2	1 - 2
Slope length / *Hellingslengte (m)* .... :	1000 - 3000	500 - 2000	50 - 300	50 - 200
Slope shape / *Hellingsvorm* .... :	Z-Y	Z-Y	Z	Z
MB0, MB1 (ha) .... :	53498	38908	2918	1945
MB2 - MB4 (ha) .... :	0	0	0	0

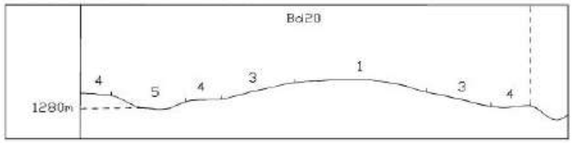
Soil series or land classes / ***Grondseries of landklasse***	**Depth** / ***Diepte*** **(mm)**	**MB**	**ha**	**%**	**ha**	**%**	**ha**	**%**	**ha**	**%**	**Total** / ***Totaal*** **ha**	**%**	**Clay content %** / ***Klei-inhoud %*** **A**	**E**	**B21**	**Hor**	**Texture** / ***Tekstuur*** **Class / *Klas***	**Depth limiting material** / ***Diepte-beperkende materiaal***
Blinkklip Cv36	>1200	0	26750	50	13618	35	146	5			40513	41.7	6-15		15-25	B	fiSaLm-SaClLm	
Soetmelk Av36	600-1000	0	16050	30	7782	20	292	10			24123	24.8	6-15		15-25	B	fiSaLm-SaClLm	sp
Annandale Cv33	>1200	0	8025	15	3891	10					11916	12.3	4-12		6-15	B	fiSa-SaLm	
Shorrocks Hu36	>1000	0			6614	17	1459	50			8073	8.3	6-15		15-25	B	fiSaLm-SaClLm	R
Mangano Hu33	>1200	0			3113	8	292	10			3404	3.5	4-12		6-15	B	fiSa-SaLm	
Arniston Va31, Waterval Va11	100-300	0			2334	6	292	10			2626	2.7	10-25		35-50	B	fiSaCl-Cl	vp,vr
Gelykvlakte Ar20, Rensburg Rg20	450-900	0	535	1	389	1	29	1	389	20	1342	1.4	45-55			A	fiSaCl-Cl	R,G
Lindley Va41, Valsrivier Va40	100-300	0					204	7	972	50	1177	1.2	10-25		30-50	B	fiSaCl-Cl	vp
Killarney Ka20	100-250	0	535	1	389	1	29	1	97	5	1051	1.1	15-30		45-60	A	fiSaLm-SaClLm	G
Limpopo Oa46, Mutale Oa47	600-900	0					146	5	194	10	340	0.4	10-25		25-45	B	fiSaCl	R
Killarney Ka20	100-300	0							194	10	195	0.2	15-30		45-60	A	fiSaLm-SaClLm	G
Gelykvlakte Ar20	450-1000	0											45-55			A	fiSaCl-Cl	R
Pans/Panne:																		
Lindley Va41	100-250	0	1605	3	778	2	29	1	97	5	2510	2.6	10-25		40-55	B	fiSaCl-Cl	vp

For an explanation of this table consult LAND TYPE INVENTORY (table of contents)

Ter verduideliking van hierdie tabel kyk LANDTIPE - INVENTARIS (inhoudsopgawe)

Terrain type / *Terreintipe :* A2

Terrain form sketch /*Terreinvormskets*



Geology: Shale, mudstone and sandstone of the Ecca and Beaufort Groups. Aeolian and possibly colluvial sand overlies the rocks.

Geologie: Skalie, moddersteen en sandsteen van die Groepe Ecca en Beaufort. Eoliese en moontlike kolluviale sande bedek die gesteentes.

CTS HERITAGE

HERITAGE SCREENER

CTS Reference Number:	**CTS22_101**
SAHRIS Reference:	
Client:	**Savannah Environmental (Pty) Ltd**
Date:	**May 2022**
Title:	**Proposed development of the Central PV Facility near Welkom**

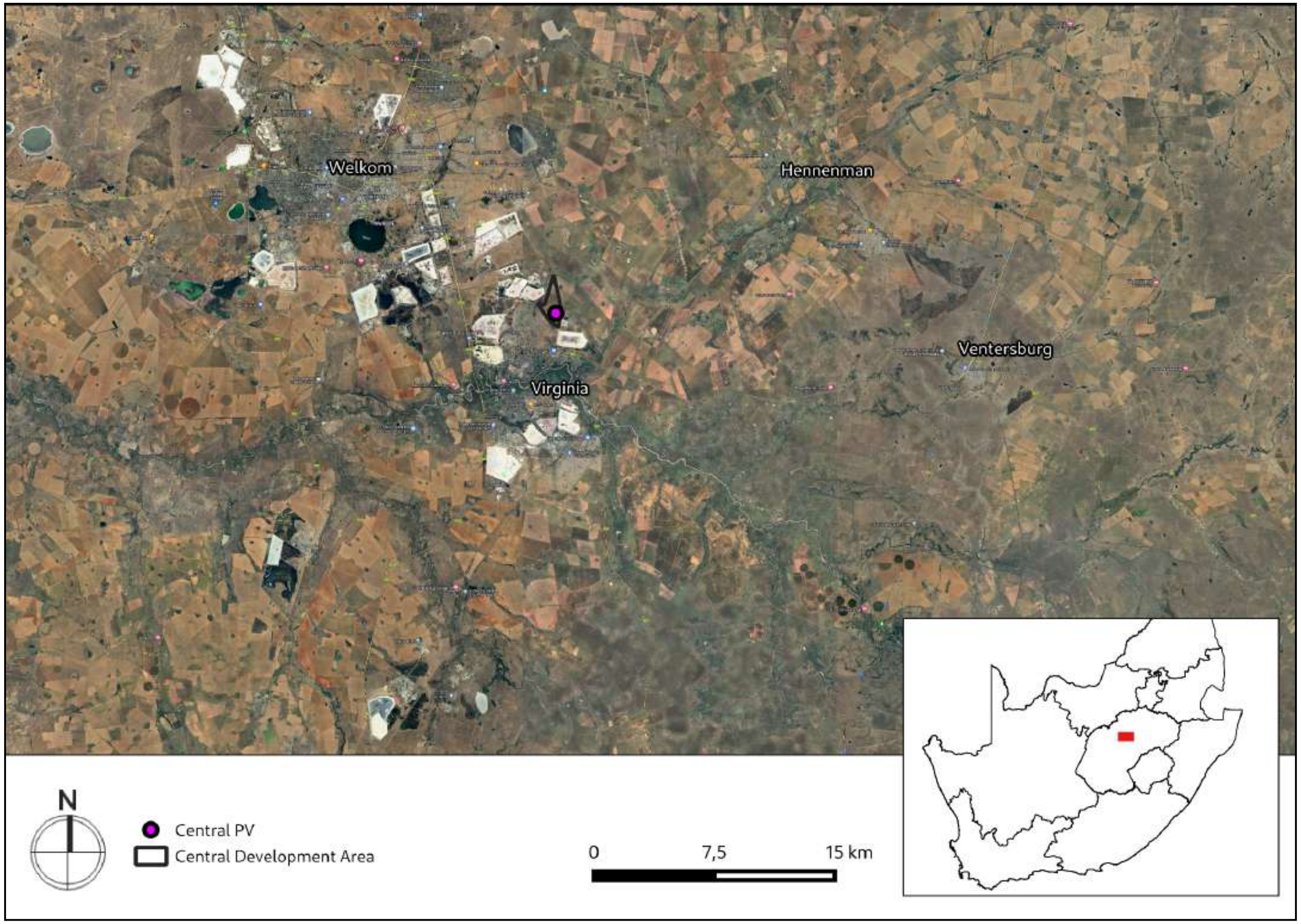


Figure 1a. Satellite map indicating the location of the proposed development in the Free State

RECOMMENDATION
As it is possible that significant heritage resources will be impacted by the proposed development, it is recommended that a Heritage Impact Assessment is completed that satisfies section 38(3) of the NHRA and assesses likely impacts to archaeological and palaeontological heritage.

CTS HERITAGE

1. Proposed Development Summary

The development of renewable energy facilities, overhead powerline and associated infrastructure is proposed by HARMONY GOLD MINING CO LTD. The project entails the development of a Photovoltaic (PV) Solar Energy Facility and associated infrastructure with a capacity of up to 14MW over 33.6 ha of land and will be known as Harmony Central Plant Solar PV, the facility will include a grid connection and other associated infrastructure.

Harmony Central Plant Solar PV is based near Harmony Gold Central Plant operations located ~6km North east of the town of Virginia and ~11km Southeast of the town of Welkom within the Matjhabeng Local Municipality respectively, and within the Lejweleputswa District Municipality, Free State Province.

2. Application References

Name of relevant heritage authority(s)	SAHRA
Name of decision making authority(s)	DFFE

3. Property Information

Latitude / Longitude	28° 3'29.54"S 26°52'53.71"E	
Erf number / Farm number	SAAIPLAAS 771	12
	RUSTGEVONDEN 564	1
Local Municipality	Matjhabeng	
District Municipality	Lejweleputswa	
Province	Free State	
Current Use	Mining	
Current Zoning	Agriculture	

4. Nature of the Proposed Development

Total Area	33.6ha
Depth of excavation (m)	<2m
Height of development (m)	Max 20m pylons

5. Category of Development

x	**Triggers: Section 38(8) of the National Heritage Resources Act**
	Triggers: Section 38(1) of the National Heritage Resources Act
x	1. Construction of a road, wall, powerline, pipeline, canal or other similar form of linear development or barrier over 300m in length.
	2. Construction of a bridge or similar structure exceeding 50m in length.
	3. Any development or activity that will change the character of a site-
x	a) exceeding 5 000m^2 in extent
	b) involving three or more existing erven or subdivisions thereof
	c) involving three or more erven or divisions thereof which have been consolidated within the past five years
	4. Rezoning of a site exceeding 10 000m^2
	5. Other (state):

6. Additional Infrastructure Required for this Development

NA

7. Mapping (please see Appendix 3 and 4 for a full description of our methodology and map legends)

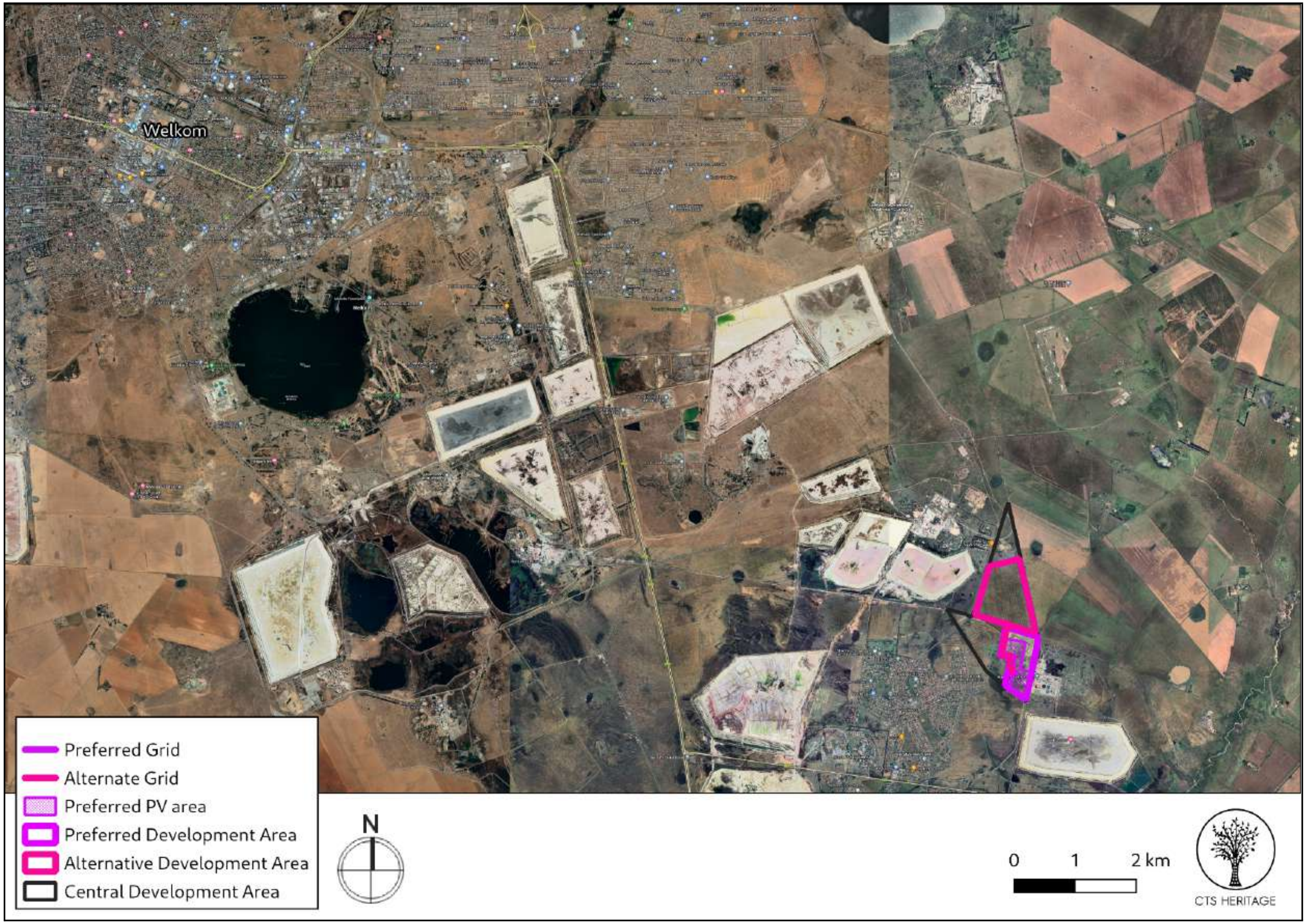


Figure 1b. Overview Map. Satellite image (2022) indicating the proposed development area

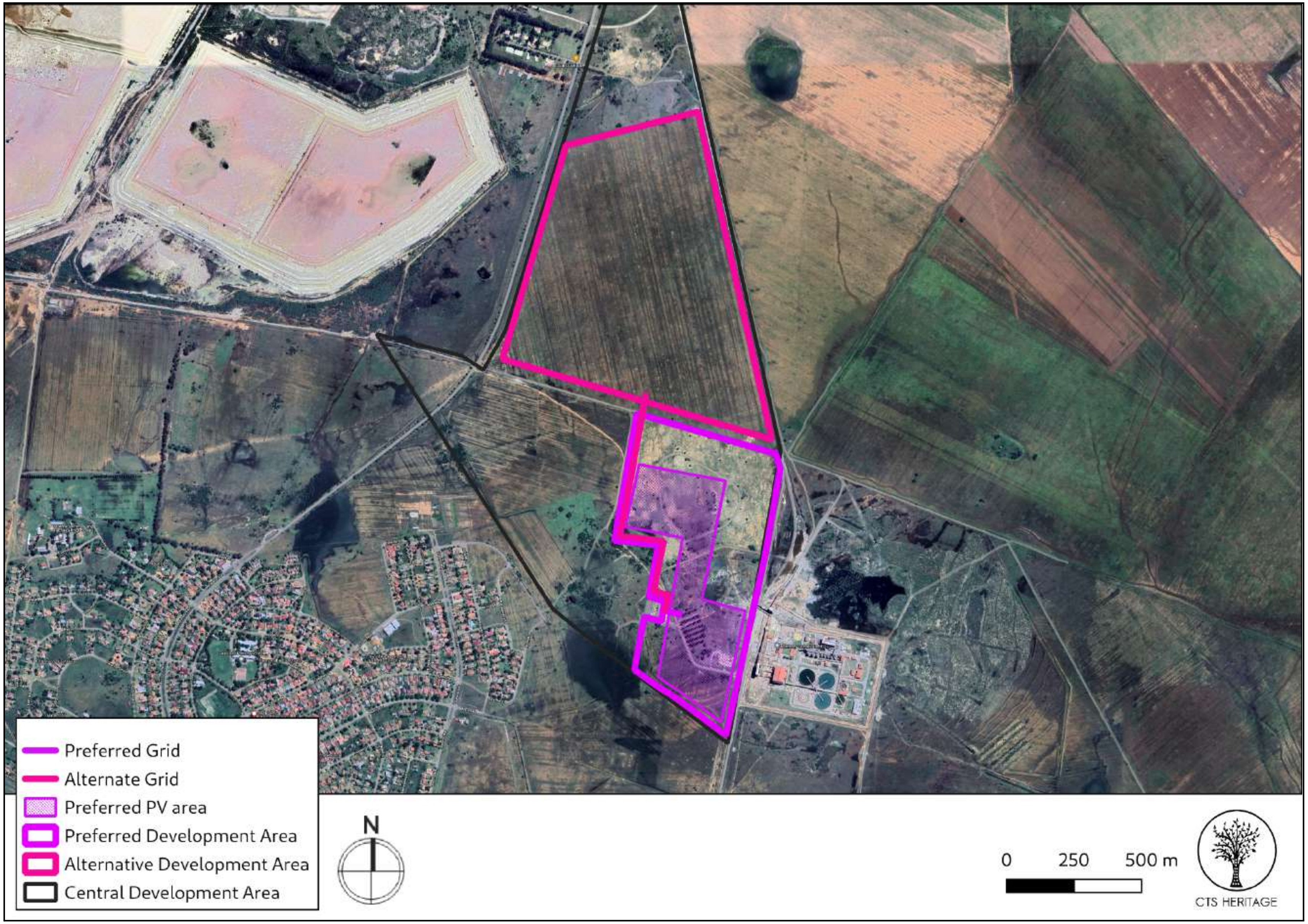


Figure 1c. Overview Map. Satellite image (2022) indicating the proposed development area

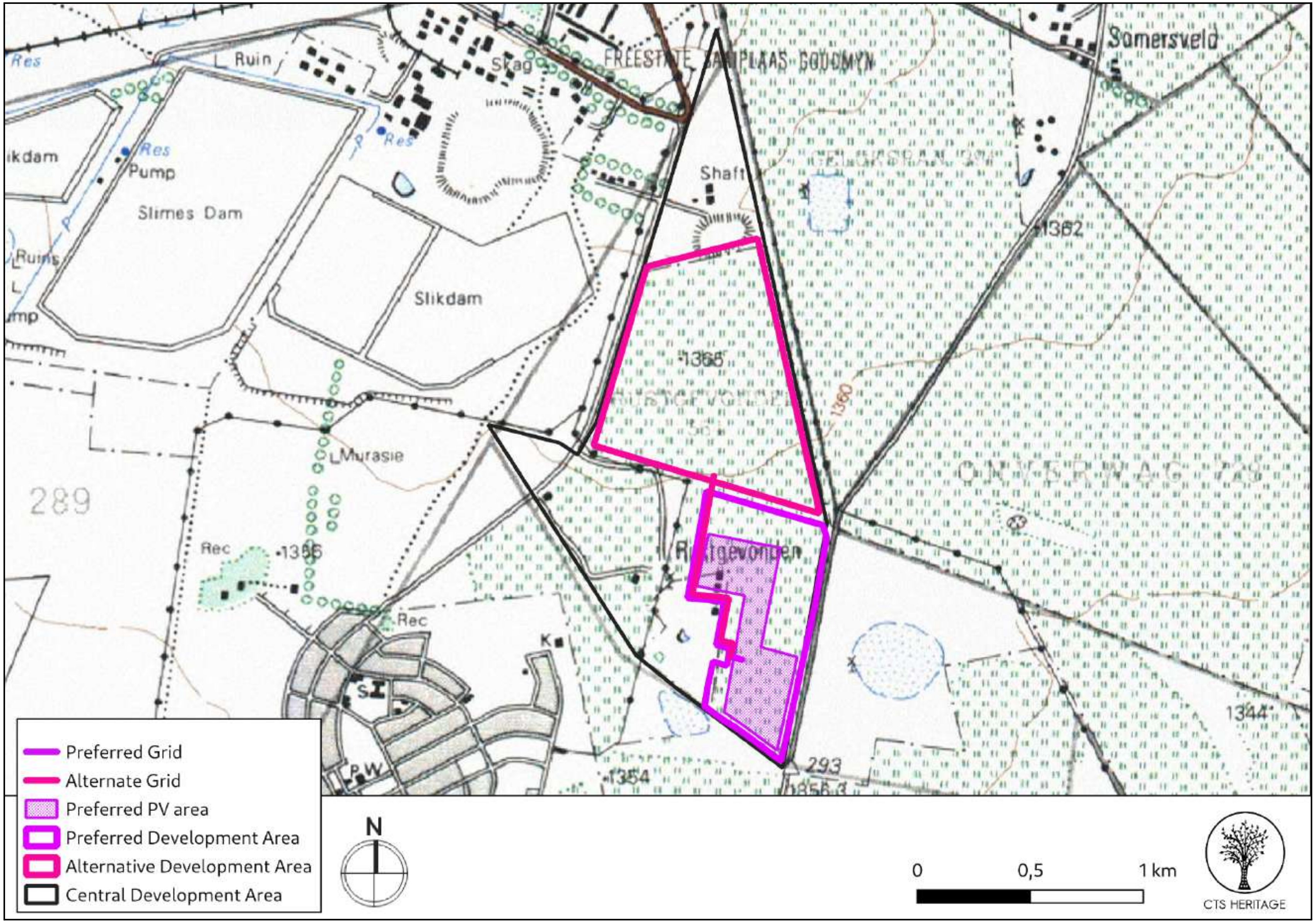


Figure 1d. Overview Map. Extract from 1:50 000 Topo

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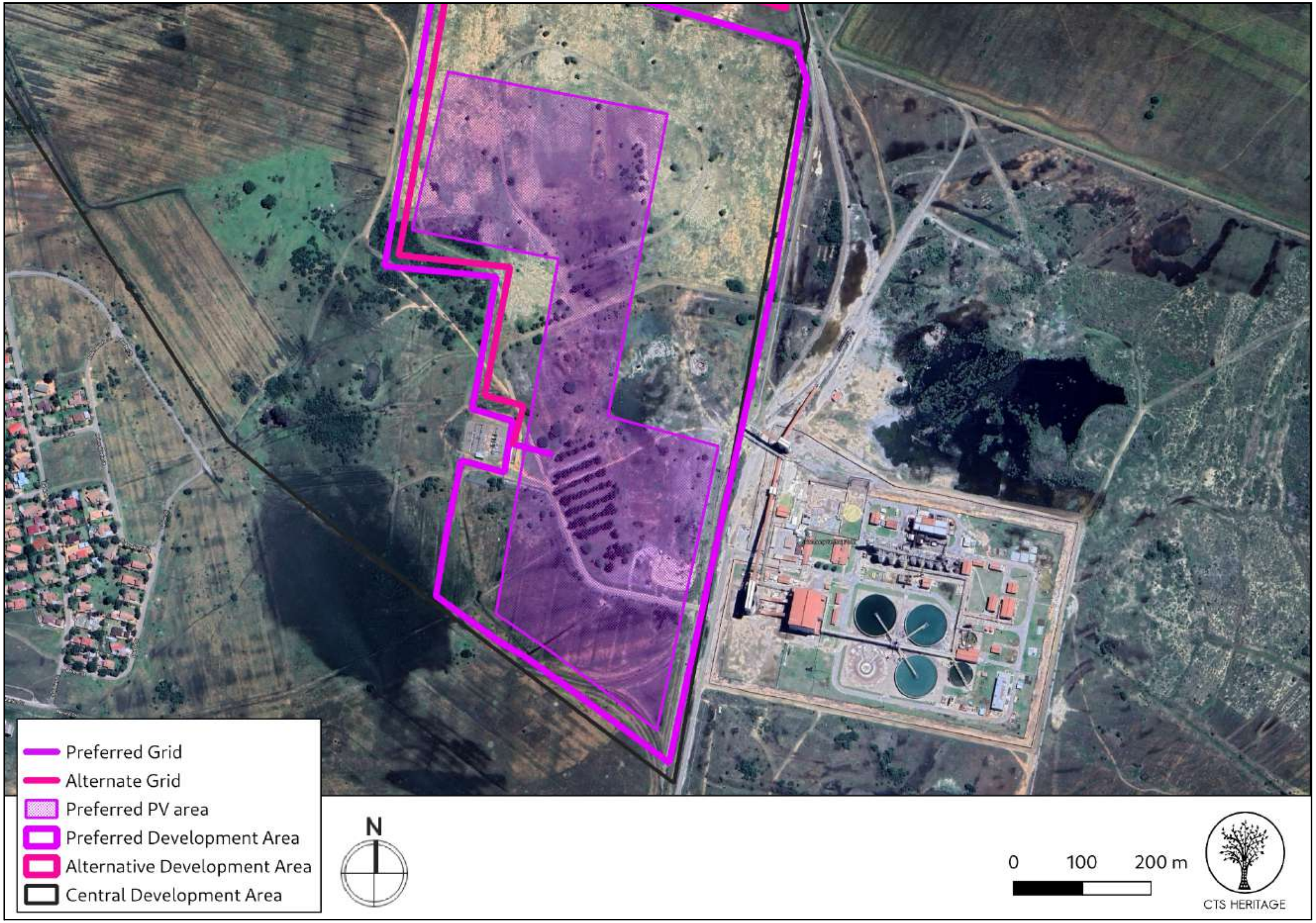

Figure 1e. Overview Map. Preferred

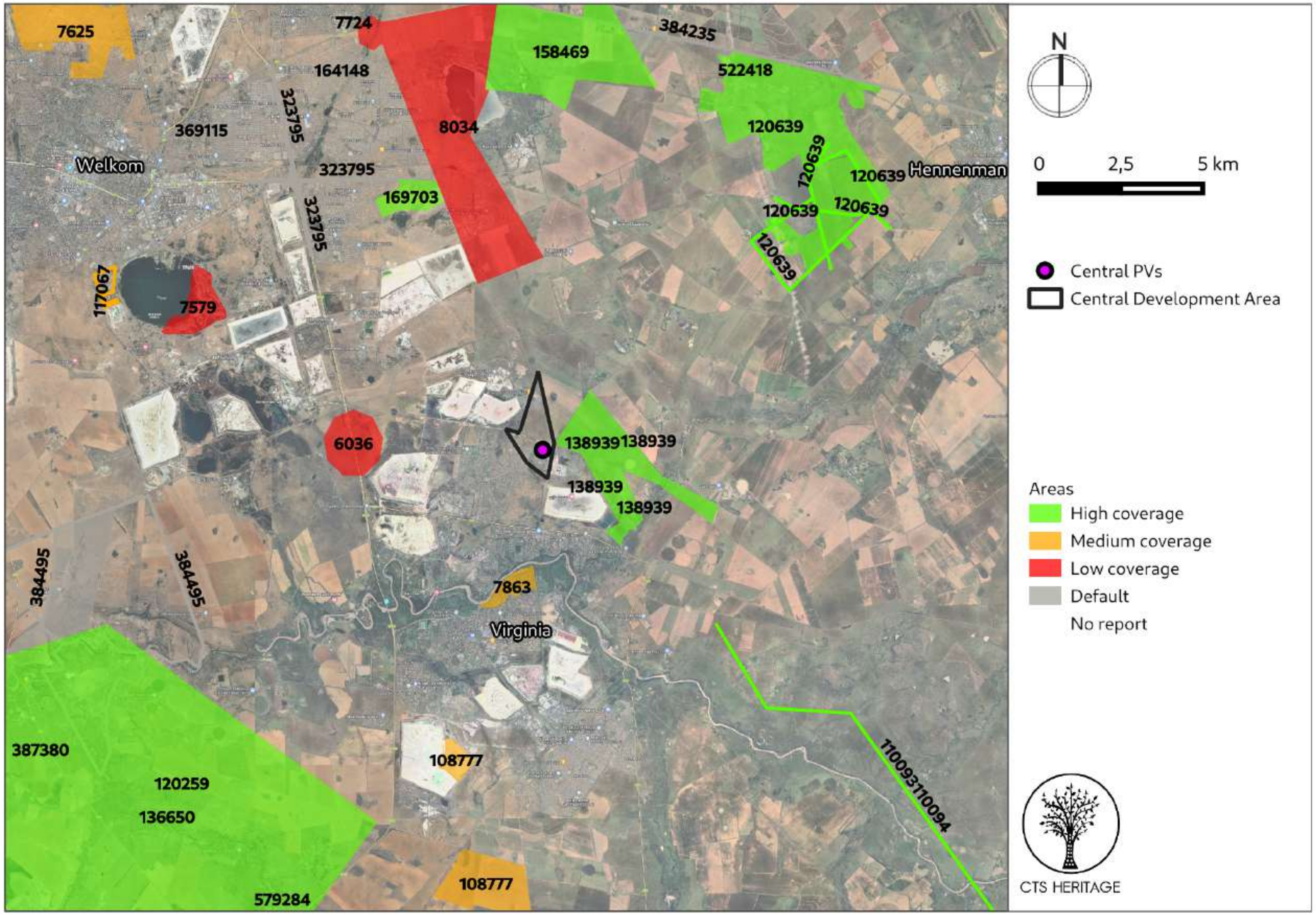

Figure 2. Previous HIAs Map. Previous Heritage Impact Assessments covering the proposed development area with SAHRIS NIDS indicated. Please see Appendix 2 for a full reference list.

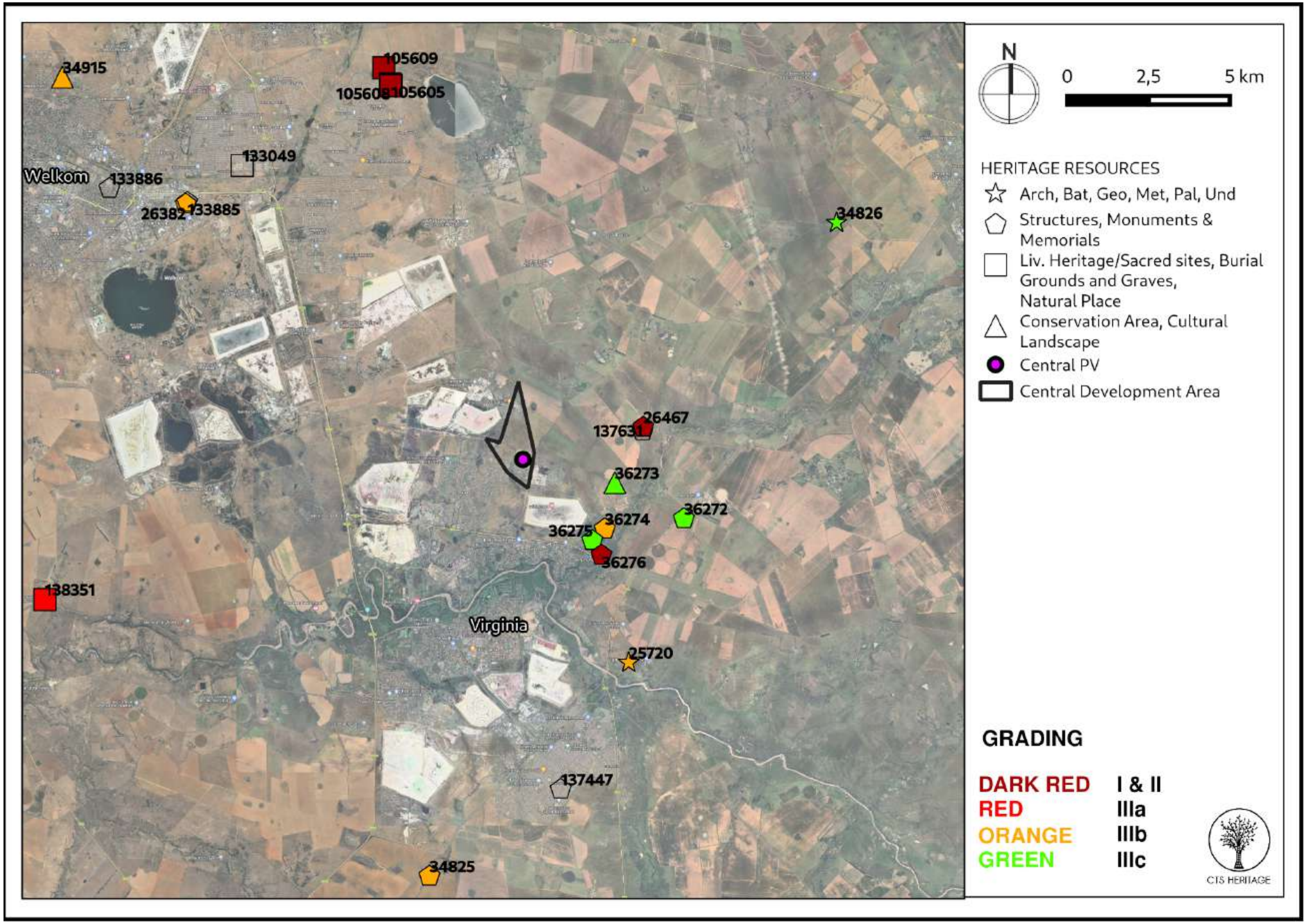

Figure 3. Heritage Resources Map. Heritage Resources previously identified within the study area, with SAHRIS Site IDs indicated in the insets below. Please See Appendix 4 for full description of heritage resource types.

CTS HERITAGE

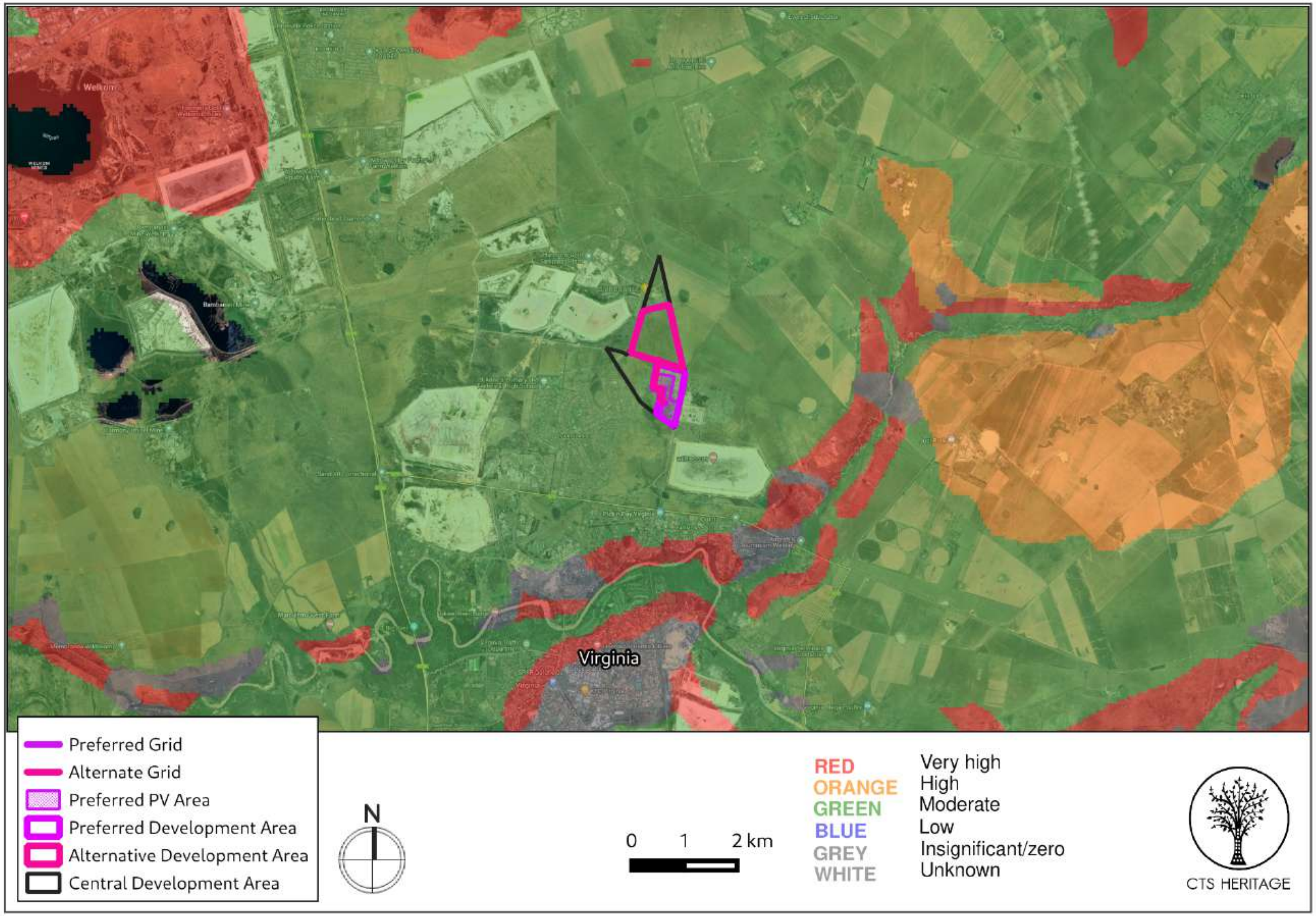

Figure 4a. Palaeosensitivity Map. Indicating fossil sensitivity underlying the study area. Please See Appendix 3 for a full guide to the legend.

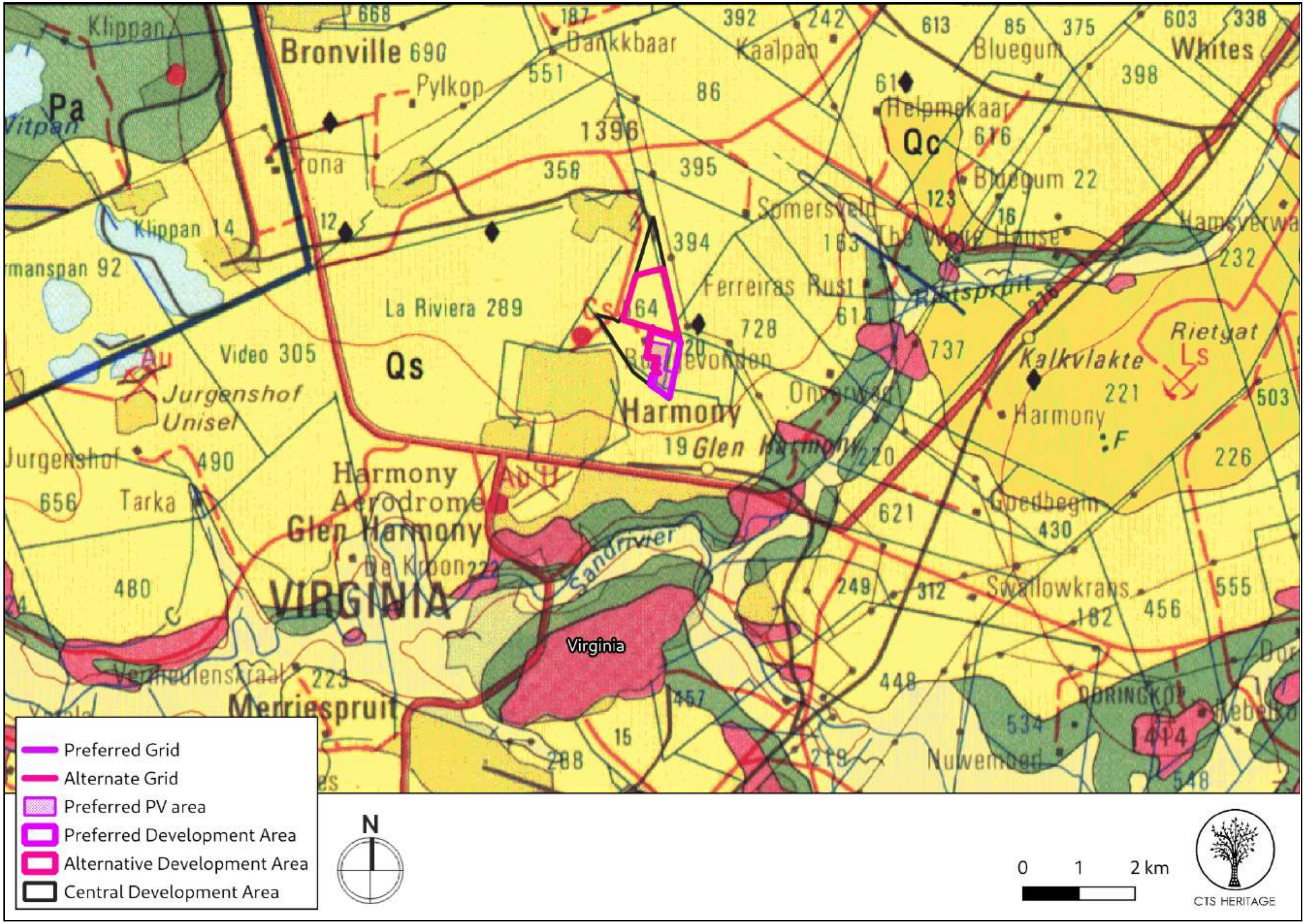

Figure 4b. Geology Map. Extract from the CGS 2826 Winberg Geology Map indicating that the development area is underlain by Quaternary Sands (Qs)

8. Heritage Assessment

Background

This application is for the proposed development of a PV facility and associated grid infrastructure located approximately 15km from the town of Welkom and 16km from the town of Henneman in the Free State Province. Much of the history of Welkom is centred around the discovery of gold in the northwestern Free State. It was proclaimed a town in 1948, nine years after a major gold discovery was made in Odendaalsrus, just north of Welkom. The proposed development is intended to supply the existing gold mining infrastructure in and near Welkom with electricity. According to Van der Walt (2015), “One of the earliest monuments at Welkom is located at the place where the Voortrekkers established a lookout post on the bank of the Sand River in the 1800s. This was in order to protect the Voortrekkers from Matabele cattle marauders. The establishment of the town was approved in 1946, and it developed very quickly thereafter. The town was named after one of the farms on which it was established. By the 1980s Welkom was a well-developed city. By 1982 13 large gold mines were located in a circumference of 23 kilometres from Welkom. (Niehaber et al. 1982: 71-72)”

Hennenman, which was built as a single railway station, was formerly denoted as *Ventersburg Road*. In 1927, it was renamed after local Afrikaner P.F. Hennenman, from Swartpan Farm. In 1944, black South Africans were confined to a segregated enclave in southern Hennenman. During apartheid, this area was cleared by order of the government and nearly all then-residents relocated to a new township some fifteen kilometres away, *Vergenoeg* (Afrikaans for "Far enough", now *Phomolong*). An area located immediately adjacent to the PV development was previously assessed by Van der Walt (2013) as part of a different development application. Van der walt (2013) describes the development area as “extremely flat and is utilized for extensive agricultural purposes (crop farming).

The study area falls within the bioregion described by Mucina et al (2006) as the Dry Highveld Grassland Bioregion with the vegetation described as Vaal-Vet Sandy Grassland within a Grassland Biome. Land use in the general area is characterized by mining and agriculture, dominated by crops and cattle farming. The study area is characterised by deep sandy to loamy soils based on the extensive agricultural activities.” According to Fourie (2021), “Existing surrounding land uses associated with the project area include a combination of mining related infrastructure and developments, powerlines, refuse dumps and dirt roads.” As the area proposed for development is located within an existing mining area, it is very unlikely that significant built environment heritage will be impacted by the proposed development. Furthermore, the history of Welkom is intimately linked with the gold mining industry and as such, it is unlikely that the proposed PV development will negatively impact on this unique cultural landscape as it is proposed to support the gold mining industry.

Archaeology

According to Fourie (2021), “The Free State has a rich archaeological and historical history going back millions of years and includes significant aspects such as Later Stone Age rock art, Battlefields and Iron Age stonewalled enclosures. The general surroundings of the study area became a melting pot of contact and conflict as it represents one of many frontiers where San hunter-gatherers, Nguni and Sotho-Tswana agro-pastoralists, Dutch Voortrekkers and British Colonists all came together. The ravages of war also swept across these plains, and in particular the South African War (1899-1902) as well as the Boer Rebellion (1914-1915).” No heritage resources of significance were identified by Van der Walt (2013) in his assessment of a nearby farm. Van der Walt (2013) notes that “some MSA finds might be possible around pans on the farm. It is important to note that the lack of sites can be attributed to a lack of sustainable water sources (no pans exist in the development footprint) in the development area as well as the lack of raw material for the manufacturing of stone tools. No Sites dating to the Early or Middle Iron Age have been recorded or are expected for the study area. The same goes for the Later Iron Age period where the study area is situated outside the western periphery of distribution of Late Iron Age settlements in the Free State. However to the north of the study area, ceramics from the Thabeng facies belonging to the Moloko branch of the Urewe tradition were recorded at Oxf 1 and Platberg 32/71 (Maggs 1976, Mason 1986)”.

In an assessment completed on the adjacent property, Van Ryneveld (2013) identified five historical structures on the property, but no archaeological heritage resources. Despite the high number of heritage impact assessments completed in the broader area (Figure 2, Appendix 2), no archaeological sites of significance have been identified in close proximity to the proposed development area. This is likely due to the extreme transformation of the area as a result of historic and ongoing gold mining activities. Based on the known archaeological sensitivity of the broader context, it is unlikely that the proposed development will impact on significant Stone Age or Iron Age archaeological heritage however it is possible that informal or unmarked graves may be present within the development area.

Palaeontology
According to the SAHRIS Palaeosensitivity Map the development sites are underlain by sediments of moderate fossil sensitivity (Figure 4) consisting of caenozoic regolith according to the extract from the CGS 2826 Winberg Geology Map (Figure 4b). According to a Palaeontological assessment completed by Groenewald (2013) for a neighbouring development, “No fossils have been described from the quaternary aeolian deposits in the study area, although fossil finds have been recorded from similar aged sediments, for example: the Cornelia Formation in the north-eastern Free State (Johnson et al, 2006).” It is possible that sensitive sediments of the Adelaide Subgroup underly the Quaternary Sands. According to Groenewald (2013), “The Permian Adelaide Subgroup is interpreted as a meandering river deposit grading upwards into a lacustrine environment and is well known for containing fossils (Johnson et al, 2006). Although difficult to correlate the study area directly with more well-known outcrops of the lower part of the Adelaide Subgroup to the east, the subgroup is known to contain very good examples of Glossopteris flora as well as numerous remains of vertebrate fossils associated with the Dicynodon Assemblage Zone in the north-eastern part of the Karoo Basin (Groenewald, 1989 and 1996).” Goenewald (2013) concludes that “There is a possibility that fossils could be encountered during excavation into both the quaternary sand deposits and the Adelaide Subgroup sediments within the development footprint. The study area has been extensively modified through agricultural development and it is unlikely that fossils will be exposed in these developed areas.”

Since there is a very small chance that fossils from the Adelaide Subgroup below the ground surface may be disturbed, it is recommended that a Fossil Chance Find Protocol be implemented during development.

RECOMMENDATION
As it is possible that significant heritage resources will be impacted by the proposed development, it is recommended that a Heritage Impact Assessment is completed that satisfies section 38(3) of the NHRA and assesses likely impacts to archaeological and palaeontological heritage.

9. Scoping Assessment Impact Table

Impact
- Impact to archaeological and built environment resources
- Impact to palaeontological resources
- Impact to Cultural Landscape
- Cumulative Impact

Desktop Sensitivity Analysis of the Site
- Impact to significant archaeological resources such as Stone Age artefact scatters, remnants of Iron Age settlements, burial grounds and graves, historical artefacts, historical structures and rock art engravings through destruction during the development phase and disturbance during the operational phase is possible.
- Impacts to palaeontological resources are unlikely.
- There is the potential for the cumulative impact of proposed solar energy facilities to negatively impact the cultural landscape due to a change in the landscape character from rural and mining to semi-industrial, however, due to the density of mining activities in the area, the impact on the experience of the cultural landscape is not foreseen to be significant.

Issue	Nature of Impact	Extent of Impact	No-Go Areas
Impact to significant heritage resources through destruction during the development phase and disturbance during the operational phase.	Destruction of significant heritage resources	Local scale with broader impacts to scientific knowledge	None known at present

Gaps in knowledge & recommendations for further study

The heritage resources in the area proposed for development are not yet sufficiently recorded

Based on the available information, including the scale and nature of the proposed development, it is likely that significant heritage resources will be impacted by the proposed development and as such it is recommended that further heritage studies are required in terms of section 38 of the NHRA with specific focus on impacts to archaeological heritage.

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APPENDIX 1

List of heritage resources within the development area

Site ID	Site no	Full Site Name	Site Type	Grading
26467	9/2/318/0001	Farmhouse, Ferreirasrust, Hennenman District	Building	Grade II
26382	9/2/345/0001	MOTH Club House, 24 12th Street, Voorspoed East, Welkom	Building	Grade IIIb
25720	VRC-01	Virginia Railway Cutting	Palaeontological	Grade IIIb
36272	LEB01	Lebone 01	Structures	Grade IIIc
36273	LEB02	Lebone 02	Cultural Landscape	Grade IIIc
36274	LEB03	Lebone 03	Building	Grade IIIb
36275	LEB04	Lebone 04	Building	Grade IIIc
36276	LEB05	Lebone 05	Transport infrastructure	Grade II
34825	DBM002	Wits Gold DBM 002	Building	Grade IIIb
34826	BEY001	Beyers 001	Artefacts, Ruin > 100 years, Deposit	Grade IIIc
34915	PHA001	Phakisa 001	Conservation Area	Grade IIIb
34824	DBM001	Wits Gold DBM 001	Burial Grounds & Graves	Grade IIIa
105608	Grave of Vuyo Edward Charles	Grave of Vuyo Edward Charles, Thabong Cemetery, Welkom	Burial Grounds & Graves	Grade II
105609	Grave of Albert Ndoyisile Xhamfu	Grave of Albert Ndoyisile Xhamfu, Thabong Cemetery, Welkom	Burial Grounds & Graves	Grade II
105610	Grave of Samuel Zuka Baloi	Grave of Samuel Zuka Baloi Site, Thabong Cemetery, Welkom	Burial Grounds & Graves	Grade II
138351	TRC1-039	TETRA4 CLUSTER 1	Burial Grounds & Graves	Grade IIIa

133049	Thabong Electricaal Infrastructure	Erven 30671 & 8172 Thabong	Place	
105605	Grave of Itumeleng Caswell Mokobo	Grave of Itumeleng Caswell Mokobo, Thabong Cemetery, Welkom	Burial Grounds & Graves	Grade II
137447	Wasgoed spruit Totius Garden of remembrance	Wasgoed spruit Totius Garden of remembrance	Monuments & Memorials	
137631	Ferreirasrust Farm	Ferreirasrust Farm	Monuments & Memorials	
133885	DC18/NAMM/0008	War Memorial, MOTH Shellhole, Welkom	Monuments & Memorials	
133886	DC18/NAMM/0013	War Memorial, Jan Hofmeyer RD, Welkom	Monuments & Memorials	

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APPENDIX 2

Reference List with relevant AIAs and PIAs

Heritage Impact Assessments				
Nid	**Report Type**	**Author/s**	**Date**	**Title**
108777	Heritage Impact Assessment Specialist Reports	Anton van Vollenhoven	30/11/2011	A REPORT ON A CULTURAL HERITAGE IMPACT ASSESSMENT FOR THE PROPOSED WITS GOLD DBM PROJECT CLOSE TO VIRGINIA, FREE STATE PROVINCE
120259	PIA Desktop	Barry Millsteed		Desktop Palaeontological Heritage Impact Assessment Report for the Oryx Solar Energy Facility
120639	Archaeological Specialist Reports	Jaco van der Walt	30/08/2013	Aracheological Impact Assessment report for the Proposed Everest Solar Energy Facility
124729	Heritage Scoping	Jaco van der Walt	08/05/2013	Archaeological Scoping Report for the Proposed Oryx Energy Facility
136650	Archaeological Specialist Reports	Jaco van der Walt	30/08/2013	Archaeological Impact Assessment report for the Oryx Solar Energy Facility
138939	Heritage Impact Assessment Specialist Reports	Karen Van Ryneveld, Gideon Groenewald	17/10/2013	Phase 1 Archaeological Impact Assessment & Palaeontological Assessment Lebone Solar Farm The Remaining Extent of the Farm Onverwag No. 728 and Portion 2 of the Farm Vaalkranz Np. 220, Welkom, Free State Province
158469	Heritage Impact Assessment Specialist Reports	Karen Van Ryneveld	19/10/2013	PHASE 1 ARCHAEOLOGICAL IMPACT ASSESSMENT. THE THABONG SOLAR FARM, UITKYK 509, WELKOM, FREE STATE, SOUTH AFRICA
164148	Heritage Impact Assessment Specialist Reports	Lloyd Rossouw	06/12/2013	Phase 1 Palaeontological and Archaeological Impact Assessment of the proposed Phokeng Township extension at Thabong, Matjhabeng Local Municipality, Free State Province.
169703		Lloyd Rossouw		
186709	PIA Desktop	Gideon Groenewald	14/10/2013	PALAEONTOLOGICAL ASSESSMENT OF THE PROPOSED DEVELOPMENT OF A 75MW

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				PHOTOVOLTAIC SOLAR FARM, ON THE FARM UITKYK 509, WELKOM, FREE STATE PROVINCE.
266924	Archaeological Specialist Reports		26/01/2015	Archaeological Impact Assessment report for the Proposed Uitsig 5MW Solar Energy Facility close to Henneman in the Free State Province
334505		John Almond	22/07/2015	Palaeontological specialist assessment: desktop study for the proposed Hennenman 5MW solar energy facility.
369115	HIA Phase 1	Candice Keeling	09/09/2016	Heritage Impact Assessment of Ernest Oppenheimer Hospital, Erf 7186, Reitzpark, Welkom, Orange Free State. Proposed Upgrade of Existing Facilities - September 2016
6036	AIA Phase 1	Cobus Dreyer	15/09/2005	Archaeological and Historical Investigation of the Proposed New Filling Station at Virginia, Free State
7579	AIA Phase 1	Cobus Dreyer	10/03/2008	First Phase Archaeological and Cultural Heritage Investigation of the Proposed Oppenheimer Park Golf Estate, Welkom, Free State
7625	AIA Phase 1	Francois P Coetzee	01/02/2008	Cultural Heritage Survey of the Proposed Phakisa Housing Development, Welkom, Free State
7724	AIA Phase 1	Cobus Dreyer	20/06/2007	First Phase Archaeological and Cultural Heritage Assessment of the Proposed New MTN Cell Phone Mast at Pumlani Cemetery, Thabong, Welkom, Free State
7863	AIA Phase 1	Cobus Dreyer	30/08/2006	First Phase Archaeological and Cultural Heritage Investigation of the Proposed Sandrivier Golf Estate, Virginia, Free State
8034	AIA Phase 1	Cobus Dreyer	05/03/2004	Archaeological and Historical Investigation of the Graves at the Proposed Housing Developments near Thabong, Welkom, Free State
110093	PIA Desktop	Job M. Kibii		Palaeontological Impact Assessmnent Deskop Study Report for the Proposed Merapi (Excelsior) PV Solar Energy Facilities
110094	HIA Phase 1	Nkosinathi Godfrey Tomose		Heritage Imapct Assessment Study for the Proposed PV Solar Energy Facilities, near Excelsior, Free State Province
117067	HIA Phase 1	Frans Prins	31/01/2013	Cultural Heritage Desktop Assessment of the proposed Bio-energy Facility, Harmony Gold Mine , Welkom, Free State Province

120639	Archaeological Specialist Reports	Jaco van der Walt	30/08/2013	Aracheological Impact Assessment report for the Proposed Everest Solar Energy Facility
323795	Heritage Impact Assessment Specialist Reports		31/03/2014	Cultural Heritage Impact Assessment Report for the Proposed SANRAL Thabong Interchange Development, Welkom Region, Free State Province
384235	AIA Phase 1	Lloyd Rossouw	30/09/2016	Phase 1 Archaeological Impact Assessment of a proposed new water pipeline and associated infrastructure between Ventersburg and the Koppie Alleen pump station, FS Province
384495	Heritage Scoping	Nkosinathi Godfrey Tomose	20/12/2016	Heritage Scoping Study for the Proposed Prospecting Rights Application on Farms Adamsons Vley 655, Jonkers Rust 72, Du Preez Leger 324 and Stillewoning 703

APPENDIX 3 - Keys/Guides

Key/Guide to Acronyms

AIA	Archaeological Impact Assessment
DARD	Department of Agriculture and Rural Development (KwaZulu-Natal)
DEA	Department of Environmental Affairs (National)
DEADP	Department of Environmental Affairs and Development Planning (Western Cape)
DEDEAT	Department of Economic Development, Environmental Affairs and Tourism (Eastern Cape)
DEDECT	Department of Economic Development, Environment, Conservation and Tourism (North West)
DEDT	Department of Economic Development and Tourism (Mpumalanga)
DEDTEA	Department of economic Development, Tourism and Environmental Affairs (Free State)
DENC	Department of Environment and Nature Conservation (Northern Cape)
DMR	Department of Mineral Resources (National)
GDARD	Gauteng Department of Agriculture and Rural Development (Gauteng)
HIA	Heritage Impact Assessment
LEDET	Department of Economic Development, Environment and Tourism (Limpopo)
MPRDA	Mineral and Petroleum Resources Development Act, no 28 of 2002
NEMA	National Environmental Management Act, no 107 of 1998
NHRA	National Heritage Resources Act, no 25 of 1999
PIA	Palaeontological Impact Assessment
SAHRA	South African Heritage Resources Agency
SAHRIS	South African Heritage Resources Information System
VIA	Visual Impact Assessment

Full guide to Palaeosensitivity Map legend

	RED:	VERY HIGH - field assessment and protocol for finds is required
	ORANGE/YELLOW:	HIGH - desktop study is required and based on the outcome of the desktop study, a field assessment is likely
	GREEN:	MODERATE - desktop study is required
	BLUE/PURPLE:	LOW - no palaeontological studies are required however a protocol for chance finds is required
	GREY:	INSIGNIFICANT/ZERO - no palaeontological studies are required
	WHITE/CLEAR:	UNKNOWN - these areas will require a minimum of a desktop study.

APPENDIX 4 - Methodology

The Heritage Screener summarises the heritage impact assessments and studies previously undertaken within the area of the proposed development and its surroundings. Heritage resources identified in these reports are assessed by our team during the screening process.

The heritage resources will be described both in terms of **type**:

- Group 1: Archaeological, Underwater, Palaeontological and Geological sites, Meteorites, and Battlefields
- Group 2: Structures, Monuments and Memorials
- Group 3: Burial Grounds and Graves, Living Heritage, Sacred and Natural sites
- Group 4: Cultural Landscapes, Conservation Areas and Scenic routes

and **significance** (Grade I, II, IIIa, b or c, ungraded), as determined by the author of the original heritage impact assessment report or by formal grading and/or protection by the heritage authorities.

Sites identified and mapped during research projects will also be considered.

DETERMINATION OF THE EXTENT OF THE INCLUSION ZONE TO BE TAKEN INTO CONSIDERATION

The extent of the inclusion zone to be considered for the Heritage Screener will be determined by CTS based on:

- the size of the development,
- the number and outcome of previous surveys existing in the area
- the potential cumulative impact of the application.

The inclusion zone will be considered as the region within a maximum distance of 50 km from the boundary of the proposed development.

DETERMINATION OF THE PALAEONTOLOGICAL SENSITIVITY

The possible impact of the proposed development on palaeontological resources is gauged by:

- reviewing the fossil sensitivity maps available on the South African Heritage Resources Information System (SAHRIS)
- considering the nature of the proposed development
- when available, taking information provided by the applicant related to the geological background of the area into account

DETERMINATION OF THE COVERAGE RATING ASCRIBED TO A REPORT POLYGON

Each report assessed for the compilation of the Heritage Screener is colour-coded according to the level of coverage accomplished. The extent of the surveyed coverage is labeled in three categories, namely low, medium and high. In most instances the extent of the map corresponds to the extent of the development for which the specific report was undertaken.

Low coverage will be used for:

- desktop studies where no field assessment of the area was undertaken;
- reports where the sites are listed and described but no GPS coordinates were provided.
- older reports with GPS coordinates with low accuracy ratings;
- reports where the entire property was mapped, but only a small/limited area was surveyed.
- uploads on the National Inventory which are not properly mapped.

Medium coverage will be used for

- reports for which a field survey was undertaken but the area was not extensively covered. This may apply to instances where some impediments did not allow for full coverage such as thick vegetation, etc.
- reports for which the entire property was mapped, but only a specific area was surveyed thoroughly. This is differentiated from low ratings listed above when these surveys cover up to around 50% of the property.

High coverage will be used for

- reports where the area highlighted in the map was extensively surveyed as shown by the GPS track coordinates. This category will also apply to permit reports.

RECOMMENDATION GUIDE

The Heritage Screener includes a set of recommendations to the applicant based on whether an impact on heritage resources is anticipated. One of three possible recommendations is formulated:

(1) The heritage resources in the area proposed for development are sufficiently recorded - The surveys undertaken in the area adequately captured the heritage resources. There are no known sites which require mitigation or management plans. No further heritage work is recommended for the proposed development.

This recommendation is made when:

- enough work has been undertaken in the area
- it is the professional opinion of CTS that the area has already been assessed adequately from a heritage perspective for the type of development proposed

(2) The heritage resources and the area proposed for development are only partially recorded - The surveys undertaken in the area have not adequately captured the heritage resources and/or there are sites which require mitigation or management plans. Further specific heritage work is recommended for the proposed development.

This recommendation is made in instances in which there are already some studies undertaken in the area and/or in the adjacent area for the proposed development. Further studies in a limited HIA may include:

- improvement on some components of the heritage assessments already undertaken, for instance with a renewed field survey and/or with a specific specialist for the type of heritage resources expected in the area
- compilation of a report for a component of a heritage impact assessment not already undertaken in the area

- undertaking mitigation measures requested in previous assessments/records of decision.

(3) The heritage resources within the area proposed for the development have not been adequately surveyed yet - Few or no surveys have been undertaken in the area proposed for development. A full Heritage Impact Assessment with a detailed field component is recommended for the proposed development.

Note:
The responsibility for generating a response detailing the requirements for the development lies with the heritage authority. However, since the methodology utilised for the compilation of the Heritage Screeners is thorough and consistent, contradictory outcomes to the recommendations made by CTS should rarely occur. Should a discrepancy arise, CTS will immediately take up the matter with the heritage authority to clarify the dispute.

APPENDIX 5 -Summary of Specialist Expertise

Jenna Lavin, an archaeologist with an MSc in Archaeology and Palaeoenvironments, and currently completing an MPhil in Conservation Management , heads up the heritage division of the organisation, and has a wealth of experience in the heritage management sector. Jenna's previous position as the Assistant Director for Policy, Research and Planning at Heritage Western Cape has provided her with an in-depth understanding of national and international heritage legislation. Her 8 years of experience at various heritage authorities in South Africa means that she has dealt extensively with permitting, policy formulation, compliance and heritage management at national and provincial level and has also been heavily involved in rolling out training on SAHRIS to the Provincial Heritage Resources Authorities and local authorities.

Jenna is a member of the Association of Professional Heritage Practitioners (APHP), and is also an active member of the International Committee on Monuments and Sites (ICOMOS) as well as the International Committee on Archaeological Heritage Management (ICAHM). In addition, Jenna has been a member of the Association of Southern African Professional Archaeologists (ASAPA) since 2009. Recently, Jenna has been responsible for conducting training in how to write Wikipedia articles for the Africa Centre's WikiAfrica project.

Since 2016, Jenna has drafted over 50 Heritage Impact Assessments throughout South Africa.

CTS HERITAGE

HERITAGE SCREENER

CTS Reference Number:	**CTS22_101**
SAHRIS Reference:	
Client:	**Savannah Environmental (Pty) Ltd**
Date:	**May 2022**
Title:	**Proposed development of the Central PV Facility near Welkom**

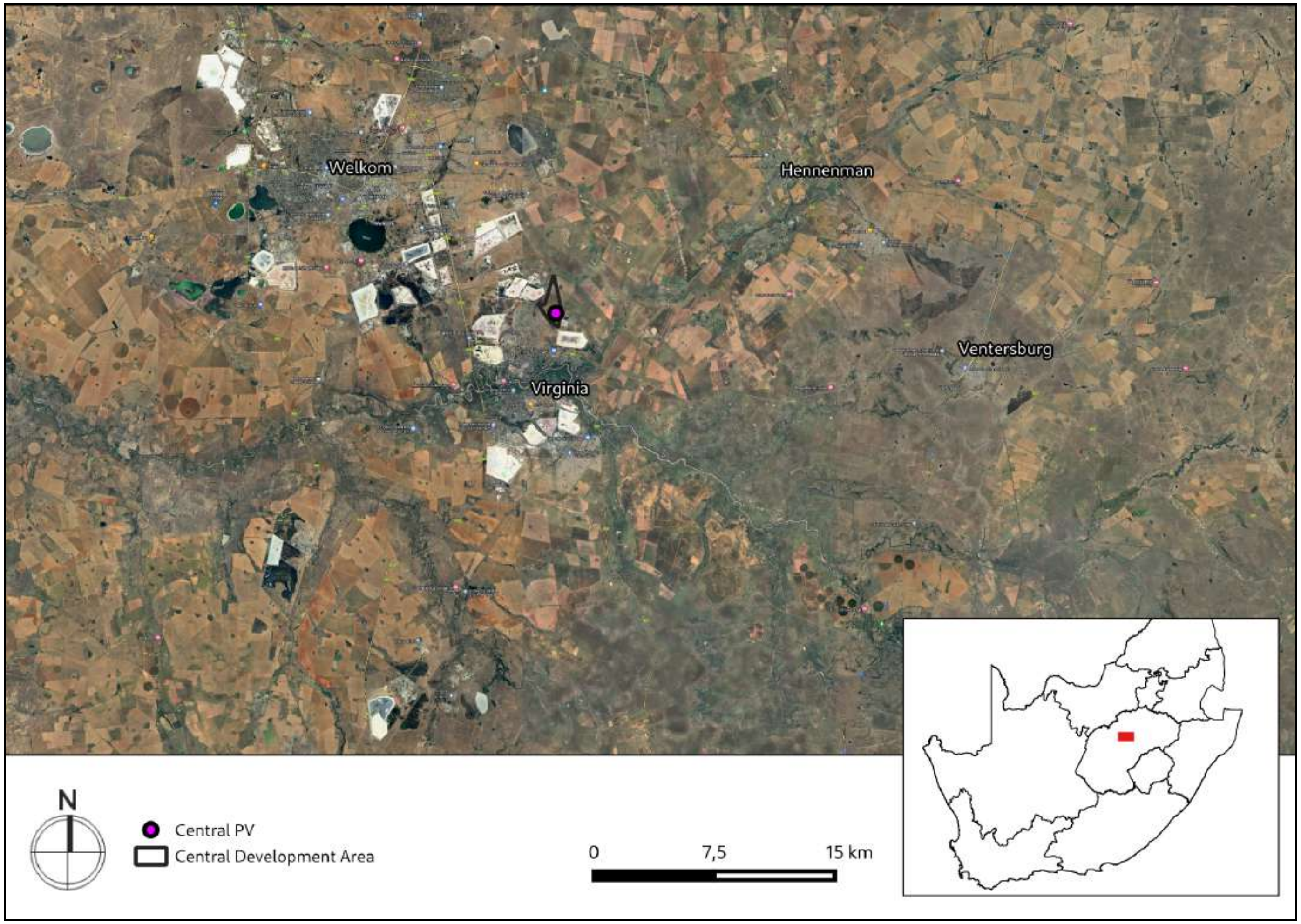

Figure 1a. Satellite map indicating the location of the proposed development in the Free State

RECOMMENDATION
As it is possible that significant heritage resources will be impacted by the proposed development, it is recommended that a Heritage Impact Assessment is completed that satisfies section 38(3) of the NHRA and assesses likely impacts to archaeological and palaeontological heritage.

CTS Heritage
16 Edison Way, Century City, Cape Town
Tel: +27 (0)87 073 5739 **Email:** info@ctsheritage.com **Web:** www.ctsheritage.com

CTS HERITAGE

1. Proposed Development Summary

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3. Property Information

Latitude / Longitude	28° 3'29.54"S 26°52'53.71"E
Erf number / Farm number	SAAIPLAAS 771 — 12 RUSTGEVONDEN 564 — 1
Local Municipality	Matjhabeng
District Municipality	Lejweleputswa
Province	Free State
Current Use	Mining
Current Zoning	Agriculture

4. Nature of the Proposed Development

Total Area	33.6ha
Depth of excavation (m)	<2m
Height of development (m)	Max 20m pylons

5. Category of Development

x	**Triggers: Section 38(8) of the National Heritage Resources Act**
	Triggers: Section 38(1) of the National Heritage Resources Act
x	1. Construction of a road, wall, powerline, pipeline, canal or other similar form of linear development or barrier over 300m in length.
	2. Construction of a bridge or similar structure exceeding 50m in length.
	3. Any development or activity that will change the character of a site-
x	a) exceeding 5 000m^2 in extent
	b) involving three or more existing erven or subdivisions thereof
	c) involving three or more erven or divisions thereof which have been consolidated within the past five years
	4. Rezoning of a site exceeding 10 000m^2
	5. Other (state):

6. Additional Infrastructure Required for this Development

NA

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7. Mapping (please see Appendix 3 and 4 for a full description of our methodology and map legends)

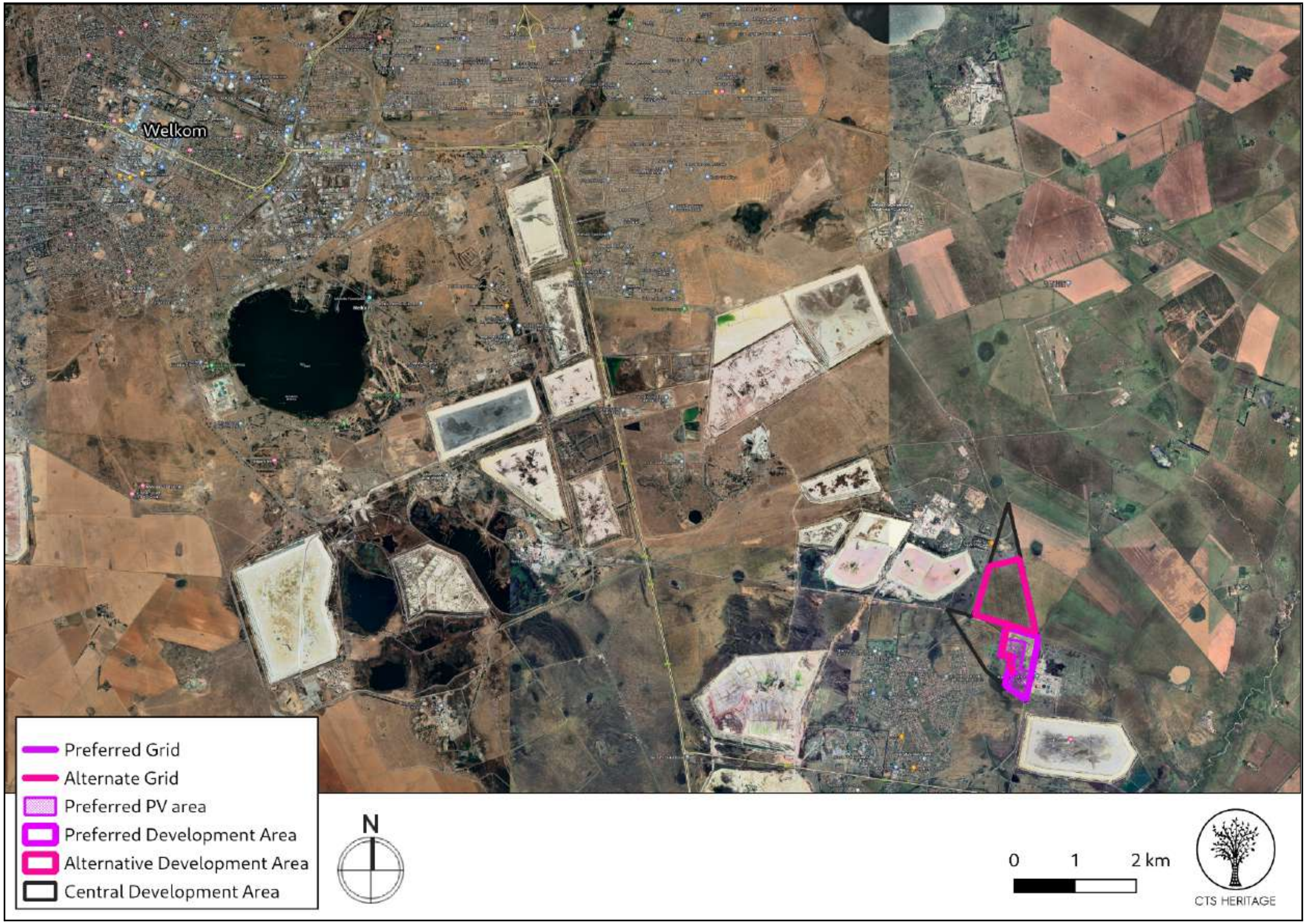

Figure 1b. Overview Map. Satellite image (2022) indicating the proposed development area

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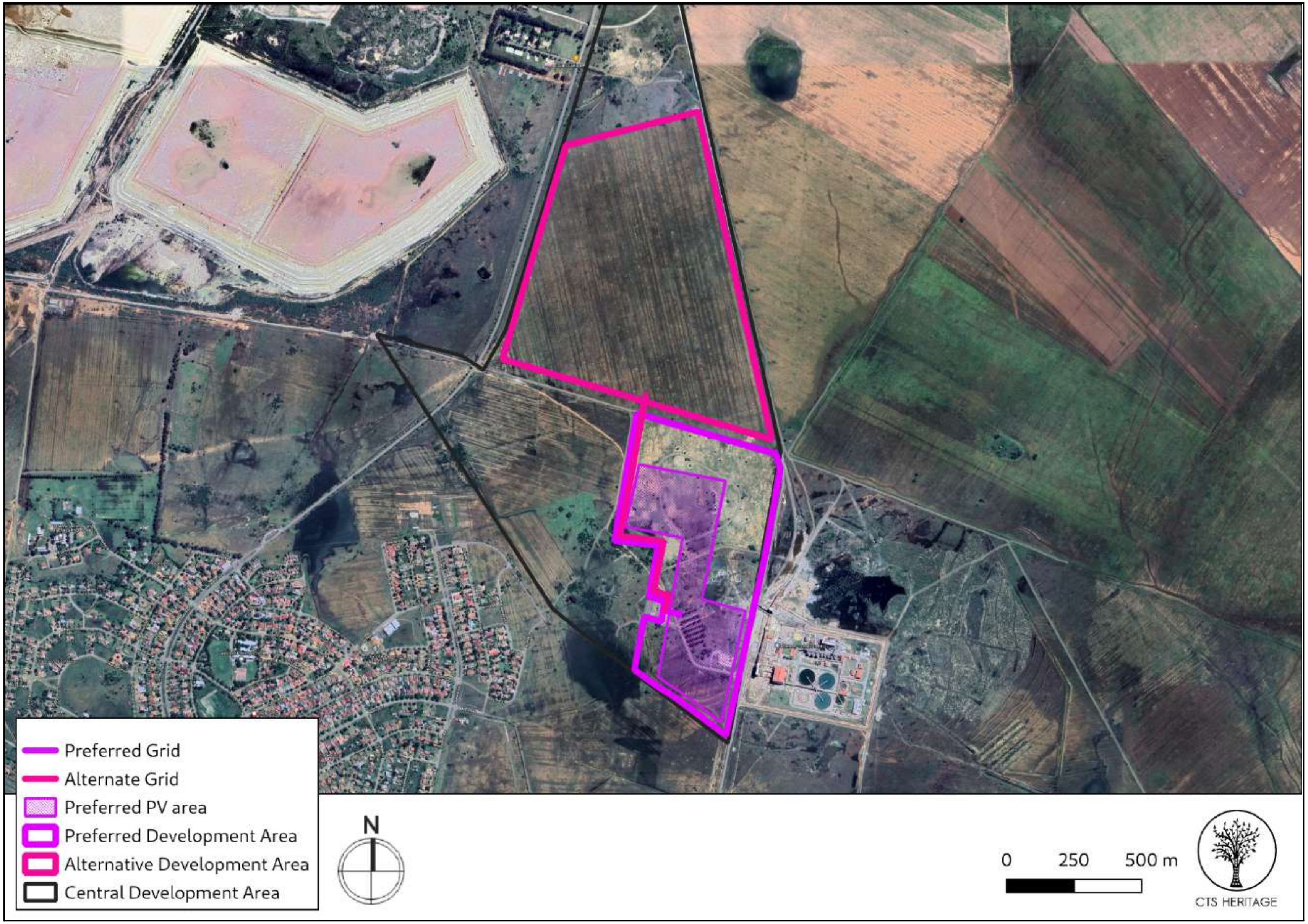

Figure 1c. Overview Map. Satellite image (2022) indicating the proposed development area

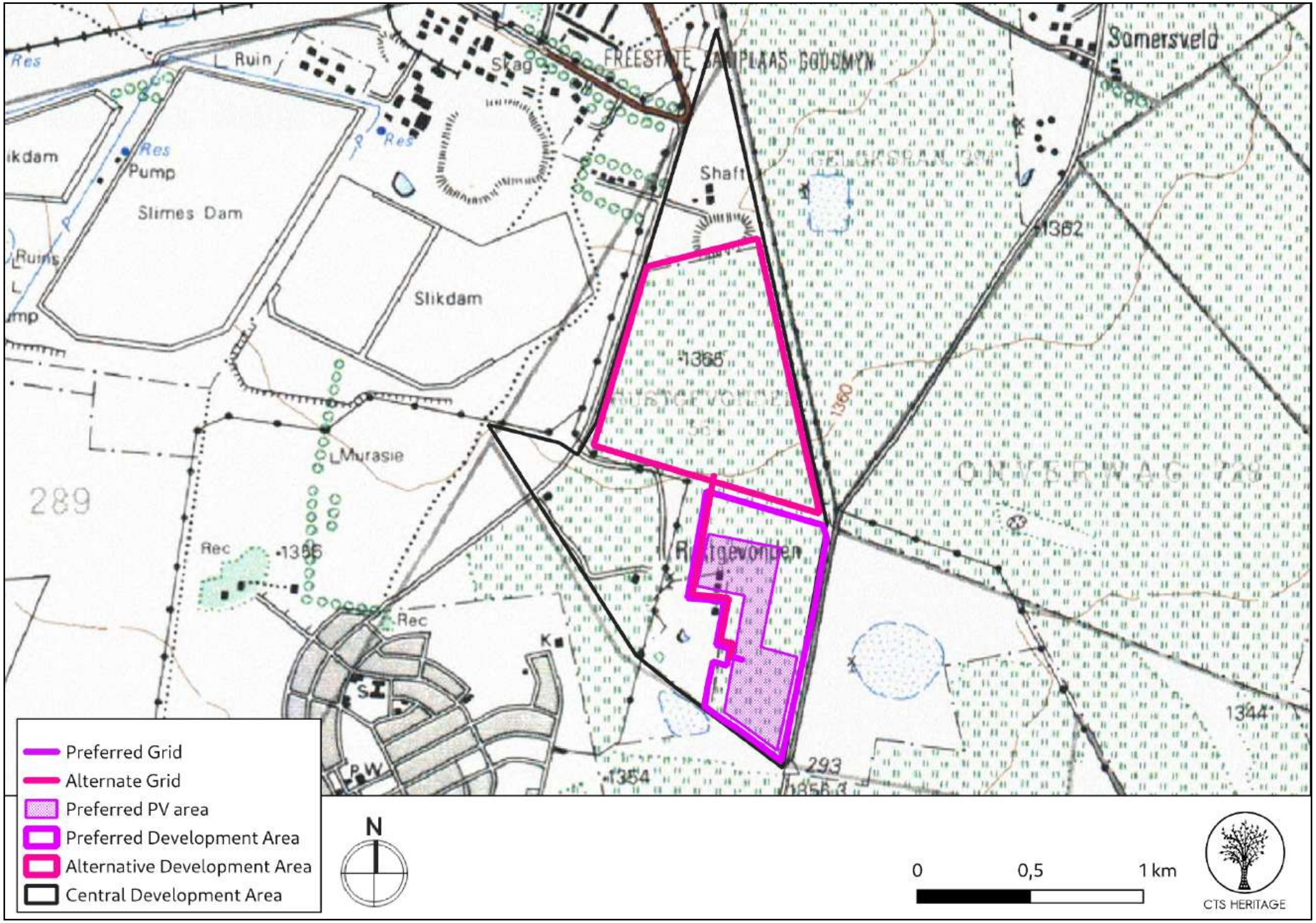

Figure 1d. Overview Map. Extract from 1:50 000 Topo

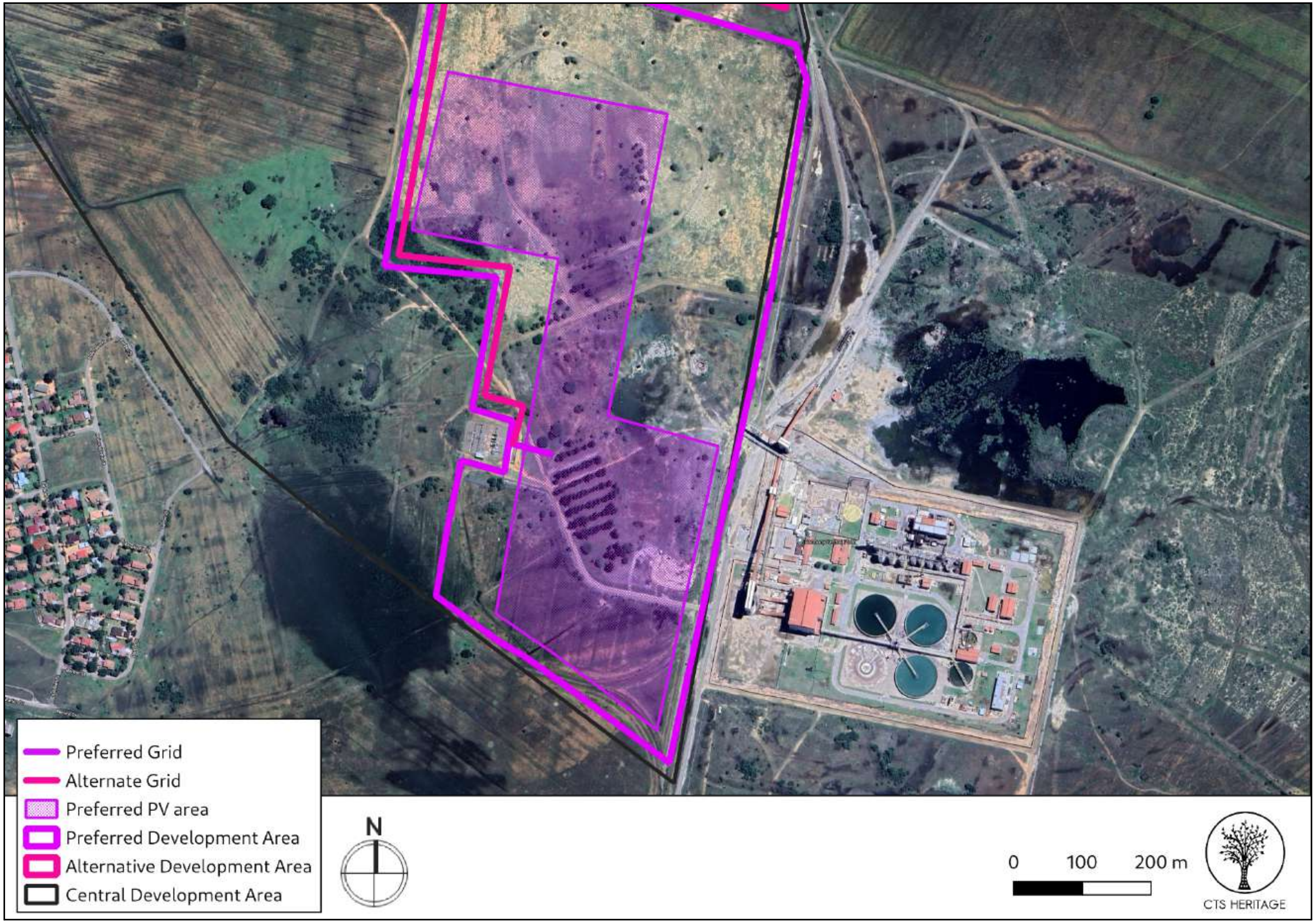

Figure 1e. Overview Map. Preferred

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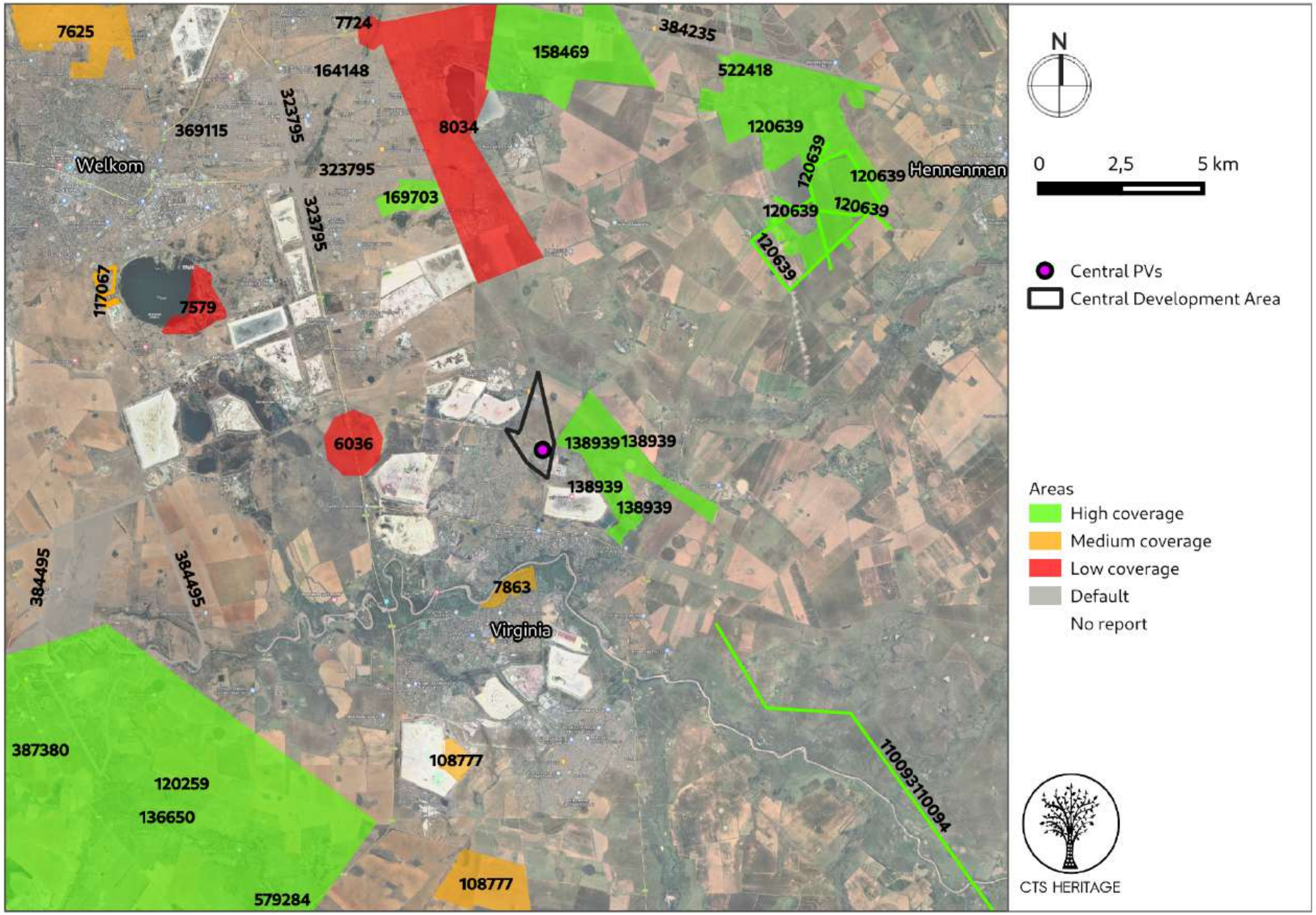

Figure 2. Previous HIAs Map. Previous Heritage Impact Assessments covering the proposed development area with SAHRIS NIDS indicated. Please see Appendix 2 for a full reference list.

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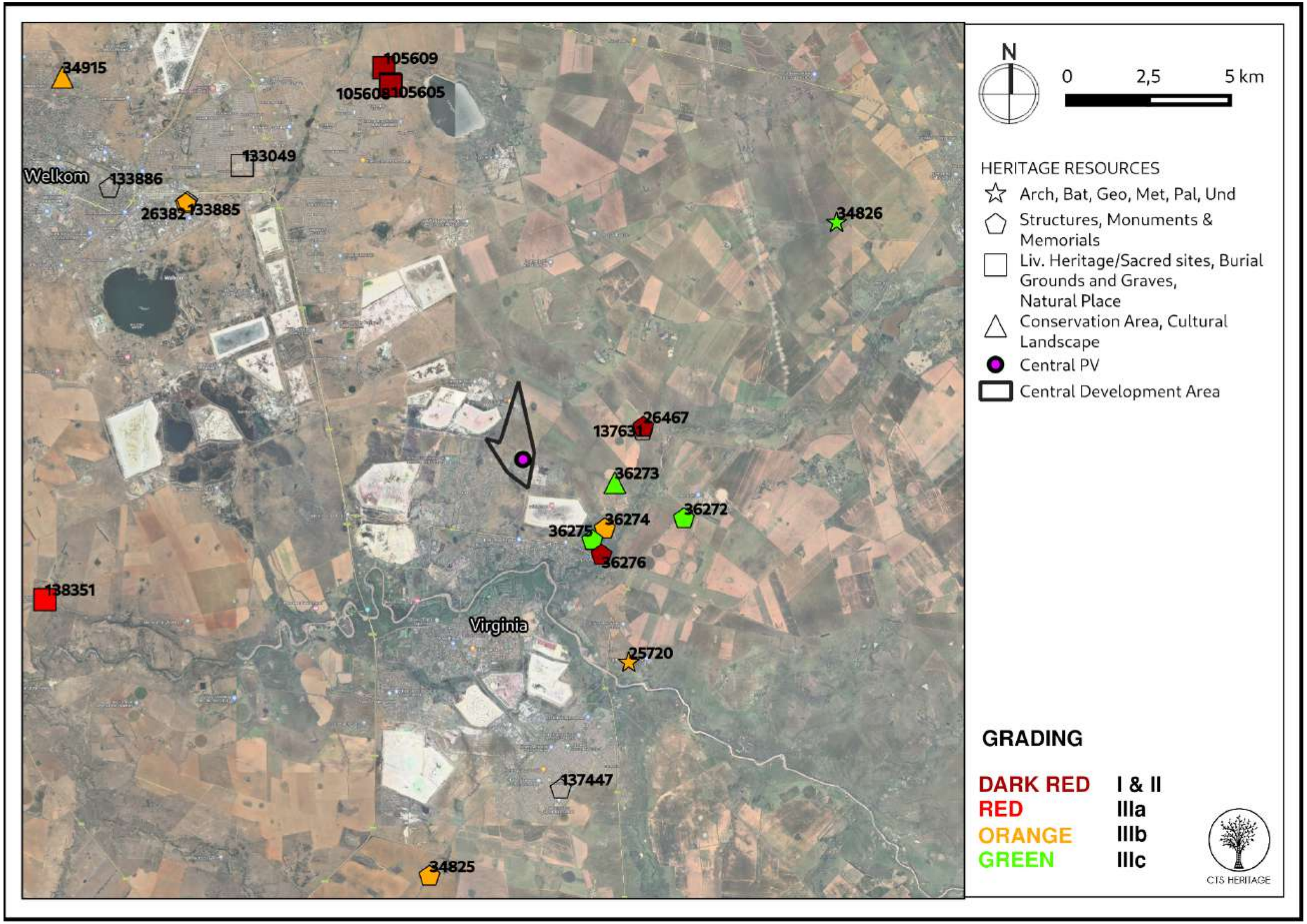

Figure 3. Heritage Resources Map. Heritage Resources previously identified within the study area, with SAHRIS Site IDs indicated in the insets below. Please See Appendix 4 for full description of heritage resource types.

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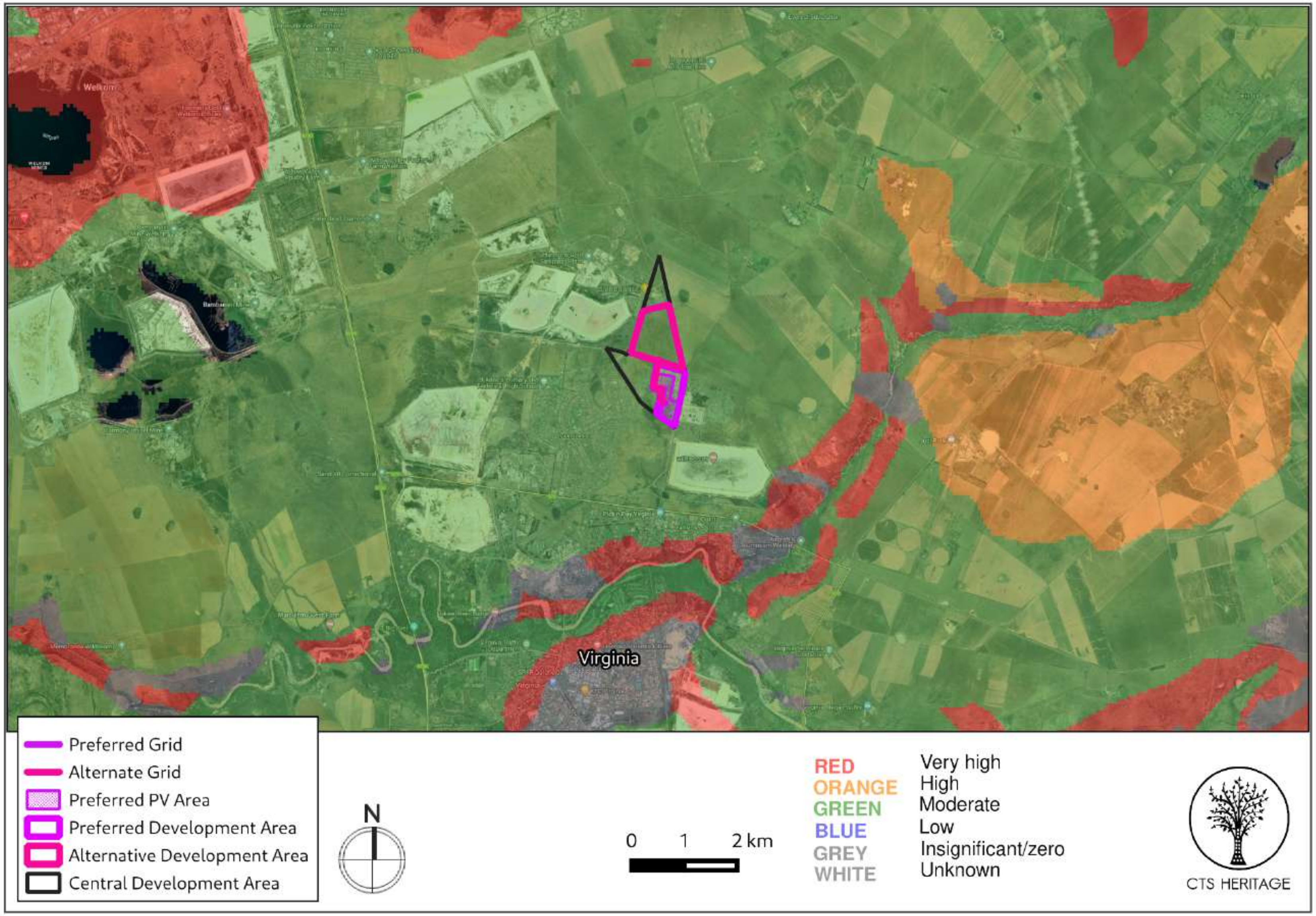

Figure 4a. Palaeosensitivity Map. Indicating fossil sensitivity underlying the study area. Please See Appendix 3 for a full guide to the legend.

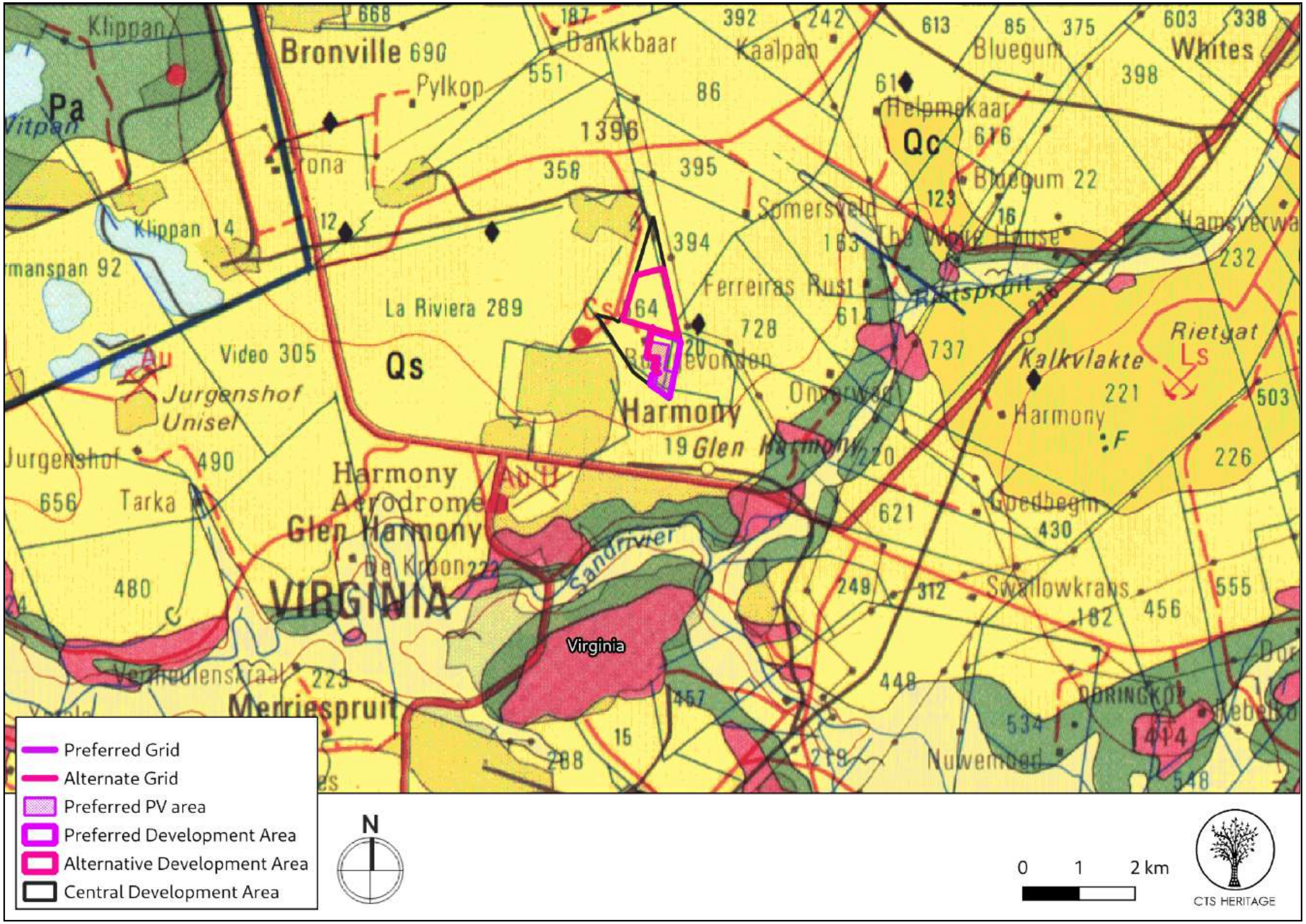

Figure 4b. Geology Map. Extract from the CGS 2826 Winberg Geology Map indicating that the development area is underlain by Quaternary Sands (Qs)

8. Heritage Assessment

Background

This application is for the proposed development of a PV facility and associated grid infrastructure located approximately 15km from the town of Welkom and 16km from the town of Henneman in the Free State Province. Much of the history of Welkom is centred around the discovery of gold in the northwestern Free State. It was proclaimed a town in 1948, nine years after a major gold discovery was made in Odendaalsrus, just north of Welkom. The proposed development is intended to supply the existing gold mining infrastructure in and near Welkom with electricity. According to Van der Walt (2015), “One of the earliest monuments at Welkom is located at the place where the Voortrekkers established a lookout post on the bank of the Sand River in the 1800s. This was in order to protect the Voortrekkers from Matabele cattle marauders. The establishment of the town was approved in 1946, and it developed very quickly thereafter. The town was named after one of the farms on which it was established. By the 1980s Welkom was a well-developed city. By 1982 13 large gold mines were located in a circumference of 23 kilometres from Welkom. (Niehaber et al. 1982: 71-72)”

Hennenman, which was built as a single railway station, was formerly denoted as *Ventersburg Road*. In 1927, it was renamed after local Afrikaner P.F. Hennenman, from Swartpan Farm. In 1944, black South Africans were confined to a segregated enclave in southern Hennenman. During apartheid, this area was cleared by order of the government and nearly all then-residents relocated to a new township some fifteen kilometres away, *Vergenoeg* (Afrikaans for "Far enough", now *Phomolong*). An area located immediately adjacent to the PV development was previously assessed by Van der Walt (2013) as part of a different development application. Van der walt (2013) describes the development area as “extremely flat and is utilized for extensive agricultural purposes (crop farming).

The study area falls within the bioregion described by Mucina et al (2006) as the Dry Highveld Grassland Bioregion with the vegetation described as Vaal-Vet Sandy Grassland within a Grassland Biome. Land use in the general area is characterized by mining and agriculture, dominated by crops and cattle farming. The study area is characterised by deep sandy to loamy soils based on the extensive agricultural activities.” According to Fourie (2021), “Existing surrounding land uses associated with the project area include a combination of mining related infrastructure and developments, powerlines, refuse dumps and dirt roads.” As the area proposed for development is located within an existing mining area, it is very unlikely that significant built environment heritage will be impacted by the proposed development. Furthermore, the history of Welkom is intimately linked with the gold mining industry and as such, it is unlikely that the proposed PV development will negatively impact on this unique cultural landscape as it is proposed to support the gold mining industry.

Archaeology

According to Fourie (2021), “The Free State has a rich archaeological and historical history going back millions of years and includes significant aspects such as Later Stone Age rock art, Battlefields and Iron Age stonewalled enclosures. The general surroundings of the study area became a melting pot of contact and conflict as it represents one of many frontiers where San hunter-gatherers, Nguni and Sotho-Tswana agro-pastoralists, Dutch Voortrekkers and British Colonists all came together. The ravages of war also swept across these plains, and in particular the South African War (1899-1902) as well as the Boer Rebellion (1914-1915).” No heritage resources of significance were identified by Van der Walt (2013) in his assessment of a nearby farm. Van der Walt (2013) notes that “some MSA finds might be possible around pans on the farm. It is important to note that the lack of sites can be attributed to a lack of sustainable water sources (no pans exist in the development footprint) in the development area as well as the lack of raw material for the manufacturing of stone tools. No Sites dating to the Early or Middle Iron Age have been recorded or are expected for the study area. The same goes for the Later Iron Age period where the study area is situated outside the western periphery of distribution of Late Iron Age settlements in the Free State. However to the north of the study area, ceramics from the Thabeng facies belonging to the Moloko branch of the Urewe tradition were recorded at Oxf 1 and Platberg 32/71 (Maggs 1976, Mason 1986)”.

In an assessment completed on the adjacent property, Van Ryneveld (2013) identified five historical structures on the property, but no archaeological heritage resources. Despite the high number of heritage impact assessments completed in the broader area (Figure 2, Appendix 2), no archaeological sites of significance have been identified in close proximity to the proposed development area. This is likely due to the extreme transformation of the area as a result of historic and ongoing gold mining activities. Based on the known archaeological sensitivity of the broader context, it is unlikely that the proposed development will impact on significant Stone Age or Iron Age archaeological heritage however it is possible that informal or unmarked graves may be present within the development area.

Palaeontology

According to the SAHRIS Palaeosensitivity Map the development sites are underlain by sediments of moderate fossil sensitivity (Figure 4) consisting of caenozoic regolith according to the extract from the CGS 2826 Winberg Geology Map (Figure 4b). According to a Palaeontological assessment completed by Groenewald (2013) for a neighbouring development, “No fossils have been described from the quaternary aeolian deposits in the study area, although fossil finds have been recorded from similar aged sediments, for example: the Cornelia Formation in the north-eastern Free State (Johnson et al, 2006).” It is possible that sensitive sediments of the Adelaide Subgroup underly the Quaternary Sands. According to Groenewald (2013), “The Permian Adelaide Subgroup is interpreted as a meandering river deposit grading upwards into a lacustrine environment and is well known for containing fossils (Johnson et al, 2006). Although difficult to correlate the study area directly with more well-known outcrops of the lower part of the Adelaide Subgroup to the east, the subgroup is known to contain very good examples of Glossopteris flora as well as numerous remains of vertebrate fossils associated with the Dicynodon Assemblage Zone in the north-eastern part of the Karoo Basin (Groenewald, 1989 and 1996).” Goenewald (2013) concludes that “There is a possibility that fossils could be encountered during excavation into both the quaternary sand deposits and the Adelaide Subgroup sediments within the development footprint. The study area has been extensively modified through agricultural development and it is unlikely that fossils will be exposed in these developed areas.”

Since there is a very small chance that fossils from the Adelaide Subgroup below the ground surface may be disturbed, it is recommended that a Fossil Chance Find Protocol be implemented during development.

RECOMMENDATION

As it is possible that significant heritage resources will be impacted by the proposed development, it is recommended that a Heritage Impact Assessment is completed that satisfies section 38(3) of the NHRA and assesses likely impacts to archaeological and palaeontological heritage.

9. Scoping Assessment Impact Table

Impact
- Impact to archaeological and built environment resources
- Impact to palaeontological resources
- Impact to Cultural Landscape
- Cumulative Impact

Desktop Sensitivity Analysis of the Site
- Impact to significant archaeological resources such as Stone Age artefact scatters, remnants of Iron Age settlements, burial grounds and graves, historical artefacts, historical structures and rock art engravings through destruction during the development phase and disturbance during the operational phase is possible.
- Impacts to palaeontological resources are unlikely.
- There is the potential for the cumulative impact of proposed solar energy facilities to negatively impact the cultural landscape due to a change in the landscape character from rural and mining to semi-industrial, however, due to the density of mining activities in the area, the impact on the experience of the cultural landscape is not foreseen to be significant.

Issue	Nature of Impact	Extent of Impact	No-Go Areas
Impact to significant heritage resources through destruction during the development phase and disturbance during the operational phase.	Destruction of significant heritage resources	Local scale with broader impacts to scientific knowledge	None known at present

Gaps in knowledge & recommendations for further study
The heritage resources in the area proposed for development are not yet sufficiently recorded
Based on the available information, including the scale and nature of the proposed development, it is likely that significant heritage resources will be impacted by the proposed development and as such it is recommended that further heritage studies are required in terms of section 38 of the NHRA with specific focus on impacts to archaeological heritage.

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APPENDIX 1

List of heritage resources within the development area

Site ID	Site no	Full Site Name	Site Type	Grading
26467	9/2/318/0001	Farmhouse, Ferreirasrust, Hennenman District	Building	Grade II
26382	9/2/345/0001	MOTH Club House, 24 12th Street, Voorspoed East, Welkom	Building	Grade IIIb
25720	VRC-01	Virginia Railway Cutting	Palaeontological	Grade IIIb
36272	LEB01	Lebone 01	Structures	Grade IIIc
36273	LEB02	Lebone 02	Cultural Landscape	Grade IIIc
36274	LEB03	Lebone 03	Building	Grade IIIb
36275	LEB04	Lebone 04	Building	Grade IIIc
36276	LEB05	Lebone 05	Transport infrastructure	Grade II
34825	DBM002	Wits Gold DBM 002	Building	Grade IIIb
34826	BEY001	Beyers 001	Artefacts, Ruin > 100 years, Deposit	Grade IIIc
34915	PHA001	Phakisa 001	Conservation Area	Grade IIIb
34824	DBM001	Wits Gold DBM 001	Burial Grounds & Graves	Grade IIIa
105608	Grave of Vuyo Edward Charles	Grave of Vuyo Edward Charles, Thabong Cemetery, Welkom	Burial Grounds & Graves	Grade II
105609	Grave of Albert Ndoyisile Xhamfu	Grave of Albert Ndoyisile Xhamfu, Thabong Cemetery, Welkom	Burial Grounds & Graves	Grade II
105610	Grave of Samuel Zuka Baloi	Grave of Samuel Zuka Baloi Site, Thabong Cemetery, Welkom	Burial Grounds & Graves	Grade II
138351	TRC1-039	TETRA4 CLUSTER 1	Burial Grounds & Graves	Grade IIIa

133049	Thabong Electricaal Infrastructure	Erven 30671 & 8172 Thabong	Place	
105605	Grave of Itumeleng Caswell Mokobo	Grave of Itumeleng Caswell Mokobo, Thabong Cemetery, Welkom	Burial Grounds & Graves	Grade II
137447	Wasgoed spruit Totius Garden of remembrance	Wasgoed spruit Totius Garden of remembrance	Monuments & Memorials	
137631	Ferreirasrust Farm	Ferreirasrust Farm	Monuments & Memorials	
133885	DC18/NAMM/0008	War Memorial, MOTH Shellhole, Welkom	Monuments & Memorials	
133886	DC18/NAMM/0013	War Memorial, Jan Hofmeyer RD, Welkom	Monuments & Memorials	

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APPENDIX 2

Reference List with relevant AIAs and PIAs

Heritage Impact Assessments				
Nid	**Report Type**	**Author/s**	**Date**	**Title**
108777	Heritage Impact Assessment Specialist Reports	Anton van Vollenhoven	30/11/2011	A REPORT ON A CULTURAL HERITAGE IMPACT ASSESSMENT FOR THE PROPOSED WITS GOLD DBM PROJECT CLOSE TO VIRGINIA, FREE STATE PROVINCE
120259	PIA Desktop	Barry Millsteed		Desktop Palaeontological Heritage Impact Assessment Report for the Oryx Solar Energy Facility
120639	Archaeological Specialist Reports	Jaco van der Walt	30/08/2013	Aracheological Impact Assessment report for the Proposed Everest Solar Energy Facility
124729	Heritage Scoping	Jaco van der Walt	08/05/2013	Archaeological Scoping Report for the Proposed Oryx Energy Facility
136650	Archaeological Specialist Reports	Jaco van der Walt	30/08/2013	Archaeological Impact Assessment report for the Oryx Solar Energy Facility
138939	Heritage Impact Assessment Specialist Reports	Karen Van Ryneveld, Gideon Groenewald	17/10/2013	Phase 1 Archaeological Impact Assessment & Palaeontological Assessment Lebone Solar Farm The Remaining Extent of the Farm Onverwag No. 728 and Portion 2 of the Farm Vaalkranz Np. 220, Welkom, Free State Province
158469	Heritage Impact Assessment Specialist Reports	Karen Van Ryneveld	19/10/2013	PHASE 1 ARCHAEOLOGICAL IMPACT ASSESSMENT. THE THABONG SOLAR FARM, UITKYK 509, WELKOM, FREE STATE, SOUTH AFRICA
164148	Heritage Impact Assessment Specialist Reports	Lloyd Rossouw	06/12/2013	Phase 1 Palaeontological and Archaeological Impact Assessment of the proposed Phokeng Township extension at Thabong, Matjhabeng Local Municipality, Free State Province.
169703		Lloyd Rossouw		
186709	PIA Desktop	Gideon Groenewald	14/10/2013	PALAEONTOLOGICAL ASSESSMENT OF THE PROPOSED DEVELOPMENT OF A 75MW

				PHOTOVOLTAIC SOLAR FARM, ON THE FARM UITKYK 509, WELKOM, FREE STATE PROVINCE.
266924	Archaeological Specialist Reports		26/01/2015	Archaeological Impact Assessment report for the Proposed Uitsig 5MW Solar Energy Facility close to Henneman in the Free State Province
334505		John Almond	22/07/2015	Palaeontological specialist assessment: desktop study for the proposed Hennenman 5MW solar energy facility.
369115	HIA Phase 1	Candice Keeling	09/09/2016	Heritage Impact Assessment of Ernest Oppenheimer Hospital, Erf 7186, Reitzpark, Welkom, Orange Free State. Proposed Upgrade of Existing Facilities - September 2016
6036	AIA Phase 1	Cobus Dreyer	15/09/2005	Archaeological and Historical Investigation of the Proposed New Filling Station at Virginia, Free State
7579	AIA Phase 1	Cobus Dreyer	10/03/2008	First Phase Archaeological and Cultural Heritage Investigation of the Proposed Oppenheimer Park Golf Estate, Welkom, Free State
7625	AIA Phase 1	Francois P Coetzee	01/02/2008	Cultural Heritage Survey of the Proposed Phakisa Housing Development, Welkom, Free State
7724	AIA Phase 1	Cobus Dreyer	20/06/2007	First Phase Archaeological and Cultural Heritage Assessment of the Proposed New MTN Cell Phone Mast at Pumlani Cemetery, Thabong, Welkom, Free State
7863	AIA Phase 1	Cobus Dreyer	30/08/2006	First Phase Archaeological and Cultural Heritage Investigation of the Proposed Sandrivier Golf Estate, Virginia, Free State
8034	AIA Phase 1	Cobus Dreyer	05/03/2004	Archaeological and Historical Investigation of the Graves at the Proposed Housing Developments near Thabong, Welkom, Free State
110093	PIA Desktop	Job M. Kibii		Palaeontological Impact Assessmnent Deskop Study Report for the Proposed Merapi (Excelsior) PV Solar Energy Facilities
110094	HIA Phase 1	Nkosinathi Godfrey Tomose		Heritage Imapct Assessment Study for the Proposed PV Solar Energy Facilities, near Excelsior, Free State Province
117067	HIA Phase 1	Frans Prins	31/01/2013	Cultural Heritage Desktop Assessment of the proposed Bio-energy Facility, Harmony Gold Mine , Welkom, Free State Province

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120639	Archaeological Specialist Reports	Jaco van der Walt	30/08/2013	Aracheological Impact Assessment report for the Proposed Everest Solar Energy Facility
323795	Heritage Impact Assessment Specialist Reports		31/03/2014	Cultural Heritage Impact Assessment Report for the Proposed SANRAL Thabong Interchange Development, Welkom Region, Free State Province
384235	AIA Phase 1	Lloyd Rossouw	30/09/2016	Phase 1 Archaeological Impact Assessment of a proposed new water pipeline and associated infrastructure between Ventersburg and the Koppie Alleen pump station, FS Province
384495	Heritage Scoping	Nkosinathi Godfrey Tomose	20/12/2016	Heritage Scoping Study for the Proposed Prospecting Rights Application on Farms Adamsons Vley 655, Jonkers Rust 72, Du Preez Leger 324 and Stillewoning 703

APPENDIX 3 - Keys/Guides

Key/Guide to Acronyms

AIA	Archaeological Impact Assessment
DARD	Department of Agriculture and Rural Development (KwaZulu-Natal)
DEA	Department of Environmental Affairs (National)
DEADP	Department of Environmental Affairs and Development Planning (Western Cape)
DEDEAT	Department of Economic Development, Environmental Affairs and Tourism (Eastern Cape)
DEDECT	Department of Economic Development, Environment, Conservation and Tourism (North West)
DEDT	Department of Economic Development and Tourism (Mpumalanga)
DEDTEA	Department of economic Development, Tourism and Environmental Affairs (Free State)
DENC	Department of Environment and Nature Conservation (Northern Cape)
DMR	Department of Mineral Resources (National)
GDARD	Gauteng Department of Agriculture and Rural Development (Gauteng)
HIA	Heritage Impact Assessment
LEDET	Department of Economic Development, Environment and Tourism (Limpopo)
MPRDA	Mineral and Petroleum Resources Development Act, no 28 of 2002
NEMA	National Environmental Management Act, no 107 of 1998
NHRA	National Heritage Resources Act, no 25 of 1999
PIA	Palaeontological Impact Assessment
SAHRA	South African Heritage Resources Agency
SAHRIS	South African Heritage Resources Information System
VIA	Visual Impact Assessment

Full guide to Palaeosensitivity Map legend

	RED:	VERY HIGH - field assessment and protocol for finds is required
	ORANGE/YELLOW:	HIGH - desktop study is required and based on the outcome of the desktop study, a field assessment is likely
	GREEN:	MODERATE - desktop study is required
	BLUE/PURPLE:	LOW - no palaeontological studies are required however a protocol for chance finds is required
	GREY:	INSIGNIFICANT/ZERO - no palaeontological studies are required
	WHITE/CLEAR:	UNKNOWN - these areas will require a minimum of a desktop study.

APPENDIX 4 - Methodology

The Heritage Screener summarises the heritage impact assessments and studies previously undertaken within the area of the proposed development and its surroundings. Heritage resources identified in these reports are assessed by our team during the screening process.

The heritage resources will be described both in terms of **type**:

- Group 1: Archaeological, Underwater, Palaeontological and Geological sites, Meteorites, and Battlefields
- Group 2: Structures, Monuments and Memorials
- Group 3: Burial Grounds and Graves, Living Heritage, Sacred and Natural sites
- Group 4: Cultural Landscapes, Conservation Areas and Scenic routes

and **significance** (Grade I, II, IIIa, b or c, ungraded), as determined by the author of the original heritage impact assessment report or by formal grading and/or protection by the heritage authorities.

Sites identified and mapped during research projects will also be considered.

DETERMINATION OF THE EXTENT OF THE INCLUSION ZONE TO BE TAKEN INTO CONSIDERATION

The extent of the inclusion zone to be considered for the Heritage Screener will be determined by CTS based on:

- the size of the development,
- the number and outcome of previous surveys existing in the area
- the potential cumulative impact of the application.

The inclusion zone will be considered as the region within a maximum distance of 50 km from the boundary of the proposed development.

DETERMINATION OF THE PALAEONTOLOGICAL SENSITIVITY

The possible impact of the proposed development on palaeontological resources is gauged by:

- reviewing the fossil sensitivity maps available on the South African Heritage Resources Information System (SAHRIS)
- considering the nature of the proposed development
- when available, taking information provided by the applicant related to the geological background of the area into account

DETERMINATION OF THE COVERAGE RATING ASCRIBED TO A REPORT POLYGON

Each report assessed for the compilation of the Heritage Screener is colour-coded according to the level of coverage accomplished. The extent of the surveyed coverage is labeled in three categories, namely low, medium and high. In most instances the extent of the map corresponds to the extent of the development for which the specific report was undertaken.

Low coverage will be used for:

- desktop studies where no field assessment of the area was undertaken;
- reports where the sites are listed and described but no GPS coordinates were provided.
- older reports with GPS coordinates with low accuracy ratings;
- reports where the entire property was mapped, but only a small/limited area was surveyed.
- uploads on the National Inventory which are not properly mapped.

Medium coverage will be used for

- reports for which a field survey was undertaken but the area was not extensively covered. This may apply to instances where some impediments did not allow for full coverage such as thick vegetation, etc.
- reports for which the entire property was mapped, but only a specific area was surveyed thoroughly. This is differentiated from low ratings listed above when these surveys cover up to around 50% of the property.

High coverage will be used for

- reports where the area highlighted in the map was extensively surveyed as shown by the GPS track coordinates. This category will also apply to permit reports.

RECOMMENDATION GUIDE

The Heritage Screener includes a set of recommendations to the applicant based on whether an impact on heritage resources is anticipated. One of three possible recommendations is formulated:

(1) The heritage resources in the area proposed for development are sufficiently recorded - The surveys undertaken in the area adequately captured the heritage resources. There are no known sites which require mitigation or management plans. No further heritage work is recommended for the proposed development.

This recommendation is made when:

- enough work has been undertaken in the area
- it is the professional opinion of CTS that the area has already been assessed adequately from a heritage perspective for the type of development proposed

(2) The heritage resources and the area proposed for development are only partially recorded - The surveys undertaken in the area have not adequately captured the heritage resources and/or there are sites which require mitigation or management plans. Further specific heritage work is recommended for the proposed development.

This recommendation is made in instances in which there are already some studies undertaken in the area and/or in the adjacent area for the proposed development. Further studies in a limited HIA may include:

- improvement on some components of the heritage assessments already undertaken, for instance with a renewed field survey and/or with a specific specialist for the type of heritage resources expected in the area
- compilation of a report for a component of a heritage impact assessment not already undertaken in the area

- undertaking mitigation measures requested in previous assessments/records of decision.

(3) The heritage resources within the area proposed for the development have not been adequately surveyed yet - Few or no surveys have been undertaken in the area proposed for development. A full Heritage Impact Assessment with a detailed field component is recommended for the proposed development.

Note:
The responsibility for generating a response detailing the requirements for the development lies with the heritage authority. However, since the methodology utilised for the compilation of the Heritage Screeners is thorough and consistent, contradictory outcomes to the recommendations made by CTS should rarely occur. Should a discrepancy arise, CTS will immediately take up the matter with the heritage authority to clarify the dispute.

APPENDIX 5 -Summary of Specialist Expertise

Jenna Lavin, an archaeologist with an MSc in Archaeology and Palaeoenvironments, and currently completing an MPhil in Conservation Management , heads up the heritage division of the organisation, and has a wealth of experience in the heritage management sector. Jenna's previous position as the Assistant Director for Policy, Research and Planning at Heritage Western Cape has provided her with an in-depth understanding of national and international heritage legislation. Her 8 years of experience at various heritage authorities in South Africa means that she has dealt extensively with permitting, policy formulation, compliance and heritage management at national and provincial level and has also been heavily involved in rolling out training on SAHRIS to the Provincial Heritage Resources Authorities and local authorities.

Jenna is a member of the Association of Professional Heritage Practitioners (APHP), and is also an active member of the International Committee on Monuments and Sites (ICOMOS) as well as the International Committee on Archaeological Heritage Management (ICAHM). In addition, Jenna has been a member of the Association of Southern African Professional Archaeologists (ASAPA) since 2009. Recently, Jenna has been responsible for conducting training in how to write Wikipedia articles for the Africa Centre's WikiAfrica project.

Since 2016, Jenna has drafted over 50 Heritage Impact Assessments throughout South Africa.

Visual Impact Report

Central
Basic Assessment
July 2022

VISUAL IMPACT REPORT

Savannah Environmental, Free State

Submitted to:

Savannah Environmental (Pty) Ltd

PO Box 148
Sunninghill
2157

Tel: 011 656 3237

Prepared by:

Eco-Thunder Consulting (Pty) Ltd

PO Box 2055
Fourways
2191
Tel: 064 655 2752

Report Revision No: 1
Date Issued: 13th July 2022
Prepared By: Brogan Geldenhuys
Reference: Eco Thunder Consulting (2022) Visual Impact Assessment for Harmony Central Plant

ACRONYMS, ABBREVIATIONS AND GLOSSARY

Acronyms & Abbreviations	
BAR	Basic Assessment Report
EIA	Environmental Impact Assessment
EMPr	Environmental Management Programme
GYLA	Graham Young Landscape Architect
SACLAP	South African Council for the Landscape Architectural Profession
VAC	Visual Absorption Capacity
VIA	Visual Impact Assessment

Glossary	
Aesthetic Value	Aesthetic value is the emotional response derived from the experience of the environment with its natural and cultural attributes. The response can be either to visual or non-visual elements and can embrace sound, smell and any other factor having a strong impact on human thoughts, feelings, and attitudes (Ramsay, 1993). Thus, aesthetic value encompasses more than the seen view, visual quality, or scenery, and includes atmosphere, landscape character and sense of place (Schapper, 1993).
Aesthetically significant place	A formally designated place visited by recreationists and others for the express purpose of enjoying its beauty. For example, tens of thousands ofpeople visit Table Mountain on an annual basis. They come from around the country and even from around the world. By these measurements,one can make the case that Table Mountain (a designated National Park) is an aesthetic resource of national significance. Similarly, a resource thatis visited by large numbers who come from across the region probably has regional significance. A place visited primarily by people whose place of origin is local is generally of local significance. Unvisited places either have no significance or are "no trespass" places. (after New York, Department of Environment 2000).
Aesthetic impact	Aesthetic impact occurs when there is a detrimental effect on the perceived beauty of a place or structure. Mere visibility, even startling visibility of a Project proposal, should not be a threshold for decision making. Instead a Project, by its visibility, must clearly interfere with or reduce (i.e. visual impact) the public's enjoyment and/or appreciation of the appearance of a valued resource e.g. cooling tower blocks a view from a National Park overlook (after New York, Department of Environment 2000).
Cumulative Effects	The summation of effects that result from changes caused by a development in conjunction with the other past, present, or reasonably foreseeable actions.
Glare	The sensation produced by luminance within the visual field that is sufficiently greater than the luminance to which the eyes are adapted, which causes annoyance, discomfort, or loss in visual performance and visibility. *See* Glint. (USDI 2013:314)
Glint	A momentary flash of light resulting from a spatially localized reflection of sunlight. *See* Glare. (USDI 2013:314)
Landscape Character	The individual elements that make up the landscape, including prominent or eye-catching features such as hills, valleys, woods, trees, water bodies, buildings, and roads. They are generally quantifiable and can be easily described.
Landscape Impact	Landscape effects derive from changes in the physical landscape, whichmay give rise to changes in its character and how this is experienced (Institute of Environmental Assessment & The Landscape Institute 1996).

Study area	For the purposes of this report this Project the study area refers to the proposed Project footprint / Project site as well as the 'zone of potential influence' (the area defined as the radius about the centre point of the Project beyond which the visual impact of the most visible features will be insignificant) which is a 5,0km radius surrounding the proposed Project footprint / site.
Project Footprint / Site	For the purposes of this report the Project *site* / *footprint* refers to theactual layout of the Project as described.
Sense of Place (geniusloci)	Sense of place is the unique value that is allocated to a specific place or area through the cognitive experience of the user or viewer. *A genius locus literally means* 'spirit of the place'.
Sensitive Receptors	Sensitivity of visual receptors (viewers) to a proposed development.
Viewshed analysis	The two-dimensional spatial pattern created by an analysis that defines areas, which contain all possible observation sites from which an object would be visible. The basic assumption for preparing a viewshed analysis is that the observer eye height is 1,8m above ground level.
Visibility	The area from which Project components would potentially be visible.Visibility depends upon general topography, aspect, tree cover or other visual obstruction, elevation, and distance.
Visual Exposure	Visibility and visual intrusion qualified with a distance rating to indicate the degree of intrusion and visual acuity, which is also influenced by weatherand light conditions.
Visual Impact	Visual effects relate to the changes that arise in the composition of available views because of changes to the landscape, to people's responses to the changes, and to the overall effects with respect to visual amenity available views because of changes to the landscape, to people's responses to the changes, and to the overall effects with respect to visualamenity.
Visual Intrusion	The nature of intrusion of an object on the visual quality of the environment resulting in its compatibility (absorbed into the landscape elements) or discord (contrasts with the landscape elements) with the landscape and surrounding land uses.
Visual absorption capacity	Visual absorption capacity is defined as the landscape's ability to absorb physical changes without transformation in its visual character and quality. The landscape's ability to absorb change ranges from low- capacity areas, in which the location of an activity is likely to cause visual change in the character of the area, to high-capacity areas, in which the visual impact of development will be minimal (Amir & Gidalizon 1990).
Worst-case Scenario	Principle applied where the environmental effects may vary, for example, seasonally or collectively to ensure the most severe potential effect isassessed.
Zone of Potential Visual Influence	By determining the zone of potential visual influence, it is possible to identify the extent of potential visibility and views which could be affected by the proposed development. Its maximum extent is the radius around an object beyond which the visual impact of its most visible features will be insignificant primarily due to distance.

EXECUTIVE SUMMARY

The extent of the study area is determined by the zone of potential influence, which in this study relates to a radius of 10km around the centre of the Project sites. At 10km and beyond the development would recede into background views and or be screened by topography, vegetation or existing/proposed (approved) power infrastructure.

The existing visual condition of the landscape that may be affected by the proposed Project has been described. The study areas scenic quality has been rated Moderate to Low within the context of the sub-region, and sensitive viewing areas and landscape types identified and mapped indicating potential sensitivity to the Project.

Visual impacts will be caused by activities associated with the Harmony Central Solar PV Project. The significance of visual impact is based on the worst-case scenario. This scenario assumes that all facilities along with the associated grid infrastructure and sub-stations would be constructed at the same time. This assumption is also based on the nature of visual impact and the fact that receptors would experience all facilities (i.e., all projects and transmission lines) within the same visual envelope from their respective locations or as they travel along adjacent roads.

Impacts on views are the highest when viewers are identified as being sensitive to change in the landscape, and their views are focused on and dominated by the change. The visual impact of the Project will cause changes in the landscape that are noticeable to viewers experiencing the study area.

The findings of the Visual Impact Assessment undertaken for the proposed $14MW_{ac}$ PV facility is that the visual environment surrounding the site, especially within a 1 - 3km radius, may be visually impacted during the anticipated operational lifespan of the facility (i.e., a minimum of 25 years).

This impact is primarily applicable to the individual Harmony Central PV facility and the cumulative impact of the Project, and the existing infrastructure would be evident. The VAC for the study area is relatively low, and the combined effect over time of these developments would result in the study area being impacted upon in a moderate manner beyond the anticipated duration of the proposed Project alone.

The following is a summary of impacts remaining, assuming mitigation as recommended, is exercised:

- During construction, there may be a noticeable increase in heavy vehicles utilising the roads to the development site that may cause, at the very least, a visual nuisance to other road users and landowners in the area. Construction activities may potentially result in high, temporary visual impact that may be mitigated to **low**.

- The PV facility is expected to have a **moderate** (to potentially **high**) visual impact on observers travelling along the R73 and adjacent secondary roads. There are no homesteads within a 1km radius of the operational PV facility structures. The facility would be highly visible from the Harmony Central Plant mining operation, but observers at this locality are associated with Harmony Gold and are assumed to be supportive of the development. The impacts may be contained to **Low** significance if the proposed impact mitigation measures are implemented.

- The operational PV facility could have a **moderate** visual impact on observers (residents and road users) located between a 1 – 3km radius of the PV facility structures, both before and after the implementation of mitigation measures.

- The anticipated impact of lighting at the PV facility is likely to be of **moderate** significance and may be mitigated to **low**.

- The potential visual impact related to solar glint and glare as an air travel hazard is expected to be of **low** significance, due to the long distance in between the proposed PV facility and the airfield. No mitigation of this impact is required since the PV facility is not expected to interfere with aircraft operations at the airfield.

- The potential visual impact of solar glint and glare as a visual distraction and possible hazard to road users is expected to have a **low** (to potentially **moderate**) visual impact on observers travelling along the R73 and secondary road. These glint and glare impacts are mitigated if the PV panels are shielded from the surrounding area by means of planted vegetation cover, or solid fencing along the road servitude. If the PV panels are not exposed to road users (due to the project being screened from the road users) the impacts associated with glint and glare is expected to be of **low** (to no) significance.

- There are no homesteads located within a 1km radius of the proposed PV facility. The closest homestead is located 1.3km south-east of the facility (Saaiplaas settlement). The potential visual impact of solar glint and glare on static ground-based receptors (residents of homesteads) in closer proximity to the PV facility is therefore expected to be of **low** significance.

- The anticipated visual impact resulting from the construction of on-site ancillary infrastructure is likely to be of **low** significance both before and after mitigation.

- The anticipated visual impact of the proposed PV facility on the regional visual quality, and by implication, on the sense of place, is difficult to quantify, but is generally expected to be of **low** significance. This is due to the relatively low viewer incidence within close proximity to the proposed development site and the presence of existing mining and industrial activities within the region.

- The anticipated cumulative visual impact of the proposed Harmony Solar PV facility is expected to be of **low** significance.

The anticipated visual impacts listed above (i.e., post mitigation impacts) range from **moderate** to **low** significance. **<u>Anticipated visual impacts on sensitive visual receptors (if and where present) in close proximity to the proposed facility are not considered to be fatal flaws for the proposed PV facility.</u>**

Considering all factors, it is recommended that the development of the facility as proposed be supported; subject to the implementation of the recommended mitigation measures (**Section 7.4.**) and management programme (**Section 8.9.**).

TABLE OF CONTENTS

ACRONYMS, ABBREVIATIONS AND GLOSSARY i

EXECUTIVE SUMMARY iii

TABLE OF CONTENTS v

1. INTRODUCTION 1

1.1. Project Overview and Background 1

1.2. Project, Project site and study area 1

1.3. Objective of the Specialist Study 2

1.4. Terms and Reference 2

1.5. Specialist Details 2

1.6. Level of Confidence 2

1.7. Assumptions, Uncertainties, and Limitations 3

2. LEGAL REQUIREMENTS AND GUIDELINES 5

2.1. National Legislation and Guidelines 5

3. APPROACH AND METHODOLOGY 6

3.1. Approach 6

3.1.1. Significance of Visual Impact 7

3.2. Methodology 7

4. DESCRIPTION OF THE PROJECT 9

4.1. Project Facilities 9

4.2. Project Phases and Activities 11

4.2.1. Site Preparation Phase 11

4.2.2. Construction Phase 11

4.2.3. Operational Phase 11

4.2.4. Decommissioning Phase 11

5. ENVIROMENTAL SETTING 13

5.1. Landscape Character 13

5.2. Land Use 13

6. VISUAL RESOURCE 19

6.1. Visual Resource Value, Scenic Quality and Landscape Sensitivity 19

6.2. Sense of Place 19

7. VISUAL IMPACT ASSESSMENT 21

7.1. Impact Index 21

7.2. Visual Absorption Capacity 22

7.3. VIA Rating Methodology 23

7.4. Visual Impact Assessment 23

7.4.1. Construction Phase 24
7.4.2. Operation Phase 27
7.4.3. Cumulative Effects 31
7.5. Impact Statement 32
8. MITIGATION AND MANAGEMENT MEASURES **34**
8.1. Preparatory Works and Construction Concerns 34
8.2. Earthworks 35
8.3. Landscaping and Ecological Approach 35
8.4. Mounting Structures and Associated Infrastructure 35
8.5. Good housekeeping 35
8.6. Operation Phase 35
8.7. Lighting 36
8.8. Branding and Marketing 36
8.9. MANAGEMENT PROGRAMME 36
9. CONCLUSION **40**
REFERENCES **41**

LIST OF FIGURES

Figure 1: Proposed Development location map. 4
Figure 2: VIA Process 7
Figure 3: Facility layout map 12
Figure 4: Center of Saaiplaas Located 2KM South West of the proposed development 14
Figure 5: R730 towards Virginia, 4km west of the development 14
Figure 6: The R730 towards Welkom, 7km North West of the development 15
Figure 7: The R73 located 2km south of the development 15
Figure 8: The R70, 11km north of the development 16
Figure 9: The proposed development as observed from Henneman Road 5km East of the proposed development 16
Figure 10: View from Near the town of Henneman approximately 10km North East of the Development 17
Figure 11: Site Topography and Slope 18
Figure 12: Viewshed analysis 20

LIST OF TABLES

Table 1: Harmony Central Plant Technical Details for the Solar PV Facility 10
Table 2: Value of the Visual Resource 19
Table 3: Construction of a PV Facility 24
Table 4: Impact of PV facility on Roads in Close Proximity 25
Table 5: Visual Impact on Residence and Homesteads in Close Proximity 26
Table 6: Glint and Glare 27
Table 7: Visual Exposure 27
Table 8: Visual intrusion 28
Table 9: Ancillary Infrastructure 29
Table 10: Sense of place 30
Table 11: Intensity of impact of the proposed Project 33
Table 12: Management programme – Planning. 36
Table 13: Management programme – Construction. 37
Table 14: Management programme – Operation. 38
Table 15: Management programme – Decommissioning. 39

1. INTRODUCTION

1.1. Project Overview and Background

Eco-Thunder Consulting was commissioned by Savannah Environmental (Pty) Ltd to carry out a Visual Impact Assessment (VIA) of the proposed Central Plant Solar PV Facility near Virginia in the Free State Province. The VIA focuses on the potential impact of the physical aspects of the proposed developments (i.e., form, scale, and bulk), and their potential impact within the local landscape and receptor context.

1.2. Project, Project site and study area

Harmony Gold is looking to supplement its energy supply by implementing Photovoltaic (PV) generation, aiding their transition to a more sustainable and environmentally friendly energy mix. In this regard, Harmony Central Plant is based near Harmony Gold Central Plant operations approximately located ~6km north-east of the town of Virginia and ~11km south-east of the town of Welkom within the Matjhabeng Local Municipality and within the Lejweleputswa District Municipality, Free State Province.

The project entails the development of a Solar PV Energy Facility with a capacity of up to14MW. A development site of up to 165ha for Central Solar PV has been identified, of which approximately 33.6ha will be utilized for the project footprint.

The project will be known as Harmony Central Plant Solar PV, the facility will include a grid connection and other associated infrastructure proposed by HARMONY GOLD MINING CO (LTD).

The details on the PV Facility and grid connection infrastructure are listed below:
PV Facility:

Farm Name	Portion Number
SAAIPLAAS 771	12
RUSTGEVONDEN 564	1

Grid connection infrastructure
The projects will tie into the Harmony North (6.6/44kV) substation. The overhead lines will have a capacity of up to 132kV.

Infrastructure associated with each solar PV facility will include the following:

- Solar PV array comprising bifacial PV modules and mounting structures, using single axis tracking technology. Once installed will stand up to 5m above ground level.
- Inverters and transformers, a SCADA room, and maintenance room.
- Cabling between the project components.
- Balance of Plant:
    - Existing spare switchgear panels upgraded switchgear circuit breakers or additional switchgear panels.
    - EK self-build works as defined in the CEL.
- On-site facility substation to facilitate the connection between the solar PV facility and Eskom electricity grid. The Size and Capacity of each of the on-site stations will be 40MW, 20MW, 40MW respectively.
- An onsite Medium voltage (MV) switching station forming part of the collector substation.
- Temporary Laydown areas.
- Access roads, internal roads and fencing around the development area.
- Up to 132kV Overhead Power Lines (OHPL) – maximum of 30m height with a 30m servitude width.
- Underground LV cabling will be used on the PV site.

As of 2019, the Industrial sector was the leading electricity consumer in South Africa, with up to 56 percent of the total consumption (*Ratshomo, 2019*). Mining and quarrying accounted for 10% of the industrial consumption while non-ferrous metals and non-metallic both accounted for 8% and 5%, respectively (*Chamber of Mines of South Africa, 2017*).

The successful development of the renewable energy projects will enable Harmony Gold to make a valuable and meaningful contribution towards growing the green economy within the province and South Africa. This will assist the Free State in creating green jobs and reducing Green House Gas emissions, whilst reducing the energy demand on the National Grid.

1.3. Objective of the Specialist Study

The main aim of the study is to document the baseline and to ensure that the visual / aesthetic consequences of the proposed Project are understood. The report therefore aims to identify scenic resources, and visually sensitive areas or receptors. It also aims to identify key concerns or issues relating to potential visual impacts arising from the Project, and which must be addressed in the assessment phase.

1.4. Terms and Reference

A specialist study is required to establish the visual baseline and to identify and potential visual impacts arising from the proposed development based on the general requirements for a comprehensive VIA. The following terms of reference were established:

- Data collected allows for a description and characterization of the receiving environment.
- Describe the landscape character, quality and assess the visual resource of the study area.
- Describe the visual characteristics of the components of the Project.
- Identify issues that must be addressed in the impact assessment phase.
- Propose mitigation options to reduce the potential impact of the Project.

1.5. Specialist Details

Eco–Thunder Consulting (ETC) is a 100% woman-owned, private company that specializes in a range of specialist studies, such as Visual Impact Assessments socio-economic research, economic development planning, development programme design and implementation as well as community trust management.

Eco–Thunder Consulting is registered with ECSA and landscape architects with interest and experience in landscape architecture, urban design, and environmental planning. The company has carried out visual impact assessments throughout Africa and specialize in project optimization in the environmental space. Aspects of this work also include landscape characterization studies, end-use studies for quarries, and computer modelling and visualization.

Based in Johannesburg, South Africa, Eco-Thunder has established itself as an expert on the conditions, needs and assets of communities that are linked to independent power generation facilities.

ETC also implements development programmes in energy communities, which ensures a comprehensive understanding of the how to drive positive social impact.

1.6. Level of Confidence

Level of confidence[1] is determined as a function of:

- The information available, and understanding of the study area by the practitioner:
    - 3: A high level of information is available of the study area and a thorough knowledge base could be established during site visits, surveys etc. The study area was readily accessible.
    - 2: A moderate level of information is available of the study area and a moderate knowledge base could be established during site visits, surveys etc. Accessibility to the study area was acceptable for the level of assessment.
    - 1: Limited information is available of the study area and a poor knowledge base could be established during site visits and / or surveys, or no site visit and / or surveys were carried out.

- The information available, understanding of the study area and experience of this type of project by the

[1] Adapted from Oberholzer (2005).

practitioner:
   - 3: A high level of information and knowledge is available of the project and the visual impact assessor is well experienced in this type of project and level of assessment.
   - 2: A moderate level of information and knowledge is available of the project and / or the visual impact assessor is moderately experienced in this type of project and level of assessment.
   - 1: Limited information and knowledge is available of the project and / or the visual impact assessor has a low experience level in this type of project and level of assessment.

The level of confidence for this assessment is determined to be **9** and indicates that the author's confidence in the accuracy of the findings is high:

- The information available, and understanding of the study area by the practitioner is rated as **3** and
- The information available, understanding and experience of this type of project by the practitioner is rated as **3**.

1.7. Assumptions, Uncertainties, and Limitations

The following assumptions and limitations have been made in the study:

- The description of project components is limited to what has been supplied to the author before the date of completion of this report.
- The Project report uses the concept of 'worst case scenario' to identify issues and rate visual impacts. This scenario assumes that all facilities along with the associated grid infrastructure and sub-stations would be constructed at the same time. At the time of writing there was no evidence to the contrary. This assumption is also based on the nature of visual impact and the fact that receptors would experience all facilities with in the same visual envelope from their respective locations or as they travel along adjacent roads.
- This assessment was undertaken during the planning stage of the project and is based on information available at that time. It is assumed that all information regarding the project details provided by the client is correct and relevant to the proposed project.

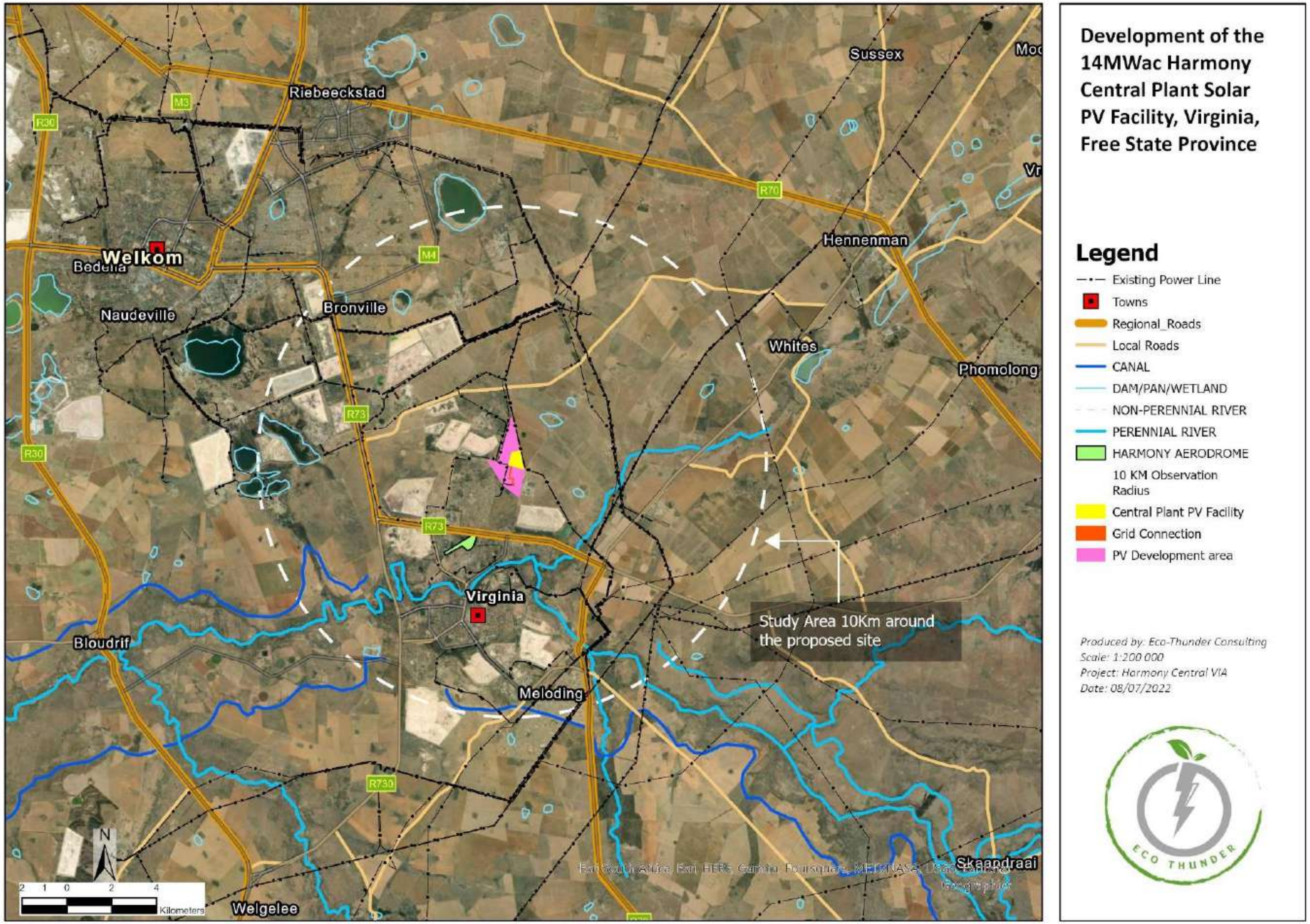

Figure 1: Proposed Development location map.

2. LEGAL REQUIREMENTS AND GUIDELINES

This report adheres to the following legal requirements and guideline documents.

2.1. National Legislation and Guidelines

National Environmental Management Act (Act 107 of 1998), EIA Regulations

The specialist report is in accordance with the specification on conducting specialist studies as per Government Gazette (GN) R 982 of the National Environmental Management Act (NEMA) Act 107 of 1998. The mitigation measures as stipulated in the specialist report can be used as part of the Environmental Management Programme (EMPr) and will be in support of the Environmental Impact Assessment (EIA) and Appendix 6 of the EIA Regulations 2014, as amended on 7 April 2017.

Specialist Screening Protocols are also required by the 2014 EIA Regulations. These were taken into consideration for each of the five projects. However, the Landscape (Solar) Theme Sensitivity was referenced as there is no specific 'visual' protocol.

Western Cape Department of Environmental Affairs & Development Planning: Guideline for Involving Visual and Aesthetic Specialists in EIA Processes Edition 1 (CSIR, 2005)

Although the guidelines were specifically compiled for the Province of the Western Cape[4], they provide guidance that is appropriate for any EIA process. The Guideline document also seeks to clarify instances when a visual specialist should get involved in the EIA process.

[4] The Western Cape Guidelines are the only official guidelines for visual impact assessment reports in South Africa and can be regarded as best practice throughout the country.

3. APPROACH AND METHODOLOGY

3.1. Approach

The effects of the development on a landscape resource and visual amenity is complex since it is determined through a combination of quantitative and qualitative evaluations. When assessing visual impact, the worst-case scenario is considered. Landscape and visual assessments are separate, although linked, procedures. The landscape, its analysis, and the assessment of impacts on the landscape all contribute to the baseline for visual impact assessment studies. The assessment of the potential impact on the landscape is carried out as an impact on an environmental resource, i.e., the physical landscape. Visual impacts, on the other hand, are assessed as one of the interrelated effects on people (i.e., the viewers and the impact of an introduced object into a view or scene).

The study was undertaken using Geographical Information Systems (GIS) software as a tool to generate viewshed analyses and to apply relevant spatial criteria to the proposed infrastructure. A detailed Digital Terrain Model (DTM) for the study area was created from topographical data provided by the Japan Aerospace Exploration Agency (JAXA), Earth Observation Research Centre, in the form of the ALOS Global Digital Surface Model "ALOS World 3D - 30m" (AW3D30) elevation model.

The scope of work for this report includes:

- Identify potentially sensitive visual receptors within the receiving environment.
- Determine the Visual Absorption Capacity of the landscape.
- Determine Visual Distance / Observer Proximity to the facility.
- Determine Viewer Incidence / Viewer Perception.
- Determine Significance of identified impacts.
- Propose mitigation to reduce or alleviate potential adverse visual impacts (to be structured as an EMPr).
- Assess the glint and glare of the PV panels
- Conclude with an Impact Statement of Significance and a project recommendation.

Visual Impact Assessment (VIA)

The VIA is determined according to the nature, extent, duration, intensity or magnitude, probability and significance of the potential visual impacts, and will propose management actions and / or monitoring programs, and may include recommendations related to the proposed Solar PV Facility.

The visual impact is determined for the highest impact-operating scenario (worst-case scenario) and varying climatic conditions (i.e., different seasons, weather conditions, etc.) are not considered.

The VIA considers potential cumulative visual impacts, or alternatively the potential to concentrate visual exposure / impact within the region.

The determination of the potential visual impacts is undertaken in terms of nature, extent, duration, magnitude, probability and significance of the construction and operation of the proposed infrastructure.

Anticipated issues related to the potential visual impact of the proposed development include the following:

- The visibility of the facility to, and potential visual impact on, observers travelling along the major local roads traversing south and west of the proposed facility.
- The visibility of the facility to, and visual impact on, the larger built-up centres or populated places (the towns of Bronville, Verginia and Meloding) as well as the homesteads (farm residences) located within close proximity of the site.
- Potential cumulative visual impacts (or alternately, consolidation of visual impacts) with specific reference to the existing power line infrastructure adjacent to the proposed development area.
- The potential visual impact of the construction of ancillary infrastructure (i.e., the substation at the facility, associated power line and access roads) on observers in close proximity of the facility.

- The potential visual impact of operational, safety and security lighting of the facility at night on observers residing in proximity of the facility.
- The visual absorption capacity of natural or planted vegetation (if applicable).
- Potential visual impacts associated with the construction phase.
- The potential to mitigate visual impacts and inform the design process.

It is envisaged that the issues listed above may constitute a visual impact at a local scale.

3.1.1. Significance of Visual Impact

A combined quantitative and qualitative methodology, as supplied by the Environmental Practitioner, was used to describe the significance of impacts. Significance of impact is rated as *consequence* of impact multiplied by the *probability* of the impact occurring. Consequence is determined using intensity, spatial scale, and duration criteria.

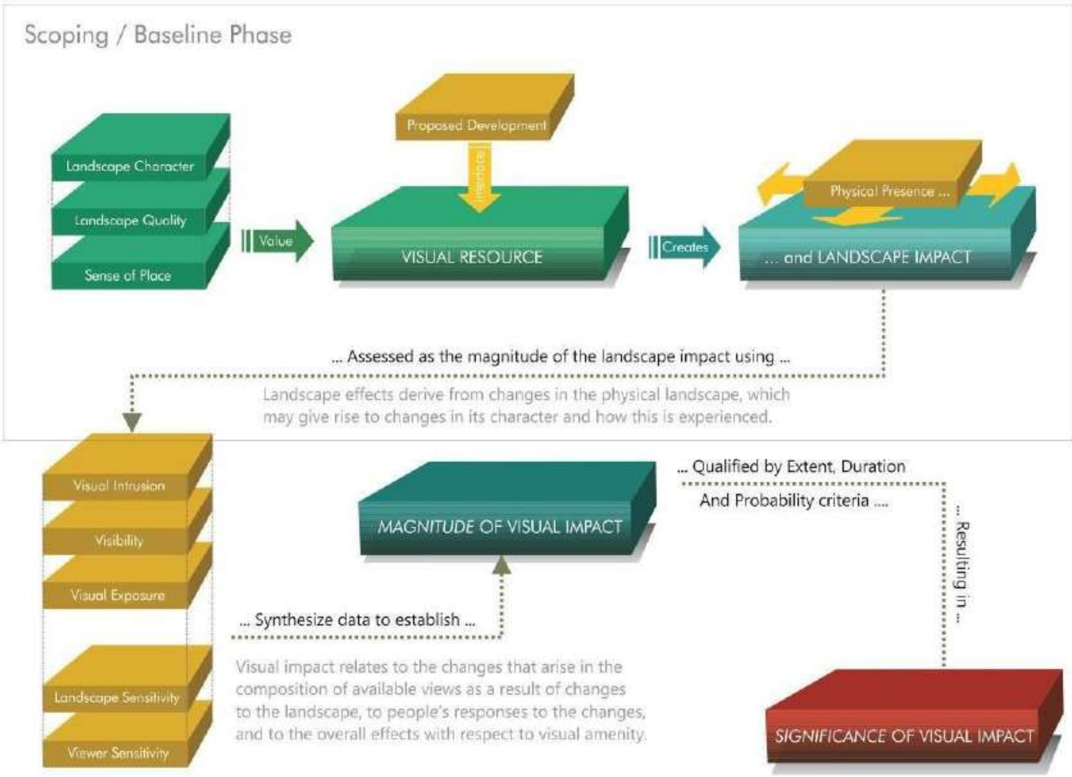

Figure 2: VIA Process

3.2. Methodology

The following method was used:

- Site visit: A field survey was undertaken so the extent of the receiving environment could be documented and adequately described. The climate conditions were mostly sunny with some cloud cover.
- Project components: The physical characteristics of the Project components were described and illustrated based on information supplied by Savannah Environmental.
- General landscape characterization: The visual resource (i.e., receiving environment) was mapped using the field survey, Google Earth imagery, and Mucina and Rutherford's (2006) reference book, The Vegetation of South Africa, Lesotho, and Swaziland. The description of the landscape focused on the nature of the land rather than the response of a viewer (refer to Appendix A).
- The character of the landscape was described and rated in terms of its aesthetic appeal using recognized contemporary research in perceptual psychology as the basis, and its sensitivity as a landscape receptor.
- The sense of place of the study area was described as to its uniqueness and distinctiveness. The primary informant of these qualities was the spatial form and character of the natural landscape together with the cultural transformations associated with the historic / current use of the land.
- The creation of viewshed analyses from the proposed Project site in order to determine the visual exposure

and the topography's potential to absorb the potential visual impact. The viewshed analyses consider the dimensions of the proposed structures and activities.

- The potential impact on the visual environment of the proposed Projects were identified; and rated according to Savannah's significance rating criteria.
- Measures to mitigate the negative impacts of the proposed Project were recommended.

4. DESCRIPTION OF THE PROJECT

4.1. Project Facilities

Development of the 14MW$_{ac}$ Harmony Central Plant Solar PV Facility, Virginia, Free State Province

The development of renewable energy facilities, overhead powerline and associated infrastructure is proposed by HARMONY GOLD MINING CO (LTD).

The project entails the development of a Photovoltaic (PV) Solar Energy Facility and associated infrastructure with a capacity of up to 14MW over 33.6ha of land and will be known as Harmony Central Plant Solar PV, the facility will include a grid connection and other associated infrastructure.

Harmony Central Plant Solar PV is based near Harmony Gold Central Plant operations located ~6km north-east of the town of Virginia and ~11km south-east of the town of Welkom within the Matjhabeng Local Municipality respectively, and within the Lejweleputswa District Municipality, Free State Province.

Table 1 includes technical information associated with the solar PV facilities and the grid connection infrastructure, as well as associated infrastructure for the proposed Project. The anticipated operational life of the plant is approximately 25 years. Beyond this duration, the proposed Project may continue to operate subject to further approvals or be decommissioned. In this assessment, it is assumed that it would be decommissioned. The construction and commissioning duration of the PV facilities and grid connection infrastructure will be approximately 12 – 18 months.

Table 1: Harmony Central Plant Technical Details for the Solar PV Facility

<table>
<tr><th>Component</th><th colspan="2">Harmony Central Plant Solar PV Facility</th></tr>
<tr><td rowspan="3">Farm name & portion number:</td><td>Farm Name</td><td>Portion Number</td></tr>
<tr><td>SAAIPLAAS 771</td><td>12</td></tr>
<tr><td>RUSTGEVONDEN 564</td><td>1</td></tr>
<tr><td>Property size:</td><td colspan="2">165ha</td></tr>
<tr><td>Project Site size:</td><td colspan="2">33.6ha</td></tr>
<tr><td>Development footprint size:</td><td colspan="2">28ha</td></tr>
<tr><td>Centre coordinates of site:</td><td colspan="2">28° 2'59.07"S; 26°52'50.19"E</td></tr>
<tr><td>Capacity</td><td colspan="2">14MW</td></tr>
<tr><td>Installed PV panel height</td><td colspan="2">Up to 5m</td></tr>
<tr><td>Number of PV panels</td><td colspan="2">TBC</td></tr>
<tr><td>IPP Substation capacity</td><td colspan="2">Up to 132kV</td></tr>
<tr><td>Substation footprint</td><td colspan="2">Up to 2ha</td></tr>
<tr><td>Grid Connection</td><td colspan="2">The projects will tie-in to the Harmony North (6.6/44kV) substation. The overhead lines will have a capacity of up to 132kV.</td></tr>
<tr><td>Grid Connection Corridor Length & Width</td><td colspan="2">Up to 2km with a servitude of 30m</td></tr>
<tr><td>BESS footprint</td><td colspan="2">TBC</td></tr>
<tr><td>BESS technology</td><td colspan="2">Lithium-ion or Redox Flow Batteries</td></tr>
<tr><td>Size of laydown area</td><td colspan="2">Up to 3ha</td></tr>
<tr><td>Operation and maintenance buildings</td><td colspan="2">• Offices
• Operations and Control Centre
• Operation and Maintenance Area / Warehouse / Workshop
• Ablution Facilities
• Security and Guard House</td></tr>
<tr><td>Main access road</td><td colspan="2">Jan Hofmeyr Road</td></tr>
</table>

4.2. Project Phases and Activities

Activities to be undertaken during each of the phases are described in the following sections below.

4.2.1. Site Preparation Phase

This phase would include the clearance of vegetation, installation of perimeter fencing and levelling of the site and preliminary earthworks. Thereafter the Project site will be marked out, a construction camp set up and the access road to the site is constructed. The clearance of vegetation is not anticipated to be site wide and will depend on the detailed layout of the proposed Project.

4.2.2. Construction Phase

The construction phase of the proposed Project will be initiated following the completion of the site preparation activities. The construction phase will include the following:

- Excavation of cable trenches;
- Ramming or drilling of the mounting structure frames;
- Installation of the PV modules onto the frames;
- Installation of measuring equipment;
- Laying of cables between the module rows to the inverter stations;
- Optionally laying of gravel or aggregate from nearby quarries placed in the rows between the PV panel array for enhanced reflection onto the panels, assisting in vegetation control and drainage;
- Construction of foundations for the inverter stations and installation of the inverters;
- Construction of the substation and BESS foundations and installation of the substation components and placement of BESS;
- Construction of operations and maintenance buildings;
- Undertaking of rehabilitation on cleared areas where required;
- Testing and commissioning; and
- Removal of equipment and disassembly of construction camp.

The construction phase of the proposed Project will be for a period of up to 12 – 18 months.

4.2.3. Operational Phase

The proposed Project will be operated on a 24 hour, 7 days a week basis. The operation phase of the proposed Project will comprise the following activities:

- Regular cleaning of the PV modules by trained personnel;
- Vegetation management under and around the PV modules and within the transmission line servitude to allow maintenance and operation at full capacity;
- Maintenance of all components including PV modules, mounting structures, trackers, inverters, substation transformers, BESS, and equipment;
- Office management and maintenance of operations and maintenance of buildings;
- Supervision of the solar PV facility operations; and
- Site security monitoring.

4.2.4. Decommissioning Phase

The proposed Project is expected to operate for at least 25 years. Once the solar PV facility reaches the end of its life, the facility and the grid connection infrastructure will be decommissioned or continue to operate following the issuance of a new Power Purchase Agreement (PPA) by Eskom. If decommissioned, all components will be removed, and the site rehabilitated. Where possible all materials will be recycled, otherwise they will be disposed of in accordance with local regulations and international best practice.

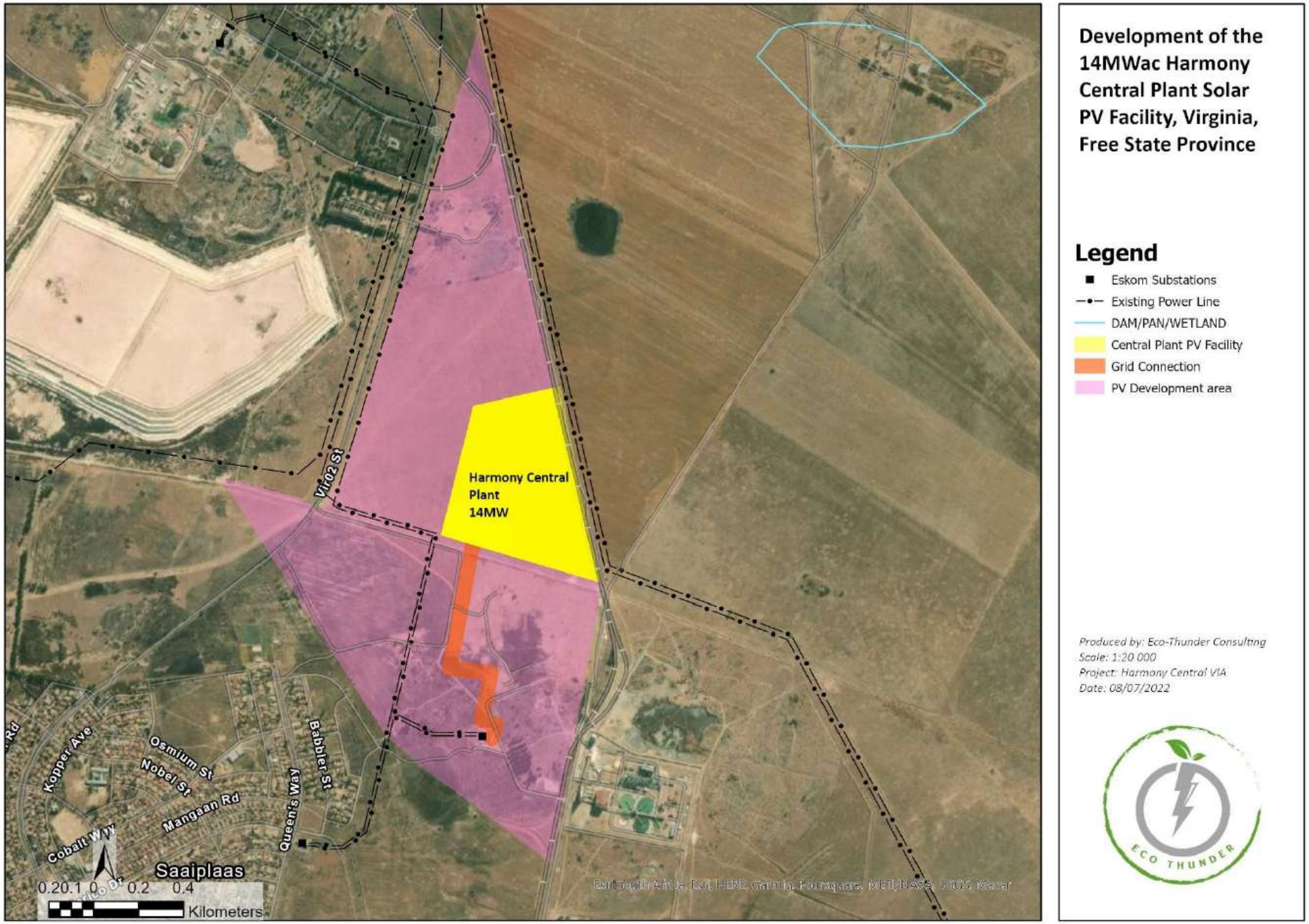

Figure 3: Facility layout map

5. ENVIROMENTAL SETTING

5.1. Landscape Character

A 10,0 km radius from the project area was evaluated. The surrounding area comprises mostly of agricultural land. The area is located within a typical Highveld climate with moderately wet, warm summers and cold dry winters.

The regional topography of the Northern Free State can be described as relatively flat, with rolling plains and low hills extending into the Welkom area. The rolling plain elevations range from 1 260 meters above mean sea level (amsl) to 1 460 meters amsl. The general slope of the terrain ranges from 1:250 to 1:100. Figure 3 indicates the viewing point of the panoramas.

The natural vegetation in the study area is dominated by two types of grasslands; the Vaal-Vet Sandy Grassland and the Highveld Alluvial Grassland. Much of these grasslands have been degraded throughout the region. Most of it has been transformed for cultivation and the rest under strong grazing pressure from cattle and sheep.

The Matjhabeng Local Municipality includes Welkom, Odendaalsrus, Virginia, Hennenman, Allanridge and Ventersburg with a combined population of 406 461 people. The economy of the Matjhabeng Municipality area centres around the mining activities located in and around Allanridge, Odendaalsrus, Welkom and Virginia. Manufacturing associated with the mining sector exists to a limited extent in the towns mentioned above. Other manufacturing activities are limited. In terms of economic contribution, the Matjhabeng Local Municipality is the most important Local Municipality in the district. The Matjhabeng Local Municipality accounts for almost 72% of the district's economic output. In terms of future economic development, there is likely to be a decline in the role played by mining, which will also negatively impact employment in the Free State Province.

5.2. Land Use

The proposed development is approximately 11km south-east of central Welkom and 6km north of the town Virginia. The project area is predominately mining development and industrial activities. Other dominant land uses in the project area include the R730 road with predominantly maize and wheat farming in the surrounding area. The area is predominantly characterised as transformed by the Harmony Gold mining activities in the area.

Farm settlements or residences occur at irregular intervals throughout the study area. Some of these, in close proximity to the proposed development site, including Saaiplaas.

The most prominent (and visible) land use within the region is the mining activities, mining infrastructure and mine dumps. Interspersed with these mining activities are agricultural land uses, ranging from irrigated agriculture to the south-west and broader south and western area. Agricultural activities include the production of maize, wheat and sunflower crops, as well as cattle farming. The farmers working these fields predominantly reside at homesteads or farm residences scattered throughout the study area.

Towns or residential areas primarily associated with the mines in the region include:

- Welkom
- Bronville
- Naudeville
- Bedelia
- Silwerstraal
- Bloudrif
- Virginia
- Meloding
- Whites
- Riebeekstad
- Odendaalsrus

The N1 national road provides access to the region and is the main connecting route in between the Gauteng Province (Pretoria) and Welkom. The proposed PV facility sites is accessible from both the M3 and the R730 via secondary roads.

Besides the large number of mines and mining infrastructure within the study area, there are numerous power lines and substations, predominantly associated with the mines. The proposed Harmony One Plant PV facility is located approximately 11.4 km north-west of the Harmony Airfield.

Figure 4: Center of Saaiplaas Located 2KM South West of the proposed development

Figure 5: R730 towards Virginia, 4km west of the development

Figure 6: The R730 towards Welkom, 7km North West of the development

Figure 7: The R73 located 2km south of the development

Figure 8: The R70, 11km north of the development

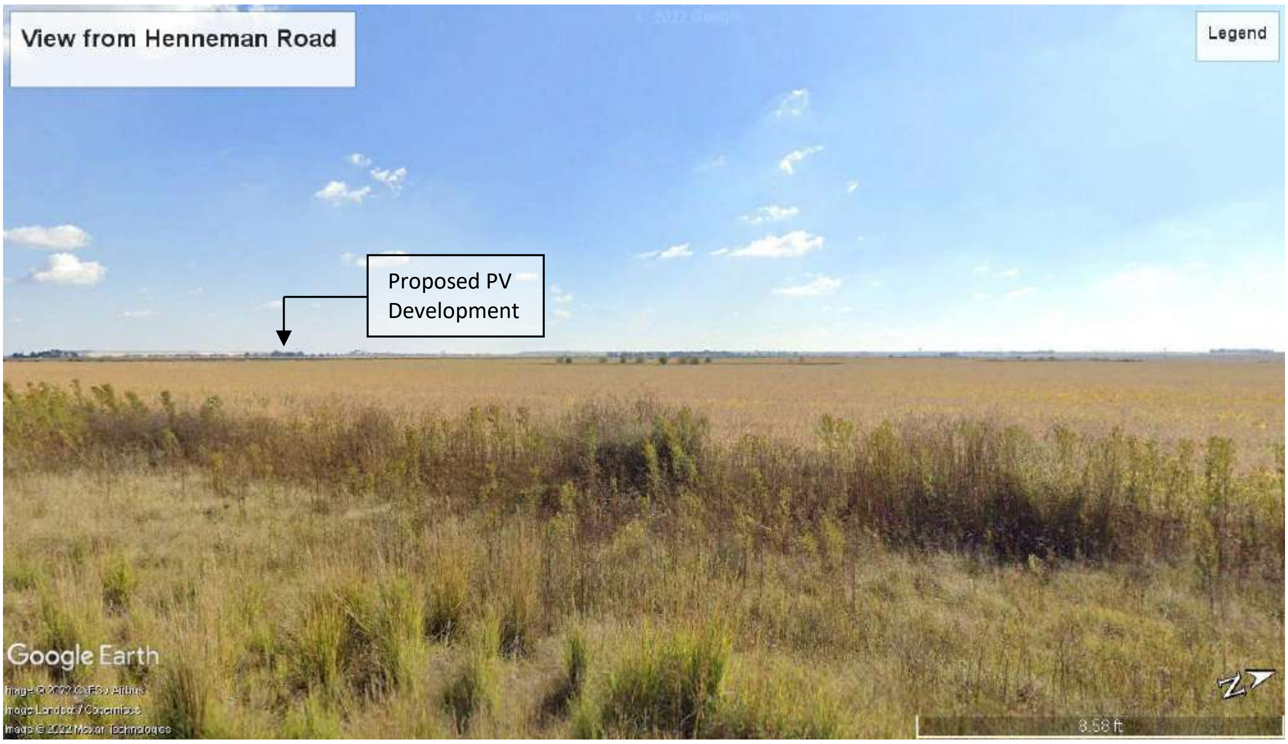

Figure 9: The proposed development as observed from Henneman Road 5km East of the proposed development

Figure 10: View from Near the town of Henneman approximately 10km North East of the Development

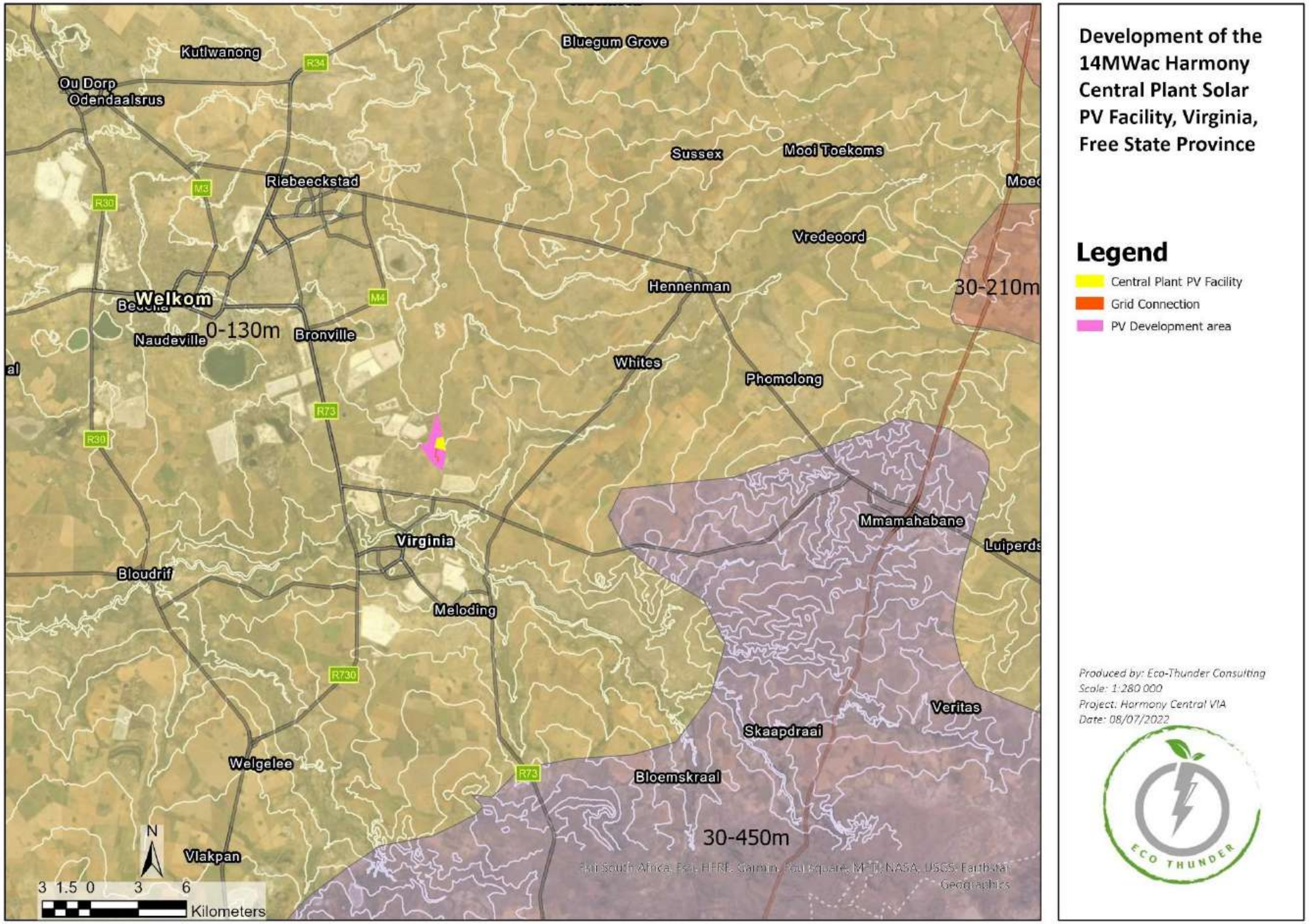

Figure 11: Site Topography and Slope

6. VISUAL RESOURCE

6.1. Visual Resource Value, Scenic Quality and Landscape Sensitivity

The value of the visual resource and its associated scenic quality are primarily derived from the combination of land-uses described above overlaid onto an open rolling topography. These are the primary features that give the area its general characteristics and a sense of place.

The sensitivity of the study area's landscape can be defined as high, medium, or low (as indicated below and in Figure 12), and is dependent on the Character – does it contribute to the area's sense of place and distinctiveness; Quality – in what condition is the existing landscape; Value – is the landscape valued by people, local community, visitors, and is the landscape recognised, locally, regionally, or nationally; and Capacity – what scope is there for change (either negative or positive) in the existing landscape character?

When the criteria is considered and understood within the context of the sub-region, a visual resource value of *low* (power utility and mining areas), *moderate* (drainage lines, open farmland, and urban recreation development), and *high* (bush-covered low hills), is allocated.

Table 2: Value of the Visual Resource
(After: LiEMA 2013)

High	Moderate	Low
This landscape type is considered to have a *high* value because it is a: Distinct landscape that exhibits an extremely positive character with valued features that combine to give the experience of unity, richness, and harmony. It is a landscape that may be of particular importance to conserve, and which has a strong sense of place. Sensitivity: It is sensitive to change in general and will be detrimentally affected if change is inappropriately dealt with.	This landscape type is considered to have a *moderate* value because it is a: Common landscape that exhibits some positive character, but which has evidence of alteration / degradation / erosion of features resulting in areas of more mixed character. Sensitivity: It is potentially sensitive to change in general and change may be detrimental if inappropriately dealt with.	This landscape type is considered to have a *low* value because it is a: Minimal landscape generally negative in character with few, if any, valued features. Sensitivity: It is not sensitive to change in general and change may be detrimental if inappropriately dealt with.

The Project sites occur within a landscape type rated moderate, with nearby power infrastructure and mines rated low. Generally, because most of the areas surrounding the site are rated moderate to moderately high in scenic value, the area is potentially sensitive to change if the change is inappropriately dealt with.

6.2. Sense of Place

According to Lynch (1992), a sense of place is the extent to which a person can recognize or recall a place as being distinct from other places - as having a vivid, unique, or at least particular character of its own. The sense of place for the study area derives from a combination of the local landscape types described above, their relative 'intactness', and their impact on the senses.

The sub-region is recognised as a major agricultural area. The combination of the mining land and farming activities, along with the distinctiveness of the rolling open land, gives the study area a mixed sense of place. One, in which new development needs to be carefully managed such that the combination of development activities associated with the Project and the landscape are not at odds with each other.

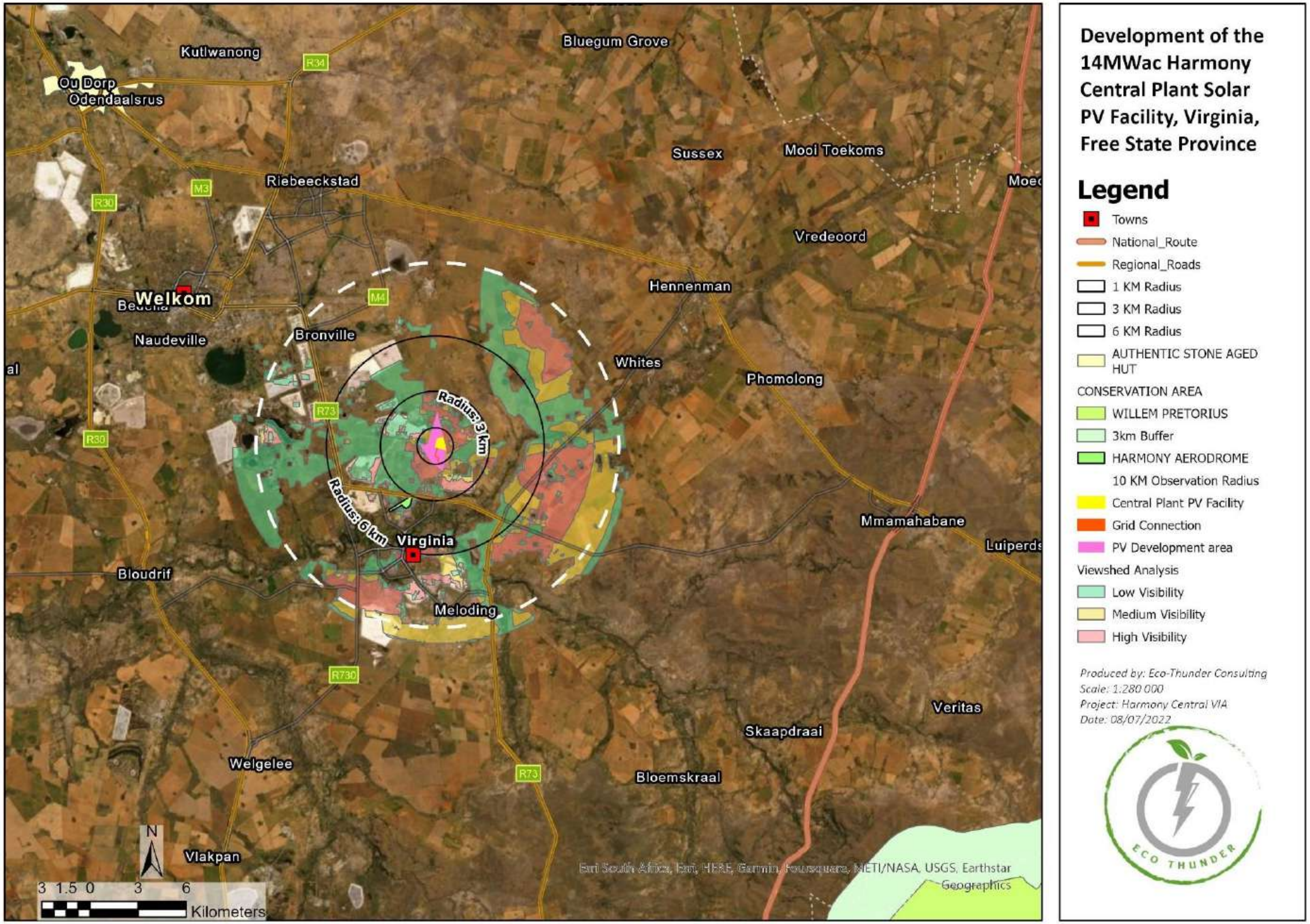

Figure 12: Viewshed analysis

7. VISUAL IMPACT ASSESSMENT

The *intensity* of impact is assessed through a synthesis of visual intrusion, visibility, visual exposure, and viewer sensitivity criteria. Once the intensity of impact has been established this value is further qualified with spatial, duration and probability criteria to determine the *significance* of the visual impact.

In assessing the intensity of visual impact, the study assumes the worst-case scenario, i.e., that the facility (PV and Grid Connections) will be built at the same time. Figure 3 shows that the facilities and grid connection infrastructure are located immediately adjacent to each other, resulting in all Project components being observed within the same visual envelope (to a greater or lesser degree) from the sensitive viewing areas.

It is anticipated that visual impacts will result from the activities and infrastructure in all Project phases i.e., construction, operational, and closure. Activities associated with the Project will be visible, to varying degrees from varying distances around the Project site. During the establishment phase, the Project's visibility will be influenced due to the preparatory activities, primarily earthworks and infrastructure establishment. During the operation phase, the visibility of the Project will be the result of the established PV arrays, the substation, and associated powerline infrastructure (grid connections).

Typical issues associated with solar PV Projects are:

- Who will be able to see the new development?
- What will it look like, and will it contrast with the receiving environment?
- Will the development affect sensitive views in the area and if so, how?
- What will be the impact of the development during the day and at night?
- What will the cumulative impact be if any?

These potential impacts will be considered and rated in the following sections.

7.1. Impact Index

The combined results of the visual exposure, viewer incidence / perception and visual distance of the proposed PV facility is displayed on Map 6. Here the weighted impact and the likely areas of impact have been indicated as a visual impact index. Values have been assigned for each potential visual impact per data category and merged to calculate the visual impact index.

An area with short distance visual exposure to the proposed infrastructure, a high viewer incidence and a potentially negative perception (i.e., a sensitive visual receptor) would therefore have a higher value (greater impact) on the index. This helps in focusing the attention to the critical areas of potential impact and determining the potential magnitude of the visual impact.

The index indicates that potentially sensitive visual receptors within a 1km radius of the PV facility may experience a very high visual impact. The magnitude of visual impact on sensitive visual receptors subsequently subsides with distance to; high within a 1 – 3km radius (where / if sensitive receptors are present) and moderate within a 3 – 6km radius (where / if sensitive receptors are present). Receptors beyond 6km are expected to have a low potential visual impact.

Magnitude of the potential visual impact

0 – 1km

The majority of the exposed areas in this zone fall within the project site, the boarders of the adjacent Harmony Central mine and tailings dam, as well as Eskom infrastructure is found within this zone, classified as vacant open space, generally devoid of observers or potential sensitive visual receptors. To the south the boundary properties of the Saaiplaas settlement can also be included in this zone, this section of the town will experience a high visual impact.

1 – 3km

To the east of the proposed site within the 1 - 3km radius the majority of the exposed area falls within the Harmony Gold mining operations.

The north and majority of the western portion within this radius is characterised by vacant farmland or natural open space, generally devoid of observers or potential sensitive visual receptors. Similarly, the south-western part of the site is a cumulation of Harmony Gold mining operations and vacant farmlands.

It has to be noted that the road and surrounding areas are quite well visually isolated by means of naturally occurring vegetation and previous mining development acting as a shield surrounding the PV facility,

To the south a section of the main road (R73) traverses along the border of the Harmony Gold Central mining operations and travels through the Saaiplaas settlement. Observers travelling along this road will be exposed to the project infrastructure.

Saaiplaas is identified as a potential sensitivity receptor within this zone (to the south-east of the site). The magnitude of the visual impact is expected to be moderate

3 – 6km

Within a 3 – 6km radius, the visual exposure becomes very scattered and interrupted due to the undulating nature of the topography.

The above-mentioned main road runs completely through this section from west to east. Everything north of this main road within the 3 – 6km radius zone is predominantly vacant farmland or natural open space.

To the south of the R73 the town of Virginia can be identified as a potential sensitivity receptor, the magnitude however is considered to be low in this area.

6 – 10km

At distances exceeding 6km the intensity of visual exposure is expected to be very low and highly unlikely due to the distance between the object (development) and the observer. Sensitive visual receptors are not likely to be visually exposed to the proposed facility, despite lying within the viewshed.

7.2. Visual Absorption Capacity

The broader study area is located within the grassland biome characterised by large open grassy plains and wetlands in the lower lying areas. Large tracts of land are utilised for maize production. Depending on the time of the season, or after the harvesting season, these agricultural fields are devoid of any significantly tall or dense vegetation.

Overall, the Visual Absorption Capacity (VAC) of the receiving environment is deemed low by virtue of the nature of the vegetation and the low occurrence of urban development. In addition, the scale and form of the structures mean that it is unlikely that the environment will visually absorb them in terms of texture, colour, form, and light / shade characteristics.

Where homesteads and settlements occur, some more significant vegetation and trees may have been planted, which would contribute to visual absorption. However, as this is not a consistent occurrence, VAC will not be taken into account for any of the homesteads or settlements, thus assuming a worst-case scenario in the impact assessment.

Closer to the proposed development site, the occurrence of existing mining is expected to greatly influence the visual exposure of the proposed PV structures and ancillary infrastructure. The existing mining infrastructure is expected to be especially effective in reducing visual exposure to the east and south of the proposed development's location (i.e., along roads and at residence settlements).

7.3. VIA Rating Methodology

This section will attempt to quantify the potential visual impacts in their respective geographical locations and in terms of the identified issues related to the visual impact.

The methodology for the assessment of potential visual impacts states the **nature** of the potential visual impact (e.g., the visual impact on users of major roads in the vicinity of the proposed power line alignment) and includes a table quantifying the potential visual impact according to the following criteria:

- **Extent** - long distance (very low = 1), medium to longer distance (low = 2), short distance (medium = 3) and very short distance (high = 4)[2].
- **Duration** - very short (0 – 1yrs. = 1), short (2 – 5yrs. = 2), medium (5 – 15yrs. = 3), long (>15 yrs. = 4), and permanent (= 5).
- **Magnitude** - None (= 0), minor (= 2), low (= 4), medium / moderate (= 6), high (= 8) and very high (= 10)[3].
- **Probability** – very improbable (= 1), improbable (= 2), probable (= 3), highly probable (= 4) and definite (= 5).
- **Status** (positive, negative or neutral).
- **Reversibility** - reversible (= 1), recoverable (= 3) and irreversible (= 5).
- **Significance** - low, medium or high.

The *significance* of the potential visual impact is equal to the *consequence* multiplied by the *probability* of the impact occurring, where the consequence is determined by the sum of the individual scores for magnitude, duration, and extent (i.e., *significance = consequence (magnitude + duration + extent) x probability*).

The significance weighting for each potential visual impact (as calculated above) is as follows:

- <30 points: Low (where the impact would not have a direct influence on the decision to develop in the area).
- 31-60 points: Medium / moderate (where the impact could influence the decision to develop in the area).
- >60: High (where the impact must have an influence on the decision to develop in the area).

7.4. Visual Impact Assessment

The identification and assessment of environmental impacts is a multi-faceted process, using a combination of quantitative and qualitative descriptions and evaluations. It involves applying scientific measurements and professional judgement to determine the significance of environmental impacts associated with the proposed project. The process involves consideration of, inter alia: the purpose and need for the Project; views and concerns of interested and affected parties (I&APs); social and political norms, and the public's interest.

The following tables summarise the consequence and significance of the visual impact of the Project. These results are based on worst-case scenario when the impacts of all aspects of the Project are taken together (PV facilities, grid connection and battery systems). Consequence of impact is a function of intensity, duration, and spatial extent (SLR 2020). Intensity of impact is taken from the worst-case situation. These facilities are rated together, from a visual impact perspective, as the one would not exist without the other and they must be understood as the collective / cumulative.

[2] Long distance = > 3km. Medium to longer distance = 1.5 – 3km. Short distance = 0.5 – 1.5km. Very short distance = < 0.5km (refer to Section 6.3. Visual distance / observer proximity to the grid connection infrastructure).

[3] This value is read from the visual impact index. Where more than one value is applicable, the higher of these will be used as a worst case scenario.

7.4.1. Construction Phase

<table>
<tr><th colspan="4">Table 3: Construction of a PV Facility</th></tr>
<tr><td colspan="4">The development of the proposed solar power plants will require approximately 33.6ha of land. The preparation (earthworks and infrastructure development) will cause a major local contrast with the existing open land, as soil is exposed to create service roads, trenches, erecting structures for the arrays, distribution lines, sub-stations, etc.

Construction activities may potentially result in a moderate (significance rating = 48), temporary visual impact, that may be mitigated to moderate (significance rating = 30).

The clearing of vegetation and exposure of soil during the establishment period will contrast dramatically with the natural layout of the site’s vegetation. Once the solar PV arrays have been installed, they will also contrast with the existing landscape due to their dark appearance.</td></tr>
<tr><td></td><td>Rating</td><td>Motivation</td><td>Significance</td></tr>
<tr><td colspan="4">Prior to Mitigation</td></tr>
<tr><td>Duration</td><td>Short (2)</td><td>Changes in the physical characteristics by changing the fabric and character of the landscape.</td><td rowspan="4">High (48)</td></tr>
<tr><td>Extent</td><td>Very Short Distance (4)</td><td>Partial loss of features that contribute to the existing landscape by the introduction of new elements and structures.</td></tr>
<tr><td>Magnitude</td><td>Moderate (4)</td><td>The PV Facility will only impact the direct area</td></tr>
<tr><td>Probability</td><td>Highly probable (4)</td><td>If development is approved there is a high probability the landscape will be impacted.</td></tr>
<tr><td colspan="4">Mitigation/Enhancement Measures</td></tr>
<tr><td colspan="4">Mitigation:
Retain and maintain natural vegetation (if present) immediately adjacent to the development footprint.
Ensure that vegetation cover adjacent to the development footprint (if present) is not unnecessarily removed during the construction phase, where possible.
Plan the placement of laydown areas and temporary construction equipment camps in order to minimise vegetation clearing (i.e., in already disturbed areas) wherever possible.
Restrict the activities and movement of construction workers and vehicles to the immediate construction site and existing access roads.
Ensure that rubble, litter, and disused construction materials are appropriately stored (if not removed daily) and then disposed regularly at licensed waste facilities.
Reduce and control construction dust using approved dust suppression techniques as and when required (i.e., whenever dust becomes apparent).
Restrict construction activities to daylight hours whenever possible in order to reduce lighting impacts.
Rehabilitate all disturbed areas (if present / if required) immediately after the completion of construction works.</td></tr>
<tr><td colspan="4">Post Mitigation/Enhancement Measures</td></tr>
<tr><td>Duration</td><td>Short (2)</td><td>Changes in the physical characteristics by changing the fabric and character of the landscape.</td><td rowspan="4">Low (30)</td></tr>
<tr><td>Extent</td><td>Very Short Distance (4)</td><td>Partial loss of features that contribute to the existing landscape by the introduction of new elements and structures.</td></tr>
<tr><td>Magnitude</td><td>Low (4),</td><td>Mitigation will reduce the impact that the PV facility has during construction</td></tr>
<tr><td>Probability</td><td>Probable (3)</td><td>If development is approved there is a high probability the landscape will be impacted.</td></tr>
<tr><td colspan="4">Cumulative Impacts:
The construction of the Solar Energy Facility (SEF) is expected to increase the cumulative visual impact within the region, considering the visual exposure of the power line infrastructure already present at this locality. Alternatively, the close proximity of the proposed site to the existing visual disturbances (power lines) allows for the effective connection with the power grid without incurring any additional expanded visual impacts.</td></tr>
<tr><td colspan="4">Residual Risks:
The visual impact will be removed after decommissioning, provided the SEF infrastructure is removed and the site is rehabilitated to its original (current) status. Failing this, the visual impact will remain.</td></tr>
</table>

Table 4: Impact of PV facility on Roads in Close Proximity			
The Solar Energy Facility (SEF) could potentially have a **moderate** visual impact on road users travelling along the main road traversing south and east of the facility, as well as the local road towards the north of the facility. These roads are however expected to be frequented primarily by local users going about their daily business (i.e., not sight-seeing), potentially lessening the probability of the impact significance.			
	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	Long term (4)	Development of the SEF will be visible for its entire lifespan.	**Moderate (48)**
Extent	Local (4)	Only road users in the area will be subjected to the impact.	
Magnitude	High (8)	Although no direct visual impact will be observed from the road the impact is associated with the increase in construction vehicles	
Probability	Probable (3)	Road users will most likely be able to see the SEF when using the roads.	
Mitigation/Enhancement Measures			
Mitigation: **Mitigation of this impact is possible** and both specific measures as well as general "best practice" measures are recommended in order to reduce / mitigate the potential visual impact to **low**. The table below illustrates this impact assessment. ***General mitigation / management:*** Planning: • Retain and maintain natural vegetation in all areas outside of the development footprint. Operations: • Maintain the general appearance of the facility as a whole. Decommissioning: • Remove infrastructure not required for the post-decommissioning use of the facility. • Rehabilitate all areas. Consult an ecologist regarding rehabilitation specifications. • Monitor rehabilitated areas post-decommissioning and implement remedial actions. ***Site specific mitigation measures:*** • Plant vegetation barriers along the border of the SEF in order to shield the structures from observers travelling along this road.			
Post Mitigation/Enhancement Measures			
Duration	Long term (4)	Development of the SEF will be visible for its entire lifespan.	**Low (24)**
Extent	Local (4)	Only road users in the area will be subjected to the impact.	
Magnitude	Low (4)	Visual impact will be reduced by use of landscape and vegetation	
Probability	Improbable (2)	Vegetation will shield any possible visual intrusion.	
Cumulative Impacts: The construction of the SEF is expected to increase the cumulative visual impact within the region, considering the visual exposure of the power line infrastructure already present at his locality. Alternatively, the close proximity of the proposed site to the existing visual disturbances (power lines) allows for the effective connection with the power grid without incurring any additional expanded visual impacts.			
Residual Risks: The visual impact will be removed after decommissioning, provided the SEF infrastructure is removed and the site is rehabilitated to its original (current) status. Failing this, the visual impact will remain.			

Table 5: Visual Impact on Residence and Homesteads in Close Proximity

The potential visual impact on residents of homesteads and homes in close proximity to the Solar Energy Facility (SEF) is expected to be of **moderate** significance. The residences in question are any farmhouses adjacent to the property as well as the SaaiPlaas settlement south-west of the proposed development site.

	Rating	Motivation	Significance
Prior to Mitigation			
Duration	Long term (4)	The residence surrounding the development will be able to see the SEF.	**Moderate (42)**
Extent	Local (4)	The development is proposed to only disrupt local visual receptors.	
Magnitude	Moderate (6)	The surrounding area existing of mining infrastructure and natural vegetation reduces the visibility of the SEF	
Probability	Probable (3)	Residence will most likely be able to see the SEF.	

Mitigation/Enhancement Measures

Mitigation:

General mitigation/management:

Planning:

- Retain and maintain natural vegetation in all areas outside of the development footprint.

Operations:

- Maintain the general appearance of the facility as a whole.

Decommissioning:

- Remove infrastructure not required for the post-decommissioning use of the facility.
- Rehabilitate all areas. Consult an ecologist regarding rehabilitation specifications.
- Monitor rehabilitated areas post-decommissioning and implement remedial actions.

Site specific mitigation measures:

- Plant vegetation barriers along the western and south-western borders of the SEF in order to shield the structures from observers residing at the above-mentioned homesteads and residential settlements.

Post Mitigation/Enhancement Measures			
Duration	Long term (4)	The SEF will be visible for its entire lifespan.	**Low (24)**
Extent	Local (4)	SEF has a low impact radius and will only intrude on homesteads and residence in close proximity if mitigation is not followed	
Magnitude	Low (4)	Implementing mitigation will reduce the visibility from homesteads	
Probability	Improbable (2)	With the correct mitigation measures in place, it is highly unlikely that there would be permanent impact on local residence.	

Cumulative impacts:

The construction of the SEF is expected to increase the cumulative visual impact within the region, considering the visual exposure of the power line infrastructure already present at this locality. Alternatively, the close proximity of the proposed site to the existing visual disturbances (power lines) allows for the effective connection with the power grid without incurring any additional expanded visual impacts.

Residual Risks:

None

7.4.2. Operation Phase

<table>
<tr><th colspan="4">Table 6: Glint and Glare</th></tr>
<tr><td colspan="4">Potential visual impact of solar glint and glare as a visual distraction and possible air / road travel hazard

The visual impact of glint and glare relates to the potential it has to negatively affect sensitive visual receptors in relatively close proximity to the source (e.g., residents of neighbouring properties), or aviation safety risk for pilots (especially where the source interferes with the approach angle to the runway).

The proposed PV facility is located approximately 4km from a semi operational airfield and 3km from a major road.

No impacts are predicted towards pilots along any of the assessed approach paths and no ATC Tower was identified.

The potential visual impact related to solar glint and glare as an air / road travel hazard is expected to be of low significance. No mitigation of this impact is required since the PV facility is not expected to interfere with aircraft operations or impact the safety of road users.</td></tr>
<tr><td></td><td>Rating</td><td>Motivation</td><td>Significance</td></tr>
<tr><td colspan="4">Prior to Mitigation</td></tr>
<tr><td>Duration</td><td>Long term (4)</td><td>This will be a possible risk for the entire life cycle of the SEF.</td><td rowspan="4">Low (24)</td></tr>
<tr><td>Extent</td><td>Very short distance (4)</td><td>This will only be a problem from short distances and at sustain times of day.</td></tr>
<tr><td>Magnitude</td><td>Low (4)</td><td>The degree to which glint and glare will be of concern is low due to the surrounding landscape and the proximity from the roads</td></tr>
<tr><td>Probability</td><td>Probable (4)</td><td>Reflection from sunlight, cars traveling on adjacent roads or night-time elimination will trigger this risk.</td></tr>
<tr><td colspan="4">Mitigation/Enhancement Measures</td></tr>
<tr><td colspan="4">Mitigation:
N/A</td></tr>
<tr><td colspan="4">Post Mitigation/Enhancement Measures</td></tr>
<tr><td>Duration</td><td>Long term (4)</td><td>This will be a possible risk for the entire life cycle of the SEF.</td><td rowspan="4">Low (24)</td></tr>
<tr><td>Extent</td><td>Very short distance (4)</td><td>This will only be a problem from short distances and at sustain times of day.</td></tr>
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<tr><td>Probability</td><td>Probable (4)</td><td>Reflection from sunlight, cars traveling on adjacent roads or night-time elimination will trigger this risk.</td></tr>
<tr><td colspan="4">Cumulative Impacts:
N/A</td></tr>
<tr><td colspan="4">Residual Risks:
N/A</td></tr>
</table>

<table>
<tr><th>Table 7: Visual Exposure</th></tr>
<tr><td>Visual exposure is determined by qualifying the visibility of an object, with a distance rating to indicate the degree of intrusion and visual acuity. As distance between the viewer and the object increases, the visual perception of the object reduces exponentially as generally changes in form, line, colour, and texture in the landscape become less perceptible with increasing distance.
The basic areas of concern are:
• The public roads including the R730,R73, Boundary Road, and local roads generally servicing the farms, towns and mines throughout the study area.
• The mining areas
• The residential areas surrounding the Project sites.</td></tr>
</table>

	Rating	Motivation	Significance
Prior to Mitigation			
Duration	Long term (4)	The development will be visible for its life cycle duration	**Moderate (42)**
Extent	Local (4)	Visual receptors within the local area will be subjected to this impact	
Magnitude	Moderate (6)	The area will be visible however given the transformed nature of the surrounding area and the proposed mitigation measures the magnitude is moderate	
Probability	Probable (3)	Without mitigation there is a high level of certainty that this impact will take place	
Mitigation/Enhancement Measures			
Mitigation: **General mitigation/management:** Planning: • Retain and maintain natural vegetation in all areas outside of the development footprint. Operations: • Maintain the general appearance of the facility as a whole. Decommissioning: • Remove infrastructure not required for the post-decommissioning use of the facility. • Rehabilitate all areas. Consult an ecologist regarding rehabilitation specifications. • Monitor rehabilitated areas post-decommissioning and implement remedial actions. **Site specific mitigation measures:** • Plant vegetation barriers along the western and south-western borders of the SEF in order to shield the structures from observers residing at the above-mentioned homesteads and residential settlements.			
Post Mitigation/Enhancement Measures			
Duration	Long term (4)	The development will be visible for its life cycle duration	**Low (24)**
Extent	Local (4)	Visual receptors within the local area will be subjected to this impact	
Magnitude	Low (4)	Visibility is reduced if mitigations are implemented	
Probability	Improbable (2)	With Mitigation this impact is likely to be significantly reduced	
Cumulative Impacts: The construction of the SEF is expected to increase the cumulative visual impact within the region, considering the visual exposure of the power line infrastructure already present at this locality. Alternatively, the close proximity of the proposed site to the existing visual disturbances (power lines) allows for the effective connection with the power grid without incurring any additional expanded visual impacts.			
Residual Risks: None			

Table 8: Visual intrusion			
Visual intrusion deals with the notion of contextualism i.e., how well does a Project component fit with or disrupt / enhance the ecological and cultural aesthetic of the landscape as a whole? And ties in with the concept of visual absorption capacity (VAC), which for the Project site is **low**.			
	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	Long term (4)	The development will be visible for its life cycle duration	**Low (30)**
Extent	Local (2)	Visual receptors within the local area will be subjected to this impact	
Magnitude	Moderate (4)	The area where the PV is developed is transformed, however agricultural holdings and natural areas are observed	

Probability	Probable (3)	A significant probability for this to occur exists, which can be mitigated	
Mitigation/Enhancement Measures			
Mitigation: **General mitigation/management:** Planning: • Retain and maintain natural vegetation in all areas outside of the development footprint. Operations: • Maintain the general appearance of the facility as a whole. Decommissioning: • Remove infrastructure not required for the post-decommissioning use of the facility. • Rehabilitate all areas. Consult an ecologist regarding rehabilitation specifications. • Monitor rehabilitated areas post-decommissioning and implement remedial actions. **Site specific mitigation measures:** • Plant vegetation barriers along the western and south-western borders of the SEF in order to shield the structures from observers residing at the above-mentioned homesteads and residential settlements.			
Post Mitigation/Enhancement Measures			
Duration	Long term (4)	The development will be visible for its life cycle duration	
Extent	Local (4)	Visual receptors within the local area will be subjected to this impact	
Magnitude	Low (4)	Visibility is reduced if mitigations are implemented	
Probability	Improbable (2)	With Mitigation this impact is likely to be significantly reduced	
Cumulative impacts: The combined effects of these changes will negatively affect the overall character of the landscape.			
Residual Risks: "Residual Risk", means the risk that will remain after all the recommended measures have been undertaken to mitigate the impact associated with the activity (Green Leaves III, 2014).			

Table 9: Ancillary Infrastructure			
On-site ancillary infrastructure associated with the PV facility includes an 11kV power line, inverters, low voltage cabling between the PV arrays, meteorological measurement station, internal access roads, workshop, office buildings, etc. No dedicated viewshed analyses have been generated for the ancillary infrastructure, as the range of visual exposure will fall within that of the PV arrays. The anticipated visual impact resulting from this infrastructure is likely to be of **low** significance both before and after mitigation.			
	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	Long term (4)	The development will be visible for its life cycle duration	**Low (24)**
Extent	Local (4)	Visual receptors within the local area will be subjected to this impact	
Magnitude	Low (4)	Characteristics surrounding the area support the development of additional infrastructure	
Probability	Improbable (2)	There is a small chance that this will impact visual receptors.	
Mitigation/Enhancement Measures			
Mitigation: **General mitigation/management:** Planning: • Retain and maintain natural vegetation in all areas outside of the development footprint. Operations: • Maintain the general appearance of the facility as a whole.			

Decommissioning: • Remove infrastructure not required for the post-decommissioning use of the facility. • Rehabilitate all areas. Consult an ecologist regarding rehabilitation specifications. • Monitor rehabilitated areas post-decommissioning and implement remedial actions. **Site specific mitigation measures:** • Plant vegetation barriers along the western and south-western borders of the SEF in order to shield the structures from observers residing at the above-mentioned homesteads and residential settlements.			
Post Mitigation/Enhancement Measures			
Duration	Long term (4)	The development will be visible for its life cycle duration	
Extent	Local (4)	Visual receptors within the local area will be subjected to this impact	
Magnitude	Low (4)	Characteristics surrounding the area support the development of additional infrastructure	
Probability	Improbable (2)	There is a small chance that this will impact visual receptors.	
Cumulative Impacts: The combined effects of these changes will negatively affect the overall character of the landscape.			
Residual Risks: None			

Table 10: Sense of place			
Sense of place refers to a unique experience of an environment by a user, based on his or her cognitive experience of the place. Visual criteria, specifically the visual character of an area (informed by a combination of aspects such as topography, level of development, vegetation, noteworthy features, cultural / historical features, etc.), plays a significant role. An impact on the sense of place is one that alters the visual landscape to such an extent that the user experiences the environment differently, and more specifically, in a less appealing or less positive light. The environment surrounding the proposed PV facility has a predominantly rural and undeveloped character. These generally undeveloped landscapes are considered to have a high visual quality, except where urban development and mining/industrial activities represents existing visual disturbances. The anticipated visual impact of the proposed PV facility on the regional visual quality, and by implication, on the sense of place, is difficult to quantify, but is generally expected to be of **low** significance. This is due to the relatively low viewer incidence within close proximity to the proposed development site and the presence of existing mining and industrial activities within the region.			
	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	Long term (4)	The development will be visible for its life cycle duration	**Low (22)**
Extent	Regional (3)	Visual receptors within the local area will be subjected to this impact	
Magnitude	Low (4)	The area is previously transformed and is located between existing mining infrastructure, the development can be seen as Like for Like	
Probability	Improbable (2)	There is a small chance that this will impact visual receptors.	
Mitigation/Enhancement Measures			
Mitigation: Not Applicable			
Post Mitigation/Enhancement Measures			
Duration	Long term (4)	The development will be visible for its life cycle duration	
Extent	Regional (3)	Visual receptors within the local area will be	

		subjected to this impact	
Magnitude	Low (4)	The area is previously transformed and is located between existing mining infrastructure, the development can be seen as Like for Like	
Probability	Improbable (2)	There is a small chance that this will impact visual receptors.	
Cumulative impacts: The combined effects of these changes will negatively affect the overall character of the landscape.			
Residual Risks: The visual impact will be removed after decommissioning, provided the PV facility infrastructure is removed. Failing this, the visual impact will remain.			

7.4.3. Cumulative Effects

Cumulative landscape and visual effects (impacts) result from additional changes to the landscape or visual amenity caused by the proposed development in conjunction with other developments (associated with or separate to it), or actions that occurred in the past, present or are likely to occur in the foreseeable future. They may also affect how the landscape is experienced. Cumulative effects may be positive or negative. Where they comprise a range of benefits, they may be considered to form part of the mitigation measures.

Cumulative effects can also arise from the intervisibility of a range of developments and / or the combined effects of individual components of the proposed development occurring in different locations or over some time. The separate effects of such individual components or developments may not be significant, but together they may create an unacceptable degree of adverse effect on visual receptors within their combined visual envelopes. Intervisibility depends upon general topography, aspect, tree cover or other visual obstruction, elevation, and distance as this affects visual acuity, which is also influenced by weather and light conditions (LI-IEMA (2013)).

<u>Cumulative effect of the Project</u>

The cumulative impact of the Project, the facilities and infrastructure taken together, is significant, along with the existing power infrastructure (ESKOM sub-station and transmission lines) that exists in the study area. Intervisibility for the proposed Project and the existing infrastructure would be evident. The VAC for the study area is relatively low, and the combined effect over time of these developments would result in the study area being impacted upon in a moderate manner beyond the anticipated negative impacts of the proposed Project alone.

Table 11: Cumulative Impact		
Nature of Impact: The potential cumulative visual impact of the PV facility on the visual quality of the landscape.		
	Overall impact of the proposed project considered in isolation (With mitigation)	***Cumulative impact of the project and other projects within the area (with mitigation)***
Extent	Very short distance **(4)**	Medium to longer distance **(2)**
Duration	Long term **(4)**	Long term **(4)**
Magnitude	Moderate **(6)**	Moderate **(6)**
Probability	Probable **(3)**	Probable **(3)**
Significance	Moderate **(42)**	Moderate **(36)**
Status (positive, neutral or negative)	Negative	Negative
Reversibility	Reversible **(1)**	Reversible **(1)**
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Best practise measures can be implemented	

Generic best practise mitigation/management measures: Planning: ➢ Retain/re-establish and maintain natural vegetation (if present) immediately adjacent to the development footprint where possible. Operations: ➢ Maintain the general appearance of the facility as a whole. Decommissioning: ➢ Remove infrastructure not required for the post-decommissioning use. ➢ Rehabilitate all affected areas. Consult an ecologist regarding rehabilitation specifications.
Residual impacts: The visual impact will be removed after decommissioning, provided the PV facility infrastructure is removed. Failing this, the visual impact will remain.

7.5. Impact Statement

The findings of the Visual Impact Assessment undertaken for the proposed $14MW_{ac}$ PV facility is that the visual environment surrounding the site, especially within a 1 - 3km radius, may be visually impacted during the anticipated operational lifespan of the facility (i.e., a minimum of 25 years).

This impact is primarily applicable to the individual Harmony Central PV facility and the cumulative impact of the Project, and the existing infrastructure would be evident. The VAC for the study area is relatively low, and the combined effect over time of these developments would result in the study area being impacted upon in a moderate manner beyond the anticipated time frame of the proposed Project alone.

The following is a summary of impacts remaining, assuming mitigation as recommended, is exercised:

- During construction, there may be a noticeable increase in heavy vehicles utilising the roads to the development site that may cause, at the very least, a visual nuisance to other road users and landowners in the area. Construction activities may potentially result in high, temporary visual impact that may be mitigated to **low**.

- The PV facility is expected to have a **moderate** (to potentially **high**) visual impact on observers travelling along the R73 and adjacent secondary roads. There are no homesteads within a 1km radius of the operational PV facility structures. The facility would be highly visible from the Harmony Central Plant mining operation, but observers at this locality are associated with Harmony Gold and are assumed to be supportive of the development. The impacts may be contained to **Low** significance, if the proposed impact mitigation measures are implemented.

- The operational PV facility could have a **moderate** visual impact on observers (residents and road users) located between a 1 – 3km radius of the PV facility structures, both before and after the implementation of mitigation measures.

- The anticipated impact of lighting at the PV facility is likely to be of **moderate** significance and may be mitigated to **low**.

- The potential visual impact related to solar glint and glare as an air travel hazard is expected to be of **low** significance, due to the long distance in between the proposed PV facility and the airfield. No mitigation of this impact is required since the PV facility is not expected to interfere with aircraft operations at the airfield.

- The potential visual impact of solar glint and glare as a visual distraction and possible hazard to road users is expected to have a **low** (to potentially **moderate**) visual impact on observers travelling along the R73 and secondary road. These glint and glare impacts are mitigated if the PV panels are shielded from the surrounding area by means of planted vegetation cover, or solid fencing along the road servitude. If the PV panels are not exposed to road users (due to the project being screened from the road users) the impacts associated with glint and glare is expected to be of **low** (to no) significance.

- There are no homesteads located within a 1km radius of the proposed PV facility. The closest homestead is located 1,3km south-east of the facility (Saaiplaas settlement). The potential visual impact of solar glint and glare on static ground-based receptors (residents of homesteads) in closer proximity to the PV facility is therefore expected to be of **low** significance.

- The anticipated visual impact resulting from the construction of on-site ancillary infrastructure is likely to be of **low** significance both before and after mitigation.

- The anticipated visual impact of the proposed PV facility on the regional visual quality, and by implication, on the sense of place, is difficult to quantify, but is generally expected to be of **low** significance. This is due to the relatively low viewer incidence within close proximity to the proposed development site and the presence of existing mining and industrial activities within the region.

- The anticipated cumulative visual impact of the proposed Harmony Solar PV facility is expected to be of **low** significance.

The anticipated visual impacts listed above (i.e., post mitigation impacts) range from **moderate** to **low** significance. **<u>Anticipated visual impacts on sensitive visual receptors (if and where present) in close proximity to the proposed facility are not considered to be fatal flaws for the proposed PV facility.</u>**

Considering all factors, it is recommended that the development of the facility as proposed be supported; subject to the implementation of the recommended mitigation measures (**Section 7.4.**) and management programme (**Section 8.9.**).

Table 12: Intensity of impact of the proposed Project

High	**Moderate**	**Low**	**Negligible**
No areas	Sections of the R73, Boundary Road, the local road south of the site as wellas farmsteads to the immediate south and east of the site that are less than 3km away.	Farmsteads, over 3,0kmnorth, east, west, and south of the Project site	The remainder of the study area including most of the open areas and farms
Major loss of or alteration to key elements / features / characteristics of the baseline in the immediate vicinity of the site. i.e. Pre-development landscape or view and / or introduction of elements considered to beuncharacteristic when set within the attributes of the receiving landscape. **High scenic quality impacts would result.**	Partial loss of or alteration to key elements / features / characteristics of the baseline. i.e. Pre-developmentlandscape or view and / or introduction of elements that may be prominent but maynot necessarily be substantially problematicwhen set within the attributesof the receiving landscape. **Moderate scenic quality impacts would result**	Minor loss of or alterationto key elements / features / characteristics of thebaseline. i.e. Pre-development landscape or view and / orintroduction of elementsthat may not be problematic when setwithin the attributes of the receiving landscape. **Low scenic quality impacts would result.**	Very minor loss or alteration to key elements / features / characteristics of the baseline. i.e. Pre-development landscape or view and / or introduction of elements that is not problematic with the surrounding landscape approximating the ‘no change’ situation. **Negligible scenic quality impacts would result.**

8. MITIGATION AND MANAGEMENT MEASURES

In considering mitigation measures three rules are considered - the measures should be feasible (economically), effective (how long will it take to implement and what provision is made for management / maintenance), and acceptable (within the framework of the existing landscape and land use policies for the area). To address these, the following principles have been established:

- Mitigation measures should be designed to suit the existing landscape character and needs of the locality.
- They should respect and build upon landscape distinctiveness.
- It should be recognized that many mitigation measures, especially the establishment of planted screens and rehabilitation, are not immediately effective.

The primary visual impact, namely the appearance of the Solar Energy Facility is not possible to mitigate. The functional design of the PV panels cannot be changed in order to reduce visual impacts. Mitigation is however possible if the recommended general actions are followed.

8.1. Preparatory Works and Construction Concerns

Mitigation of visual impacts associated with the construction phase, albeit temporary, would entail proper planning, management and rehabilitation of the construction site. Recommended mitigation measures include the following:

- Ensure that vegetation is not unnecessarily cleared or removed during the construction period.
- Reduce the construction period through careful logistical planning and productive implementation of resources.
- Plan the placement of lay-down areas and any potential temporary construction camps in order to minimise vegetation clearing (i.e., in already disturbed areas) wherever possible.
- Restrict the activities and movement of construction workers and vehicles to the immediate construction site and existing access roads.
- Ensure that rubble, litter, and disused construction materials are appropriately stored (if not removed daily) and then disposed regularly at licensed waste facilities.
- Reduce and control construction dust through the use of approved dust suppression techniques as and when required (i.e., whenever dust becomes apparent).
- Restrict construction activities to daylight hours in order to negate or reduce the visual impacts associated with lighting.
- Rehabilitate all disturbed areas, construction areas, roads, slopes, etc. immediately after the completion of construction works. If necessary, an ecologist should be consulted to assist or give input into rehabilitation specifications.
- With the preparation of the portions of land onto which activities will take place the minimum amount of existing vegetation and topsoil should be removed. Large trees should be saved were possible, specifically along the R73.
- Ensure, wherever possible, natural indigenous vegetation is retained and incorporated into the site rehabilitation.
- All topsoil that occurs within the proposed footprint of an activity must be removed and stockpiled for later use. The construction contract must include the stripping and stockpiling of topsoil. Topsoil would be used later during the rehabilitation phase of disturbed areas. The presence of degraded areas and disused construction roads, which are not rehabilitated, will increase the overall visual impact.
- Specifications with regards to the placement of construction camps, as well as a site plan of the construction camp, indicating waste areas, storage areas, and placement of ablution facilities should be included in the EMPr. These areas should either be screened or positioned in areas where they would be less visible from human settlements and main roads.
- Construction activities should be limited to between 08:00 and 17:00 or in conjunction with the ECO.
- Adopt responsible construction practices aimed at strictly containing the construction / establishment activities to specifically demarcated areas.

- Building or waste material discarded should be undertaken at an authorised location, which should not be within any sensitive areas.

8.2. Earthworks

- Earthworks should be executed in such a way that only the footprint and a small 'construction buffer zone' around the proposed activities are exposed. In all other areas, the naturally occurring vegetation should be retained, especially along the periphery of the sites.
- All cut and fill slopes (if any) and areas affected by construction work should be progressively top soiled and re-vegetated as soon as possible.
- Any soil must be exposed for the minimum time possible once cleared of vegetation to avoid prolonged exposure to wind and water erosion and to minimise dust generation.

8.3. Landscaping and Ecological Approach

- It is recommended that the existing vegetation cover be maintained / established in all areas outside of the actual development footprint, both during construction and operation of the proposed facility. This will minimise visual impact as a result of cleared areas, power line servitudes and areas denuded of vegetation.
- Where new vegetation is proposed to be introduced to the site, an ecological approach to rehabilitation as opposed to a horticultural approach should be adopted. For example, communities of indigenous plants will enhance biodiversity, a desirable outcome for the area. This approach can significantly reduce long-term costs as less maintenance would be required over conventional landscaping methods as well as the introduced landscape being more sustainable.
- Progressive rehabilitation of all construction areas should be carried out immediately after they have been established.
- Undertake planting of screening vegetation along the eastern and southern boundaries of the Project sites.

8.4. Mounting Structures and Associated Infrastructure

- Paint the mounting structures with colours that reflect and compliment the colours of the surrounding landscape.
- Ensure the perimeter fence is of a 'see through' variety and that its colour blends with the environment.

8.5. Good housekeeping

- "Housekeeping" procedures should be developed for the Project to ensure that the Project site and lands adjacent to the Project site are kept clean of debris, garbage, graffiti, fugitive trash, or waste generated onsite; procedures should extend to control "track out" of dirt on vehicles leaving the active construction site and controlling sediment in stormwater runoff.
- During construction, temporary fences surrounding the material storage yards and laydown areas should be covered with 'shack' cloth (khaki coloured).
- Operating facilities should be actively maintained during operation.

8.6. Operation Phase

- During operation, the maintenance of the PV panels, ancillary structures and infrastructure will ensure that the facility does not degrade, preventing aggravation of the visual impact. Roads must be maintained to forego erosion and to suppress dust, and rehabilitated areas must be monitored for rehabilitation failure. Remedial actions must be implemented as and when required. Once the facility has exhausted its life span, the main facility and all associated infrastructure not required for the post rehabilitation use of the site should be removed and all disturbed areas appropriately rehabilitated. An ecologist should be consulted to give input into rehabilitation specifications. All rehabilitated areas should be monitored for at least a year following decommissioning, and remedial actions implemented as and when required. Where sensitive visual receptors are likely affected, it is recommended that the developer enter negotiations regarding the potential screening of visual impacts, either at the receptor site or along the perimeter of the facility. This may entail the planting of vegetation or the construction of landscaped berms or screens.

8.7. Lighting

Light pollution is largely the result of bad lighting design, which allows artificial light to shine outward and upward into the sky, where it is not wanted, instead of focusing the light downward, where it is needed. Ill- designed lighting washes out the darkness of the night sky and radically alters the light levels in rural areas where light sources shine as 'beacons' against the dark sky and are generally not wanted.

Of all the pollutions faced, light pollution is perhaps the most easily remedied. Simple changes in lighting design and installation yield immediate changes in the amount of light spilled into the atmosphere. The following are measures that must be considered in the lighting design of the Project, particularly at the management and service platforms:

Mitigation measures include the following:

- Shielding the sources of light by physical barriers (walls, vegetation, or the structure itself);
- Limiting mounting heights of lighting fixtures, or alternatively using foot-lights or bollard level lights;
- Making use of downward directional lighting fixtures;
- Making use of minimum lumen or wattage in fixtures;
- Making use of down-lighters, or shielded fixtures;
- Making use of Low Pressure Sodium lighting or other types of low impact lighting.
- Making use of motion detectors on security lighting. This will allow the site to remain in relative darkness, until lighting is required for security or maintenance purposes.

In terms of ancillary infrastructure, it is recommended that access roads and other on-site infrastructure be planned so that the clearing of vegetation is minimised. Consolidate infrastructure as much as possible and make use of already disturbed areas rather than pristine sites, wherever possible. Mitigation of lighting impacts includes the pro-active design, planning and specification lighting for the facility. The correct specification and placement of lighting and light fixtures for the proposed Solar Energy Facility and ancillary infrastructure will go far to contain rather than spread the light.

8.8. Branding and Marketing

The applicants may wish to give consideration, where appropriate, to the development and installation of viewing areas, interpretation panels, visitor, or educational facilities as part of the development proposal. This may appeal to tourists visiting the area who may be curious about renewable energy projects.

8.9. Management Programme

The following management plan tables aim to summarise the key findings of the visual impact report and suggest possible management actions in order to mitigate the potential visual impacts. Refer to the tables below.

Table 13: Management programme – Planning.

Objective	**The mitigation and possible negation of visual impacts associated with the planning of the proposed PV facility.**	
Project Component/s	The solar energy facility and ancillary infrastructure (i.e., PV panels, access roads, transformers, security lighting, workshop, power line, etc.).	
Potential Impact	Primary visual impact of the facility due to the presence of the PV panels and associated infrastructure as well as the visual impact of lighting at night.	
Activity/Risk Source	The viewing of the above mentioned by observers on or near the site (i.e., within 1km of the site) as well as within the region.	
Mitigation: Target/Objective	Optimal planning of infrastructure to minimise the visual impact.	
Mitigation: Action/control	**Responsibility**	**Timeframe**
Plan the placement of laydown areas and temporary construction equipment camps in order to minimise	Project proponent / contractor	Early in the planning phase.

vegetation clearing (i.e., in already disturbed areas) wherever possible.		
Retain and maintain natural vegetation (if present) immediately adjacent to the development footprint.	Project proponent/ design consultant	Early in the planning phase.
Make use of existing roads wherever possible and plan the layout and construction of roads and infrastructure with due cognisance of the topography to limit cut and fill requirements.	Project proponent/ design consultant	Early in the planning phase.
Plan all roads, ancillary buildings and ancillary infrastructure in such a way that clearing of vegetation is minimised. Consolidate infrastructure and make use of already disturbed sites rather than undisturbed areas.	Project proponent/ design consultant	Early in the planning phase.
Consult a lighting engineer in the design and planning of lighting to ensure the correct specification and placement of lighting and light fixtures for the PV Facility and the ancillary infrastructure. The following is recommended: o Shield the sources of light by physical barriers (walls, vegetation, or the structure itself). o Limit mounting heights of fixtures, or use foot-lights or bollard lights. o Make use of minimum lumen or wattage in fixtures. o Making use of down-lighters or shielded fixtures. o Make use of Low Pressure Sodium lighting or other low impact lighting. o Make use of motion detectors on security lighting, so allowing the site to remain in darkness until lighting is required for security or maintenance purposes.	Project proponent / design consultant	Early in the planning phase.

Performance Indicator	Minimal exposure (limited or no complaints from I&APs) of ancillary infrastructure and lighting at night to observers on or near the site (i.e. within 3km) and within the region.
Monitoring	Monitor the resolution of complaints on an ongoing basis (i.e. during all phases of the project).

Table 14: Management programme – Construction.

Objective	The mitigation and possible negation of visual impacts associated with the construction of the proposed Central PV facility.
Project Component/s	Construction site and activities
Potential Impact	Visual impact of general construction activities, and the potential scarring of the landscape due to vegetation clearing and resulting erosion.
Activity/Risk Source	The viewing of the above mentioned by observers on or near the site.

Mitigation: Target/Objective	Minimal visual intrusion by construction activities and intact vegetation cover outside of immediate construction work areas.	
Mitigation: Action/control	**Responsibility**	**Timeframe**
Ensure that vegetation cover adjacent to the development footprint (if present) is not unnecessarily removed during the construction phase, where possible.	Project proponent / contractor	Early in the construction phase.
Reduce the construction phase through careful logistical planning and productive implementation of resources wherever possible.	Project proponent / contractor	Early in the construction phase.
Restrict the activities and movement of construction workers and vehicles to the immediate construction site and existing access roads.	Project proponent / contractor	Throughout the construction phase.
Ensure that rubble, litter, and disused construction materials are appropriately stored (if not removed daily) and then disposed regularly at licensed waste facilities.	Project proponent / contractor	Throughout the construction phase.
Reduce and control construction dust through the use of approved dust suppression techniques as and when required (i.e. whenever dust becomes apparent).	Project proponent / contractor	Throughout the construction phase.
Restrict construction activities to daylight hours in order to negate or reduce the visual impacts associated with lighting, where possible.	Project proponent / contractor	Throughout the construction phase.
Rehabilitate all disturbed areas (if present/if required) immediately after the completion of construction works.	Project proponent / contractor	Throughout and at the end of the construction phase.
Performance Indicator	Vegetation cover on and in the vicinity of the site is intact (i.e. full cover as per natural vegetation present within the environment) with no evidence of degradation or erosion.	
Monitoring	Monitoring of vegetation clearing during construction (by contractor as part of construction contract). Monitoring of rehabilitated areas quarterly for at least a year following the end of construction (by contractor as part of construction contract).	

Table 15: Management programme – Operation.

Objective	The mitigation and possible negation of visual impacts associated with the operation of the proposed Central PV facility.	
Project Component/s	The solar energy facility and ancillary infrastructure (i.e. PV panels, access roads, workshop, etc.).	
Potential Impact	Visual impact of facility degradation and vegetation rehabilitation failure.	
Activity/Risk Source	The viewing of the above mentioned by observers on or near the site.	
Mitigation: Target/Objective	Well maintained and neat facility.	
Mitigation: Action/control	**Responsibility**	**Timeframe**
If specific sensitive visual receptors are identified during operation, investigate screening at the receptor site.	Project proponent / operator	Throughout the operation phase.

Investigate the potential to screen the PV facility from the Secunda secondary road (located within 1km of the facility) with planted vegetation cover or solid fencing, where possible/if required.	Project proponent / operator	Throughout the operation phase.
Maintain the general appearance of the facility as a whole, including the PV panels, servitudes and the ancillary structures.	Project proponent / operator	Throughout the operation phase.
Maintain roads and servitudes to forego erosion and to suppress dust.	Project proponent / operator	Throughout the operation phase.
Monitor rehabilitated areas, and implement remedial action as and when required.	Project proponent / operator	Throughout the operation phase.
Investigate and implement (should it be required) the potential to screen visual impacts at affected receptor sites.	Project proponent / operator	Throughout the operation phase.
Performance Indicator	Well maintained and neat facility with intact vegetation on and in the vicinity of the facility.	
Monitoring	Monitoring of the entire site on an ongoing basis (by operator).	

Table 16: Management programme – Decommissioning.

Objective	The mitigation and possible negation of visual impacts associated with the decommissioning of the proposed Central PV facility.	
Project Component/s	The solar energy facility and ancillary infrastructure (i.e. PV panels, access roads, workshop, transformers, etc.).	
Potential Impact	Visual impact of residual visual scarring and vegetation rehabilitation failure.	
Activity/Risk Source	The viewing of the above mentioned by observers on or near the site.	
Mitigation: Target/Objective	Only the infrastructure required for post decommissioning use of the site retained and rehabilitated vegetation in all disturbed areas.	
Mitigation: Action/control	**Responsibility**	**Timeframe**
Remove infrastructure not required for the post-decommissioning use of the site.	Project proponent / operator	During the decommissioning phase.
Rehabilitate access roads and servitudes not required for the post-decommissioning use of the site. If necessary, an ecologist should be consulted to give input into rehabilitation specifications.	Project proponent / operator	During the decommissioning phase.
Monitor rehabilitated areas quarterly for at least a year following decommissioning, and implement remedial action as and when required.	Project proponent / operator	Post decommissioning.
Performance Indicator	Vegetation cover on and in the vicinity of the site is intact (i.e. full cover as per natural vegetation within the environment) with no evidence of degradation or erosion.	
Monitoring	Monitoring of rehabilitated areas quarterly for at least a year following decommissioning.	

9. CONCLUSION

The proposed Solar Energy Facility utilises a renewable source of energy to generate power. It does not emit any harmful by-products or pollutants and is not negatively associated with health risks to observers. It is therefore perceived to be accepted in a more favourable light by visual receptors.

The facility has a generally unfamiliar novel and futuristic design that invokes a curiosity factor not generally present with other conventional power generating plants, to the effect that people may actually visit the area to see the facility. A number of mitigation measures have been proposed (Section 8), which, if implemented and maintained, will reduce the significance of certain visual impacts associated with the proposed facility.

The existing visual condition of the landscape that may be affected by the proposed Project has been described. The study areas scenic quality has been rated moderate within the context of the sub-region, sensitive viewing areas and landscape types identified and mapped indicating potential sensitivity to the Project. The site itself is in a landscape type rated as moderate.

Visual impacts will be caused by activities associated with the Harmony Central Project. The significance of visual impact is based on the worst-case scenario. This scenario assumes that all facilities along with the associated grid infrastructure and sub-stations would be constructed at the same time. At the time of writing there was no evidence to the contrary. This assumption is also based on the nature of the visual impact and the fact that receptors would experience all facilities in the same visual envelope from their respective locations or as they travel along adjacent roads.

Impacts on views are the highest when viewers are identified as being sensitive to change in the landscape, and their views are focused on and dominated by the change. The visual impact of the Project will cause changes in the landscape that are noticeable to viewers experiencing the study area from the R73, Boundary Road, local roads to the west and south of the site, and homesteads also in this general area.

Visual impacts that would potentially result from Project activities are likely to be moderately adverse, long-term, and will most likely cause loss of landscape and visual resources. If mitigation is undertaken as recommended, it is concluded that the significance of anticipated visual impacts will remain at acceptable levels. As such, the facility and the proposed ancillary infrastructure would be considered to be acceptable from a visual perspective.

The cause of these anticipated visual impacts would be:

Construction Phase:

- Removal of vegetation, the building of access roads, earthworks, and exposure of earth to establish the areas to be developed.
- Physical presence of construction camps and the movement of construction vehicles within the site and along local roads.
- Generation of dust by construction activities.

Operational Phase

- Physical presence of the solar arrays and a minor potential of glint and glare.
- Reduction in the rural sense of place for the study area.
- Light pollution.

Decommissioning Phase

- Physical presence of the activities associated with removing the structures and rehabilitating the site.

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SOCIAL IMPACT REPORT

CENTRAL
BASIC ASSESSMENT
JULY 2022

SOCIAL IMPACT REPORT

Savannah Environmental, Free State

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Reference: Eco Thunder Consulting (2022) Social Impact Assessment for Harmony Central Plant

ACRONYMS, ABBREVIATIONS AND GLOSSARY

Acronyms & Abbreviations	
DESTEA	Free State Department of Economic, Small Enterprise, Tourism and Environmental Affairs
DoE	Department of Energy
DM	District Municipality
EA	Environmental Authorisation
EIA	Environmental Impact Assessment
EMPr	Environmental Management Programme
GDP	Gross Domestic Product
GNR	Government Notice
I&AP	Interested and Affected Party
IDP	Integrated Development Plan
IEP	Integrated Energy Plan
IRP	Integrated Resource Plan
km	Kilometre
LM	Local Municipality
NEMA	National Environmental Management Act (No. 107 of 1998)
NDP	National Development Plan
O&M	Operation and Maintenance
PGDS	Provincial Growth and Development Strategy
PICC	Presidential Infrastructure Coordinating Committee
PSDF	Provincial Spatial Development Framework
SDF	Spatial Development Framework
SIA	Social Impact Assessment
SIP	Strategic Infrastructure Project
DESTEA	Free State Department of Economic, Small Enterprise, Tourism and Environmental Affairs
DoE	Department of Energy
DM	District Municipality
EA	Environmental Authorisation
EIA	Environmental Impact Assessment
EMPr	Environmental Management Programme
GDP	Gross Domestic Product
GNR	Government Notice
I&AP	Interested and Affected Party

EXECUTIVE SUMMARY

DESCRIPTION OF PROPOSED PHOTOVOLTAIC FACILITY

Harmony Gold is looking to supplement its energy supply by implementing Photovoltaic (PV) generation, aiding their transition to a more sustainable and environmentally friendly energy mix. In this regard, Harmony Central Plant is based near Harmony Gold Central Plant operations approximately located ~6km north-east of the town of Virginia and ~11km south-east of the town of Welkom within the Matjhabeng Local Municipality and within the Lejweleputswa District Municipality, Free State Province.

The project entails the development of a Solar PV Energy Facility with a capacity of up to14MW. A development site of up to 165ha for Central Solar PV has been identified, of which approximately 33.6ha will be utilized for the project footprint.

The project will be known as Harmony Central Plant Solar PV, the facility will include a grid connection and other associated infrastructure proposed by HARMONY GOLD MINING CO (LTD).

The details on the PV Facility and grid connection infrastructure are listed below:
PV Facility:

Farm Name	Portion Number
SAAIPLAAS 771	12
RUSTGEVONDEN 564	1

Grid connection infrastructure

The projects will tie-in to the Harmony North (6.6/44kV) substation. The overhead lines will have a capacity of up to 132kV.

The onsite infrastructure will include:

- Solar PV array comprising bifacial PV modules and mounting structures, using single axis tracking technology. Once installed will stand up to 5m above ground level.
- Inverters and transformers a SCADA room, and maintenance room.
- Cabling between the project components.
- Balance of Plant:
    - Existing spare switchgear panels upgraded switchgear circuit breakers or additional switchgear panels.
    - EK self-build works as defined in the CEL.
- On-site facility substation to facilitate the connection between the solar PV facility and Eskom electricity grid. The Size and Capacity of each of the on-site stations will be 40MW, 20MW, 40MW respectively.
- An onsite Medium voltage (MV) switching station forming part of the collector substation
- Temporary Laydown areas.
- Access roads, internal roads and fencing around the development area.
- Up to 132kV Overhead Power Lines (OHPL) – maximum of 30m height with a 30m servitude width.
- Underground LV cabling will be used on the PV site.

As of 2019, the Industrial sector was the leading electricity consumer in South Africa, with up to 56 percent of the total consumption (*Ratshomo 2019*). Mining and quarrying accounted for 10% of the industrial consumption while non-ferrous metals and non-metallic both accounted for 8% and 5%, respectively (*Chamber of Mines of South Africa, 2017*).

The successful development of the renewable energy projects will enable Harmony Gold to make a valuable and meaningful contribution towards growing the green economy within the province and South Africa. This will assist the Free State in creating green jobs and reducing Green House Gas emissions, whilst reducing the energy demand on the National Grid.

APPROACH TO THE STUDY

The approach to the SIA study is based on the Western Cape Department of Environmental Affairs and Development Planning Guidelines for Social Impact Assessment (*February 2007*). These guidelines are based on international best practice. The key activities in the SIA process embodied in the guidelines include:

- Describing and obtaining an understanding of the proposed intervention (type, scale, location), the settlements and communities likely to be affected by the proposed project.
- Collecting baseline data on the current social and economic environment.
- Identifying the key potential social issues associated with the proposed project.
- Assessing and documenting the significance of social impacts associated with the proposed intervention.
- Identifying alternatives and mitigation measures.

The study therefore involved:

- Review of demographic data from Census Survey and other available sources.
- Review of relevant planning and policy framework for the area.
- Review of information from similar studies.
- Review of documented government experience and expectations associated with solar energy projects.
- Community survey involving 94 local community members as respondents.

KEY FINDINGS

On aggregate, the project will have a positive social impact. Based on an assessment of needs as expressed through policies, plans and community survey, it is clear that the local economy requires a catalyst for growth and development. Similarly, the national economy requires new power generation facilities that can increase electricity supply for economic growth without damaging the environment. A solar power plant addresses all these needs. More specifically, this power plant will contribute to the following positive outcomes:

- Job creation
- Enterprise growth
- Socio-economic development
- Local economic growth through enterprise development

FIT WITH POLICY AND PLANNING

The following policy and planning documents were referred to in determining the validity of the proposed facility and its potential impact at all levels: local, provincial, and national.

- National Energy Act (No. 34 of 2008)
- National White Paper on Renewable Energy (2003)
- National Integrated Resource Plan for Electricity (2010, 2013 draft)
- Renewable Energy Independent Power Producer Programme RFP (2015)
- National Development Plan (2013)
- Free State Provincial Growth And Development Strategy (NCPSDF) (Aug 2012)
- Regional Sector Skills Plan, Free State and Free State Region (Sep 2013)
- Provincial Renewable Energy Strategy (2015)
- Lejweleputswa District Municipality Integrated Development Plan 2022
- Matjabeng Local Municipality Integrated Development Plan 2022/2021

TABLE OF CONTENTS

ACRONYMS, ABBREVIATIONS AND GLOSSARY i

EXECUTIVE SUMMARY ii

DESCRIPTION OF PROPOSED PHOTOVOLTAIC FACILITY ii

APPROACH TO THE STUDY iii

KEY FINDINGS iii

FIT WITH POLICY AND PLANNING iii

TABLE OF CONTENTS iv

TABLE OF FIGURES vi

TABLE OF TABLES vi

1. INTRODUCTION 1

1.1. Terms of Reference 1

1.2. Specialist Details 1

1.3. Report Structure 1

1.4. Project Description 2

1.5. Project Location 2

2. METHOLODGY AND APPROACH 5

2.1. Purpose of the Study 5

2.2. Approach to Study 5

2.2.1. Definition of Social Impacts 6

2.2.2. Timing of Social Impact 7

2.3. Assumptions and Limitations 7

2.3.1. Assumptions 7

2.3.2. Limitations 7

2.4. Assessment Criteria 7

3. POLICY AND PLANNING 9

3.1. National Planning and Policies 9

3.1.1. Constitution of South Africa 9

3.1.2. The National White Paper on Renewable Energy 9

3.1.3. National Energy Act 10

3.1.4. Integrated Resource Plan for Electricity 10

3.1.5. National Development Plan 10

3.2. Provincial Planning and Policy 10

3.2.1. Free State Provincial Growth and Development Strategy (FSGDS) (2005 – 2014) 10

3.2.2. Free State Provincial Growth and Development Strategy (FSGDS), Revised October 2007 10

3.2.3. Free State Provincial Spatial Development Framework (PSDF) - Executive Summary 11

3.2.4. Free State Investment Prospectus (2019) 11

3.3. District Level Planning and Policies 11

3.3.1. Lejweleputswa District Municipality Integrated Development Plan (IDP) 2020/2021 11

3.3.2. Matjhabeng Local Municipality Integrated Development Plan IDP (2020 – 2021) 12

3.4. Conclusion 12

4. OVERVIEW OF THE STUDY AREA 13

4.1. Overview of Study Area 13

4.2. Administrative Context of Study Area 16
4.3. Provincial Socio-Economic Context 16
4.3.1. Population 17
4.3.2. Economy 19
4.3.3. Employment 20
4.3.4. Human Development 20
4.3.5. Education 20
4.3.6. Income and poverty 21
4.4. Lejweleputswa District Municipality 21
4.4.1. Population 22
4.4.2. Economy 22
4.4.3. Employment 23
4.4.4. Education 23
4.4.5. Income and poverty 24
4.5. Matjhabeng Local Municipality 24
4.5.1. Population 24
4.5.2. Economy 25
4.5.3. Employment 25
4.5.4. Education 26
4.5.5. Income and poverty 26
5. ASSESSMENT OF KEY SOCIAL ISSUES AND IMPACT 27
5.1. Introduction 27
5.2. Identification of Key Social Issues 27
5.3. Social Impacts Associated with the Construction Phase 27
5.4. Social Issues Associated with the Operation Phase 36
5.4.1. Creation of Employment and Business Opportunities 36
5.4.2. Benefits Associated with the Additional Funding 38
5.5. Social Issues Associated with the Decommissioning Phase 40
5.6. Social Issues Associated with the No-Development Option 41
5.7. Social Issues Associated with the Cumulative Impact on Sense of Place 42
6. CONCLUSIONS AND IMPACT STATEMENT 45
6.1. Conclusions and Recommendations 45
6.2. Key findings 46
6.3. Conclusion 47
7. REFERENCES AND SOURCES 48
WEBSITES 48
FURTHER SOURCES 48
8. Appendix A: SIA ENVIRONMENTAL MANAGEMENT PROGRAMME (EMPRr) 49
Appendix B: Key Stakeholders Contacted and Meeting Scheduled 55

TABLE OF FIGURES

Figure 1: Map of project site and surrounding REIPPPP projects (Source: EnergyBlog, accessed 08/07/2022) 3
Figure 2: The proposed site and 10km radius of the Harmony Central PV Facility 4
Figure 3A: Location of the site within the main study area, within the Free State Province 14
Figure 3B: Location of the site within the main study area, within the Free State Province 15
Figure 4: Location of Lejweleputswa District Municipality (left) and Matjhabeng Local Municipality (right) within the Free State Province 16
Figure 5: Map showing the districts of the Free State Province (Source: www.municipalities.co.za). 17
Figure 6: Population pyramid of the study area 18
Figure 7: Poverty Within the District Municipality 21
Figure 8: Local Municipalities of Lejweleputswa District Municipality Source: (Local Government Handbook, 2015) 22
Figure 9: Predicted population growth 2009 -2019 22
Figure 10: District municipality Economic Sector 23
Figure 11: Contribution of the municipality to the GVA 25
Figure 12: Average income in Matjabeng municipality 26

TABLE OF TABLES

Table 1: Spatial Context of the study area for the development of the Harmony Central Solar PV 16
Table 2: Population Structure of the District municipality 18
Table 3: GDP per sector from 2014 -2020 for the Free State Province 19
Table 4: Education per Free State District 21
Table 5: Overview of the population in the Study area 24
Table 6: Overview of Employment Statistics in the study area 25
Table 7: Overview of Education in the study area 26
Table 8.1- Creation of employment and business opportunities during the construction phase 28
Table 8.2 - Potential harmful impacts on family structures and social networks associated with the presence of non-local and foreign construction workers in the project surrounding local communities and towns 29
Table 8.3- Potential impact on local employment associated the construction phase 31
Table 8.4- Potential impact on local farmers associated with Increased risk of stock theft, poaching and damage to farm infrastructure 32
Table 8.5- Potential impact on safety of local developments 33
Table 8.6- Potential impact on veld fires due to construction phase 34
Table 8.7- Potential impact on local communities and infrastructure associated with vehicle movements during construction phase 35
Table 8.8- Creation of employment and business opportunities during the Operations phase 36
Table 8.9 – Development of infrastructure to improve energy security and support renewable sector 37
Table 8.10- Potential impact on community owing to Economic development 38
Table 8.11- Potential impact on community owing to Economic development 39
Table 8.12: Social impacts associated with retrenchment including loss of jobs, and source of income 40
Table 8.13- The no-development option would result in the lost opportunity for South Africa to supplement is current energy needs with renewable energy. 41
Table 8.14: Impact on Sense of place 43
Table 8.15: Impact on Local services 43
Table 8.16: Impact on Local Economy 44
Table 9.4: Summary of potential social impacts identified for the detailed design and construction phase 45
Table 9.5: Summary of potential social impacts identified for the operation phase 45

1. INTRODUCTION

Eco-Thunder Consulting was commissioned by Savannah Environmental (Pty) Ltd as the lead consultant to manage the Social Impact Assessment (SIA) process for the establishment of the proposed Central Plant Solar PV Facility near Virginia in the Free State Province.

This report contains the findings of the SIA undertaken as part of the broader Environmental Impact Assessment (EIA) process.

1.1. Terms of Reference

Objective of the Basic Assessment Process

This SIA Report has been prepared as part of the Basic Assessment (BA) process being undertaken for Harmony Central Solar PV Facility and associated infrastructure. The purpose of this SIA Report is to provide details on the nature and extent of development of Harmony Central Solar PV Facility and associated infrastructure, and the potential social impacts associated with the construction, operation, and decommissioning of the project. The inputs contained within this SIA Report are intended to provide a high-level overview of the social environment within which the project is proposed and identify potential social issues which will be addressed in detail as part of the BA process specialist investigations.

The objective of this SIA Report is therefore to:

- Identify and review policies and legislation which may have relevance to the activity from a social perspective.
- Provide comment on the need and desirability of the proposed activity from a social perspective.
- Identify potential impacts and risks associated with the preferred activity and technology alternatives.
- Identify key social issues to be addressed in the BA phase.
- Agree on the level of assessment to be undertaken, including the methodology to be applied to determine the impacts and risks the activity will impose on the preferred site through the life of the activity, including the nature, significance, consequence, extent, duration and probability of the impacts to inform the location of the development footprint within the preferred site.
- Identify suitable measures to avoid, manage or mitigate identified social impacts and determine the extent of residual risks that need to be managed and monitored.

1.2. Specialist Details

Eco–Thunder Consulting (ETC) is a 100% woman-owned, private company that specializes in a range of specialist studies, such as socio-economic research, economic development planning, development program design and implementation as well as community trust management. Based in Johannesburg, South Africa, Eco-Thunder has established itself as an expert on the conditions, needs and assets of communities that are linked to independent power generation facilities.

ETC has conducted research on behalf of and advised IPPs since 2017. Its client base is thus comprised of IPPs that have been successful across all the REIPPPP bidding rounds. ETC also implements development programs in energy communities, which ensures a comprehensive understanding of the how to drive positive social impact.

1.3. Report Structure

The report is organised into six sections:

- Section 1: Introduction.
- Section 2: Methodology & Approach.
- Section 3: Policy and Planning Review.
- Section 3: Overview of the Study Area.
- Section 5: Assessment of Key Social Issues and Impact.
- Section 6: Conclusions and Impact Statement.

1.4. Project Description

Harmony Gold is looking to supplement its energy supply by implementing Photovoltaic (PV) generation, aiding their transition to a more sustainable and environmentally friendly energy mix.

The project entails the development of a Solar PV Energy Facility with a capacity of up to14MW. A development site of up to 165ha for Central Solar PV has been identified, of which approximately 33.6ha will be utilized for the project footprint.

The project will be known as Harmony Central Plant Solar PV, the facility will include a grid connection and other associated infrastructure proposed by HARMONY GOLD MINING CO (LTD).

The details on the PV Facility and grid connection infrastructure are listed below:
PV Facility:

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RUSTGEVONDEN 564	1

Grid connection infrastructure
The projects will tie-in to the Harmony North (6.6/44kV) substation. The overhead lines will have a capacity of up to 132kV.

Infrastructure associated with each solar PV facility will include the following:

- Solar PV array comprising bifacial PV modules and mounting structures, using single axis tracking technology. Once installed will stand up to 5m above ground level.
- Inverters and transformers a SCADA room, and maintenance room.
- Cabling between the project components.
- Balance of Plant:
  - Existing spare switchgear panels upgraded switchgear circuit breakers or additional switchgear panels.
  - EK self-build works as defined in the CEL.
- On-site facility substation to facilitate the connection between the solar PV facility and Eskom electricity grid. The Size and Capacity of each of the on-site stations will be 40MW, 20MW, 40MW respectively.
- An onsite Medium voltage (MV) switching station forming part of the collector substation.
- Temporary Laydown areas.
- Access roads, internal roads and fencing around the development area.
- Up to 132kV Overhead Power Lines (OHPL) – maximum of 30m height with a 30m servitude width
- Underground LV cabling will be used on the PV site.

As of 2019, the Industrial sector was the leading electricity consumer in South Africa, with up to 56 percent of the total consumption (*Ratshomo 2019*). Mining and quarrying accounted for 10% of the industrial consumption while non-ferrous metals and non-metallic both accounted for 8% and 5%, respectively (*Chamber of Mines of South Africa, 2017*).

The successful development of the renewable energy projects will enable Harmony Gold to make a valuable and meaningful contribution towards growing the green economy within the province and South Africa. This will assist the Free State in creating green jobs and reducing Green House Gas emissions, whilst reducing the energy demand on the National Grid.

1.5. Project Location

The proposed 14MW Central Solar Energy Facility (SEF) is located on Farm Saaiplaas 771, portion 12 and Farm Rustgevonden 564, portion 1. The development is located near Harmony Gold Central Plant operations approximately ~6km north-east of the town of Virginia and ~11km south-east of the town of Welkom within the Matjhabeng Local Municipality and within the Lejweleputswa District Municipality, Free State Province.

The project area is predominately mining development and industrial activities. Other dominant land uses in the project area include the R730 road with predominantly maize and wheat farming in the surrounding area. The area is predominantly characterised as transformed by the Harmony Gold mining activities in the area

The regional topography of the Northern Free State can be described as relatively flat, with rolling plains and low hills extending into the Welkom area. The rolling plain elevations range from 1 260 meters above mean sea level (amsl) to 1 460 metres amsl. The general slope of the terrain ranges from 1:250 to 1:100.

The Matjhabeng Local Municipality incorporates Welkom, Odendaalsrus, Virginia, Hennenman, Allanridge and Ventersburg with a combined population of 406 461 people. The economy of the Matjhabeng Municipality area centers around the mining activities located in and around Allanridge, Odendaalsrus, Welkom and Virginia.

Manufacturing associated with the mining sector exists to a limited extent in the towns mentioned above. Other manufacturing activities are limited. In terms of economic contribution, the Matjhabeng Local Municipality is the most important Local Municipality in the district. The Matjhabeng Local Municipality accounts for almost 72% of the district's economic output. In terms of future economic development, there is likely to be a decline in the role played by mining, which will also impact negatively on employment in the Free State Province.

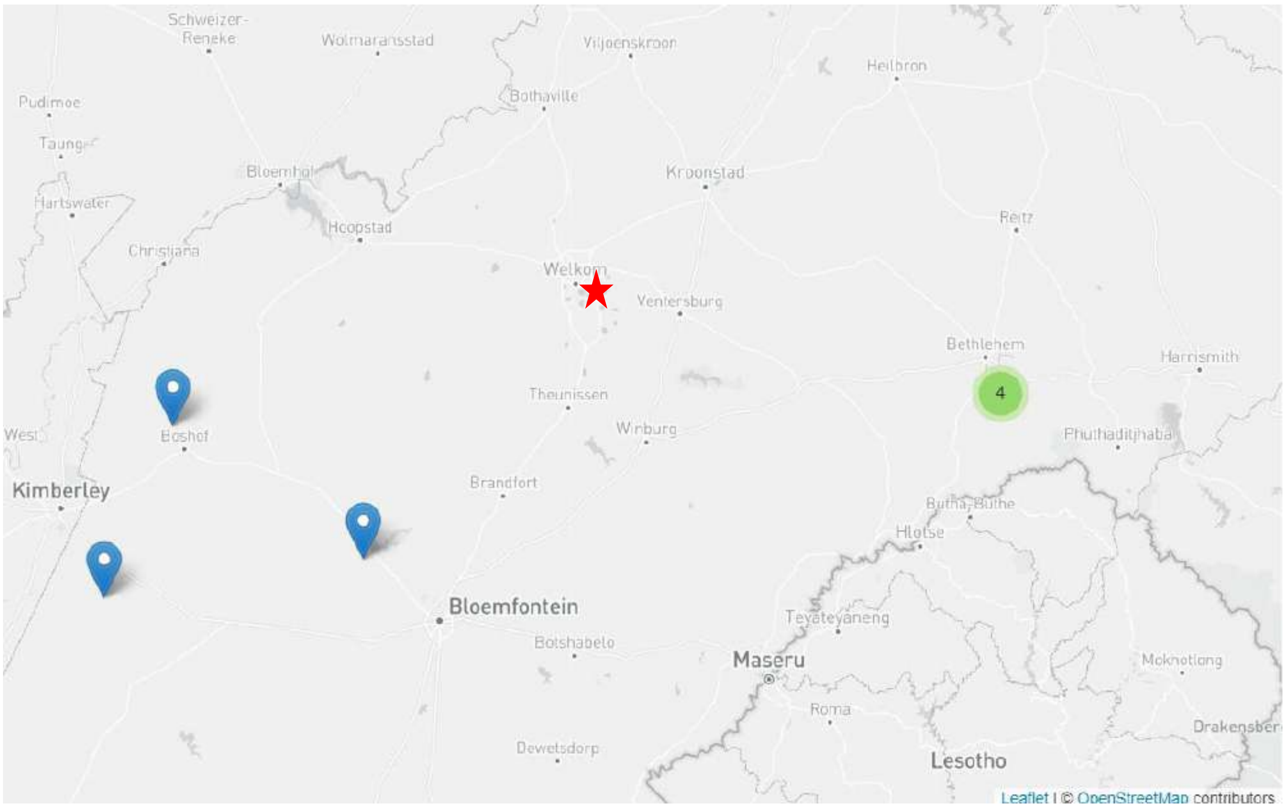

Figure 1: Map of project site and surrounding REIPPPP projects (Source: EnergyBlog, accessed 08/07/2022)

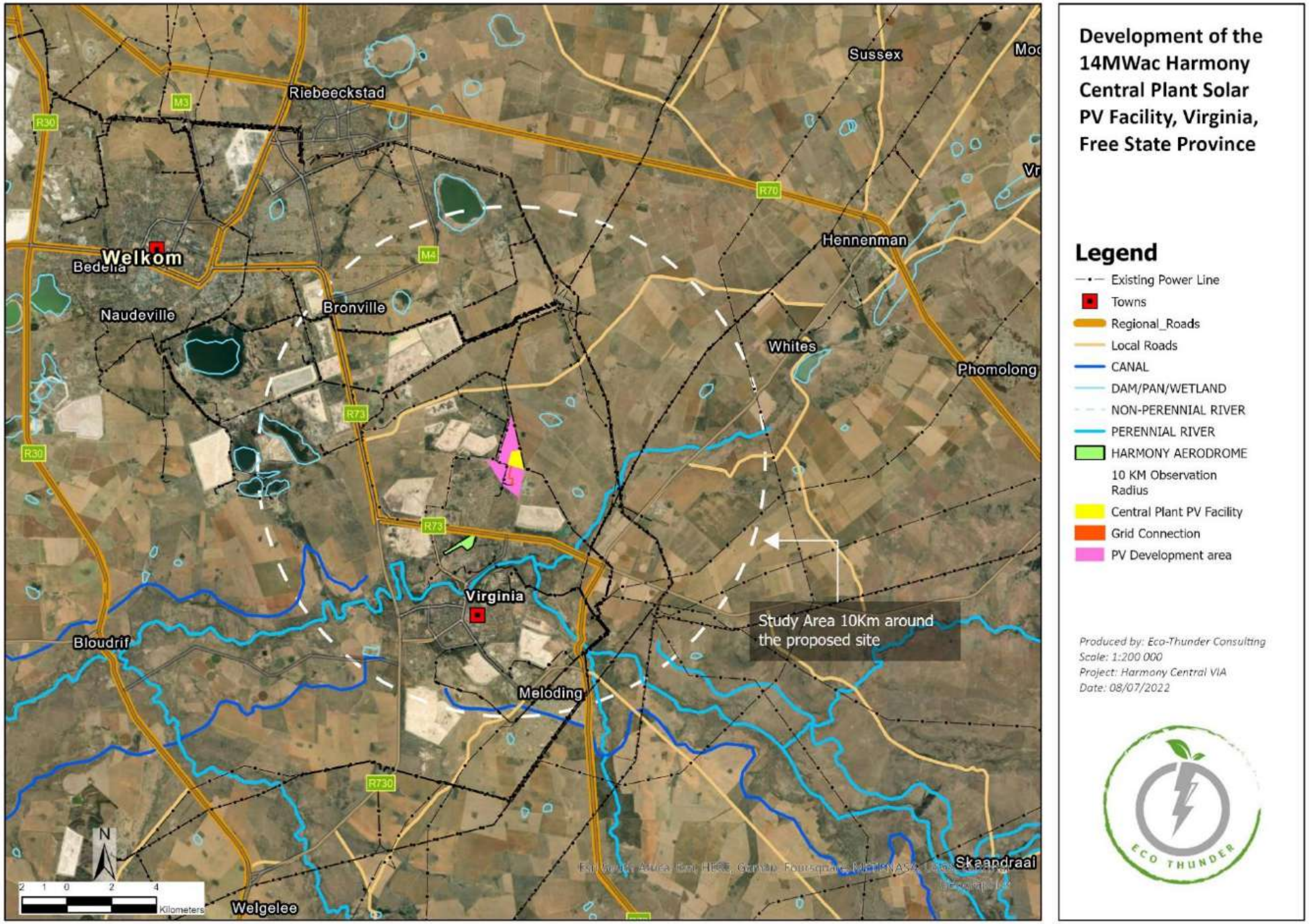

Figure 2: The proposed site and 10km radius of the Harmony Central PV Facility

2. METHOLODGY AND APPROACH

2.1. Purpose of the Study

The International Principles for Social Impact Assessment define SIA as:

“The processes of analyzing, monitoring and managing the intended and unintended social consequences, both positive and negative, of planned interventions (policies, programs, plans, projects) and any social change processes invoked by those interventions”.

The International Principles for Social Impact Assessment define social impacts as changes to one or more of the following:

- People’s way of life – that is, how they live, work, play and interact with one another on a day-to-day basis.
- Their culture – that is, their shared beliefs, customs, values and language or dialect.
- Their community – its cohesion, stability, character, services and facilities.
- Their political systems – the extent to which people are able to participate in decisions that affect their lives, the level of democratisation that is taking place, and the resources provided for this purpose.
- Their environment – the quality of the air and water people use, the availability and quality of the food they eat, the level of hazard or risk, dust and noise they are exposed to, the adequacy of sanitation, their physical safety, and their access to and control over resources.
- Their health and wellbeing – health is a state of complete physical, mental, social and spiritual wellbeing and not merely the absence of disease or infirmity.
- Their personal and property rights – particularly whether people are economically affected, or experience personal disadvantage which may include a violation of their civil liberties.
- Their fears and aspirations – their perceptions about their safety, their fears about the future of their community, and their aspirations for their future and the future of their children.

The purpose of this SIA Process is therefore to:

- Provide baseline information describing the social environment within which the project is proposed, and which may be impacted (both positively and negatively) as a result of the proposed development.
- Identify, describe and assess possible social risks / fatal flaws and social impacts that may arise as a result of the proposed development (in terms of the detailed design and construction, operation, and decommissioning phases of the project).
- Recommend ways in which negative impacts can be avoided, minimised, or their significance reduced, and positive impacts maximised or enhanced.

2.2. Approach to Study

The approach to the Basic Assessment Level SIA study is based on the Western Cape Department of Environmental Affairs and Development Planning Guidelines for Social Impact Assessment (*February 2007*). These guidelines are based on international best practice. The key activities in the SIA process embodied in the guidelines include:

- Describing and obtaining an understanding of the proposed intervention (type, scale, and location), the settlements, and communities likely to be affected by the proposed project.
- Collecting baseline data on the current social and economic environment.
- Identifying the key potential social issues associated with the proposed project. This requires a site visit to the area and consultation with affected individuals and communities. As part of the process a basic information document was prepared and made available to key interested and affected parties. The aim of the document was to inform the affected parties of the nature and activities associated with the construction and operation of the proposed development to enable them to better understand and comment on the potential social issues and impacts.
- Assessing and documenting the significance of social impacts associated with the proposed intervention.
- Identifying alternatives and mitigation measures.
- A site visit will be undertaken during the Assessment Phase of the SIA. The site visit will include interviews with interested and affected parties.

- Preparation of a SIA Report for inclusion in the Basic Assessment Report to be prepared for the project.

Collection and Review of Existing Information
Existing desktop information that has relevance to the proposed project, project area and / or surroundings was collected and reviewed. The following information was examined as part of this process:

- Project maps and layouts.
- Google Earth imagery.
- A description of the project (as provided by the project proponent).
- Responses to questions posed to the project proponent regarding employment and social upliftment and local economic development opportunities (as provided by the project proponent).
- Census Data (2011), and the Local Government Handbook (2019).
- Planning documentation such as Provincial Growth and Development Strategies (PGDSs), Local and District Municipality Integrated Development Plans (IDPs), Spatial Development Frameworks (SDFs), and development goals and objectives.
- Relevant legislation, guidelines, policies, plans, and frameworks.
- Available literature pertaining to social issues associated with the development and operation of solar PV power plant and associated infrastructure.

The identification of potential social issues associated with the proposed Solar Energy Facility is based on primary and secondary information about the area and visits to the relevant communities and town by field workers / members of the SIA study team. Annexure A contains a list of the secondary information reviewed and interviews conducted. Annexure B summarises the assessment methodology used to assign significance ratings to the assessment process.

2.2.1. Definition of Social Impacts

Social impacts can be defined as "The consequences to human populations of any public or private actions (these include policies, programmes, plans and / or projects) that alter the ways in which people live, work, play, relate to one another, organise to meet their needs and generally live and cope as members of society. These impacts are felt at various levels, including individual level, family or household level, community, organisation or society level. Some social impacts are felt by the body as a physical reality, while other social impacts are perceptual or emotional" (*Vanclay, 2002*).

When considering social impacts it is important to recognise that social change is a natural and on-going process (*Burdge, 1995*). However, it is also important to recognise and understand that policies, plans, programmes and / or projects implemented by government departments and / or private institutions have the potential to influence and alter both the rate and direction of social change. Many social impacts are not in themselves "impacts" but change process that may lead to social impacts (*Vanclay, 2002*). For example, the influx of temporary construction workers is in itself not a social impact. However, their presence can result in range of social impacts, such as increase in antisocial behaviour. The approach adopted by Vanclay stresses the importance of understanding the processes that can result in social impacts. It is therefore critical for social assessment specialists to think through the complex causal mechanisms that produce social impacts. By following impact pathways, or causal chains, and specifically, by thinking about interactions that are likely to be caused, the full range of impacts can be identified (*Vanclay, 2002*).

An SIA should therefore enable the authorities, project proponents, individuals, communities and organisations to understand and be in a position to identify and anticipate the potential social consequences of the implementation of a proposed policy, programme, plan or project. The SIA process should alert communities and individuals to the proposed project and possible social impacts, while at the same time allowing them to assess the implications and identify potential alternatives. The assessment process should also alert proponents and planners to the likelihood and nature of social impacts and enable them to anticipate and predict these impacts in advance so that the findings and recommendations of the assessment are incorporated into and inform the planning and decision-making process.

However, the issue of social impacts is complicated by the way in which different people from different cultural, ethic, religious, gender, and educational backgrounds, etc. view the world. This is referred to as the "social construct of reality". The social construct of reality informs people's worldview and the way in which they react to changes.

2.2.2. Timing of Social Impact

Social impacts vary in both time and space. In terms of timing, all projects and policies go through a series of phases, usually starting with initial planning, followed by implementation (construction), operation, and finally closure (decommissioning). The activities, and hence the type and duration of the social impacts associated with each of these phases are likely to differ.

2.3. Assumptions and Limitations

2.3.1. Assumptions

- The identification of the proposed site was informed by technical information relating to local climatic conditions in the area, specifically annual rates of solar radiation, local topography and land availability. It is therefore assumed that the project site identified fulfils the requirements for a suitable site to install a photovoltaic project with the outlined specifications.
- Legislation and policies reflect societal norms and values. The legislative and policy context therefore plays an important role in identifying and assessing the potential social impacts associated with a proposed development. In this regard a key component of the SIA process is to assess the proposed development in terms of its fit with key planning and policy documents. As such, if the findings of the study indicate that the proposed development in its current format does not conform to the spatial principles and guidelines contained in the relevant legislation and planning documents, and there are no significant or unique opportunities created by the development, the development cannot be supported.
- It is assumed that the motivation for as well as the planning and feasibility study of the project was undertaken with integrity, and that information provided by the project proponent was accurate and true at the time of preparing this SIA Report.

2.3.2. Limitations

- This SIA Report was prepared based on information that was available to the specialist at the time of preparing the report. The sources consulted are not exhaustive, and the possibility exists that additional information which might strengthen arguments, contradict information in this report, and / or identify additional information might exist. Additional information available from the public participation undertaken during the BA process will be included and considered within the final report, where relevant.
- The socio-economic data presented in this study is largely based on Census information and data and research conducted or contracted by other levels of government. The quality of this data is compromised by the limitations associated with the Census data collection process.
- The census data is supported through additional data. The study draws primary data collected from towns / villages located in close proximity to the proposed project site. This additional information was collected through a survey of the communities within a 50km radius of the site. Limitation associated with this data include:
  - A small sample size
  - Lack of qualitative data to support quantitative findings

2.4. Assessment Criteria

Direct, indirect, and cumulative impacts associated with the projects must be assessed in terms of the following criteria:

- The nature, which shall include a description of what causes the effect, what will be affected and how it will be affected.
- The extent, wherein it will be indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 will be assigned as appropriate (with 1 being low and 5 being high):
- The duration, wherein it will be indicated whether:
  - the lifetime of the impact will be of a very short duration (0 – 1 years) – assigned a score of 1;
  - the lifetime of the impact will be of a short duration (2 – 5 years) – assigned a score of 2;
  - medium-term (5 – 15 years) – assigned a score of 3;
  - long term (> 15 years) – assigned a score of 4; or

  - permanent – assigned a score of 5;
- The magnitude, quantified on a scale from 0 – 10, where 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
- The probability of occurrence, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale of 1 – 5, where 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).
- The significance, which shall be determined through a synthesis of the characteristics described above and can be assessed as low, medium or high; and
- The status, which will be described as either positive, negative or neutral.
- The degree to which the impact can be reversed.
- The degree to which the impact may cause irreplaceable loss of resources.
- The degree to which the impact can be mitigated.

The **significance** is calculated by combining the criteria in the following formula: S=(E+D+M)P

S = Significance weighting

E = Extent

D = Duration

M=Magnitude

P=Probability

The **significance weightings** for each potential impact are as follows:

- < 30 points: Low (i.e., where this impact would not have a direct influence on the decision to develop in the area).
- 30 – 60 points: Medium (i.e., where the impact could influence the decision to develop in the area unless it is effectively mitigated).
- > 60 points: High (i.e., where the impact must have an influence on the decision process to develop in the area).

The summarizing of assessment impacts in a prescribed table format including the rating values as per above criteria. Measures for inclusion in the Environmental Management Programme.

3. POLICY AND PLANNING

This section introduces the relevant policies on various levels of government and their content. Relevant policy content is contained in the National White Paper on Renewable Energy, National Energy Act, Integrated Resources Plan for Electricity and the National Development Plan (NDP).

The National Energy Regulator of South Africa (NERSA) and the Department of Energy (DOE) govern the energy sector's regulatory framework. Critical stakeholders further include the national utility Eskom, National Treasury, Department of Trade and Industry, and the Department of Economic Development

The legislative and policy context applicable to a project plays an important role in identifying and assessing the potential social impacts associated with the development. In this regard a key component of the SIA process is to assess a proposed development in terms of its suitability with regards to key planning and policy documents.

The following key pieces of documentation were reviewed as part of this legislation and policy review process:

National Policy and Planning Context:

- Constitution of the Republic of South Africa, 1996
- National Environmental Management Act (No. 107 of 1998) (NEMA)
- White Paper on the Energy Policy of the Republic of South Africa (1998)
- National Energy Act (No. 34 of 2008)
- Integrated Energy Plan (IEP) (2015)
- National Development Plan (NDP) 2030 (2012)
- Strategic Infrastructu0s (SIPs)

Provincial Policy and Planning Context:

- Free State Provincial Growth and Development Strategy (FSGDS) (2005 – 2014)
- Free State Provincial Growth and Development Strategy (FSGDS), Revised October 2007
- Free State Provincial Spatial Development Framework (PSDF) - Executive Summary (Inception Report)
- Free State Green Economy Strategy (2014)
- Free State Investment Prospectus (2019)

Local Policy and Planning Context:

- Lejweleputswa District Municipality Integrated Development Plan (IDP) 2020 / 2021
- Matjhabeng Local Municipality Integrated Development Plan IDP (2020 – 2021)

3.1. National Planning and Policies

3.1.1. Constitution of South Africa

Section 24 of the Constitution pertains specifically to the environment. It states that everyone has the right to an environment that is not harmful to their health or well-being, and to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that prevent pollution and ecological degradation, promote conservation and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

The Constitution outlines the need to promote social and economic development. Section 24 of the Constitution therefore requires that development be conducted in such a manner that it does not infringe on an individual's environmental rights, health, or well-being. This is especially significant for previously disadvantaged individuals who are most at risk to environmental impacts.

3.1.2. The National White Paper on Renewable Energy

In 1998, the White Paper on Energy Policy for South Africa (December 1998) identifies renewable energy as a future commercial opportunity for the country. "Government policy is based on an understanding that renewables are energy sources in their own right, are not limited to small-scale and remote applications, and have significant medium and long-term commercial potential".

The document argues that the abundant renewable energy resources have an important role to play in promoting sustainable energy security going forward. "Renewable resources generally operate from an unlimited resource base and, as such, can increasingly contribute towards a long-term sustainable energy future".

3.1.3. National Energy Act

Government promulgated the National Energy Act in 2008 (Act No 34 of 2008). Next to other objectives, the Act sets out to promote diversity of supply of energy and energy sources. The preamble makes direct reference to this objective, emphasizing the importance of renewable resources, including solar:

"To ensure that diverse energy resources are available, in sustainable quantities, and at affordable prices, to the South African economy, in support of economic growth and poverty alleviation, taking into account environmental management requirements to provide for increased generation and consumption of renewable energies...".

3.1.4. Integrated Resource Plan for Electricity

The latest, promulgated Integrated Resource Plan was written in 2010. An updated version was released in 2013 for public comment. Both versions support the procurement of renewable energy. The 2010 version allocates 17.8GW to renewables by 2030. The 2013 version stipulates that 2.2GW shall be integrated into the grid, on an annual basis.

3.1.5. National Development Plan

The National Development Plan, which was adopted by government, makes various suggestions for the enhancement of energy and electricity infrastructure. The NDP, published in 2013, specifically supports the procurement of renewable energy. It stipulates a goal of a minimum of 20GW to be procured by 2030.

3.2. Provincial Planning and Policy

The study site is located in the Free State Province. Relevant policy and planning documents on provincial level include:

3.2.1. Free State Provincial Growth and Development Strategy (FSGDS) (2005 – 2014)

The overarching goal of the Free State Growth and Development Strategy (FSGDS) is to align the provincial and national policies and Programmes and to guide development in terms of effective and efficient management and governance to achieve growth and development. The strategy is a living document that uses the latest business planning and evaluation tools in order to maximize the effect of all spending.

Based on the social and economic development challenges of the province, the Strategy identifies a few primary objectives, including stimulating economic development, developing and enhancing the infrastructure for economic growth and social development, poverty alleviation through human and social development, ensuring a safe and secure environment for all, and the promotion of effective and efficient governance and administration.

The solar and infrastructure development supports the overall objective of stimulating economic development and infrastructure investment towards growth and social development, by contributing to the energy mix, supply, and infrastructure of the province. The development of the facility will also contribute (albeit limited) to the alleviation of poverty through the creation of direct and indirect employment opportunities and skills development.

3.2.2. Free State Provincial Growth and Development Strategy (FSGDS), Revised October 2007

The revised FSGDS refers to specific imperatives which sets the tone and pace for shared growth and development in the province. These include:

- The need to effectively use scarce resources within the province, whilst addressing the real causes of development challenges.
- The need to accelerate service delivery based on a common provincial development agenda as the basis for provincial strategic direction.
- The need to identify investment opportunities and provide an environment of certainty, critical for private-

sector investment.

- The need to promote intergovernmental coordination between the three spheres of government.
- The need to facilitate the implementation of the People's Contract within the Province.
- The need to provide a common vision as the basis for common action amongst all stakeholders, both inside and outside government.
- The need to provide a framework for budgets, implementation, performance management and spatial development.

The solar and infrastructure development will assist with the need to effectively use scare resources and the need to identify investment opportunities, including private sector-investment. The development of a solar facility reduces the need to make use of non-renewable resources for the generation of electricity and opens up the province to further future solar energy development.

3.2.3. Free State Provincial Spatial Development Framework (PSDF) - Executive Summary

The Free State PSDF is a provincial spatial and strategic planning policy that responds to and complies with the National Development Plan Vision 2030 and the National Spatial Development Perspective (NSDP). The latter encourages all spheres of government to prepare spatial development plans and frameworks (such as the PSDF) that promote a developmental state in accordance with the principles of global sustainability as is advocated by, among others, the South African Constitution, and the enabling legislation.

The Free State Provincial Growth and Development Strategy states that sustainable economic development is the only effective means by which the most significant challenge of the Free State, namely poverty, can be addressed. The PSDF gives practical effect to sustainable development, which is defined as development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs.

The PSDF is prepared in accordance with bioregional planning principles that were adapted to suit the site-specific requirements of the Free State. It incorporates and complies with the relevant protocols, conventions, agreements, legislation and policy at all applicable levels of planning, ranging from the international to the local.

The solar and infrastructure development will contribute to sustainable and economic development goals of the Free State PSDF, once completed and formally adopted.

3.2.4. Free State Investment Prospectus (2019)

The Premier of the Free State provides individual investors' access to accurate and pertinent information which makes it easier for investors to glean investor ready opportunities that are currently available in the Free State.

Opportunity for the development of renewable energy is considered in the key sectors overview. The prospectus states that opportunities are opening up in the province for the energy sector, including renewable energy. Rezoning for the development of multiple solar energy facilities has already been undertaken in the province. The development of a Solar Park in the Xhariep region is seen as a driver of growth along the banks of the Orange River.

Considering the future opportunities available for the development of renewable energy facilities (including solar PV facilities) the solar and infrastructure development is considered to be in-line with the Investment Prospectus of the Province.

3.3. District Level Planning and Policies

3.3.1. Lejweleputswa District Municipality Integrated Development Plan (IDP) 2020/2021

Lejweleputswa District Municipality main objectives according to its IDP is to promote economic development in the district to create jobs and wealth, reduce poverty levels and promote Lejweleputswa region as a commercial hub and also function as springboard for Private, Public Partnership (PPP) for the District. The vision for the district is to be a leader in sustainable development and service delivery to all. Economic development opportunities are the key determinant of the settlement pattern as well as the distribution of industrial areas in the district. Economic development typically responds to the availability of environmental capital (e.g. water, suitable agricultural soil, mining resources, etc.) and infrastructural capital (e.g. roads, electricity, bulk engineering services etc.).

Under SPCF Renewable Energy Structures the IDP refers to support by the district on any wind turbines or solar voltaic apparatus, or grouping thereof, which captures and converts wind or solar radiation into energy for commercial gain irrespective of whether it feeds onto an electricity grid or not. The Final Draft Free State Provincial Spatial Development Framework 2014 supports the NDP strategic priority which states that new large-scale infrastructure should be prioritized in settlements with high economic growth potential.

Currently the Solar Energy Hub in Virginia where projects are at Dealesville and Boshof should be promoted to expand into a solar energy hub for the south-western part of the district. The said towns are also indicated as solar energy nodes on the district sdf map.

3.3.2. Matjhabeng Local Municipality Integrated Development Plan IDP (2020 – 2021)

The Municipality's vision and mission are translated into the following five municipal key performance areas:

- KPA1: Good governance
- KPA 2: Basic Service delivery
- KPA 3: Inclusive economic development and job creation
- KPA 4: Institutional transformation
- KPA 5: Financial sustainability and viability

The Matjhabeng Local Municipality recognises the need to meet the energy requirements of its residents in a dynamic changing sector. The LM understands the benefits of renewable energy development as playing the following factors to the region:

- Savings on the current and already substantial Eskom Bill as the Project's tariff is lower than the Eskom tariff and the escalation rate is fixed per year at its applicable CPI rates during the life-cycle of the Project;
- Potential to attract foreign investments and subsequently achieve economic growth;
- Additional revenue stream due to the innovational technology, which has the potential to enable the selling of excess power to Eskom or another off-taker;
- Refinancing the current Eskom debt for immediate relief;
- Financial investment into the municipality jurisdiction that will boost the economic cycle of the community;
- New upcoming industrialization activity attraction;
- Job creation, skills development and Small Medium Micro Enterprises (SMME) development; and
- Transforming the energy sector in SA and Africa as per its current timeline.

For the mining sector the major challenges include the over-dependence of the local economies on mining. Linked to these key sectors is the need to consider youth development. The key issues pertaining to both the province and the MLM include:

- African youths are the majority in the Free State and they are also the most disadvantaged. Consequently, all attempts at intervening on behalf of youths should mainly target the African youth.
- There is an inherent lack of skills particularly amongst the African and Coloured youths, which leads to high unemployment amongst these groups.
- Youths are both perpetrators and victims of wrong social behaviours. They are at risk of being exposed to risky sexual behaviour, HIV & AIDS, and being head of a household.

3.4. Conclusion

The review of relevant legislation, policies and documentation pertaining to the proposed development indicates that the establishment of the solar development and associated infrastructure is supported at a national, provincial, and local level, and that the proposed project will contribute positively towards a number of targets and policy aims.

4. OVERVIEW OF THE STUDY AREA

4.1. Overview of Study Area

This section outlines the relevant administrative context as well as the provincial socio-economic and municipal contexts. It closes with a description of the local context of the immediate surroundings of the proposed PV Facility site.

The Harmony Central Solar PV Facility will be located on the farm Rustgevonden 564 which is ~6km north-east of the town of Virginia and ~11km south-east of the town of Welkom, within the Free State Province. A development site of approximately up to 165ha has been identified for Harmony Central Solar PV Facility, of which an approximately 33.6ha will be identified for the project footprint.

This chapter provides an overview of the socio-economic environment of the province, DM, and LM within which the Harmony Central Solar PV Facility is proposed and provides the socio-economic basis against which potential issues can be identified.

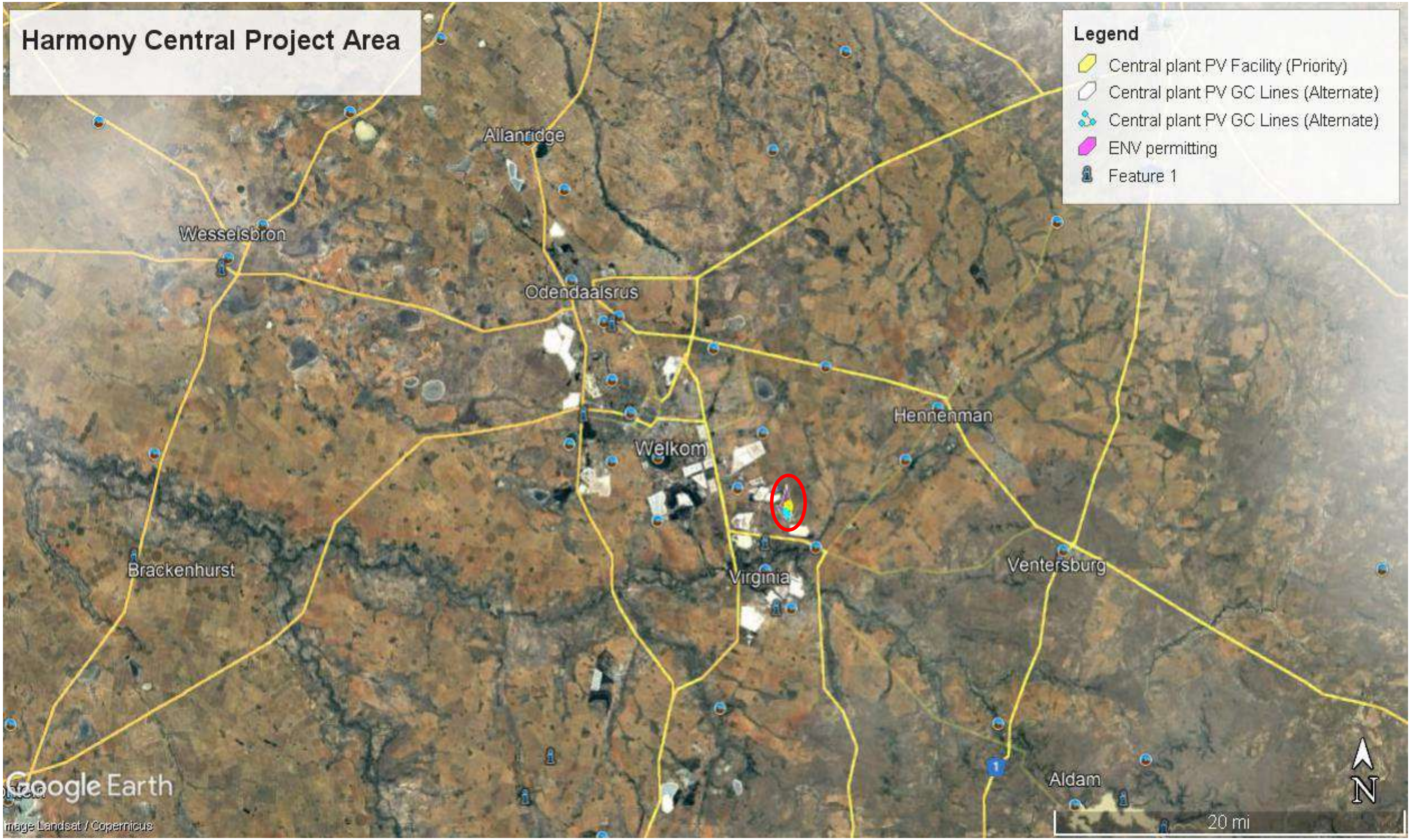

Figure 3A: Location of the site within the main study area, within the Free State Province

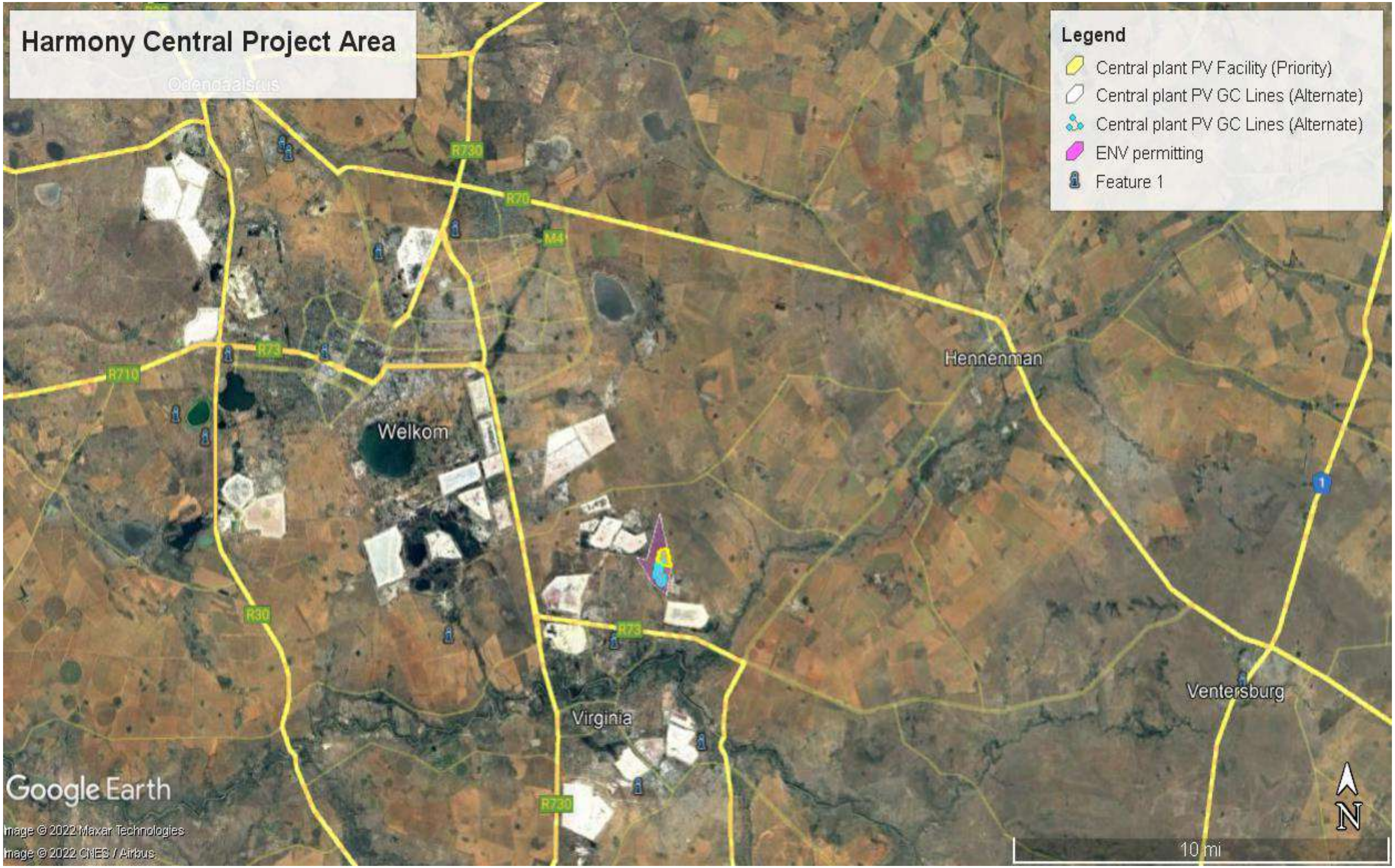

Figure 3B: Location of the site within the main study area, within the Free State Province

4.2. Administrative Context of Study Area

The Harmony Central Solar Energy Facility (SEF) is located within the Matjhabeng Local Municipality (MLM), which is one of five local municipalities that make up the Lejweleputswa District Municipality (LDM) in the Free State Province. The town of Welkom is the administrative seat for both the LDM and MLM.

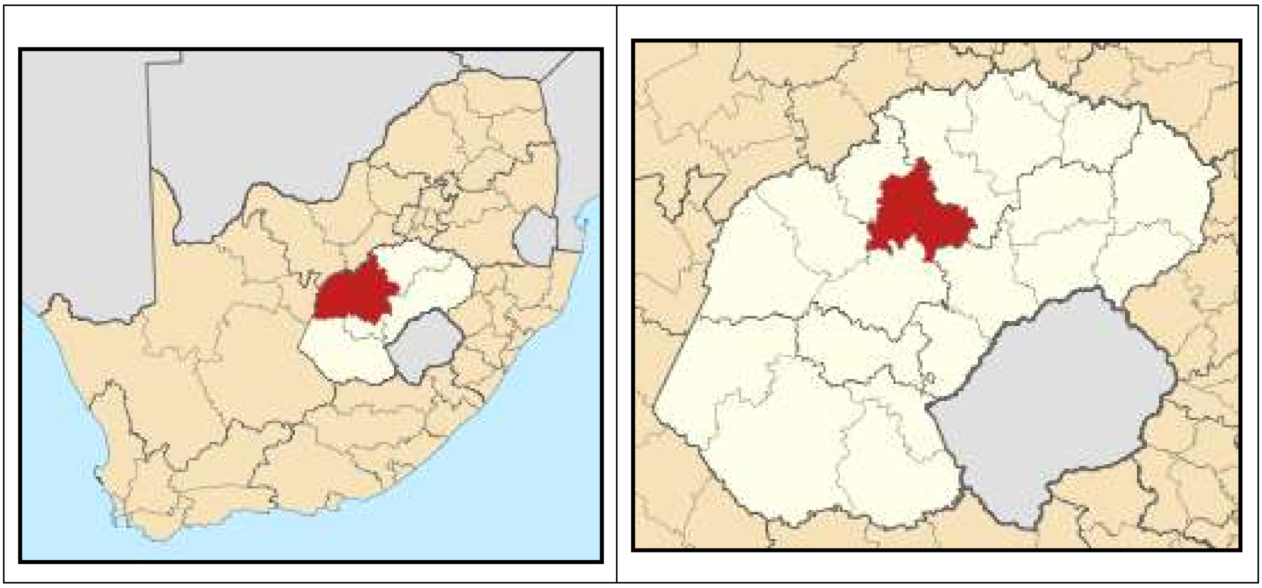

Figure 4: Location of Lejweleputswa District Municipality (left) and Matjhabeng Local Municipality (right) within the Free State Province

Table 1: Spatial Context of the study area for the development of the Harmony Central Solar PV

Province	Free State Province
District Municipality	Lejweleputswa District Municipality
Local Municipality	Matjhabeng Local Municipality
Ward number(s)	8
Nearest town(s)	~ 6km north-east of the town of Virginia
Current Zoning	Agriculture
Current land use	The properties both currently lie fallow, having been used historically for agriculture
Access	The site can be readily accessed via an existing gravel access road (Unnamed Rd Virginia, Free State)

4.3. Provincial Socio-Economic Context

The proposed Solar Energy Facility (SEF) is in the Free State Province which covers an area of 129 464 km², or 10.6% of the total land area of the country. The western part of the Free State is characterised by flat plains, pans, and undulating land. The south is primarily lowlands with hills. To the east the escarpment extends from Lesotho into low mountains and irregular undulating land with hills. The northern and central portions are marked by undulating land and hills. The climatic conditions range from moist and warm in the east to dry and warm in the west.

The province is the granary of South Africa, with agriculture central to its economy, while mining in the goldfield reefs is its largest employer.

Economic towns include Bloemfontein, Welkom, Kroonstad, Parys, QwaQwa, and Bethlehem. The Free State is the third- largest Province in South Africa, but it has the second-smallest population and the second-lowest population density. The culture is centered on traditional cultures but built on the influences of the early European settlers.

Close to 2.8 million people live in the Free State, with two-thirds speaking Sesotho, followed by Afrikaans, Zulu, Tswana, Xhosa and English.

The Free State is strategically placed to take advantage of the national transport infrastructure. Two corridors are of particular importance: the Harrismith node on the N3 corridor between Gauteng and KwaZulu-Natal, and the N8. The N1 connects Gauteng to the Western Cape. Bram Fischer International Airport in Bloemfontein handles about 250 000 passengers and 221 000 tons of cargo a year. Manufacturing also features in the provincial economic profile. This sector makes up 14% of the provincial output, with petrochemicals (via Sasol) accounting for more than 85% of the output.

The Free State Province comprises of four (4) Districts, namely Fezile Dabi, Lejweleputswa, Thabo Mofutsanyana and Xhariep (refer to Figure 5).

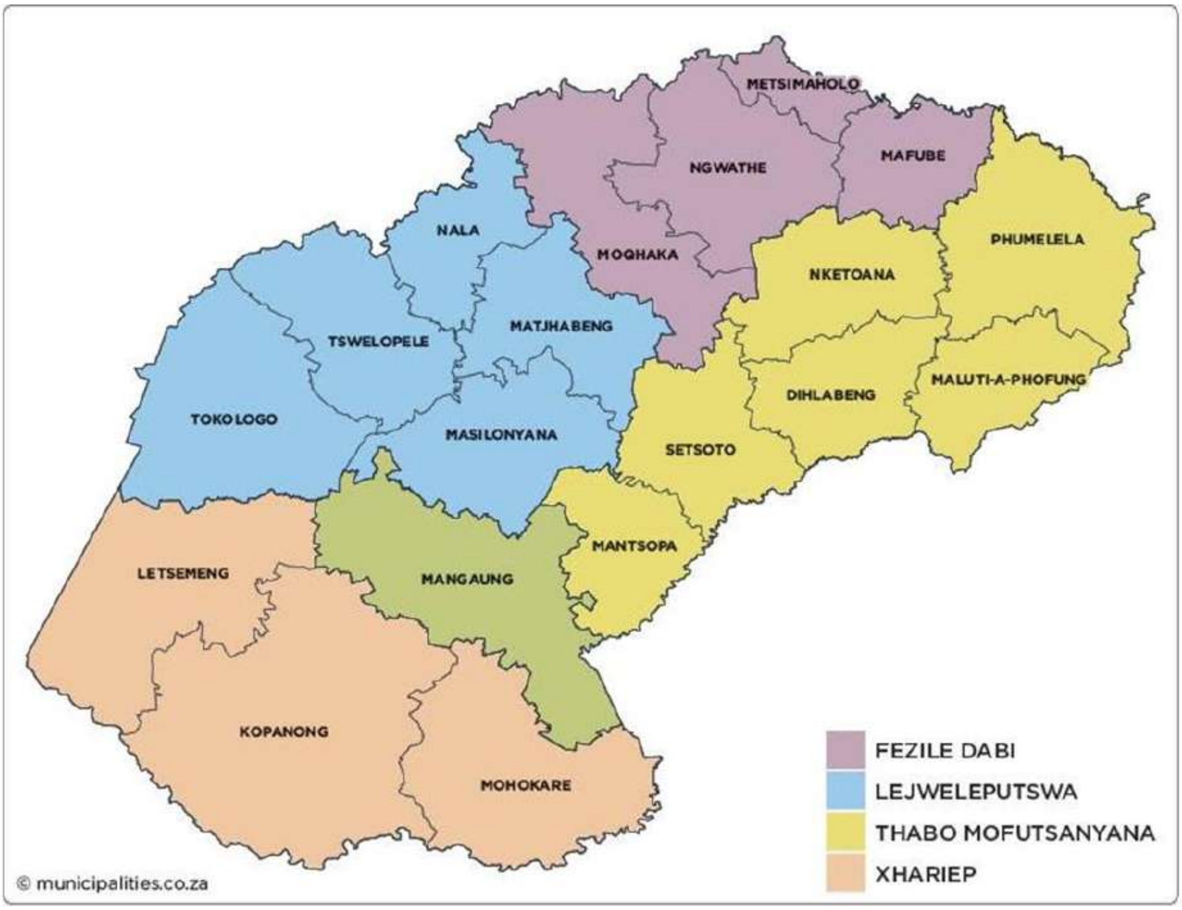

Figure 5: Map showing the districts of the Free State Province (Source: www.municipalities.co.za).

4.3.1. Population

The population of the Free State increased by an estimated 116 010 people, from 2.7 million in 2011 to 2.8 million in 2016, making it the second smallest increase after the Northern Cape (45 839). The proportion of the Free State's population to national total population decreased by 0.2 percentage points; from 5.3 percent in 2011 to 5.1 percent in 2016, which is the highest decline nationally. The negative change in the Free State's population in particular has severe consequences on the province's share of nationally raised revenue via the equitable share formulae. Because the formula is largely population-driven (over 60 percent of the formula uses population data), the allocations capture shifts in population across provinces. As a result, provinces with increased populations, like Gauteng, receive additional resources, while those with decreasing populations, like the Free State, receive reduced allocations.

Table 2: Population Structure of the District municipality

Province/district/local municipality	Census 2011	Community Survey 2016	Growth rate
DC16: Xhariep	**121 945**	**125 884**	**0,7**
FS161: Letsemeng	38 628	40 044	0,8
FS162: Kopanong	49 171	49 999	0,4
FS163: Mohokare	34 146	35 840	1,1
DC18: Lejweleputswa	**624 746**	**646 920**	**0,8**
FS181: Masilonyana	59 895	62 770	1,1
FS182: Tokologo	28 986	29 149	0,1
FS183: Tswelopele	47 625	47 373	-0,1
FS184: Matjhabeng	407 020	429 113	1,2
FS185: Nala	81 220	78 515	-0,8
DC19: Thabo Mofutsanyana	**735 679**	**779 330**	**1,3**
FS191: Setsoto	112 038	117 362	1,1
FS192: Dihlabeng	128 704	140 044	1,9
FS193: Nketoana	60 324	64 893	1,7
FS194: Maluti-A-Phofung	335 784	353 452	1,2
FS195: Phumelela	47 772	50 054	1,1
FS196: Mantsopa	51 056	53 525	1,1
DC20: Fezile Dabi	**488 036**	**494 777**	**0,3**
FS204: Metsimaholo	149 108	163 564	2,1
FS205: Mafube	57 876	57 574	-0,1
FS201: Moqhaka	160 532	154 732	-0,8
FS203: Ngwathe	120 520	118 907	-0,3
MAN: Mangaung	**775 184**	**787 803**	**0,4**
Free State	**2 745 590**	**2 834 714**	**0,7**

The figure below shows the population structure of the Free State in 2016 by means of a population pyramid. Population pyramids are graphical representations of the age and sex of a population. The age-sex structure of any population affects the labour force, demand for education facilities, retirement and medical systems amongst others. Therefore, the population pyramid provides crucial data that can be used by the government when planning. The Free State has what is called an expansive population pyramid. Expansive population pyramids depict populations that have a larger percentage of people in younger age groups. Populations with this shape usually have high fertility rates with lower life expectancies. The implications of such a structure is excessive strain on the economically active population. The pyramid narrows toward the top because the death rate is higher among older people than among younger people. Free State's population pyramid depicts the characteristics of a developing nation which are: (i) low growth rates, (ii) high birth rate, and (iii) short life expectancy

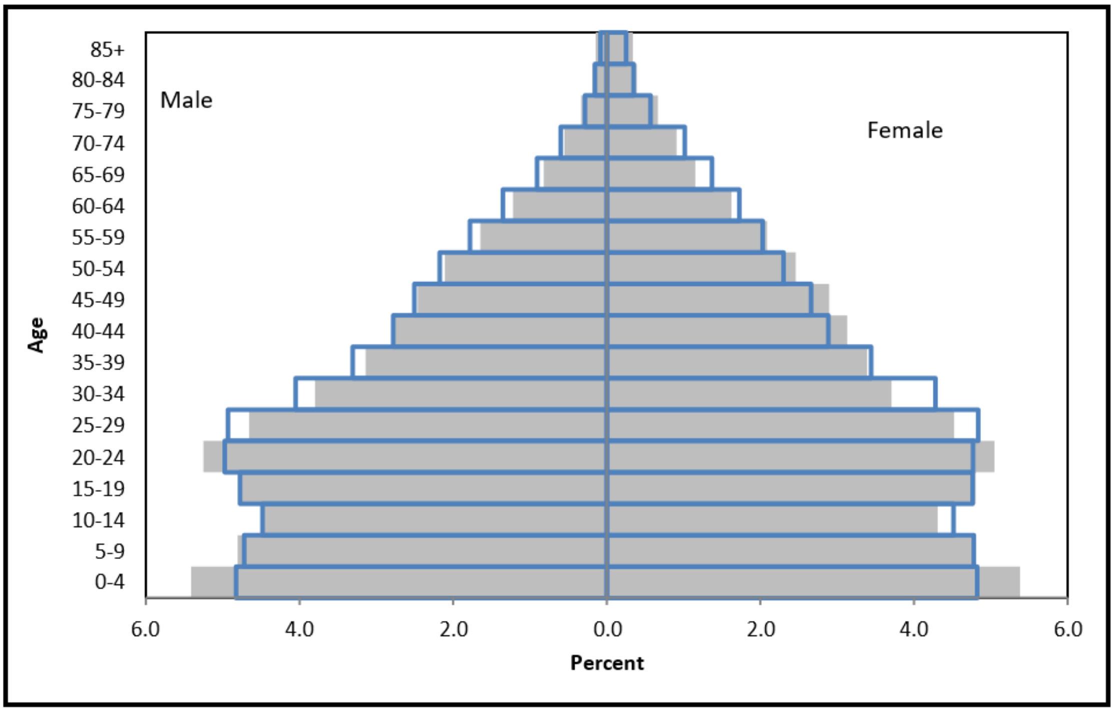

Figure 6: Population pyramid of the study area

4.3.2. Economy

The economy of the Free State faced several headwinds in 2016, in line with some the challenges faced by the global, regional and national economies. The El Nino episode, which resulted in the drought experienced by Southern Africa (including the South Africa and the Free State), infiltrated into the beginning of 2016. This drought resulted in less grain being planted throughout the country, which resulted in the need to import grain during 2015 and 2016. Coupled with a weaker domestic currency, the drought fueled food inflation to double digit territory, and negatively impacted consumer and business confidence in 2016.

The Table below shows that the Free State economic output is anticipated to expand from R159.9 billion in 2016 to R160.3 billion in 2017 and grow further to R167.3 billion in 2020. Following a similar trend, all industries in the provincial economy are projected to grow by 0.3 percent in 2017 and accelerate further to grow by 1.7 percent in 2020. The agricultural industry of the province is projected to recover from reducing by 7.2 percent in 2016 to expand by 0.5 percent in 2017.

Table 3: GDP per sector from 2014 -2020 for the Free State Province

R'1000	2014	2015	2016	2017	2018	2019	2020
Gross Domestic Product	160 328 010	161 027 129	159 866 989	160 291 315	162 062 529	164 400 919	167 312 446
Total Industries	1.9%	0.4%	-0.6%	0.3%	1.0%	1.4%	1.7%
GDPR by Industry (real change)							
Agriculture	6.7%	-7.1%	-7.2%	0.5%	0.5%	0.9%	1.7%
Mining	2.2%	1.6%	-4.5%	2.6%	0.9%	0.9%	0.0%
Manufacturing	2.6%	-0.2%	1.5%	-0.1%	1.1%	1.1%	1.3%
Electricity	-0.6%	-1.3%	-1.8%	-0.1%	1.2%	2.2%	2.9%
Construction	2.2%	0.5%	-0.9%	0.1%	-0.2%	-0.4%	0.0%
Trade	1.1%	0.8%	-0.6%	-0.3%	0.9%	1.1%	1.6%
Transport	2.7%	0.6%	-0.7%	0.1%	1.8%	2.0%	3.1%
Finance	1.5%	1.7%	0.6%	0.3%	2.0%	2.1%	2.5%
Community services	1.5%	0.5%	1.4%	-0.3%	0.4%	1.6%	2.1%

As the second biggest producer of maize and wheat in the country, Free State agriculture will benefit from more rainfalls in 2017. The downside risk faced by the industry includes the presence of army worms, which can destroy harvest and disrupt food security for the province. However, the agricultural industry is projected to recover and grow by 1.7 percent in 2020. The other half of the primary industries, mining industry, is also projected to recover from a decline of 4.5 percent in 2016 to a growth of 2.6 percent in 2017.

As an energy-intensive industry, mining will benefit from the continuous and reliable supply of electricity. Also, gold and coal prices showed signs of recovery in 2016, which is a positive for the province. In the medium term, the growth rate of the mining industry in the Free State is projected to decline from 0.9 percent in 2017 to 0 percent in 2020. In the secondary industries, the output of the electricity industry is projected to decline by 0.1 percent in 2017, and thereafter recover and reach 2.9 percent in 2020. In South Africa, hydroelectricity was reduced in 2016 following the drought and even in the mist of rainfalls, the water sub-industry might recover gradually in 2017.

The construction industry continues to be disadvantaged by fiscal consolidation as well as weak private investment and over the medium term, the industry is projected to reduce by an average of 0.2 percent per annum. In the tertiary industry, increased global protectionism and uncertain trade policies are anticipated to have a negative bearing on the trade industry, which is projected to decline by 0.3 percent in 2017. However, favourable trade policies from the EU and anticipated from the UK may favour the tertiary industry of the province, which is projected to recover and grow by 1.6 percent in 2020.

The transport industry, which is projected to grow by a minute 0.1 percent in 2017, is projected to grow more robustly over the medium term by 3.1 percent in 2020. The national and provincial government continues to support the development and maintenance of transport infrastructure in the province e.g. public sector investment in mixed-use

Airport Development Node as well as the 2nd phase of the Integrated Public Transport Network in the Mangaung region.

4.3.3. Employment

The International Labour Organization (ILO) (2017) highlighted that the global economy grew by 3.1 percent in 2016, which is the lowest economic growth rate in the past six years. Although the global economy is projected to recover and grow by 3.4 percent in 2017, global uncertainties such as increased trade protectionism pose downside risks to the global economic outlook. In the context of a subdued global economy, the ILO raises concerns in the labour market, such as will a sufficient number of jobs be created; will the quality of the jobs in existence be improved; and lastly will the gains from growth be inclusively distributed? The ILO expects unemployment to remain high in the medium term, which will be worsened if labour force growth outstrips job creation.

According to Statistics South Africa the province has the highest unemployment rate in the country (34.7 percent in Q4:2016) and approximately 68 000 jobs were lost in 2016. An estimated economic growth rate of 0.3 percent in 2017 will make it very difficult for the province to create sufficient jobs to reduce the high unemployment rate of the province. According to Statistics South Africa (2017) the labour force of the Free State has declined by 16 000 (or 1.4 percent) between Q4:2015 and Q4:2016. Over the review period, employment drastically declined by 68 000 (or 8.2 percent), whilst the number of unemployed individuals increased by 52 000 (or 14.7 percent). As indicated in table 3 above, the official unemployment rate of the province increased from 29.8 percent in Q4:2015 to 34.7 percent in Q4:2016, which represents a 4.9 percentage point increase.

As indicated in the economy section above, the provincial economy faced several headwinds in 2016 which included drought in the agricultural and water industries, low commodity prices in mining, subdued global and national economies, fiscal consolidation, as well as reduced consumer and business confidence. These are among several factors which may have plummeted the provincial economy into negative growth territory in 2016 and subsequently increased the provincial unemployment rate.

Employment in South Africa increased by 51 000 (or 0.3 percent) between Q4:2015 and Q4:2016. However, employment in the country increased by 235 000 between Q3: 2016 and Q4: 2016, boosted mainly by community services (73 000), transport (46 000) and manufacturing (44 000) industries. In terms of provinces, the biggest gains in employment, year-on-year, occurred in Limpopo (103 000), Eastern Cape (36 000) and Gauteng (22 000). The biggest losses in employment over the same period occurred in Free State (68 000), Mpumalanga (36 000) and Northern Cape (14 000). Quarter to quarter changes reveal that the largest gains in employment occurred in Western Cape (70 000), Limpopo (64 000) and North West (60 000). Over the same period, the largest losses in employment occurred in Free State (24 000), Mpumalanga (19 000) and Northern Cape (10 000).

4.3.4. Human Development

HDI for both the Free State and South Africa has been steadily increasing for the period of 2005 to 2015. Historically, the HDI for the province has always been lower than that of the country. Despite this, HDI has been on an increasing trend moving from 0.51 in 2005 to 0.63 in 2015. This increase in the HDI might be due to the increasing trend in life expectancy and education in the same period despite the low prosperity of the economy. This increase shows that the social and economic development in the province is moderate. Overall, the different variables indicate that the province is still on the right track to deliver improved services to its residents.

4.3.5. Education

During the period 2011 to 2016, the number of learners at ordinary schools increased for both the country and the province. Provincially, the number of learners increased by 30 339 leaners, from 658 010 in 2011 to 688 349 in 2016, whilst for the country it increased by 644 571 learners, from 12 287 994 in 2011 to 12 932 565 in 2016. The number of learners has increased at a faster annual average rate of 1.03 percent nationally compared to 0.91 percent provincially. Free State's share of learners decreased from 5.4 percent in 2011 to 5.3 percent in 2016; a decline of 0.1 percentage point.

Table 4: Education per Free State District

District and local municipality	Census 2011		CS 2016	
	Number	%	Number	%
Xhariep	**31 103**	**69,8**	**33 192**	**69,4**
1FS161: Letsemeng	9 084	65,6	9 574	62,3
FS162: Kopanong	12 374	71,2	12 753	70,7
FS163: Mohokare	9 646	72,4	10 865	75,4
Lejweleputswa	**158 066**	**70,7**	**170 825**	**73,6**
FS181: Masilonyana	14 768	70,1	16 286	71,5
FS182: Tokologo	7 001	66,5	7 392	69,6
FS183: Tswelopele	13 031	69,7	14 104	75,1
FS184: Matjhabeng	101 830	71,5	110 623	73,5
FS185: Nala	21 435	69,4	22 419	76,6
Thabo Mofutsanyana	**218 696**	**75,0**	**244 043**	**76,7**
FS191: Setsoto	32 339	73,8	36 814	78,0
FS192: Dihlabeng	33 843	73,5	39 992	75,7
FS193: Nketoana	17 259	73,2	19 450	74,0
FS194: Maluti-A-Phofung	108 045	77,3	117 193	77,9
FS195: Phumelela	13 325	71,2	14 890	72,1
FS196: Mantsopa	13 885	71,0	15 704	75,4
Fezile Dabi	**121 309**	**72,3**	**123 960**	**71,8**
FS204: Metsimaholo	35 503	71,8	40 014	72,1
FS205: Mafube	16 580	74,0	16 243	73,3
FS201: Moqhaka	37 396	71,1	38 284	72,3
FS203: Ngwathe	31 829	73,6	29 418	70,0
Mangaung	**206 827**	**74,0**	**231 996**	**77,5**
Free State	**736 002**	**73,1**	**804 016**	**75,2**

4.3.6. Income and poverty

A study by the Free State Provincial Treasury on poverty and inequality (*G.G Mashibini and O.S Omoshoro-Jones, 2016*) found that poverty rates in the province have declined (using all three poverty lines), but the level remains high, as also seen in figure 7 below. The improvement is mostly attributable to a redistributive fiscal policy and average income growth. The study further states that poverty severity is substantially higher in rural areas than urban, which could be triggered by rural-urban migration.

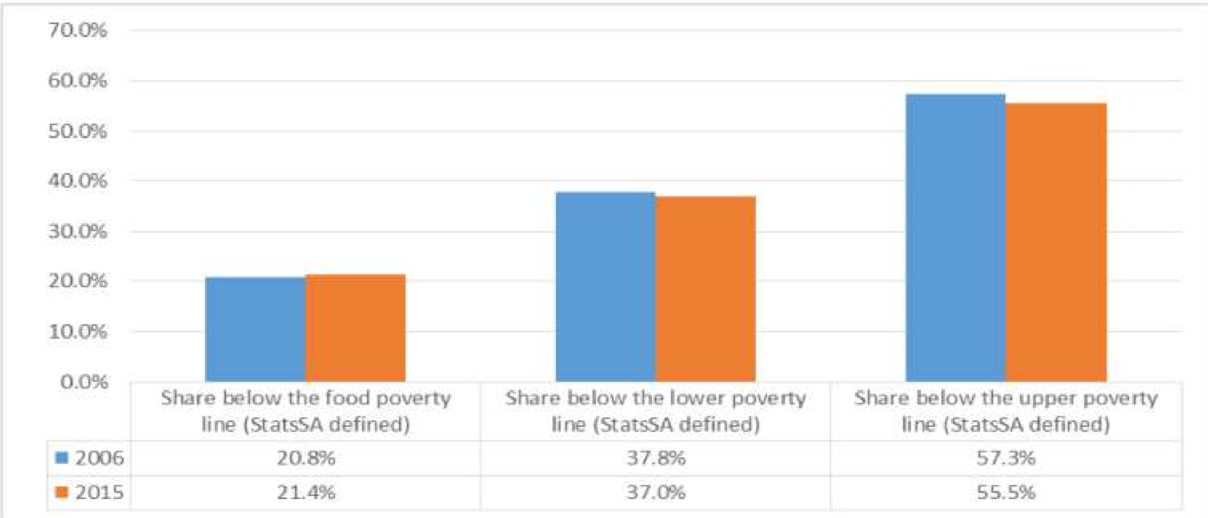

Figure 7: Poverty Within the District Municipality

4.4. Lejweleputswa District Municipality

Lejweleputswa District Municipality is situated in the mid-western part of the Free State province, with an estimated area of about 31 930 km² (*Local government handbook, 2013*). The district borders the North-West province to the north, Fezile Dabi District Municipality to the north-east, and Thabo Mofutsanyane District Municipality to the east. It also borders Mangaung Metro and Xhariep District to the south and the Northern Cape Province to the west. It consists of 22.9% of the Free State province's population, down from 26.7 % in 1996 (*IHS Global Insight, 2015*). The District is made up of five local municipalities, namely; Matjhabeng, Tokologo, Tswelopele, Nala and Masilonyana with about 17 towns.

The economy of the district relies heavily on the gold mining sector as the largest sector, dominant in two of the municipalities, Matjhabeng and Masilonyana, whilst the other Municipalities are dominated by agriculture. There is less diversification of the district's economy relying heavily on the mining sector and community service sector as the largest employers in the District. Matjhabeng is the largest municipality in the district and contributes the largest share of GVA-R in the District. The average annual GDP-R growth rate stands at -1.5 percent in 2014 for the district and forecast to decline even further to -2.9 percent in 2016 according to IHS Global Insight, as a result of low international commodity prices and a persistent drought in the agricultural sector. Output in agriculture is forecasted downwards and prices in agricultural goods are expected to rise due to low output levels as given by the South African Reserve Bank in their monetary policy statement in September 2015 for the country in general.

The Lejweleputswa District Municipality has five municipalities within its district (refer to figure 8).

Figure 8: Local Municipalities of Lejweleputswa District Municipality Source: (Local Government Handbook, 2015)

4.4.1. Population

With an annual population growth rate of 1.5 percent, the district has a population of 634 462 in 2019. This is 22 % of the total population of the Free State Province.

Based on the present age-gender structure and the present fertility, mortality and migration rates, Lejweleputswa's population is projected to grow at an average annual rate of 0.3% from 634 462 in 2019 to 644 000 in 2024.

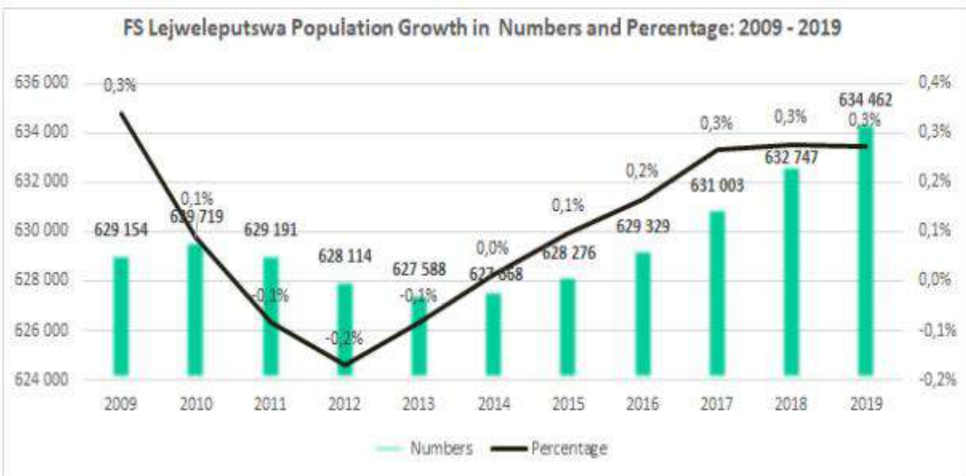

Figure 9: Predicted population growth 2009 -2019

4.4.2. Economy

The economy of Lejweleputswa thrives on mining and farming. The district is rich in gold deposits and lies at the heart of the province's goldfields. In terms of farming, the district is a major producer of maize and sunflower. Mining and farming as the primary sector of the economy in the district contributed 28.6%. Activities in the secondary sector (manufacturing: 6.9%, electricity: 1% and construction: 5.7%) collectively contributed 13.6% to the GVA of the district. The tertiary sector (trade: 22.7%, transport: 4.4%, finance: 9.9% and community services: 20.8%) accounts for 57.8% of the GVA of the district. Economic activities in the tertiary sector comprises of finance, insurance, real estate and business services, wholesale and retail trade, catering and accommodation and general government sectors.

In recent years the contribution of mining in Lejweleputswa's economy has been declining due to a number of reasons and recently the effect of lower world commodity prices has fueled the decline of the sector. The share of the primary sector is illustrated below in the Lejweleputswa Economic Sector. Lejweleputswa's GVA has also been on a decline, indicating a shift away from the primary sector to the tertiary sector. The community services sector is growing strongly in all of Lejweleputswa's municipalities and is also forecasted to grow further.

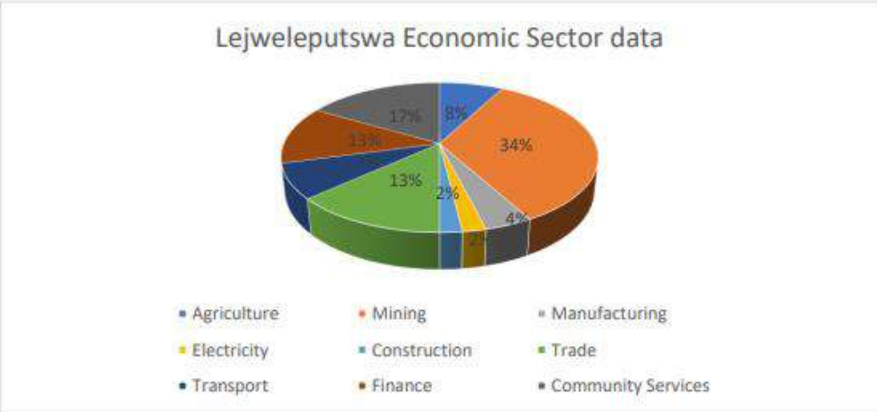

Figure 10: District municipality Economic Sector

4.4.3. Employment

In 2019, Lejweleputswa employed 142 000 people which is 18.26% of the total employment in Free State Province (779 000), 0.87% of total employment in South Africa (16.4 million). Employment within Lejweleputswa decreased annually at an average rate of -1.63% from 2009 to 2019. In Lejweleputswa district municipality the economic sectors that recorded the largest number of employments in 2019 was the trade sector with a total of 28 400 employed people or 20.0% of total employment in the district municipality. The community services sector with a total of 26 400 (18.6%) employs the second highest number of people relative to the rest of the sectors. The electricity sector with 1 320 (0.9%) is the sector that employs the least number of people in Lejweleputswa District Municipality, followed by the transport sector with 5 560 (3.9%) people employed. Employment in Lejweleputswa for both the formal and informal sector dropped by 17 720 individuals between 2008 and 2018. This decline was primarily driven by the reduction of employment in the mining and agricultural sectors. In 2019, there were a total number of 137 000 people unemployed in Lejweleputswa, which is an increase of 61 800 from 75 100 in 2009. The total number of unemployed people within Lejweleputswa constitutes 33.17% of the total number of unemployed people in Free State Province. It is reported by IHS Markit Regional eXplorer version 1946 (2019) that Lejweleputswa district municipality registered 50.9% unemployment in 2019. Lejweleputswa is one of the worst municipalities with the highest rate of unemployment in the Free State province. When comparing unemployment rates among municipalities within Lejweleputswa district municipality, Matjhabeng local municipality has indicated the highest unemployment rate of 55.3%, which has increased from 31.9% in 2009. It can be seen that the Tokologo local municipality had the lowest unemployment rate of 26.1% in 2019.

4.4.4. Education

According to Community Survey (2016), 68% of young people completed Grade 9 or higher and 37,4% completed matric or higher

However, in 2019, 18 900, people of the population of Lejweleputswa district (aged 15 years and older) had no education, while 83.9% (aged 15 years and older) of the population had completed primary schooling. The number of people without any schooling in Lejweleputswa district municipality accounts for 19.67% of the number of people without schooling in the province and a total of 0.85% of the national share. In 2019, the number of people in Lejweleputswa district municipality with a matric only was 114,000 which is a share of 21.61% of the province's total number of people that has obtained a matric. The number of people with a matric and a post graduate degree constitutes 16.25% of the province and 0.75% of the national proportion. Those aged 15 and above who completed secondary education were 114,000 making up 21.6% of the provincial population with matric. In 2019 the matric pass rate in the district was 87.8%, which is comparable to the rest of the districts in the province. In 2018, the district had a total number of 241 schools in ten circuits (19.8% of the province) and 157 321 learners (22% of the province), an indication of high population density and possible overcrowding in schools (Department of Basic Education, 2017/18 Annual Report). In terms of higher education, there is one TVET college (Goldfields TVET College) in Lejweleputswa District Municipality. Goldfields TVET College forms part of the fifty registered and accredited public TVET Colleges in South Africa. It operates on 3 Campuses and 1 satellite campus around the Lejweleputswa District Municipality. The college offers a wide range of courses / programmes in business and engineering studies. The University of the Free State (UFS) has two satellite campuses, one located in Thabo Mofutsanyane and the other in Welkom, Lejweleputswa.

4.4.5. Income and poverty

The South African Multidimensional Poverty Index (SAMPI) head count poverty rate in Lejweleputswa is 3%, down from 6% in 2011. In 2019, the Lejweleputswa District has 45.9% of its inhabitants living below the poverty line, according to IHS Markit (Global Insight). This is worse than the provincial average of 44%. Apart from poverty, the Lejweleputswa district outperformed the country on the following indicators: Household Income Growth of 6.7% (South Africa – 5.7%), Increase in Informal Employment of 18.6% (national 17.7%), and Productivity Growth of 0.2% (national -0.1%) over a 10-year average (Cooperative Governance and Traditional Affairs, 2020). In 2019, the Gini coefficient in Lejweleputswa District Municipality was at 0.62.

4.5. Matjhabeng Local Municipality

Matjhabeng Local Municipality is situated in the Lejweleputswa District Municipality in the Free State. It is bound by the Nala Local Municipality to the north, Masilonyana Local Municipality to the south, Tswelopele Local Municipality to the east and Moqhaka Local Municipality to the west. Matjhabeng represents the hub of mining activity in the Free State province.

The Matjhabeng Municipal area, previously known as the Free State Goldfields, consists of the following towns:

- Welkom / Thabong
- Allanridge / Nyakalong
- Odendaalsrus / Kutlwanong
- Hennenman / Phomelong
- Ventersburg / Mmamahbane
- Virginia / Meloding

The area is favourably located in the north-eastern Free State about 250km south of Johannesburg and 160km north of Bloemfontein. The nearest harbour is Durban and it is approximately 565km from Matjhabeng by road.

4.5.1. Population

MLM's population grew at an annual growth rate of 5% between 2008 and 2018 and is expected to grow by 2.3% and 2.2% from 2020 to 2025 and from 2025 to 2030 respectively. Comparatively, all geographic regions, including South Africa, experienced a decline in the population growth rate for the period 2025 – 2030.

Table 5: Overview of the population in the Study area

Area	Total Population		Growth Rate	Total Population		Growth Rate	Total Population		Growth Rate
	2009	2019	2008 - 2018	2020	2024	2019 - 2025	2025	2030	2025 - 2030
South Africa	49 176 550	57 725 606	17%	49 928 233	58 669 595	14.9%	63 434 676	67 579 205	6.1%
Free State	2 770 303	2 954 348	7%	2 95 6442	305 4058	3.2%	3 072 325	3 158 716	2.7%
Lejweleputswa	636 995	664 592	4%	664 818	680 260	2.3%	682 670	694 778	1.7%
Matjhabeng	408 253	427 770	5%	430 313	440 408	2.3%	442 111	452 010	2.2%

The Matjhabeng Local Municipality has a total population of 406 461 people, of which 87.7% are Black African. The Coloured population makes up 2.1%, and 9.6% are White. Of the people aged 20 and older, 38.8% have some form of secondary schooling and only 28.1% have matric. In the municipality, 4.6% of people have no schooling and 14% have some form of primary schooling.

4.5.2. Economy

Matjhabeng is the largest municipality in the district and it contains most of the mining activities, especially gold mining, followed by Masilonyana with some of the gold and diamond mining. Recently the mining sector has been on a downward trend because of closures of many of the shafts due to high costs of production among others and the need for deep mining. The recent decline in world commodity prices, has aggravated the situation in general with many businesses that were traditionally dependent on the mining sector have either closed down or are in the process of closing down. Other municipalities primary sector relies heavily on agriculture.

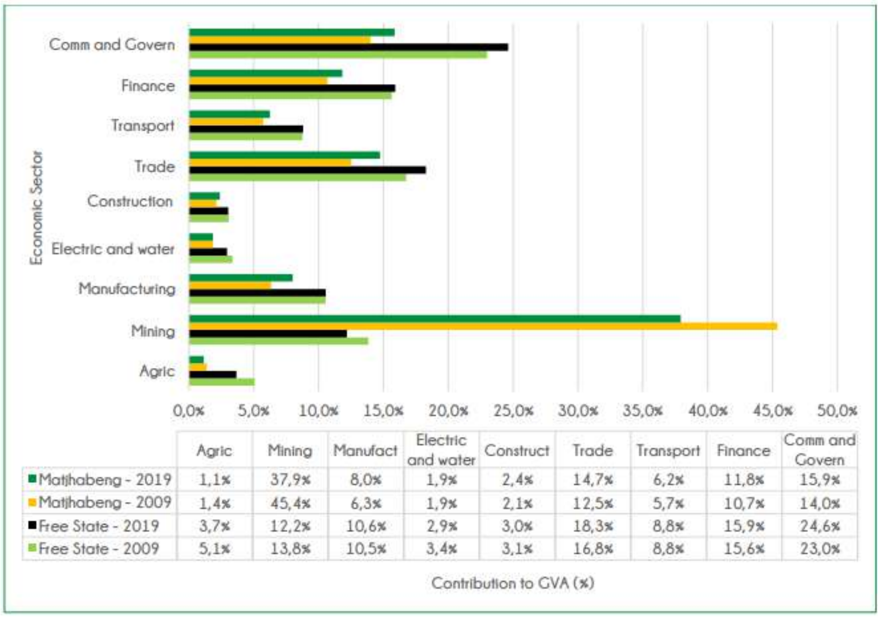

Figure 11: Contribution of the municipality to the GVA

4.5.3. Employment

The Matjhabeng Local Municipality (MLM) has an official unemployment rate of 34%. Table 6 provides a comparative labour profile for the MLM relative to the wider economy between 2009 and 2019. It shows that unemployment in the MLM is similar to the average or the Lejweleputswa DM (35%) and the Free State (35%), and lower than the national rate, with an approximate 10% increase over the past ten years. This implies that although job creation is a top priority for the MLM, the unemployment situation is severe, as in other areas of the Province.

Table 6 also illustrates the number of non-economically active people in each economy. It shows that the MLM has approximately 97 276 non-economically active people, almost 10 000 more than in 2009, including students, mothers, discouraged workers and others not currently looking for employment.

Table 6: Overview of Employment Statistics in the study area

Geographic Area		South Africa	Free State	Lejweleputswa	Matjhabeng
Unemployment. Rate	2009	23%	23%	21%	21%
	2019	40%	35%	35%	34%
Not Economically Active	2009	13 829 026	712 017	145 036	87 601
	2019	14 750 988	743 230	160 448	97 276
Working Age Pop	2009	32 652 624	1 770 707	407 459	269 970
	2019	36 806 037	1 859 667	429 471	285 950
Labour Force Participation Rate	2009	58%	60%	64%	68%
	2019	65%	65%	68%	71%
Youth Unemployment Rate (15 - 24)	2009	44%	46%	47%	48%
	2019	49%	50%	50%	53%

4.5.4. Education

The skills level within a study area is best illustrated in comparison to the wider region, which competes for investment and skilled workers. Table 7 compares the highest level of education of residents in the MLM to those in the wider regions in 2019. MLM has the lowest proportion of residents with no schooling in the study region. Although the residents with grade 12 is low, it is consistent with that of the wider region. These figures indicate that the Free State, as a whole, should pay more attention to the education of scholars as economic development and industrialization depends on the skill levels and education of the workforce.

Table 7: Overview of Education in the study area

	Matjhabeng	Dihlabeng	Maluti a Phofung	Ngwathe	Metsimaholo
No Schooling	7%	10%	10%	10%	8%
Less Than Grade 7	39%	39%	40%	43%	34%
Less Than Grade 12	36%	32%	33%	31%	36%
Grade 12 / Matric	2%	2%	2%	1%	3%
More than Grade 12	4%	5%	3%	3%	5%
N/A	13%	13%	12%	12%	14%

4.5.5. Income and poverty

The level of household income in a study area is an important indicator of socio-economic wellbeing. It also illustrates the purchasing power within a local population and thus the viability of retail and other businesses. Finally, income levels are used to measure poverty and determine areas requiring significant social welfare investment. The purpose of this sub-section is to provide an overview and comparison of income and poverty levels in the MLM. This information will be utilised to gauge the demand for and extent of LED necessary in the region.

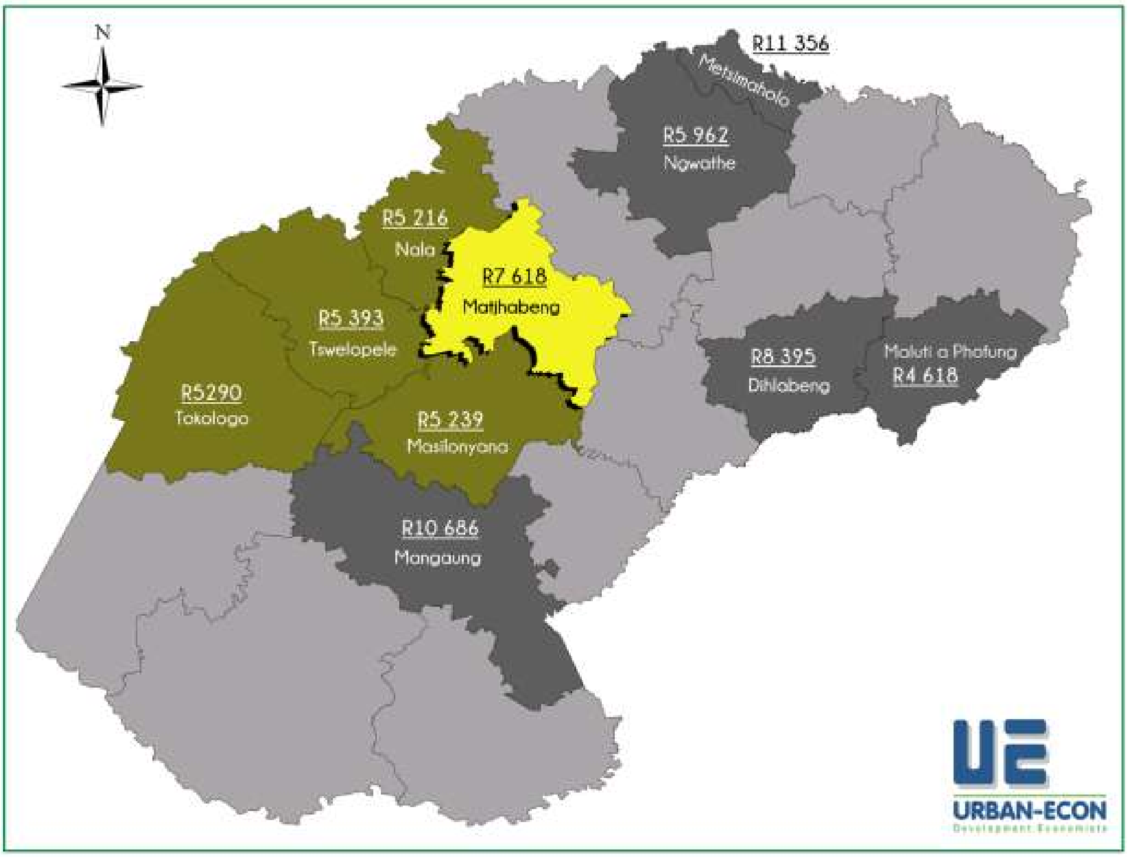

Figure 12: Average income in Matjabeng municipality

5. ASSESSMENT OF KEY SOCIAL ISSUES AND IMPACT

5.1. Introduction

Section 5 identifies the key social issues identified during the SIA study. The identification of social issues was based on:

- Review of project related information, including other specialist studies;
- Application of relevant Legislation from a local to national level;
- Experience of the authors of the area and the local conditions; and
- Experience with similar projects.

In identifying the key issues the following assumption is made:

- The area identified for the proposed SEF meets the technical criteria required for such facilities.

This Chapter provides a detailed description and evaluation of the potential social impacts that have been identified for the detailed design and construction, operation, and decommissioning phases, of the proposed Harmony Central Solar PV.

This assessment considered the following points:

- The nature, extent and significance of the features within the social landscape being considered.
- The existing disturbance already present within the social landscape (i.e. mining activities and other industrial developments / infrastructure).

Social impacts are expected to occur during both the construction and operation phases of the Harmony Central Solar PV. The status of the impacts will either be positive or negative and either mitigation or enhancement measures are recommended for the management of the impacts, depending on the status of the impacts.

5.2. Identification of Key Social Issues

The identified key social issues are discussed below. They are divided into policy and planning related, and local and site-specific issues. Local and site-specific issues are further divided into construction and operational related issues.

5.3. Social Impacts Associated with the Construction Phase

The majority of social impacts associated with the project are anticipated to occur during the construction phase of the development and are typical of the type of social impacts generally associated with construction activities. These impacts will be temporary and short-term (~12 months) but could have long-term effects on the surrounding social environment if not planned or managed appropriately. It is therefore necessary that the detailed design phase be conducted in such a manner so as not to result in permanent social impacts associated with the ill-placement of project components or associated infrastructure or result in the mismanagement of the construction phase activities.

The positive and negative social impacts identified and assessed for the construction phase includes:

Potential positive impacts

- Creation of employment and business opportunities

Potential negative impacts

- Impacts associated with the presence of construction workers on site
- Threat to safety and security of farmers associated with the presence of
- construction workers on site
- Increased risk of stock theft, poaching and damage to farm infrastructure associated with presence of construction workers on the site
- Increased risk of veld fires associated with construction-related activities
- Impact of heavy vehicles, including damage to roads, safety, noise and dust
- Potential loss of grazing land associated with construction-related activities.

Table 8 - Creation of employment and business opportunities during the construction phase

	Rating	Motivation	Significance
Prior to Mitigation			
Duration	Short Term (2)	The construction period is estimated to range between 18 to 24 months depending on the scope of work.	**Medium (36)**
Extent	Local – Regional (2)	Standard practices for mines are to incentive the employing of local labour and contractors.	
Magnitude	Low (4)	No significant impact is predicted	
Probability	Highly probable (4)	If the solar facility is approved	
Mitigation / Enhancement Measures			

Enhancement:

In order to enhance local employment and business opportunities associated with the construction phase the following measures should be implemented:

Employment

- Where reasonable and practical the contractors appointed by the proponent should appoint local contractors and implement a 'locals first' policy, especially for semi and low-skilled job categories. However, due to the low skills levels in the area, the majority of skilled posts are likely to be filled by people from outside the area.
- Where feasible, efforts should be made to employ local contactors that are compliant with Broad Based Black Economic Empowerment (BBBEE) criteria;
- Before the construction phase commences the proponent and its contractors should meet with representatives from the MLM to establish the existence of a skills database for the area. If such as database exists it should be made available to the contractors appointed for the construction phase.
- The local authorities, community representatives, and organisations on the interested and affected party database should be informed of the final decision regarding the project and the potential job opportunities for locals and the employment procedures that the proponent intends following for the construction phase.
- Where feasible, training and skills development programmes for locals should be initiated prior to the initiation of the construction phase.
- The recruitment selection process should seek to promote gender equality and the employment of women wherever possible.

Business

- The proponent should seek to develop a database of local companies, specifically Broad Based Black Economic Empowerment (BBBEE) companies, which qualify as potential service providers (e.g. construction companies, catering companies, waste collection companies, security companies etc.) prior to the commencement of the tender process for construction contractors. These companies should be notified of the tender process and invited to bid for project-related work;
- The proponent, in consultation with the MLM and the local Chamber of Commerce, should identify strategies aimed at maximising the potential benefits associated with the project.
- Note that while preference to local employees and companies is recommended, it is recognised that a competitive tender process may not guarantee the employment of local labour for the construction phase.

Opportunities for Skills Development and On-Site Training

The proposed energy project provides additional opportunities for skills development and on-site training in the following areas:

- Site Area preparation work
- Road
- Fences
- Base foundation for Cabins
- Trenching for MV, LV (AC, DC) and Data cables
- Installation of foundation
- Installation of supporting structure
- Installation of FV modules
- Solar cables & DC cables
- String boxes and LV cables

• Inverter cabins including MV&LV panels & switchgears & AUX transformer • MV cables • Lightning protection system, video surveillance and intrusion detection system • Assembling and test of the overall equipment			
Assessment of No-Go Option			
The potential employment and economic benefits associated with the construction of the proposed SEF would be forgone. The potential opportunity costs in terms of the capital expenditure, employment, skills development, and opportunities for local business are therefore regarded as a negative.			
Post Mitigation/Enhancement Measures			
Duration	Short Term (2)	Improved the skills of local communities which will improve the quality of life	**Medium (32)**
Extent	Local – Regional (2	Largely local however work influx may occur	
Magnitude	Low (4)	No significant impact is predicted	
Probability	Highly probable (4)	Historical trends show that development of any significance has a definite impact on local economies	
Cumulative Impacts: Opportunity to up-grade and improve skills levels in the area.			
Residual Risks: Improved pool of skills and experience in the local area.			

Presence of Non-Local and Foreign Construction Workers in the Area

The presence of construction workers in the area, in particular if they relocated into the area from other parts of South Africa, the continent or even overseas, poses a potential risk to social cohesion and dynamics amongst people living in the area. Family structures and social networks are possibly influenced by the influx of construction workers to the area.

The social behaviour and general conduct of these workers as well as that of the local population determines the realized impact. Potential risks include:

- An increase in alcohol and drug use;
- An increase in crime levels;
- An increase in teenage and unwanted pregnancies;
- An increase in prostitution; and
- An increase in sexually transmitted diseases (STDs).

While the potential threat posed by construction workers to the community as a whole is likely to be low, the impact on individual members who are affected by the presence of construction workers has the potential to be high.

Table 9 - Potential harmful impacts on family structures and social networks associated with the presence of non-local and foreign construction workers in the project surrounding local communities and towns

	Rating	Motivation	Significance
Prior to Mitigation			
Duration	Medium Term (3) Long term-permanent (5)	Medium Term for community as a whole (3) Long term-permanent for individuals who may be affected by pregnancy and STD's etc. (5)	**Low for the community as a whole (27)** **Moderate-High for specific individuals who may be affected by pregnancy and STD's etc. (57)**
Extent	Local (2)	The impact will be on specific members of the community	
Magnitude	Low (4) High/Very High (10)	Low for the community as a whole (4) High-Very High for specific individuals who may be affected by pregnancy and STD's etc.(10)	
Probability	Probable (3)	Applicable if development invites non local residence	
Mitigation / Enhancement Measures			

Mitigation:

The potential risks associated with construction workers can be mitigated. The aspects that should be covered include, on site:

- Where possible, the proponent should make it a requirement for contractors to implement a 'locals first' policy for construction jobs, specifically semi and low-skilled job categories. This will reduce the potential impact that this category of worker could have on local family and social networks;
- The proponent should consider the establishment of a Monitoring Forum (MF) for the construction phase. The MF should be established before the construction phase commences and should include key stakeholders, including representatives from the local community, local councillors, farmers, and the contractor. The role of the MF would be to monitor the construction phase and the implementation of the recommended mitigation measures. The MF should also be briefed on the potential risks to the local community associated with construction workers;
- The proponent and the contractors should, in consultation with representatives from the MF, develop a Code of Conduct for the construction phase. The code should identify what types of behaviour and activities by construction workers are not permitted. Construction workers that breach the code of good conduct should be dismissed. All dismissals must comply with the South African labour legislation;
- The proponent and the contractors should ensure that all workers on-site have equal access and rights to any programmes offered and facilities provided for the entertainment and benefit of workers.

In the project-surrounding local communities and town:

- The proponent and the contractor should implement an HIV/AIDS awareness programme for all construction workers at the outset of the construction phase;
- The proponent and the contractor should communicate the conditions of employment, in particular the temporality of employment to the residents of the area, using appropriate structures and communication processes.
- The proponent and the contractor, in collaboration with the established MF, should identify appropriate and feasible strategies to support a positive social integration of the construction workers in their roles as temporary residents of the area. Such strategies should target specific interests and exchanges, fostering skills and knowledge amongst participants through for example sport, musical or language activities.
- The movement of construction workers on and off the site should be closely managed and monitored by the contractors. In this regard the contractors should be responsible for making the necessary arrangements for transporting workers to and from site on a daily basis;
- The contractor should make necessary arrangements to enable workers from outside the area to return home over weekends and or on a regular basis during the 18 – 24 month construction phase. This would reduce the risk posed by non-local construction workers to local family structures and social networks;
- No construction workers, with the exception of security personnel, will be permitted to stay overnight on the site.

Assessment of No-Go Option

There is no impact as it maintains the current status quo. However, the potential positive impacts on the local economy associated with additional spending by construction workers in the local economy would be lost.

Post Mitigation/Enhancement Measures

Duration	Local (1)	Large construction projects tend to attract people to the area in the hope that they will secure a job, even if it is a temporary job	**Low for the community as a whole (24)** **Moderate-High for specific individuals who may be affected by pregnancy and STD's etc. (51)**
Extent	Medium Term (3) Long term-permanent (5)	Medium Term for community as a whole (3) Long term-permanent for individuals who may be affected by pregnancy and STD's etc. (5)	
Magnitude	Low (4) High/Very High (10)	Low for the community as a whole (4) High-Very High for specific individuals who may be affected by pregnancy and STD's etc.(10)	
Probability	Probable (3)	If development is approved there is a probability the community will be impacted	

Cumulative Impacts:

Impacts on family and community relations that may, in some cases, persist for a long period. Also in cases where unplanned / unwanted pregnancies occur or members of the community are infected by an STD, specifically HIV and or AIDS, the impacts may be permanent and have long term to permanent cumulative impacts on the affected individuals and / or their families and the community. The development of other solar energy projects in the area may exacerbate these impacts.
Residual Risks: Community members affected by STDs etc. and associated impact on local community and burden services etc.

Loss of Labour to the Construction of the PV Facility

Typically, in areas with a scarcity of skilled workers and / or a shortage of people available to work, employers compete for employees. Experience made on other renewable energy projects, including solar energy projects in South Africa indicated that they entice workers with attractive salaries. This can lead to a migration of workers from one employer to another. In a rural South African context, like this project area, this can entail people resigning or not returning (in case of seasonal jobs) to their usual employer. These employers are most often from farms and factories.

This might impact workers and their respective dependents. Farmers, mining institutions and factories risk losing employees to the proposed Harmony Central PV Facility for temporary or permanent employment. The likelihood of this is determined by the actual number of jobs available on-site, the level of education and skills and the appropriateness of these to qualify job seekers for employment on-site, wages offered by competing employers, as well as practicalities involved, including transport available to reach the solar energy site and working conditions.

A positive impact might occur on the workers that do commerce working or change to work on the solar energy site. They might gain skills and work experience allowing them to pursue a different career in the future

Table 10 - Potential impact on local employment associated the construction phase

	Rating	Motivation	Significance
Prior to Mitigation			
Duration	Medium Term (2)	Assumed that labor can be replaced	**Medium (30)**
Extent	Local (2)	Labor is generally sourced locally, although new labor may be migrating in, they will be considered local once established	
Magnitude	Moderate (6)	Assumed that local labor will be used	
Probability	Probable (3)	Seeking better wages and training it is assumed that some labor will migrate into development and maintenance of the solar plant	
Mitigation / Enhancement Measures			
Enhancement: The proponent can liaise with the local community and bigger employers to inform and discuss the possible competition for workers as well as associated timelines. Direct measures to prevent workers from change jobs are not possible to be implemented, beyond possibly identified strategies to coordinate the need for workers with the existing employers. Workers on the other hand shall be informed about the temporary employment opportunity and incentivized to focus on skills enhancement for future.			
Assessment of No-Go Option			
There is no impact as it maintains the current status quo given ease of labor replacement.			
Post Mitigation/Enhancement Measures			
Duration	Medium Term (3)	Assumed that labor can be replaced	**Low (24)**
Extent	Local (3)	Assumed that labor can be replaced	
Magnitude	Low (2)	Mitigation measures taking place	
Probability	Probable (3)	Labor is generally sourced locally, although new labor may be migrating in, they will be considered local once established	
Cumulative Impacts: Impacts on sectors such as farming operations due to loss of experienced labor.			

Residual Risks:
Increase in unemployment amongst local farm workers who are not rehired once construction worker comes to an end. On positive side, may result in increased skills for local farm workers and improve their economic mobility.

Increased Risk of Stock Theft, Poaching and Damage to Farm Infrastructure

- The construction phase lends itself to a high degree of stock theft. In this case, stock refers to both livestock and construction stock.
- Such damages foreseen include damages to infrastructure such as gates, barns and irrigation systems where relevant.
- The most severe stock losses would be a result of negligence on the part of the construction company as well as poor security.
- In particular, it is anticipated that December will be the most vulnerable construction month due to the construction holiday.
- The social impacts are thus adverse to the extent that local community members may participate in criminal activity during the construction phase.
- However, these impacts can be ameliorated through sound health & safety practices as well as the presence of 24-hour security on the site.

Table 11 - Potential impact on local farmers associated with Increased risk of stock theft, poaching and damage to farm infrastructure

	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	Medium Term (3)	Expected occurrence during the construction period	**Medium (33)**
Extent	Local (2)	Potential farms in the adjacent areas	
Magnitude	Moderate (6)	Due to reliance on agriculture and livestock for maintaining livelihoods	
Probability	Probable (3)	The presence on and movement of construction workers on and off the site poses a potential safety threat to local famers and farm workers in the vicinity of the site. In addition, farm infrastructure, such as fences and gates, may be damaged and stock losses may also result from gates being left open and / or fences being damaged	
Mitigation / Enhancement Measures			

Mitigation:

The mitigation measures that can be considered to address the potential impact on livestock, game, and farm infrastructure include:

- The proponent should enter into an agreement with the affected landowners whereby the company will compensate for damages to farm property and disruptions to farming activities. This includes losses associated with stock theft and damage to property etc. This agreement should be finalised before the commencement of the construction phase;
- The proponent should investigate the option of establishing a MF (see above) that includes local farmers and develop a Code of Conduct for construction workers. Should such a MF be required it should be established prior to commencement of the construction phase. The Code of Conduct should be signed by the proponent, the neighbouring landowners and the contractors before the contractors move onto site;
- The proponent should hold contractors liable for compensating farmers and communities in full for any stock losses and / or damage to farm infrastructure that can be linked to construction workers. This should be contained in tender documents for contractors and the Code of Conduct to be signed between the proponent, the contractors and neighbouring landowners. The agreement should also cover loses and costs associated with fires caused by construction workers or construction related activities (see below);
- The EMP must outline procedures for managing and storing waste on site, specifically plastic waste that poses a threat to livestock if ingested; Contractors appointed by the proponent should ensure that all workers are informed at the outset of the construction phase of the conditions contained on the Code of Conduct, specifically consequences of stock theft and trespassing on adjacent farms.
- Contractors appointed by the proponent should ensure that construction workers who are found guilty of stealing livestock, poaching and / or damaging farm infrastructure should be charged as per the conditions

contained in the Code of Conduct. All dismissals must be in accordance with South African labour legislation; • The housing of construction workers on the site should be limited to security personnel.			
Assessment of No-Go Option			
Assuming the no-go scenario, landowners as well as the project company would suffer extensive losses based on the severity of theft. The key mitigant for this is 24-hour on-site security. Additionally, the parties should take out insurance contracts to cover the potential losses.			
Post Mitigation/Enhancement Measures			
Duration	Medium Term (3)	Expected for the duration of construction activities	**Low (24)**
Extent	Local (1)	Directly affected properties where applicable	
Magnitude	Low (4)	Unemployment is high in the area, mitigation measures ensure equal opportunity	
Probability	Probable (3)	The potential risks (safety, livestock, and farm infrastructure) can be effectively mitigated by careful planning and managing the movement of construction on the site workers during the construction phase	
Cumulative Impacts: Impacts on farm operations due to loss of experienced farm labour.			
Residual Risks: Increase in unemployment amongst local farm workers who are not rehired once construction worker comes to an end. On positive side, may result in increased skills for local farm workers and improve their economic mobility.			

Safety and Security Risk

- The construction phase, due to increased traffic in the broader area may lend itself to greater security risks.
- However, given that the bulk of the labour force will be drawn from local community, the risk of crime as a result of labour influx is consistent with the norm.
- Other local industries such as mines may be impacted by the project through any damages to infrastructure, including:
  - Water supply
  - Electricity networks
  - Roads

Table 12 - Potential impact on safety of local developments

	Rating	Motivation	Significance
Prior to Mitigation			
Duration	Medium Term (2)	Expected occurrence during the construction period	**Medium (30)**
Extent	Local (2)	Potential farms, mines and industries in the adjacent areas	
Magnitude	Moderate (6)	Some safety issues are a concern with any new development, theft and illegal electricity connections must be monitored	
Probability	Probable (3)	The presence on and movement of construction workers on and off the site poses a potential safety threat to local famers / mines and the workers in the vicinity of the site. In addition, infrastructure, such as fences and gates, may be damaged and stock losses may also result from gates being left open and / or fences being damaged.	
Mitigation / Enhancement Measures			
Mitigation: It is critical to ensure that the project company can be held liable for any infrastructure damage that is directly linked to construction. In this way, they will assume a greater level of responsibility and claims can be duly made against them in cases of neglect.			
Assessment of No-Go Option			
All existing infrastructure remains as is, without any damage or improvements as a result of the project's likely investments. Evidence from the other renewable energy projects indicates that the movement and activities of construction workers can			

impact on local communities. However, this is usually associated with projects located in rural areas and the risks are to local farmers.			
Post Mitigation/Enhancement Measures			
Duration	Short Term (2)	Expected occurrence during the construction period	**Low (21)**
Extent	Local (2)	Potential developments in the adjacent areas	
Magnitude	Low (4)	Low impact is predicted	
Probability	Probable (3)	The presence on and movement of construction workers on and off the site poses a potential safety threat.	
Cumulative Impacts: Minimal			
Residual Risks: Delays in repairing damaged infrastructure may result in temporary unrest.			

Increased Risk of Veld Fires

The presence of construction workers and construction-related activities on the site poses an increased risk of veld fires that in turn pose a threat to the livestock, wildlife, and farmsteads in the area. In the process, farm infrastructure may also be damaged or destroyed and human lives threatened. All of the landowners interviewed, identified that veld fires were an issue of concern. In this regard all of the farms in the area are dependent on grazing and any loss of grazing due to a fire would therefore impact negatively on the livelihoods of the affected farmers. The potential risk of veld fires is likely to be higher during the dry, winter months.

Table 13 - Potential impact on veld fires due to construction phase			
	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	Local (4)	Rated as 4 due to potential severity of impact on local farmers	**Medium (36)**
Extent	Short Term (2)	Fires are mainly a risk during winter months and only if the proper measures are not in place	
Magnitude	Moderate (6)	The impact predicted are subjected to specific conditions	
Probability	Probable (3)	Due to the climate and sparseness of vegetation, the study area is not considered veld fire prone. The potential fire risk of grass fires is highest during the dry winter months	
Mitigation / Enhancement Measures			
Mitigation: The landowner and project company should insure against fires to then compensate for any losses suffered by both themselves and neighbouring farms.			
Assessment of No-Go Option			
There is least risk in the no-go scenario, however it does not completely ameliorate against the risk of fire owing to its fundamentally seasonal nature.			
Post Mitigation/Enhancement Measures			
Duration	Local (2)	Rated as 2 due to potential severity of impact on local farmers	**Low (24)**
Extent	Short Term (2)	The potential fire risk of grass fires is highest during the dry winter months	
Magnitude	Low (4)	With mitigation the predicted impact has a low magnitude	
Probability	Probable (3)	Higher risk during the winter months as mentioned above	
Cumulative Impacts: If fire spreads to neighboring properties, the effects will be compounded.			
Residual Risks: No, provided losses are compensated for.			

Impacts Associated with Movement of Construction Vehicles

Construction activities on the site, including the movement of heavy construction vehicles, have the potential to create noise, dust, and safety impacts and damage roads, specifically unsurfaced roads. Experience from other projects also indicates that the transportation of construction workers to and from the site can result in the generation of waste along the route (packaging and bottles etc. thrown out of windows etc.). The preparation of the site and associated levelling and clearing of vegetation will expose the soil to wind and result in dust. The dust impacts will be exacerbated during windy periods.

- Large construction vehicles will invariably create noise, dust and disruptions to traffic on the main roads leading to the site.
- The most severe adverse effects can be damage to tarred roads.
- Additionally, neglect on the part of drivers can result in traffic accidents.
- The SIA notes that movement between communities is low due to an under-developed transport system and therefore would foresee a low probability of community members being endangered as a result of the construction traffic.

Table 14 - Potential impact on local communities and infrastructure associated with vehicle movements during construction phase

	Rating	Motivation	Significance
Prior to Mitigation			
Duration	Medium Term (3)	For the length of construction	**Low (27)**
Extent	Local-Regional (2)	The project components are also likely to be transported to the site via the M1, R73 and the M1, which are key transport routes linking Gauteng and the Western and Eastern Cape. The transport of components to the site therefore has the potential to impact on other road users travelling along these roads, including tourists.	
Magnitude	Low (4)	The potential impacts on travelers and tourists can be effectively mitigated by restricting construction traffic movements to weekdays, and, where possible, limiting activities during holiday periods, specifically Christmas and Easter holiday periods and other long weekends	
Probability	Probable (3)	The movement of heavy construction vehicles will also damage internal farm roads and other unsurfaced public roads that may be used to access the site. The damage will need to be repaired after the completion of the construction phase.	
Mitigation / Enhancement Measures			

Mitigation:

It is critical to ensure that the project company can be held liable for any infrastructure damage that is directly linked to construction. In this way, they will assume a greater level of responsibility and claims can be duly made against them in cases of neglect:

- The proponent should prepare a Community Health, Safety and Security Plan (CHSSP) prior to commencement of the construction phase.
- As far as possible, the transport of components to the site should be planned to avoid weekends and holiday periods.
- The movement of heavy construction vehicles should be timed to avoid start and closing times of schools and am and pm peaks.
- The contractor should inform local farmers and representatives from the LM and relevant provincial road authorities of dates and times when abnormal loads will be undertaken.
- The contractor must ensure that damage caused by construction related traffic to the gravel public roads and local, internal farm roads is repaired on a regular basis throughout the construction phase. The costs associated with the repair must be borne by the contractor.
- Dust suppression measures must be implemented for heavy vehicles such as wetting of gravel roads on a regular basis, adhering to speed limits and ensuring that vehicles used to transport sand and building materials are fitted with tarpaulins or covers.
- All vehicles must be roadworthy, and drivers must be qualified and made aware of the potential road safety

issues and need for strict speed limits. • The Contractor should ensure that workers are informed that no waste can be thrown out of the windows while being transported to and from the site. Workers who throw waste out windows should be fined. • The Contractor should be required to collect waste along access roads on a weekly basis. • Waste generated during the construction phase should be transported to the local permitted landfill site. • EMPr measures (and penalties) should be implemented to ensure farm gates are closed at all times. • EMPr measures (and penalties) should be implemented to ensure speed limits are adhered to at all times.			
Assessment of No-Go Option			
There is no impact as it maintains the current status quo.			
Post Mitigation/Enhancement Measures			
Duration	Medium (2)	During the construction phase	**Low (24)**
Extent	Local-Regional (1)	Affecting local and regional transport and access routes	
Magnitude	Low (4)		
Probability	Probable (3)	It is assumed that some infrastructure integrity be lost due to construction activities	
Cumulative Impacts: Impacts on farm operations due to damaged infrastructure.			
Residual Risks: If damage to local farm roads is not repaired, then this will affect the activities in the area and result in higher maintenance costs for vehicles of local farmers and other road users. The costs will be borne by road users who were not responsible for the damage.			

5.4. Social Issues Associated with the Operation Phase

The operational phase is associated with the following key potential positive and negative social issues.

Potential positive impacts:

- Creation of employment and business opportunities.
- Benefits associated with the additional funding available for socio-economic and / or enterprise development measures;
- Benefits associated with the establishment of a legal entity representing allocated beneficiary community (such as a community trust);
- Impact on tourism;
- The establishment of renewable energy infrastructure.

Potential negative impacts:

- The visual impacts and associated impact on sense of place;
- Potential impact on tourism;
- Influx of job seekers to the area;
- Loss of farm labour.

5.4.1. Creation of Employment and Business Opportunities

The power plant's 20-year license provides the perfect platform for long-term employment creation and business development through procurement. As a result, it has the potential to sustain a large number of families and critically, to catalyse additional industries in order to sustain the development gains, post decommissioning.

The power plant is anticipated to employ 50 people per annum during its operations phase. These people are likely to be employed through 3 key contractors, businesses which will grow as a result of doing business with the power plant i.e., landscaping, security and cleaning.

Table 15 - Creation of employment and business opportunities during the Operations phase

	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	Long Term (4)	The benefits of employment will be seen during the	**Medium (33)**

		operation phase for over 20 years	
Extent	Local and Regional (1)	Local and regionally migrating individuals will be affected	
Magnitude	Moderate (6)	The impact is relevant for socio economic development to take place in the area	
Probability	Probable (3)	It is assured that this impact will occur although on a smaller scale than other types of development	
Mitigation / Enhancement Measures			
Enhancement: The enhancement measures listed in Section 5.3, i.e., to enhance local employment and business opportunities during the construction phase, also apply to the following: • The proponent should implement a training and skills development programme for locals during the first 5 years of the operational phase. • The aim of the programme should be to maximise the number of locals employed during the operational phase of the project. • The proponent, in consultation with the MLM, should investigate the opportunities for establishing a Community Trust (see above comments).			
Assessment of No-Go Option			
The potential opportunity costs in terms of the loss of employment and skills and development training would be lost which would represent a negative impact.			
Post Mitigation/Enhancement Measures			
Duration	Long Term (4)	The benefits of employment will be seen during the operation phase for over 20 years	**Medium (48)**
Extent	Local and Regional (2)	Local and regionally migrating individuals will be affected	
Magnitude	Moderate (6)	The impact is relevant for socio economic development to take place in the area	
Probability	Highly Probable (4)	It is assured that this impact will occur although on a smaller scale than other types of development	
Cumulative Impacts: Opportunity to up-grade and improve skills levels in the area.			
Residual Risks: Improved pool of skills and experience in the local area.			

Improve energy security and support the renewable energy sector

The primary goal of the proposed project is to improve energy security in South Africa by generating additional energy. The proposed SEF also reduces the carbon footprint associated with energy generation. The project should therefore be viewed within the context of the South Africa's current reliance on coal powered energy to meet the majority of its energy needs.

Table 16 - Development of infrastructure to improve energy security and support renewable sector			
	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	Long Term (4)	Will have a positive impact on the national electricity grid.	**Medium (52)**
Extent	Local and International (3)	Reduces the need for coal fired power and will attract international opportunities	
Magnitude	Moderate (6)	With the move towards sustainable energy this impact is inline with National goals	
Probability	Highly Probable (4)	Effect will be noted from independent power generation.	
Mitigation / Enhancement Measures			
South Africa's energy crisis, which started in 2007 and is ongoing, has resulted in widespread rolling blackouts (referred to as load shedding) due to supply shortfalls. The load shedding has had a significant impact on all sectors of the economy and on investor confidence. A review of the REIPPPP and establishment of renewable energy facilities not only addresses environmental issues associated with climate change and consumption of scarce water resources, but also create significant socio-economic opportunities and benefits, specifically for historically disadvantaged, rural communities.			

No mitigation is recommended.			
Assessment of No-Go Option			
The potential loss of opportunity in terms of the loss of alternative energy generation, employment creation and sector development will have a negative impact.			
Post Mitigation/Enhancement Measures			
Duration	Long Term (4)	N/A	**Medium (52)**
Extent	Local and International l (3)	N/A	
Magnitude	Moderate (6)	N/A	
Probability	Highly Probable (4)	N/A	
Cumulative Impacts: Opportunity to up-grade and improve skills levels in the area as well as aid in the elimination of rolling black outs			
Residual Risks: • The renewable energy infrastructure places this project at the heart of the national strategy to increase power supply as well as reduce power generation impacts on climate. • The power plant's location also uniquely connects the local community to skills for this sector, thus improving their employability.			

5.4.2. Benefits Associated with the Additional Funding

Table 17 - Potential impact on community owing to Economic development

	Rating	Motivation	Significance
Prior to Mitigation			
Duration	Long Term (4)	Creation of employment and business opportunities associated with the operational phase.	**Medium (36)**
Extent	Local and Regional (2)	The proposed development will create in the region of 20 full time employment opportunities during the operational phase, of which 70% will be unskilled, 25% semi-skilled 25%, and 5% skilled 5%.	
Magnitude	Moderate (6)	The direct employment opportunities associated with the operational phase of renewable energy projects are relatively limited. However, a review of the REIPPPP indicates that the benefits associated with the operation of renewable energy projects are significant and extend beyond direct employment opportunities.	
Probability	Probable (3)	Employment opportunities although limited will be created	
Mitigation / Enhancement Measures			
Enhancement: In order to maximise the benefits and minimise the potential for corruption and misappropriation of funds the following measures should be implemented: • The proponent in consultation with the MLM should establish criteria for identifying and funding community projects and initiatives in the area. The criteria should be aimed at maximising the benefits for the community as a whole and not individuals within the community. • The proponent in consultation with the MLM should ensure that strict financial management controls, including annual audits, should be implemented to ensure that the funds generated for the community trust from the SEF are managed for benefit of the community as a whole and not individuals within the community.			
Assessment of No-Go Option			
There is no impact as it maintains the current status quo. However, the potential opportunity costs in terms of the supporting the social and economic development in the area would be lost. This would also represent a negative impact.			
Post Mitigation/Enhancement Measures			
Duration	Long Term (4)	Creation of employment and business opportunities associated with the operational phase.	**High (65)**
Extent	Local and Regional (3)	The proposed development will create in the region of 20 full time employment opportunities during the operational	

		phase, of which 70% will be unskilled, 25% semi-skilled 25%, and 5% skilled 5%.	
Magnitude	Moderate (6)	The direct employment opportunities associated with the operational phase of renewable energy projects are relatively limited. However, a review of the REIPPPP indicates that the benefits associated with the operation of renewable energy projects are significant and extend beyond direct employment opportunities.	
Probability	Definite (5)	Employment opportunities although limited will be created	
Cumulative Impacts: The community can invest in long-term development projects from dividends earned.			
Residual Risks: The community will gain administrative autonomy in determining their own development trajectory.			

The Visual Impacts and Associated Impact on Sense of Place

The solar panels and related parts will have an impact on the appearance of the landscape. However, given that these ground-mounted panels will not be very high, the impact will be low if not negligible.

Sense of place refers to a unique experience of an environment by a user, based on his or her cognitive experience of the place. Visual criteria, specifically the visual character of an area (informed by a combination of aspects such as topography, level of development, vegetation, noteworthy features, cultural / historical features, etc.), plays a significant role.

An impact on the sense of place is one that alters the visual landscape to such an extent that the user experiences the environment differently, and more specifically, in a less appealing or less positive light.

The environment surrounding the proposed PV facility has a predominantly rural and undeveloped character. These generally undeveloped landscapes are considered to have a high visual quality, except where urban development and mining/industrial activities represents existing visual disturbances.

The anticipated visual impact of the proposed PV facility on the regional visual quality, and by implication, on the sense of place, is difficult to quantify, but is generally expected to be of **low** significance. This is due to the relatively low viewer incidence within close proximity to the proposed development site and the presence of existing mining and industrial activities within the region.

Table 18 - Potential impact on community			
	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	Long term (4)	The development will be visible for its life cycle duration	**Low (22)**
Extent	Regional (3)	Visual receptors within the local area will be subjected to this impact	
Magnitude	Low (4)		
Probability	Improbable (2)	There is a small chance that this will impact visual receptors.	
Mitigation/Enhancement Measures			
Mitigation:			
Post Mitigation/Enhancement Measures			
Duration	Long term (4)	The development will be visible for its life cycle duration	
Extent	Regional (3)	Visual receptors within the local area will be subjected to this impact	
Magnitude	Low (4)		
Probability	Improbable (2)	There is a small chance that this will impact visual receptors.	
Cumulative impacts: The combined effects of these changes will negatively affect the overall character of the landscape.			

***Residual Risks:** The visual impact will be removed after decommissioning, provided the PV facility infrastructure is removed. Failing this, the visual impact will remain.*

5.5. Social Issues Associated with the Decommissioning Phase

The social impact of decommissioning the Central PV project is likely to be significant. While there are a relatively small number of people employed during the operational phase (20), the associated funding available for community projects and benefits are significant and expected to end with decommissioning of the plant. With mitigation however, the impacts are assessed to be low.

The proponent should inform and discuss with the stakeholder and wider community involved and affected in the governance, management and implementation of community funds about the decommissioning of the energy project. This communication needs to be timed well in advance of the decommissioning, allowing all relevant parties to prepare. Further consideration is required to develop strategies for rehabilitation of the land.

Table 19 - Social impacts associated with retrenchment including loss of jobs, and source of income			
	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	Medium Term (2)	Influx of unemployed workers, it is assumed that these workers will be reemployed or relocate.	**Medium (44)**
Extent	Local and regional (3)	Local community member will lose a source of income, individuals who have migrated in will struggle to support their families in surrounding areas	
Magnitude	Moderate (6)	Economic setbacks will occur as a result of decommissioning	
Probability	Highly Probable (4)	Decommissioning will result in loss of employment	
Mitigation / Enhancement Measures			
Mitigation: The following mitigation measures are recommended: • The proponent should ensure that retrenchment packages are provided for all staff who stand to lose their jobs when the plant is decommissioned. • All structures and infrastructure associated with the proposed facility should be dismantled and transported off-site on decommissioning. • The proponent should investigate the option of establishing an Environmental Rehabilitation Trust Fund to cover the costs of decommissioning and rehabilitation of disturbed areas. The Trust Fund should be funded by a percentage of the revenue generated from the sale of energy to the national grid over the 20 year operational life of the facility. The rationale for the establishment of a Rehabilitation Trust Fund is linked to the experiences with the mining sector in South Africa and failure of many mining companies to allocate sufficient funds during the operational phase to cover the costs of rehabilitation and closure.			
Assessment of No-Go Option			
There is no impact as it maintains the current status quo.			
Post Mitigation/Enhancement Measures			
Duration	Very Short Term (1)	The mitigation measures will ensure that the workforce will be able to establish themselves before unemployment occurs	**Low (16)**
Extent	Local and regional (2)	Impact will effect local individuals as well as individuals who have migrated in to the area.	
Magnitude	Low (4)	Economic setbacks will occur as a result of decommissioning however mitigation negates the risk	
Probability	Highly Probable (4)	Decommissioning will result in loss of jobs; however the mitigation measures will provide alternative opportunities.	
Cumulative Impacts: Loss of jobs and associated loss of income etc. can impact on the local economy and other businesses. However, decommissioning can also create short term, temporary employment opportunities associated with dismantling etc.			
Residual Risks:			

Typically, major social impacts associated with the decommissioning phase are linked to the loss of jobs and associated income and will be like the impacts during the construction phase associated with construction activities. This has implications for the households who are directly affected, the communities within which they live, and the relevant local authorities. The impact of the decommissioning phase is expected to be negligible due to the small number of permanent employees affected. The potential impacts associated with decommissioning phase can also be effectively managed with the implementation of a retrenchment and downscaling programme. With mitigation, the impacts are assessed to be Low (negative).

5.6. Social Issues Associated with the No-Development Option

The "no-go" alternative is the option of not constructing the Harmony Central Solar PV. The implementation of the proposed project is expected to result in a number of positive and negative social impacts. The majority of negative impacts identified for the project are associated with the construction phase of the project, while the positive impacts are associated with both the construction and operation phases of the project.

Potential negative social impacts associated with the construction and operation of the project include the following:

- Potential influx of job seekers and an associated change in population and increase in pressure on basic services.
- Potential safety and security impacts.
- Potential impacts on daily living and movement patterns.
- Potential nuisance impacts (noise and dust).
- Potential visual impact and impact on the sense of place.
- Potential loss of agricultural land.

Potential positive social impacts associated with the construction and operation of the project include the following:

- Potential direct and indirect employment opportunities.
- Potential economic multiplier effect.

The impacts of pursuing the "no-go" alternative can therefore be summarised as follows:

- The benefits would be that there is no disruption from nuisance impacts (noise and dust during construction), visual impacts and safety and security impacts. The impact is therefore neutral.
- There would also be an opportunity loss in terms of limited job creation, skills development, community upliftment and associated economic business opportunities for the local economy. This impact is considered to be negative.
- The opportunity to strengthen the grid connection within the municipal area would be lost which will have a negative impact on economic growth and development and therefore result in negative social impacts.

The No-Development option would mean that the electricity generated through renewable sources, in this case solar energy, is not generated and fed into the national electricity grid. In the given and described policy context, this would represent a negative social and environmental cost.

In addition, the employment opportunities associated with the construction and operational phase, as well as the benefits associated with the additional funding for socio-economic and enterprise development measures and the established local ownership entity representing beneficiary communities would be forgone.

Table 20 - The no-development option would result in the lost opportunity for South Africa to supplement is current energy needs with renewable energy.

	Rating	Motivation	Significance
Prior to Mitigation			
Duration	Long Term (4)	The current status quo will remain	**Medium (54)**
Extent	Local-International (4)	Local workers and international investors will not be granted opportunities in the region	
Magnitude	Moderate (6)	Currently there is sever pressure on the development of renewables	
Probability	Highly Probable (4)	Lost opportunity to improve energy security and	

		develop clean, renewable energy	
Mitigation / Enhancement Measures			
The primary goal of the Project is to assist in providing additional capacity to Eskom to assist in addressing the current energy supply constraints. The project also aims to reduce the carbon footprint associated with energy generation. As indicated above, energy supply constraints and the associated load shedding have had a significant impact on the economic development of the South African economy. South Africa also relies on coal-powered energy to meet more than 90% of its energy needs. South Africa is therefore one of the highest per capita producers of carbon emissions in the world and Eskom, as an energy utility, has been identified as the world's second largest producer carbon emissions. The development of the proposed SEF would represent an enhancement measure. However, the impact of large facilities on the sense of place and landscape are issues that need to be addressed in the location, design and layout of the proposed plant.			
Assessment of No-Go Option			
There is no impact as it maintains the current status quo.			
Post Mitigation/Enhancement Measures			
Duration	Long Term (4)	The current status quo will remain	**Medium (54)**
Extent	Local-International (4)	Local workers and international investors will not be granted opportunities in the region	
Magnitude	Moderate (6)	High national pressure on the development of renewables	
Probability	Highly Probable (4)	Lost opportunity to improve energy security and develop clean, renewable energy	
Cumulative Impacts: The No-Development option would represent a lost opportunity for South Africa to improve energy security and supplement is current energy needs with clean, renewable energy. Given South Africa's current energy security challenges and its position as one of the highest per capita producers of carbon emissions in the world, this would represent a significant negative social cost.			
Residual Risks: Not applicable			

5.7. Social Issues Associated with the Cumulative Impact on Sense of Place

The potential cumulative impacts on the areas sense of place will be largely linked to potential visual impacts. In this regard the Scottish Natural Heritage (2005) describes a range of potential cumulative landscape impacts associated with wind farms on landscapes. These issues are also likely to be relevant to solar facilities and associated infrastructure. The relevant issues identified by Scottish Natural Heritage study include:

- Combined visibility (whether two or more wind farms will be visible from one location).
- Sequential visibility (e.g., the effect of seeing two or more wind farms along a single journey, e.g. road or walking trail).
- The visual compatibility of different wind farms in the same vicinity.
- Perceived or actual change in land use across a character type or region.
- Loss of a characteristic element (e.g., viewing type or feature) across a character type caused by developments across that character type.

The guidelines also note that cumulative impacts need to be considered in relation to dynamic as well as static viewpoints. The experience of driving along a tourist road, for example, needs to be considered as a dynamic sequence of views and visual impacts, not just as the cumulative impact of several developments on one location. The viewer may only see one renewable energy facility and the associated infrastructure at a time, but if each successive stretch of the road is dominated by views of renewable energy facilities, then that can be argued to be a cumulative visual impact (National Wind Farm Development Guidelines, DRAFT - July 2010).

As indicated above, the potential impact of the proposed REF and associated infrastructure on the areas sense of place is likely to be negligible. The cumulative impacts are also likely to be very low.

The establishment of the facility will be a game-changing event for the community and local municipality. It'll result in the following impacts, in varying degrees:

- People
    - Skills development
    - Employment
    - Renewed sense of hope
    - Improved social outcomes owing to SED investments:
        - Health
        - Education
        - Economic participation
    - Social cohesion for the community beneficiaries
    - Increased sense of prestige for the community and town
- Planet
    - Increased power supply for the country, with less damage to the planet as a consequence.
- Profit
    - Increased revenue for local municipality
    - Increased economic activity in local community and broader municipality
    - Investment in social and commercial infrastructure to increase economic activity.

Cumulative impacts have been considered as part of this energy facility and has the potential to result in significant positive cumulative impacts; specifically with the establishment of a number of Solar energy facilities in the vicinity of the Local Municipality. This will create a number of socio-economic opportunities for the area, which in turn, will result in a positive social benefit. The positive cumulative impacts include creation of employment, skills development and training opportunities, and downstream business opportunities. Benefits to the local, regional and national economy through employment and procurement of services could be substantial should many renewable energy facilities proceed. This benefit will increase significantly should critical mass be reached that allows local companies to develop the necessary skills to support construction and maintenance activities and that allows for components of the renewable energy facilities to be manufactured in South Africa. Furthermore at municipal level, the cumulative impact could be positive and could incentivize operation and maintenance companies to centralize and expand their activities towards education and training.

Table 8.14: Impact on Sense of place

Nature: An increase in employment opportunities, skills development and business opportunities with the establishment of more than one solar energy facility		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	Low -regional (3)	Low-regional (3)
Duration	Long-term (4)	Long-term (4)
Magnitude	Low (4)	Moderate(6)
Probability	Probable (3)	Probable (3)
Significance	**Medium (33)**	**Medium (52)**
Status (positive or negative)	Positive	Positive
Reversibility	N/A	N/A
Irreplaceable loss of resources?	N/A	N/A
Can impacts be mitigated?	Yes	Yes
Confidence in findings: High.		
Mitigation: The establishment of a number of solar energy facilities in the area does have the potential to have a positive cumulative impact on the area in the form of employment opportunities, skills development and business opportunities. The positive benefits will be enhanced if local employment policies are adopted, and local services providers are utilised by the developers to maximise the project opportunities available to the local community.		

Table 8.15: Impact on Local services

Nature: The establishment of a number of renewable energy facilities in the ELM has the potential to place pressure on local services, specifically medical, education and accommodation

	Overall impact of the proposed project considered in isolation	Cumulative impact of the project and other projects in the area
Extent	Local (1)	Local and regional (2)
Duration	Long term (4)	Long term (4)
Magnitude	Low (4)	Low (4)
Probability	Probable (3)	Probable (3)
Significance	Low (27)	Medium (30)
Status (positive/negative)	Negative	Negative
Reversibility	Yes. Solar energy plant components and other infrastructure can be removed.	
Loss of resources?	No	No
Can impacts be mitigated?	Yes	
Confidence in findings: High.		
Comment on No-Go option There is no impact as it maintains the current status quo. .		

Table 8.16: Impact on Local Economy

Nature: The establishment of a number of solar energy facilities in the ELM will create employment, skills development and training opportunities, creation of downstream business opportunities.		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	Local (1)	Local and regional (2)
Duration	Long term (4)	Long term (4)
Magnitude	Low (4)	Moderate (6)
Probability	Probable (3)	Definite (5)
Significance	Low (27)	High (60)
Status (positive/negative)	Positive	Positive
Reversibility	Yes. Solar energy plant components and other infrastructure can be removed.	
Loss of resources?	No	No
Can impacts be mitigated?	Yes	
Confidence in findings: High.		
Assessment of No-Go option There is no impact as it maintains the current status quo. This would represent a lost socio-economic opportunity for the ELM. **Recommended mitigation measures** The proposed establishment of suitably sited renewable energy facilities within the ELM should be supported.		

6. CONCLUSIONS AND IMPACT STATEMENT

6.1. Conclusions and Recommendations

The project represents an important development opportunity for the communities surrounding Harmony Central PV. Should it be approved, it will not only supply the mine with much needed clean power, but will also achieve the following for social upliftment:

- Increase educational attainment of local youth through a bursary programme funded through SED.
- Improved renewable energy presence in the country
- Elevation of the national energy crisis
- Increase the number of job-creating enterprises funded through ED.
- Improve key infrastructure identified by the community such as housing and roads.
- Increase the skills levels of local community.
- Lead to lasting economic development gains for the local community and province.

The No Development option does not have any impact. However, given the developmental agenda of both the country and the local area, failure to develop is to deny improvements in the wellbeing of households and the growth of the economy. The No Development option is particularly undesirable because the project's potentially negative impacts are largely small and are all manageable. Therefore, because the project's positive impacts heavily outweigh the negative impacts, it is recommended that it be permitted.

This SIA has focused on the collection of primary data to identify and assess social issues and potential social impacts. Secondary data was collected and presented in a literature review and primary data was collected through the public participation process and telephonic consultation with key stakeholders. The environmental assessment framework for assessment of impacts and the relevant criteria were applied to evaluate the significance of the potential impacts.

A summary of the potential positive and negative impacts identified for the detailed design, construction and operation phases are presented in Table 9.4 and 9.5 for the potential impacts identified.

Table 9.4: Summary of potential social impacts identified for the detailed design and construction phase

Impact	Significance without mitigation/enhancement	Significance with mitigation/enhancement
Positive Impacts		
Direct employment and skills development	Low	Medium
Economic multiplier effects	Low	Medium
Negative Impacts		
Safety and security risks	Low	Low
Impacts on daily living and movement patterns	Medium	Low
Nuisance impact (noise and dust)	Negative	Low

Table 9.5: Summary of potential social impacts identified for the operation phase

Impact	Significance without mitigation/enhancement	Significance with mitigation/enhancement
Positive Impacts		
Direct employment and skills development	Low	Medium
Development of clean, renewable energy infrastructure	Medium	Medium
Negative Impacts		
Visual and sense of place impacts	Low	Low

Impacts associated with the loss of agricultural land.	Medium	Medium

6.2. Key findings and Recommendations

Key Findings

From a social perspective it is concluded that the project is supported, but that mitigation measures should be implemented and adhered to. Positive and negative social impacts have been identified. The assessment of the key issues indicated that there are no negative impacts that can be classified as fatal flaws and which are of such significance that it cannot be successfully mitigated. Positive impacts could be enhanced by implementing appropriate enhancement measures and through careful planning. Based on the social assessment, the following general conclusions and findings can be made:

- The potential negative social impacts associated with the construction phase are typical of construction related projects and not just focused on the construction of PV facilities (these relate to influx of non-local workforce and jobseekers, intrusion and disturbance impacts, safety and security) and could be reduced with the implementation of the mitigation measures proposed.
- Employment opportunities will be created in the construction and operation phase and the impact is rated as positive even if only a small number of individuals benefit in this regard.
- The proposed project could assist the local economy in creating entrepreneurial development, especially if local business could be involved in the provision of general material and services during the construction and operational phases.
- Capacity building and skills training among employees are critical and would be highly beneficial to those involved, especially if they receive portable skills to enable them to also find work elsewhere and in other sectors.
- The proposed development also represents an investment in infrastructure for the generation of clean, renewable energy, which, given the challenges created by climate change, represents a positive social benefit for society.

Recommendations

The following recommendations are made based on the Social Impact Assessment and a thorough review of the concerns and suggestions raised by stakeholders and interested and affected parties during the stakeholder engagement process. The proposed mitigation measures should be implemented to limit the negative impacts and enhance the positive impacts. Based on the social assessment, the following recommendations are made:

- In terms of employment related impacts, it is important to consider that job opportunities for the unskilled and semi-skilled are scarce commodities in the study area and could create competition among the local unemployed. Introducing an outside workforce will therefore most likely worsen local endeavors to obtain jobs and provoke discontent as well as put pressure on the local services available. Local labour should be utilised to enhance the positive impact of employment creation in the area. Local businesses should be involved with the construction activities where possible. It is imperative that local labour be sourced to ensure that benefits accrue to the local communities. Preference should thus be given to the use of local labour during the construction and operational phases of the project as far as possible.
- Locals should also be allowed an opportunity to be included in a list of possible local suppliers and service providers, enhancing the multiplier effect. This aspect would serve to mitigate other subsequent negative impacts such as those associated with the inflow of outsiders to the area, the increased pressure on the infrastructure and services in the area, as well as the safety and security concerns.
- Impacts associated with the construction period should be carefully mitigated to minimise any dust and noise pollution.
- Safety and security concerns should be considered during the planning and construction phases of the proposed project.

6.3. Conclusion

A site visit was undertaken during the Assessment Phase of the SIA. The site visit include primary interviews with key stakeholders and interested and affected parties, this will further be expanded upon during the public participation phase for the basic assessment. The proposed Central Solar PV facility and associated infrastructure is unlikely to result in permanent damaging social impacts. From a social perspective it is concluded that the project could be developed subject to the implementation of the recommended mitigation measures and management actions contained in the report.

7. REFERENCES AND SOURCES

- National Energy Act (No. 34 of 2008)
- National White Paper on Renewable Energy (2003)
- National Integrated Resource Plan for Electricity (2010, 2013 draft)
- National Development Plan (2013)
- Republic of South Africa, Department Government Communication and Information System. South Africa Yearbook 2014/15
- Department of Energy, State of Renewable Energy in South Africa, 2015
- Free State Provincial Spatial Development Framework , Phase 3/3rd Draft Report (2013)
- Housing Development Agency, Free State: Informal settlements Status (2013)
- Free State Overview of Provincial Revenue and Expenditure 2012/13 (2013) Relevant policy and planning documents on district level include:
- Xhariep Integrated Development Plan 2012-2017
- Ka Seme District Municipality Integrated Development Plan 2015/16
- Renosterberg Local Municipality Integrated Development Plan 2014/15 (draft)
- Letsemeng Local Municipality Integrated Development Plan 2014/15
- Kopanong Local Municiaplity Integrated Development Plan 2014/15

WEBSITES

- http://northerncapepsdf.co.za/
- http://greencape.co.za/
- http://www.fdc.co.za/about-the-free-state/energy

FURTHER SOURCES

- http://greencape.co.za/assets/Uploads/GreenCape-MIR-Renewable-Energy.pdf
- http://www.infrastructurene.ws/2014/08/07/new-renewable-energy-centre-of- excellence-launched/

8. Appendix A: SIA ENVIRONMENTAL MANAGEMENT PROGRAMME (EMPRr)

Construction Phase:

Direct employment and skills development

OBJECTIVE: Maximise local employment and skills opportunities associated with the construction phase		
Project component/s	Construction of the proposed Becrux II solar energy facility and associated infrastructure	
Potential Impact	The opportunities and benefits associated with the creation of local employment and skills development to be maximised.	
Activity/risksource	» Construction procurement practice employed by the Ccontractor » Developers investment plan	
Mitigation Target/Objective	The developer should aim to employ as many low-skilled and semi-skilled workers from the local area as possible. This shouldalso be made a requirement for all contractors.	
Enhancement: Action/control	**Responsibility**	**Timeframe**
Employ local contractors that are compliant with Broad Based Black Economic Empowerment (BBBEE) criteria	The Proponent & EPC Contractors	Pre-construction & construction phase
Adopt a local employment policy to maximise the opportunities made available to the local labour force as far as possible (preference to Local Municipality)	The Proponent & EPC Contractors	Pre-construction & construction phase
In the recruitment selection process; consideration must be given to women during recruitment process	EPC Contractors	Pre-construction & construction phase
Set realistic local recruitment targets for the construction phase (preference to Local Municipality)	The Proponent & EPC Contractors	Pre-construction & construction phase
Training and skills development programmes to be initiated prior to the commencement of the construction phase	The Proponent	Pre-construction & construction phase
Performance Indicator	» Employment and business policy document that sets out local employment and targets completed before construction phasecommences; » Employ as many semi and unskilled labour from the local area or local municipality as possible » Training and skills development programme undertaken prior to the commencement of construction phase.	
Monitoring	» The developer and EPC contractor must keep a record of local recruitments and information on local labour to be shared with the ECO for reporting purposes.	

Economic multiplier effects

OBJECTIVE: Maximise local economic multiplier effect during construction phase		
Project component/s	Construction of the proposed Becrux II solar energy facility and associated infrastructure	
Potential Impact	Potential local economic benefits	
Activity/risksource	Developers procurement plan	
Mitigation Target/Objective	Increase the procurement of goods and services especially within the local economy	
Enhancement: Action/control	**Responsibility**	**Timeframe**

A local procurement policy to be adopted to maximise the benefit to the local economy where feasible (Local Municipality)	The Proponent & EPC Contractors	Pre-construction & construction phase
Develop a database of local companies, specifically Historically Disadvantaged (HD) which qualify as potential service providers (e.g. construction companies, security companies, catering companies, waste collection companies, transportation companies etc.) prior to the tender process and invite them to bid for project-related work where applicable	The Proponent & EPC Contractors	Pre-construction & construction phase
Source as much goods and services as possible from the local area (Local Municipality). Engage with local authorities and business organisation to investigate the possibility	The Proponent	Pre-construction & construction phase

Performance Indicator	» Local procurement policy is adopted » Local goods and services are purchased from local suppliers where feasible (Local Municipality)
Monitoring	» The developer must monitor indicators listed above to ensure that they have been met for the construction phase.

Safety and security impacts

OBJECTIVE: To avoid or reduce the possibility of the increase in crime and safety and security issues during the construction phase		
Project component/s	Construction of the proposed Central Solar energy facility and associated infrastructure	
Potential Impact	Increase in crime due to influx of non-local workforce and job seekers into the area	
Activity/risksource	Safety and security risks associated with construction activities	
Mitigation Target/Objective	To avoid or minimise the potential impact on local communities and their livelihoods	
Enhancement: Action/control	**Responsibility**	**Timeframe**
Access in and out of the construction camp should be strictly controlled by a securitycompany	EPC Contractor	Construction phase
The appointed EPC contractor must appoint a security company and appropriate securityprocedures are to be implemented	EPC Contractor	Construction phase
Open fires on the site for heating, smoking orcooking are not allowed, except in designated areas.	EPC Contractor	Construction phase
Contractor must provide adequate firefighting equipment on site and provide firefighting training to selected construction staff.	EPC Contractor	Pre-construction & construction phase
A comprehensive employee induction programme to be developed and utilised to cover land access protocols, fire managementand road safety	EPC Contractor	Pre-construction & construction phase
Method of communication should be implemented whereby local landowners can express any complaints or grievances with construction process	EPC Contractor	Pre-construction & construction phase

Performance Indicator	» Employee induction programme, covering land accessprotocols, fire management and road safety » The construction site is appropriately secured with a controlledaccess system » Security company appointed and security procedures implemented
Monitoring	» The developer and EPC contractor must monitor the indicators listed above to ensure that they have been met for theconstruction phase

Impacts on daily living and movement patterns

OBJECTIVE: To avoid or reduce traffic disruptions and movement patterns of local community during the construction phase		
Project component/s	Construction of the proposed Central Solar energy facility and associated infrastructure	
Potential Impact	Increase in traffic disruptions, safety hazards, and impacts onmovement patterns of local community as well as impact on private property due to the upgrade of the existing road and heavy vehicle traffic in the local area	
Activity/risksource	Construction activities affecting daily living and movement patterns	
Mitigation Target/Objective	To avoid or minimise the potential impact on local communities and their livelihoods	
Enhancement: Action/control	**Responsibility**	**Timeframe**
All vehicles must be road worthy and drivers must be qualified, obey traffic rules, followspeed limits and made aware of the potential road safety issues	EPC Contractor	Construction phase
Heavy vehicles should be inspected regularly to ensure their road safety worthiness.	EPC Contractor	Construction phase
Implement penalties for reckless driving for the drivers of heavy vehicles as a way toenforce compliance to traffic rules.	EPC Contractor	Construction phase
Any damage / wear and tear caused by construction related traffic to the roads is repaired	The Proponent & EPC contractor	Construction phase
Provide adequate and strategically placed traffic warning signs and control measures along the R38 and secondary roads to warn road users of the construction activities taking place, displaying road safety messages and speed limits for the duration of the construction phase. Traffic warning signs must also be well illuminated at night.	EPC Contractor	Pre-construction & construction phase
A comprehensive employee induction programme to cover land access protocols and road safety. This must be addressed in the	EPC Contractor	Construction phase
Appoint a Community Liaison Officer and create method of communication whereby local community member can express any complaints or grievances	EPC Contractor	Pre-construction & construction phase
Performance Indicator	» Vehicles are roadworthy, inspected regularly and speed limits are adhered to » Traffic warning signs along R38 and secondary roads, also illuminated at night appointed and security procedures implemented	
Monitoring	» The developer and EPC contractor must monitor the indicators listed above to ensure that they have been met for theconstruction phase	

Pressure on economic and social infrastructure impacts from an in migration of people

OBJECTIVE: Reduce the pressure on economic and social infrastructure and social conflicts from an influx of a non-local workforce and jobseekers during the construction phase	
Project component/s	Construction of the proposed Central Solar energy facility and associated infrastructure
Potential Impact	Increase in traffic disruptions, safety hazards, and impacts onmovement patterns of local community as well as impact on private property due to the upgrade of the existing road and heavy vehicle traffic in the local area

Activity/risksource	Construction activities affecting daily living and movement patterns		
Mitigation Target/Objective	To avoid or minimise the potential impact on local communities and their livelihoods		
Enhancement: Action/control		**Responsibility**	**Timeframe**
Where possible, make it a requirement for contractors to implement a 'locals first' policy. Should be advertised for construction employment opportunities, especially for semi and low-skilled job categories (preference to the local Municipality). Enhance employment opportunities for the immediate local area, , if this is not possible, then the broader focus areas should be considered for sourcing workers such as the Local Municipality		The proponent & EPC Contractor	Pre- construction phase & construction phase
Prior to construction commencing representatives from the local community e.g. ward councillor, surrounding landowners should be informed of details of the construction schedule and exact size of the workforce.		EPC Contractor	Construction phase
Recruitment of temporary workers at the gates of the development should not be allowed. A recruitment office located in town with a Community Liaison officer should be established to deal with jobseekers.		EPC Contractor	Construction phase
Have clear rules and regulations for access to the proposed site to control loitering.		The Proponent & EPC contractor	Construction phase
A Community Liaison Officer should be appointed. A method of communication should be implemented whereby procedures to lodge complaints are set out in order for the local community to express any complaints or grievances with the construction process		EPC Contractor	Pre-construction & construction phase
Performance Indicator	» Percentage of the workers employed in construction that come from local communities		
Monitoring	» The developer must keep a record of local recruitments and information on local labour to be shared with the ECO for reporting purposes		

Nuisance impacts (Noise &Dust)

OBJECTIVE: To avoid or minimise the potential impacts of noise and dust from construction activities during the construction phase			
Project component/s	Construction of the proposed Becrux II Solar energy facility and associated infrastructure		
Potential Impact	Heavy vehicles and construction activities can generate noise and dust impacts.		
Activity/risksource	Construction activities		
Mitigation Target/Objective	To avoid and or minimise the potential noise and dust impacts associated with construction activities		
Enhancement: Action/control		**Responsibility**	**Timeframe**
Implement dust suppression measures for heavy vehicles such as wetting the roads on a regular basis and ensuring that vehicles used to transport sand and building materials are fitted with tarpaulins or covers		EPC Contractor	Construction phase
Ensure all vehicles are road worthy, driversare qualified and are made aware of the potential noise and dust issues		EPC Contractor	Construction phase
Ensure that drivers adhere to speed limits		EPC Contractor	Construction phase
A Community Liaison Officer should be appointed. A method of		The Proponent & EPC contractor	Pre-construction & construction phase

communication should be implemented whereby procedures to lodge complaints are set out in order for the local community to express any complaints or grievances with the construction process		

Performance Indicator	» Dust suppression measures implemented for all heavy vehicles that require such measures during the construction phase » Enforcement of strict speeding limits » Road worthy certificates in place for all vehicles » Community liaison officer available for community grievances and communication channel
Monitoring	» The EPC contractor must monitor the indicators to ensure that they have been met for the construction phase

Operational Phase:

Direct employment and skills development during operation phase

OBJECTIVE: Maximise local employment and skills opportunities associated with the construction phase		
Project component/s	Operation and maintenance of the proposed Becrux II Solar energy facility and associated infrastructure	
Potential Impact	Loss of opportunities to stimulate production and employment of the local economy	
Activity/risksource	Labour practices employed during operations	
Enhancement: Target/Objective	Maximise local community employment benefits in the local economy	
Enhancement: Action/control	**Responsibility**	**Timeframe**
Adopt a local employment policy to maximise the opportunities made available to the local labour force. (preference to Local Municipality)	The Proponent & EPC Contractors	Operation phase
The recruitment selection process should seek to promote gender equality and the employment of women wherever possible	The Proponent & EPC Contractors	Operation phase
Establish vocational training programs for the local labour force to promote the development of skills	The Proponent & EPC Contractors	Operation phase
Performance Indicator	» Percentage of workers that were employed from local communities (Local Municipality) » Number of people attending vocational training throughout the operation phase	
Monitoring	» The developer must keep a record of local recruitments and information on local labour to be shared with the ECO for reporting purposes	

Visual and 'sense of place' impacts

OBJECTIVE: Reduce the visual and sense of place impacts associated with the operation phase of the project	
Project component/s	Operation and maintenance of the Proposed Becrux II solar energy facility and associated infrastructure
Potential Impact	Change in the sense of place that also leads to the negative impact on the area and visual intrusions
Activity/risksource	The PV facility and associated infrastructure

Enhancement: Target/Objective	Reduce the visual disturbances to minimise the losses of the sense of place		
Enhancement: Action/control		**Responsibility**	**Timeframe**
» Vegetation screening to be placed between the site and adjacent properties if required.		The Proponent	Operation phase
Performance Indicator	» Vegetation screening if required/necessary		
Monitoring	» The developer must monitor the indicators if vegetation screening is required by adjacent landowners		

Appendix B: Key Stakeholders Contacted and Meeting Scheduled

A site visit was undertaken 04 July 2022 and observations were made outside the facility as site access was not arranged accordingly and permission was not yet granted.

A questionnaire will be administrated when the Basic Assessment is made available to the public, and when the public participation process kicks off.

Plan of Study (for consultation):

The Interested and Affected Database will be utilized and taken from the Public Participation Process (PPP) to reach key stakeholders and arrange a discussion. Key stakeholders that are not reachable through the PPP process will be emailed and/or if no email is available a voice message will be left on their phone, even more a message on WhatsApp or SMS.

DEVELOPMENT OF THE HARMONY CENTRAL PLANT SOLAR PV FACILITY, VIRGINIA, FREE STATE PROVINCE

Avifauna Baseline and Impact Assessment Report

July 2022

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EXECUTIVE SUMMARY

Pachnoda Consulting cc was requested by Savannah Environmental (Pty) Ltd on behalf of Harmony Gold Mining Ltd to compile an avifauna impact assessment report for the Harmony Central Plant Solar PV facility with a contracted capacity of up to 14MW located on a site approximately 11km south east of the town of Welkom in the Free State Province.

The objectives of the avifaunal study were to: (a) describe the avifauna associations in the study area according to species composition and richness prior to construction activities; (b) provide an inventory of bird species occurring in the project area including species prone towards collisions with the proposed infrastructure; (c) provide an impact assessment; and (d) provide an indication of the occurrence of species of concern (e.g. threatened and near threatened species).

Baseline avian data was obtained from point count sampling techniques during two independent sampling sessions (June 2022 and July 2022).

Five avifaunal habitat types were identified on the study site and surroundings, ranging from untransformed and secondary grassland, bush clump mosaics to transformed and landscape/manicured areas. The study site was also surrounded by a number of pans, which provided habitat for a high diversity of waterbird taxa. Approximately 152 bird species are expected to occur in the wider study area, of which 85 species were observed in the study area (during two surveys). The expected richness included five threatened or near threatened species, 14 southern African endemics and 14 near-endemic species. The vulnerable Lanner Falcon (*Falco biarmicus*) was observed on the study site (during a fly-over). Eleven southern African endemics and 11 near-endemic species were confirmed on the study site. In addition, a total of 51 collision-prone bird species have been recorded from the wider study area (*sensu* atlas data), of which 13 species were birds of prey and 29 were waterbirds/shorebird taxa.

The main impacts associated with the proposed PV solar facility included the following:

- The loss of habitat and subsequent displacement of bird species due to the ecological footprint required during construction.
- Direct interaction (collision trauma) by birds with the surface infrastructure (photovoltaic panels) caused by polarised light pollution and/or colliding with the panels (as they are mistaken for waterbodies).
- Collision with associated infrastructure (mainly overhead power lines).

An evaluation of potential and likely impacts on the avifauna revealed that the impact significance was moderate to low after mitigation (depending on the type of impact). However, the risk for certain waterbirds (including flamingo taxa) colliding with the PV infrastructure remained eminent due to the presence of inundated pans in the study

area. Post-construction monitoring was recommended along with the installation of appropriate bird diverters to minimise the potential risk of collision trauma in birds.

No fatal-flaws were identified during the assessment, although it was strongly recommended that the proposed mitigation measures and monitoring protocols (e.g. post construction monitoring) be implemented during the construction and operational phase of the project.

TABLE OF CONTENTS

EXECUTIVE SUMMARY I
TABLE OF CONTENTS III
LIST OF FIGURES IV
LIST OF TABLES V
LIST OF APPENDICES VI
DECLARATION OF INDEPENDENCE VII
1. INTRODUCTION 1
1.1 PROJECT DESCRIPTION 1
1.2 OBJECTIVES AND TERMS OF REFERENCE 2
1.3 SCOPE OF WORK 5
2. METHODS & APPROACH 6
2.1 LITERATURE SURVEY AND DATABASE ACQUISITION 6
2.2 FIELD METHODS 8
2.3 SENSITIVITY ANALYSIS 10
2.4 LIMITATIONS 11
3. DESCRIPTION OF THE AFFECTED ENVIRONMENT 12
3.1 LOCALITY 12
3.2 REGIONAL VEGETATION DESCRIPTION 12
3.3 LAND COVER, LAND USE AND EXISTING INFRASTRUCTURE. 14
3.4 CONSERVATION AREAS, PROTECTED AREAS AND IMPORTANT BIRD AREAS 15
3.5 ANNOTATIONS ON THE NATIONAL WEB-BASED ENVIRONMENTAL SCREENING TOOL 15
4. RESULTS AND DISCUSSION 18
4.1 AVIFAUNAL HABITAT TYPES 18
4.2 SPECIES RICHNESS AND SUMMARY STATISTICS 22
4.3 BIRD SPECIES OF CONSERVATION CONCERN 27
4.4 BIRD ASSEMBLAGE STRUCTURE AND COMPOSITION 30
4.5 PASSERINE BIRD DENSITIES 36
4.6 MOVEMENTS/DISPERSAL OF COLLISION-PRONE BIRDS 36
4.7 AVIFAUNAL SENSITIVITY 37
4.8 OVERVIEW OF AVIAN IMPACTS AT SOLAR FACILITIES 39
4.8.1 Background to solar facilities and their impact on birds 39
4.8.2 Impacts of PV solar facilities on birds 40
4.9 IMPACTS ASSOCIATED WITH THE HARMONY CENTRAL PLANT SOLAR PV FACILITY 41
4.9.1 Loss of habitat and displacement of birds 41
4.9.2 Creation of "new" avian habitat and bird pollution 41
4.9.3 Collision trauma caused by photovoltaic panels (the "lake-effect") 42
4.9.4 Interaction with overhead powerlines and reticulation 43
4.9.5 Collision-prone bird species 46
4.10 CUMULATIVE IMPACTS 48
4.11 RECOMMENDED AVIFAUNAL MITIGATION 50
4.11.1 Loss of habitat and displacement bird taxa 50
4.11.2 Creation of "new" avian habitat and bird pollution 51

4.11.3 Collision trauma caused by photovoltaic panels (the "lake-effect") 51
4.11.4 Power line interaction: collision and electrocution with power lines 52
4.11.5 General mitigation measures 53
4.12 SUGGESTED MONITORING AND ENVIRONMENTAL MANAGEMENT PLAN 54
4.13 OPINION REGARDING THE FEASIBILITY OF THE PROJECT 57
5. REFERENCES 58

LIST OF FIGURES

Figure 1: An image illustrating the geographic position of proposed Harmony Central Plant Solar PV facility. The map also shows the locality of the proposed Harmony 1 Plant Solar PV facility. 4
Figure 2: A satellite image illustrating the geographic position of the proposed Harmony Central Plant Solar PV facility and associated infrastructure. 5
Figure 3: A map illustrating the pentad grids that were investigated for this project. .. 8
Figure 4: A map illustrating the spatial position of 12 bird point counts located within the study area. 10
Figure 5: A satellite image illustrating the regional vegetation type corresponding to the study site and immediate surroundings. Vegetation type categories were defined by Mucina & Rutherford (2006; updated 2012). 14
Figure 6: A map illustrating the land cover classes (Geoterrainimage, 2015) corresponding to the proposed study and development areas. 15
Figure 7: The animal species sensitivity of the study site and immediate surroundings according to the Screening Tool. 16
Figure 8: The relative avian sensitivity of the study site and immediate surroundings according to the Screening Tool. 17
Figure 9: The relative terrestrial biodiversity sensitivity of the study site and immediate surroundings according to the Screening Tool. 18
Figure 10: A map illustrating the avifaunal habitat types on the study site. 20
Figure 11: A collage of images illustrating examples of avifaunal habitat types observed on the study area: (a - d) Untransformed grassland (e - f) bush clump mosaics, (g - j) secondary grassland on old cultivated land, (k - l) transformed and landscaped land and (m - n) a nearby inundated pan located north of the study site. 22
Figure 12: The bird species richness per pentad grid in comparison to the broader study area (see arrow) (map courtesy of SABAP2 and the Animal Demography Unit). According to the SABAP2 database, the study area hosts between 141 and 180 bird species. 24
Figure 13: The species accumulation curve (SAC) (red line) for bird points sampled during the June 2022 and July 2022 survey sessions. The blue line represents an accumulation of one species for every additional point count. The black line is parallel to the blue one and is tangent to the SAC approximately after 18 counts (as represented by the vertical red stippled line). The green stippled line represents the Michaelis-Menten curve. 26
Figure 14: A map illustrating the occurrence of the vulnerable Lanner Falcon (*Falco biarmicus*) on the study site. 30

Figure 15: A map of the study area illustrating the spatial distribution of bird richness values (number of species) obtained for each point count. 32
Figure 16: A map of the study area illustrating the distribution of bird abundance values (average number of individuals) obtained for each point count. 33
Figure 17: A two-dimensional non-metric multidimensional scaling ordination (stress=0.08) of the relative abundances of bird species based on Bray-Curtis similarities obtained from 12 point counts on the project area. It differentiates between the following bird associations: (1) an association on inundated pans, an (2) association pertaining tree canopy cover and (3) an association confined to grassland (in the absence of tree cover). 34
Figure 18: A map of the study site illustrating the occurrence and movements of collision-prone birds. Solid arrows illustrates the movements/dispersal of waterbirds between two pans, ... 37
Figure 19: A map illustrating the avifaunal sensitivity of the study site based on habitat types supporting bird taxa of conservation concern and important ecological function (the pans include a 500m buffer area which should be viewed as sensitive). 38
Figure 20: Two bird-friendly tower designs to be considered for the current project. 53

LIST OF TABLES

Table 1: A summary table of the total number of species, Red listed species (according to Taylor *et al*., 2015 and the IUCN, 2022), endemics and biome-restricted species (Marnewick *et al*., 2015) expected (*sensu* SABAP1 and SABAP2) to occur in the study site and immediate surroundings. 23
Table 2: Expected biome-restricted species (Marnewick *et al*, 2015) likely to occur on the study area. 24
Table 3: Endemic bird species and species of conservation concern occurring in the broader study area which could collide and/ or become displaced by the proposed PV infrastructure. 24
Table 4: Bird species of conservation concern that could utilise the study area based on their historical distribution range and the presence of suitable habitat. Red list categories according to the IUCN (2022)* and Taylor et al. (2015)**. 28
Table 5: Bird species with a frequency of occurrence greater than 50% observed on the study area (according to 12 counts)... 31
Table 6: Typical bird species on the study area. 33
Table 7: A summary of the observed species richness and number of bird individuals confined to the bird associations on the study area. 36
Table 8: The quantification of impacts associated with the proposed PV facility and its infrastructure. 44
Table 9: Collision-prone bird species expected to be present on the study area and inferred from the South African Atlas Project (SABAP2). 47
Table 10: A summary of the cumulative impacts. 48

LIST OF APPENDICES

Appendix 1: A shortlist of bird species expected to be present on the study area. The list provides an indication of the species occurrence according to SABAP2 reporting rates. The list was derived (and modified) from species observed in pentad grid 2800_2650 and the eight surrounding grids. The reporting rates include submissions made during June and July 2022. 61
Appendix 2: Preliminary density estimates of birds recorded from the study area during two independent surveys conducted during June 2022 and July 2022. . 68

DECLARATION OF INDEPENDENCE

I, Lukas Niemand (Pachnoda Consulting CC) declare that:

- I act as the independent specialist in this application to Savannah Environmental (Pty) Ltd and Harmony Gold Mining Co Ltd;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have no vested financial, personal or any other interest in the application;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority; and
- All the particulars furnished by me in this form are true and correct.

Lukas Niemand (Pr.Sci.Nat)
25 July 2022

Lukas Niemand is registered with The South African Council for Natural Scientific Professionals (400095/06) with more than 20 years of experience in ecological-related assessments and more than 15 years in the field of bird interactions with electrical and renewable energy infrastructure. He has conducted numerous ecological and avifaunal impact assessments including Eskom Transmission projects, hydro-electric schemes, solar farms and other activities in South Africa and other African countries.

1. INTRODUCTION

1.1 Project Description

Harmony Gold is looking to supplement its energy supply by implementing PV generation, aiding their transition to a more sustainable and environmentally friendly energy mix. In this regard, Harmony Gold is proposing the construction and operation of 5 solar PV facilities located on 5 different Harmony Gold Mine sites within the Free State Province. The project entails the development of five (5) separate solar PV facilities, each including grid connection and other associated infrastructure. The projects will all tie-in to the electricity grid behind the Eskom meter at the respective Harmony mine customer substations. Each project will be developed through a different Special Purpose Vehicle (SPV).

The successful development of the renewable energy projects will enable Harmony Gold to make a valuable and meaningful contribution towards growing the green economy within the province and South Africa. This will assist the Free State in creating green jobs and reducing Green House Gas emissions, whilst reducing the energy demand on the National Grid.

Pachnoda Consulting cc was requested by Savannah Environmental (Pty) Ltd on behalf of Harmony Gold Mining Ltd to compile an avifauna impact assessment report for a photovoltaic (PV) Solar Energy Facility and associated infrastructure (herewith referred to as the "Harmony Central Plant Solar PV facility") with a contracted capacity of up to 14MW located on a site approximately 11km south east of the town of Welkom in the Free State Province (Figure 1). Harmony Central Plant Solar PV facility is based near Harmony Gold Central Plant operations located approximately 6km north east of the town of Virginia. The study site is situated within the Matjhabeng Local Municipality respectively, and within the Lejweleputswa District Municipality, Free State Province.

The solar facility will be located on a 33.6ha development area, which will include the PV arrays, associated infrastructure and grid connection infrastructure (Figure 2). The infrastructure associated PV facility includes:

- Solar PV arrays comprising of bifacial PV modules and mounting structures, using single axis tracking technology. Once installed, it will stand up to 5m above ground level.
- Inverters and transformers, a SCADA room, and maintenance room.
- Cabling between the project components.
- Balance of Plant:
    - Existing spare switchgear panels, upgraded switchgear circuit breakers or additional switchgear panels.
    - EK self-build works as defined in the CEL.

- On-site facility substation to facilitate the connection between the solar PV facilities and Eskom electricity grid. The Size and Capacity of the on-site stations will be 40MW.
- An onsite Medium voltage (MV) switching station forming part of the collector substation.
- Temporary laydown areas.
- Access roads, internal roads and fencing around the development area.
- Up to 132kV Overhead Power Lines (OHPL) with a maximum of 30m height with a 30m servitude width.
- Underground LV cabling will be used on the PV sites.

The PV facility will be located on the following farm portions:

Farm Name	Portion Number
SAAIPLAAS 771	12
RUSTGEVONDEN 564	1

The facility will tie-in to the Harmony North (6.6/44kV) substation. The grid line will have a connection capacity of up to 132kV. The line connecting the PV facility to the respective substation will be up to 44kV.

1.2 Objectives and Terms of Reference

The main objectives of the avifaunal study were to: (a) describe the avifauna associations in the study area according to species composition and richness prior to construction activities; (b) provide an inventory of bird species occurring in the study area including species prone towards collisions with the proposed infrastructure; (c) provide an impact assessment; and (d) provide an indication of the occurrence of species of concern (e.g. threatened and near threatened species; sensu IUCN, 2022; Taylor et al., 2015; Marnewick et al., 2015).

A bird assessment is required as part of the Environmental Impact Assessment process to investigate the impacts of the proposed solar facility on the avian attributes at the study site and its immediate surroundings. The avifaunal attributes at the proposed PV facility will be determined by means of a desktop analysis of GIS based information, third-party datasets and a number of site surveys. It also provides the results from two independent pre-construction surveys as per the best practice guidelines of Jenkins *et al.* (2017).

The terms of reference are to:

- conduct a baseline bird assessment based on available information pertinent to the ecological and avifaunal attributes on the project area and habitat units;
- conduct an assessment of all information on an EIA level in order to present the following results:

- typify the regional and site-specific avifaunal macro-habitat parameters that will be affected by the proposed project;
- provide a shortlist of bird species present as well as highlighting dominant species and compositions;
- provide an indication on the occurrence of threatened, near threatened, endemic and conservation important bird species likely to be affected by the proposed project;
- provide an indication of sensitive areas or bird habitat types corresponding to the study area;
- highlight areas of concern or "hotspot" areas;
- identify and describe impacts that are considered pertinent to the proposed development;
- highlight gaps of information in terms of the avifaunal environment; and
- recommend additional surveys and monitoring protocols (*sensu* Jenkins et al., 2017).

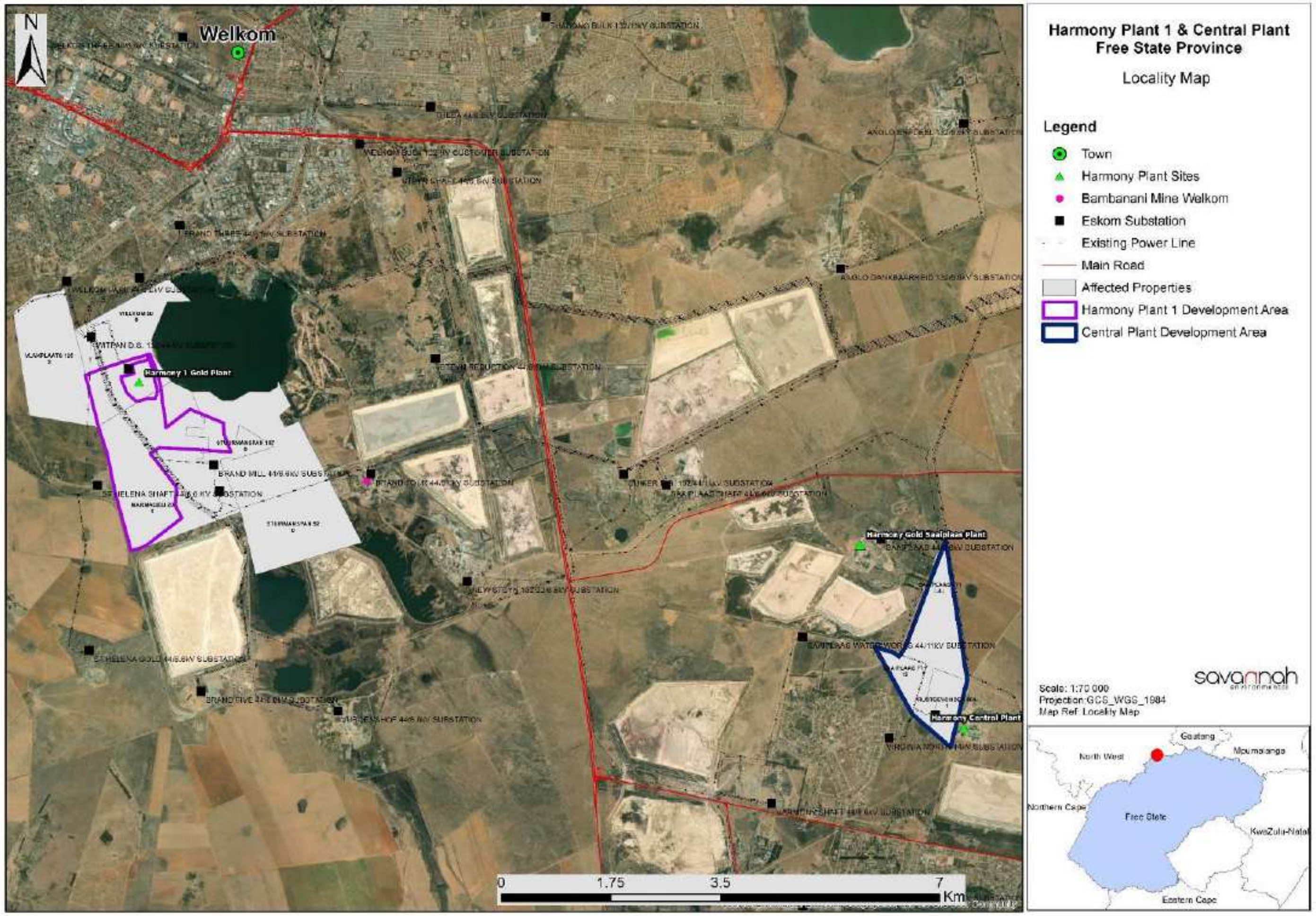

Figure 1: An image illustrating the geographic position of proposed Harmony Central Plant Solar PV facility. The map also shows the locality of the proposed Harmony 1 Plant Solar PV facility.

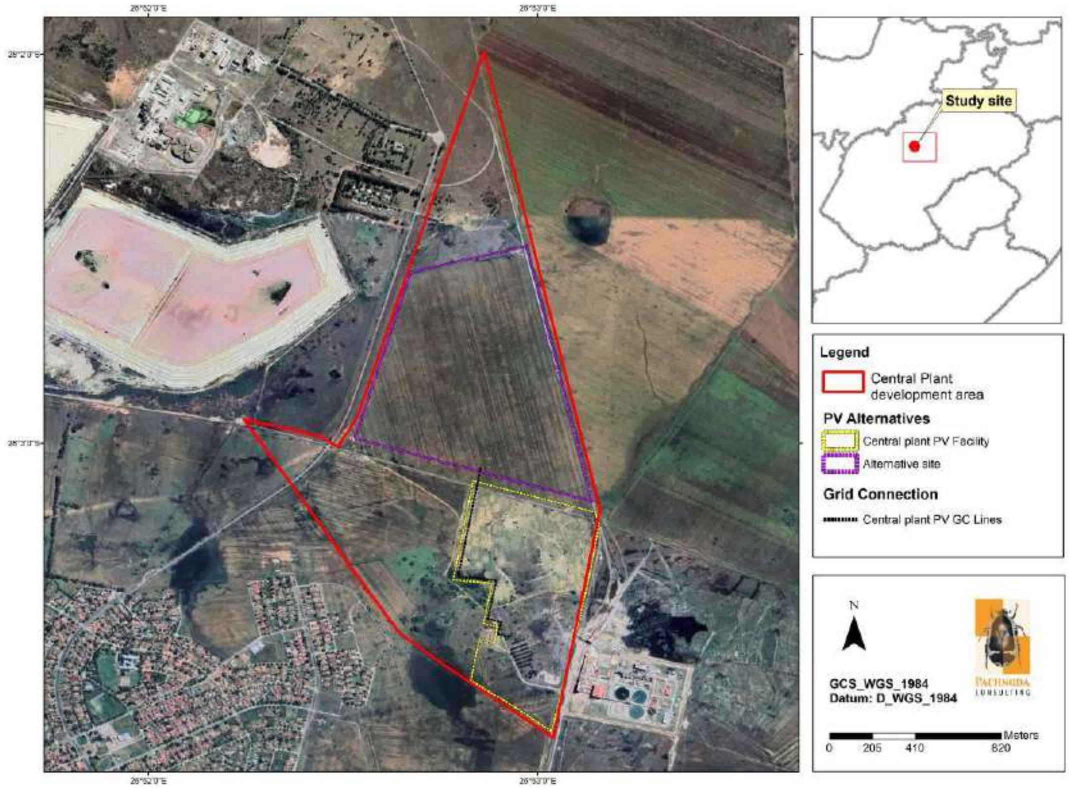

Figure 2: A satellite image illustrating the geographic position of the proposed Harmony Central Plant Solar PV facility and associated infrastructure.

1.3 Scope of Work

The following aspects form part of the Scope of Work:

- A desktop study of bird species expected to occur (e.g. species that could potentially be present), as well as species recorded in the past (e.g. SABAP1);
- A baseline survey of observed bird species according to ad hoc observations and two sampling surveys;
- A list of bird species historically recorded within the relevant quarter degree grid in which the study site occurs (SABAP1);
- Any protected or threatened bird species recorded in the past within the relevant quarter degree grid, their scientific names and colloquial names, and protected status according to IUCN red data lists; and
- The potential of these protected or threatened species to persist within the study area.

The following aspects will be discussed during this avifaunal assessment:

- Collision-prone bird species expected to be present and or observed;

- A list of the dominant bird species;
- A list of observed and expected threatened and near threatened species (according to IUCN red data list);
- Possible migratory or nomadic species;
- Potential important flyways/ congregatory sites and/or foraging sites; and
- Avian impacts associated with the PV solar facility.

2. METHODS & APPROACH

The current report places emphasis on the avifaunal community as a key indicator group on the proposed study area, thereby aiming to describe the conservation significance of the ecosystems in the area. Therefore, the occurrence of certain bird species and their relative abundances may determine the outcome of the ecological sensitivity of the area and the subsequent proposed layouts of the solar facility infrastructure.

The information provided in this report was principally sourced from the following sources/observations:

- relevant literature – see section below;
- observations made during two site visits (06-09 June 2022 and 25-29 July 2022); and
- personal observations from similar habitat types in close proximity to the study area, with emphasis on assessments conducted by Pachnoda Consulting (2020).

2.1 Literature survey and Database acquisition

A desktop and literature review of the area under investigation was commissioned to collate as much information as possible prior to the detailed baseline survey. Literature consulted primarily makes use of small-scale datasets that were collected by citizen scientists and are located at various governmental and academic institutions (e.g. Animal Demography Unit & SANBI). These include (although are not limited to) the following:

- Hockey *et al*. (2005) for general information on bird identification and life history attributes.
- Marnewick *et al.* (2015) was consulted for information regarding the biogeographic affinities of selected bird species that could be present on the study area.
- The conservation status of bird species was categorised according to the global IUCN Red List of threatened species (IUCN, 2022) and the regional conservation assessment of Taylor *et al.* (2015).
- Distributional data was sourced from the South African Bird Atlas Project (SABAP1) and verified against Harrison et al. (1997) for species corresponding to the quarter-degree grid cell (QDGC) 2826BB (Virginia). The information was then modified according to the prevalent habitat types

present on the development area. The SABAP1 data provides a “snapshot” of the abundance and composition of species recorded within a quarter degree grid cell (QDGC) which was the sampling unit chosen (corresponding to an area of approximately 15 min latitude x 15 min longitude). It should be noted that the atlas data makes use of reporting rates that were calculated from observer cards submitted by the public as well as citizen scientists. It therefore provides an indication of the thoroughness of which the QDGCs were surveyed between 1987 and 1991;

- Additional distributional data was also sourced from the SABAP2 database (http://www.sabap2.birdmap.africa). The information was then modified according to the prevalent habitat types present on the study area. Since bird distributions are dynamic (based on landscape changes such as fragmentation and climate change), SABAP2 was born (and launched in 2007) from SABAP1 with the main difference being that all sampling is done at a finer scale known as pentad grids (5 min latitude x 5 min longitude, equating to 9 pentads within a QDGC). Therefore, the data is more site-specific, recent and more comparable with observations made during the site visit (due to increased standardisation of data collection). The pentad grid relevant to the current project is 2800_2650 (although all eight pentad grids surrounding grid 2800_2650 were also scrutinised) (Figure 3).
- The choice of scientific nomenclature, taxonomy and common names were recommended by the International Ornithological Committee (the IOC World Bird List v. 12.1), unless otherwise specified (see www.worldbirdnames.org as specified by Gill et al, 2022). Colloquial (common) names were used according to Hockey *et. al.* (2005) to avoid confusion;
- The best practice guidelines for assessing and monitoring the impact of solar power generating facilities on birds in southern Africa were also consulted (Jenkins *et al.,* 2017).

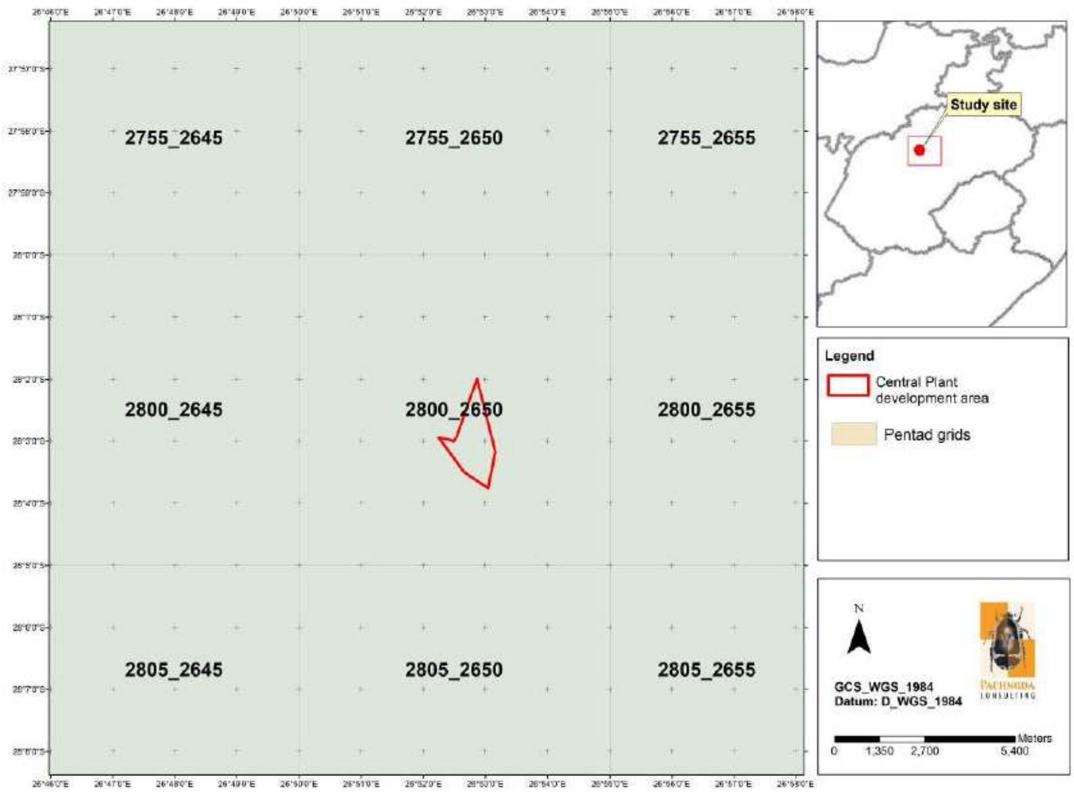

Figure 3: A map illustrating the pentad grids that were investigated for this project.

2.2 Field Methods

The avifauna of the study site was surveyed during two independent site visits (June and July 2022).

The baseline avifaunal survey was conducted by means of the following survey techniques:

2.2.1 Point Counts

Bird data was collected by means of 12 point counts (as per Buckland et al. 1993) from the study area. Data from the point counts has been analysed to determine dominant and indicator bird species (so-called discriminant species), relative densities and to delineate the different bird associations present.

The use of point counts is advantageous since it is the preferred method to use for skulking or elusive species. In addition, it is the preferred method to line transect counts where access is problematic, or when the terrain appears to be complex (e.g. mountainous). It is considered to be a good method to use, and very efficient for gathering a large amount of data in a short period of time (Sutherland, 2006). The spatial position of each point count is illustrated in Figure 4. The spatial placement of the point counts was determined through a stratified random design which ensures coverage of each habitat type and/or macro-habitat (Sutherland et al., 2004).

Therefore, the sampling approach was adapted so that all the bird species seen within approximately 50m from the centre of the point were recorded (resulting in an area of 0.78 ha) along with their respective abundance values (a laser rangefinder was used to delineate the area to be surveyed at each point). Each point count lasted approximately 20 -30 minutes, while the area within the 50m radius of homogenous habitat was slowly traversed to ensure that all bird species were detected and or flushed (as proposed by Watson, 2003). To ensure the independence of observations, points were positioned at least 200 m apart. Observations were not truncated, and in order to standardise data collection, the following assumptions were conformed to (according to Buckland *et al.*, 1994):

- All birds on the point must be seen and correctly identified. This assumption is in practice very difficult to meet in the field as some birds in the nearby vicinity may be overlooked due to low visibility or were obscured by vegetation (e.g. graminoid cover). Therefore, it is assumed that the portion of birds seen on the point count represents the total assemblage on the point.
- All birds must be recorded at their initial location. All movements of the birds are random and therefore natural in relation to the movements of the observer. None of the birds moved in response to the presence of the observer, and birds flying past without landing were omitted from the analysis.
- In other words, no bird is recorded more than once.

2.2.2 Random (ad hoc) surveys

To obtain an inventory of bird species present (apart from those observed during the point counts), all bird species observed/detected while moving between point counts were identified and noted. Particular attention was devoted to suitable roosting, foraging and nesting habitat for species of conservation concern (e.g. threatened or near threatened species). In addition, the fly patterns of large non-passerine and birds of prey were recorded, as well as the locality of collision-prone birds.

2.2.3 Analyses

Data generated from the point counts was analysed according to Clarke & Warwick (1994) based on the computed percentage contribution (%) of each species, including the consistency (calculated as the similarity coefficient/standard deviation) of its contribution. Hierarchical Agglomerative Clustering (a cluster analysis-based group-average linkages; Clarke & Warwick 1994) was performed on calculated Bray-Curtis coefficients derived from the data. A cluster analysis is used to assign "species associations" between samples with the aim to objectively delineate groups or assemblages. Therefore, sampling entities that group together (being more similar) are believed to have similar compositions.

The species richness and diversity of each bird association was analysed by means of richness measures (such as the total number of species recorded (S) and Shannon Wiener Index) were calculated to compare the associations with each other.

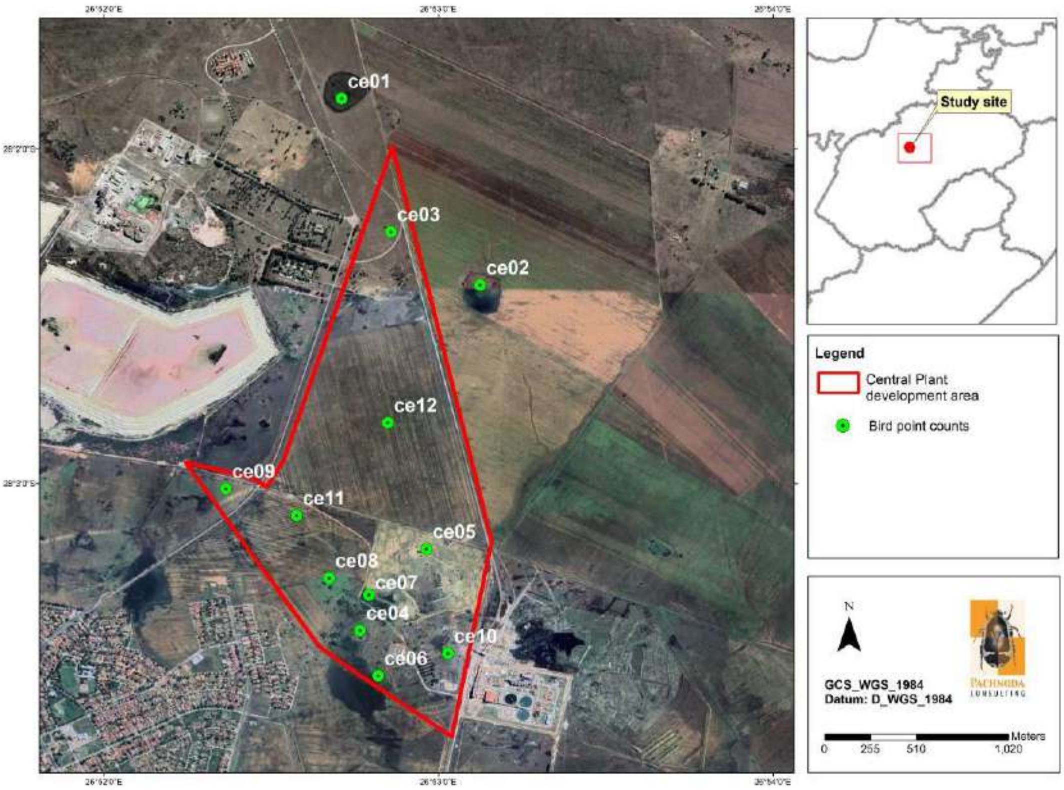

Figure 4: A map illustrating the spatial position of 12 bird point counts located within the study area.

2.3 Sensitivity Analysis

A sensitivity map was compiled based on the outcome of the baseline results.

The ecological sensitivity of any piece of land is based on its inherent ecosystem service (e.g. wetlands) and overall preservation of biodiversity.

2.3.1 Ecological Function

Ecological function relates to the degree of ecological connectivity between systems within a landscape matrix. Therefore, systems with a high degree of landscape connectivity amongst one another are perceived to be more sensitive and will be those contributing to ecosystem services (e.g. wetlands) or the overall preservation of biodiversity.

2.3.2 Avifaunal Importance

Avifaunal importance relates to species diversity, endemism (unique species or unique processes) and the high occurrence of threatened and protected species or ecosystems protected by legislation.

2.3.3 Sensitivity Scale

- *High* – Sensitive ecosystems with either low inherent resistance or low resilience towards disturbance factors or highly dynamic systems considered important for the maintenance of ecosystem integrity. Most of these systems represent ecosystems with high connectivity with other important ecological systems OR with high species diversity and usually contain high numbers of threatened, endemic or rare bird species. These areas should preferably be protected;
- *Moderately high* - Untransformed or productive habitat units (which can also be artificial) which contain high bird numbers and/or bird richness values. These areas are often fragmented OR azonal, and hence of small surface area that are often surrounded by habitat of moderate or low sensitivity. These habitat units also include potential habitat for threatened species. Development is often considered permissible on these areas if there is enough reason to believe that these areas are widespread in the region and future planned developments are unlikely to result in the widespread loss (>50 %) of similar habitat at a regional scale.
- *Medium* – These are slightly modified systems which occur along gradients of disturbances of low-medium intensity with some degree of connectivity with other ecological systems OR ecosystems with intermediate levels of species diversity but may include potential ephemeral habitat for threatened species; and
- *Low* – Degraded and highly disturbed/transformed systems with little ecological function and are generally very poor in bird species diversity (most species are usually exotic or weeds).

2.4 Limitations

- It is assumed that third party information (obtained from government, academic/research institution, non-governmental organisations) is accurate and true.
- Some of the datasets are out of date and therefore extant distribution ranges may have shifted although these datasets provide insight into historical distribution ranges of relevant species.
- The datasets are mainly small-scale and could not always consider azonal habitat types that may be present on the study area (e.g. artificial livestock watering points). In addition, these datasets encompass surface areas larger

than the study area, which could include habitat types and species that are not present on the study site. Therefore the potential to overestimate species richness is highly likely while it is also possible that certain cryptic or specialist species could have been be overlooked in the past.

- Some of the datasets (e.g. SABAP2) managed by the Animal Demography Unit of the University of Cape Town were recently initiated and therefore incomplete.
- A replicative sampling protocol was followed which coincided with the austral dry season. The austral dry season is not the most optimal time of the year to conduct bird surveys since many of the migratory species (Palearctic and Intra-African migratory species) will be absent. However, these species represents a small percentage of the expected species that could occur on the study site. In addition, many resident species also become less vocal (e.g. cisticolas) during the dry season with the risk that these species may be overlooked. However, replicative surveys detected the majority of these species and the observed species list for the study site is considered to be a true representation of the expected richness.
- This company, the consultants and/or specialist investigators do not accept any responsibility for conclusions, suggestions, limitations and recommendations made in good faith, based on the information presented to them, obtained from the surveys or requests made to them at the time of this report.

3. DESCRIPTION OF THE AFFECTED ENVIRONMENT

3.1 Locality

The proposed PV facility will be located near the Harmony Gold Central Plant operations located ~6km north east of the town of Virginia and ~11km south east of the town of Welkom, Free State Province (Figure 1).

3.2 Regional Vegetation Description

The proposed PV facility corresponds to the Grassland Biome and more particularly to the Dry Highveld Grassland Bioregion as defined by Mucina & Rutherford (2006). It comprehends an ecological type known as Vaal-Vet Sandy Grassland (Mucina & Rutherford, 2006) (Figure 5).

From an avifaunal perspective it is evident that bird diversity is positively correlated with vegetation structure, and floristic richness is not often regarded to be a significant contributor of patterns in bird abundance and their spatial distributions. Although grasslands are generally poor in woody plant species, and subsequently support lower bird richness values, it is often considered as an important habitat for many terrestrial bird species such as larks, pipits, korhaans, cisticolas, widowbirds including large terrestrial birds such as Secretarybirds, cranes and storks. Many of these species are also endemic to South Africa and display particularly narrow distribution ranges. Due to the restricted spatial occurrence of the Grassland Biome and severe habitat transformation, many of the bird species that are restricted to the grasslands are also threatened or experiencing declining population sizes.

The Vaal-Vet Sandy Grassland occurs in the Free State and North-West Provinces, where it extends from Lichtenburg and Ventersdorp southwards to Klerksdorp, Leeudoringstad, Bothaville and the Brandfort area north of Bloemfontein. It occurs at an altitude of 1 220-1 560 m and is mainly confined to aeolian and colluvial sand overlying shales and mudstones. The floristic structure of the Vaal-Vet Sandy Grassland is mainly a low tussocky grassland with many karroid elements. In its untransformed condition, *Themeda triandra* is an important dominant graminoid, while intense grazing and erratic rainfall is responsible for an increase of *Elionurus muticus, Cymbopogon pospischilii* and *Aristida congesta*.

The Vaal-Vet Sandy Grassland is a threatened (**Endangered**) ecosystem with only a few remaining patches of untransformed grassland being statutorily conserved (c. 0.3 % at Bloemhof Dam, Schoonspruit, Sandveld, Faan Meintjies, Wolwespruit and Soetdoring Nature Reserves). In addition, the Vaal-Vet Sandy Grassland is a Critically Endangered Ecosystem (as per Section 52 of National Environmental Management Biodiversity Act, (Act No. 10 of 2004)) and a Critical Biodiversity Area as per the Free State Conservation Plan (DESTEA, 2015). More than 63 % of this grassland type is already transformed by cultivation, and intense livestock grazing.

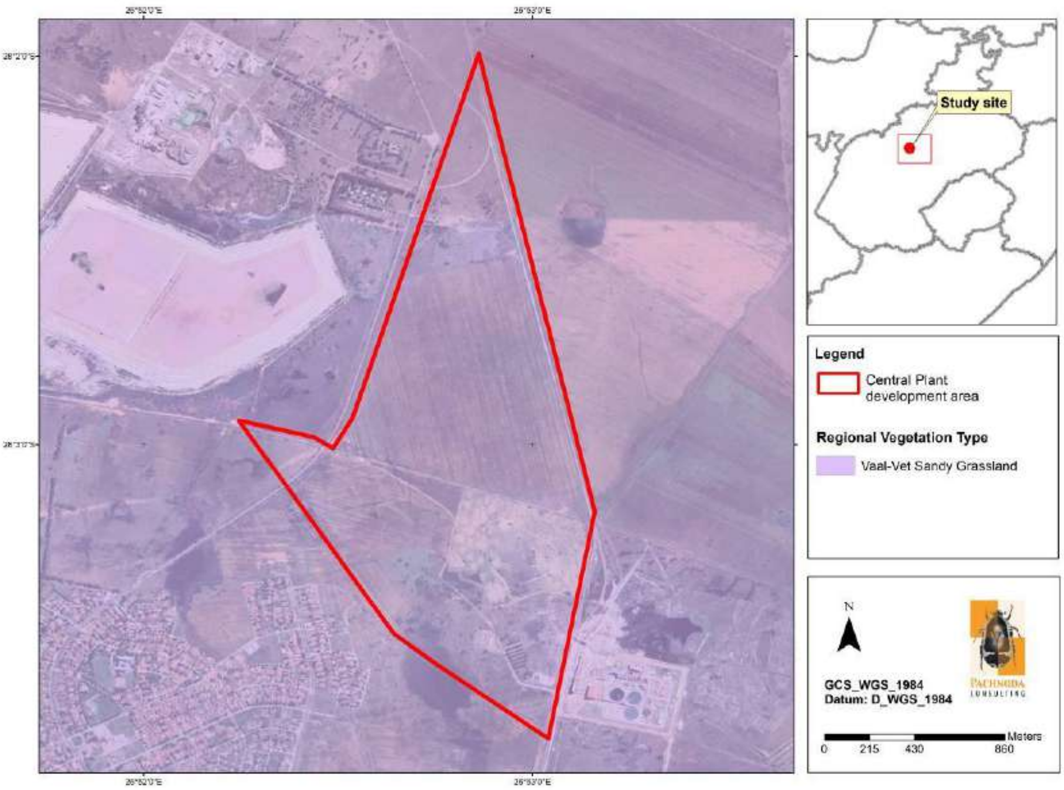

Figure 5: A satellite image illustrating the regional vegetation type corresponding to the study site and immediate surroundings. Vegetation type categories were defined by Mucina & Rutherford (2006; updated 2012).

3.3 Land cover, land use and existing infrastructure.

According to the South African National dataset of 2013-2014 (Geoterrainimage, 2015) the study area comprehends the following land cover categories (Figure 6):

Natural areas:

- Grassland;
- Low shrubland; and
- Woodland and open bush.

Transformed areas:

- Mines and quarries;
- Cultivation; and
- Urban/build-up areas

From the land cover dataset it is evident that most of the study site is covered by old cultivated land that is currently covered by secondary grassland. However, the northern, western and southern parts are covered in natural clay grassland and scattered microphyllous bush clumps. The remainder of the site consists of mining infrastructure.

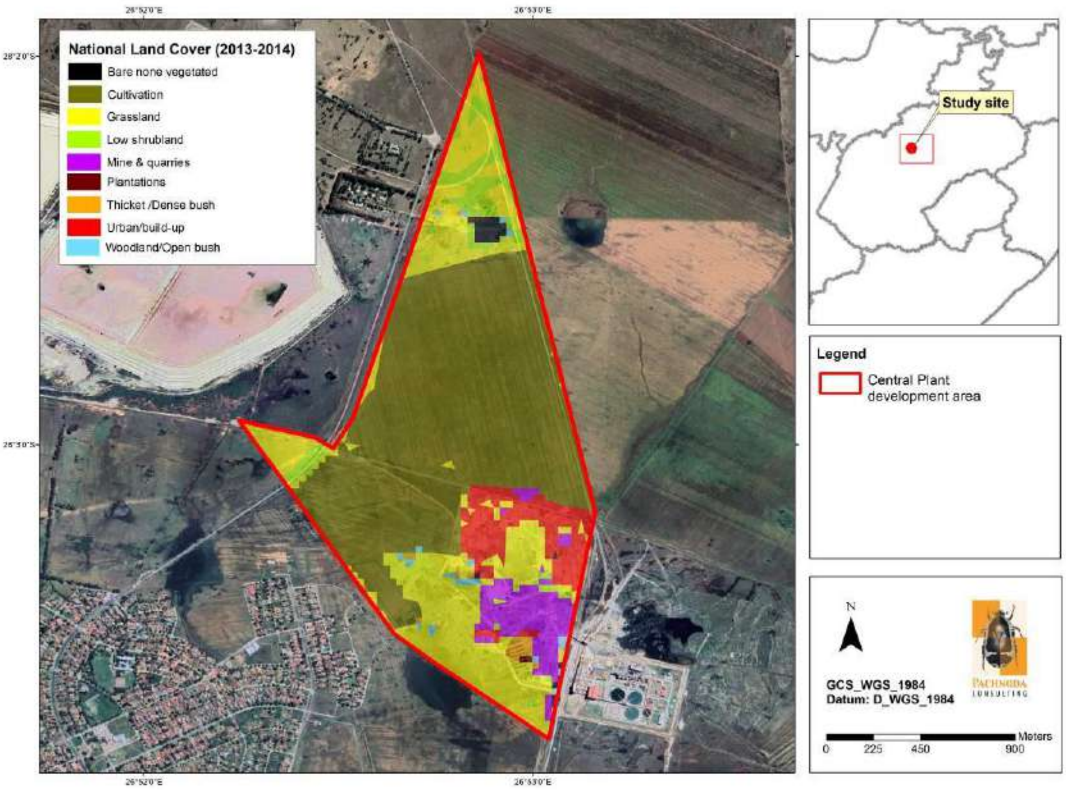

Figure 6: A map illustrating the land cover classes (Geoterrainimage, 2015) corresponding to the proposed study and development areas.

3.4 Conservation Areas, Protected Areas and Important Bird Areas

The study site does not coincide with any conservation area or Important Bird and Biodiversity Area (IBA). The nearest conservation area to the proposed study site is the Willem Pretorius Game Reserve, which is located 35 km south-east of the study site. The Willem Pretorius Game Reserve is also a recognised IBA (SA044).

3.5 Annotations on the National Web-Based Environmental Screening Tool

Regulation 16(1)(v) of the Environmental Impact Assessment Regulations, 20145 (EIA Regulations) provides that an applicant for Environmental Authorisation is required to submit a report generated by the Screening Tool as part of its application. On 5 July 2019, the Minister of Environmental Affairs, Forestry and Fisheries published a notice in the Government Gazette giving notice that the use of the Screening Tool is compulsory for all applicants to submit a report generated by the Screening Tool from 90 days of the date of publication of that notice.

The Screening Tool is intended to allow for pre-screening of sensitivities in the landscape to be assessed within the EA process. This assists with implementing the mitigation hierarchy by allowing developers to adjust their proposed development footprint to avoid sensitive areas. The Screening Tool report will indicate the (preliminary) environmental sensitivities that intersect with the proposed development footprint as defined by the applicant as well as the relevant Protocols.

As the Screening Tool contains datasets that are mapped at a national scale, there may be areas where the Screening Tool erroneously assigns, or misses, environmental sensitivities because of mapping resolution and a high paucity of available and accurate data. Broad-scale site investigations will provide for an augmented and site-specific evaluation of the accuracy and 'infilling' of obvious and large-scale inaccuracies. Information extracted from the National Web-based Environmental Screening Tool (Department of Environmental Affairs, 2020), indicated that the study site and immediate surroundings hold a **medium** sensitivity with respect to the relative animal species protocol (Figure 7) (report generated 25/04/2022):

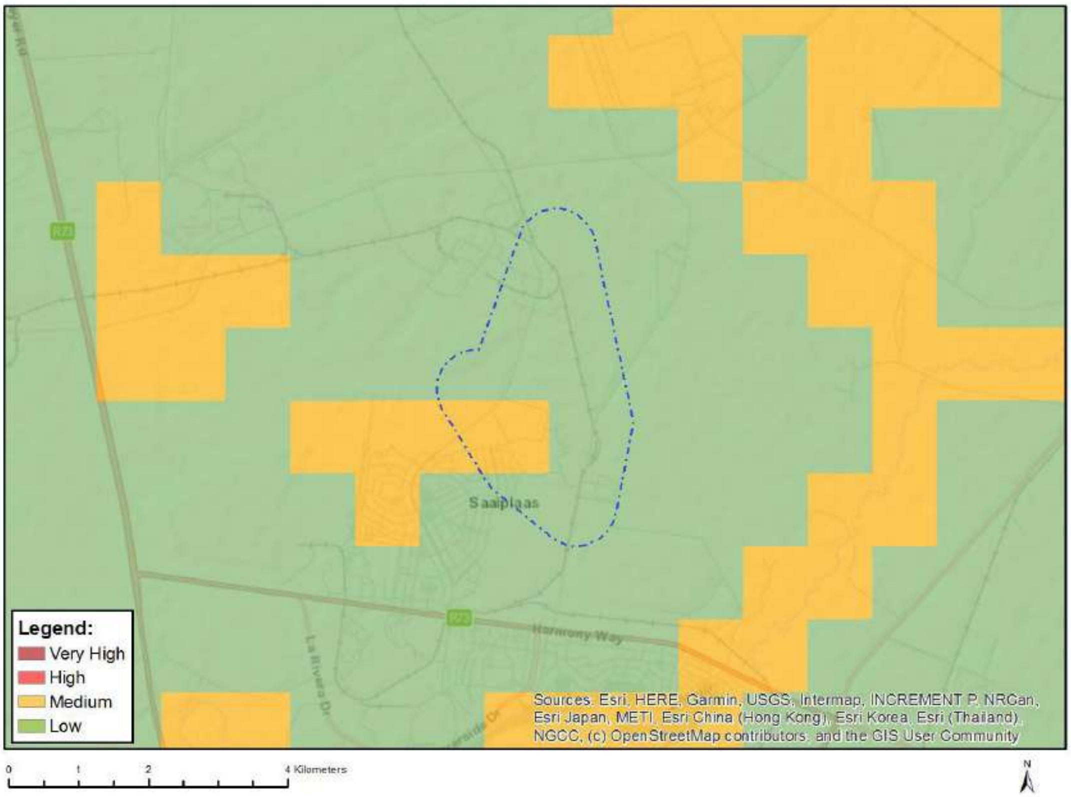

Figure 7: The animal species sensitivity of the study site and immediate surroundings according to the Screening Tool.

Sensitive features include the following:

Sensitivity	Feature(s)
Low	Low sensitivity
Low	Reptilia-*Smaug giganteus*

According to the results of the screening tool, a low probability of occurrence is evident for threatened bird species although the western section holds a medium sensitivity for a threatened lizard species.

It is evident that the study site and immediate surroundings correspond to a **low** avian theme sensitivity (see Figure 8).

Figure 8: The relative avian sensitivity of the study site and immediate surroundings according to the Screening Tool.

Sensitive features include the following:

Sensitivity	Feature(s)
Low	Low sensitivity

However, the study site and immediate surroundings hold a **very high** sensitivity with respect to the relative terrestrial biodiversity theme (Figure 9):

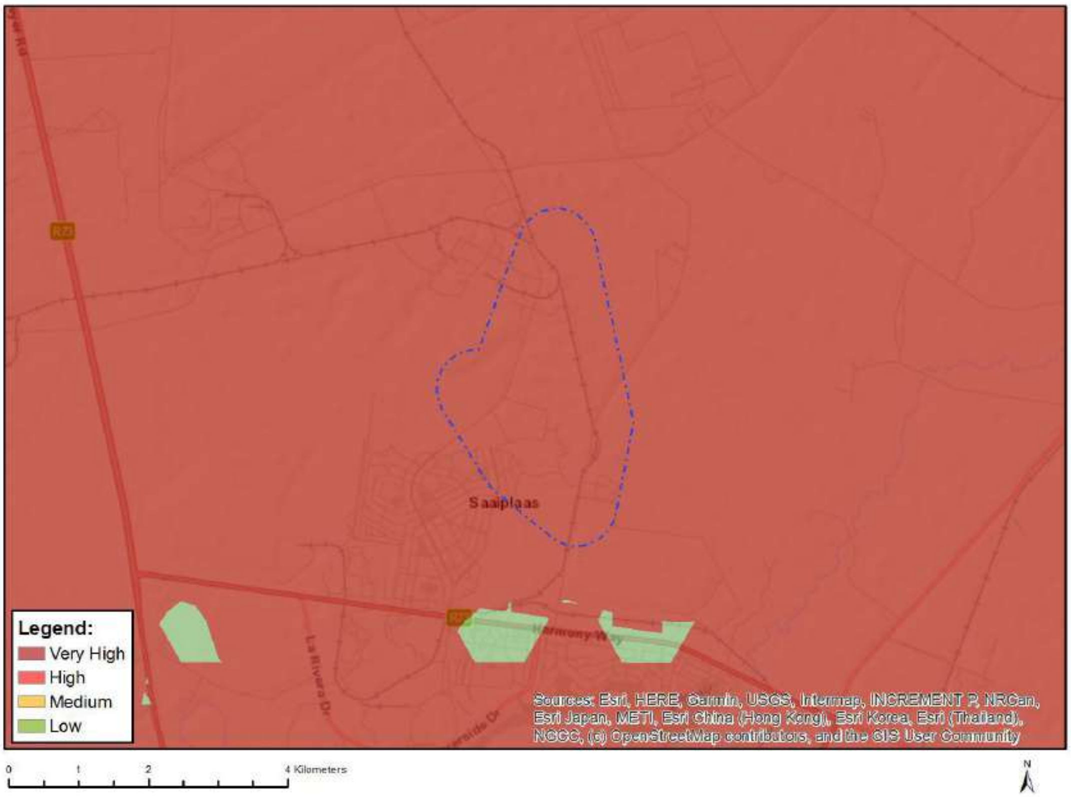

Figure 9: The relative terrestrial biodiversity sensitivity of the study site and immediate surroundings according to the Screening Tool.

Sensitive features include the following:

Sensitivity	Feature(s)
Very High	Critical Biodiversity Area 1
Very High	Endangered Ecosystem

It is evident from the results of the Screening Tool report that part of the entire study area coincides with a Critical Biodiversity Area 1 (CBA 1) as per the Free State Biodiversity Plan (DESTEA, 2015). In addition, the study site also coincides with an Endangered ecosystem which is represented by the Vaal-Vet Sandy Grassland.

4. RESULTS AND DISCUSSION

4.1 Avifaunal habitat types

Apart from the regional vegetation type, the local composition and distribution of the vegetation associations on the study site are a consequence of a combination of factors simulated by historical disturbance regimes and soil moisture regimes which have culminated in a number of habitat types that deserve further discussion (Figure 10 and Figure 11):

1. *Untransformed grassland:* This unit is located on the northern and western parts of the study site. The graminoid structure and composition is essentially of an untransformed nature and dominated by a variety of *Eragrostis* species

as well as *Themeda triandra*, of which the graminoid composition appears to be more diverse when compared to historically disturbed areas (e.g. secondary grassland). The bird composition is typified by widespread grassland species such as Crowned Lapwing (*Vanellus coronatus*), Cape Longclaw (*Macronyx capensis*), African Pipit (*Anthus cinnamomeus*) and Cloud Cisticola (*Cisticola textrix*).

2. *Old cultivated land and secondary grassland:* This unit is prominent on the central section of the study site was probably utilised as cultivation in the past. It represents a grassland sere with a secondary albeit monotonous composition that is dominated by *Cynodon dactylon*, *Eragrostis cf. lehmanniana, Aristida congesta, Chloris gayana* and *Gomphocarpus fruticosus*. The bird composition is represented by cryptic grassland and nomadic species including high numbers of Red-capped Lark (*Calandrella cinerea*) and Desert Cisticola (*Cisticola aridulus*). It also provides ephemeral foraging habitat for a small sub-population of the collision-prone species, namely the Northern Black Korhaan (*Afrotis afraoides*).

3. *Bush clump mosaics*: This unit is localised and .located on the southern part of the study site where it is represented by a distinct woody canopy dominated by *Vachellia karroo*. The eminent increase in vertical heterogeneity provided by the woody layer is colonised by a "Bushveld" bird association consisting of insectivorous passerines such as Black-chested Prinia (*Prinia flavicans*), Chestnut-vented Warbler (*Sylvia subcoerulea*), Kalahari Scrub Robin (*Cercotrichas paena*), African Red-eyed Bulbul (*Pycnonotus nigricans*) as well as granivores such as Yellow Canary (*Crithagra flaviventris*) and Southern Masked Weaver (*Ploceus velatus*). Non-passerine bird taxa are represented by Laughing Dove (*Spilopelia senegalensis*), Ring-necked Dove (*Streptopelia capicola*), Acacia Pied Barbet (*Tricholaema leucomelas*) and White-backed Mousebird (*Colius colius*). It also provides nesting and roosting habitat for the White-browed Sparrow-weaver (*Plocepasser mahali*).

4. *Transformed and landscaped (manicured) areas*: These areas are represented by build-up land and landscaped areas of which the tree cover is predominantly composed of exotic species. These features are invariably also artificial although colonised by widespread and generalist bird species such as the Laughing Dove (*Spilopelia senegalensis*), Ring-necked Dove (*Streptopelia capicola*) and Southern Fiscal (*Lanius collaris*).

It is also worth noting that the nearby ephemeral pans north of the study site were inundated and provide foraging habitat for waterbird taxa such as Reed Cormorant (*Microcarbo capensis*), Glossy Ibis (*Plegadis falcinellus*), Little Grebe (*Tachybaptus ruficollis*), Red-knobbed Coot (*Fulica cristata*) and Common Moorhen (*Gallinula chloropus*).

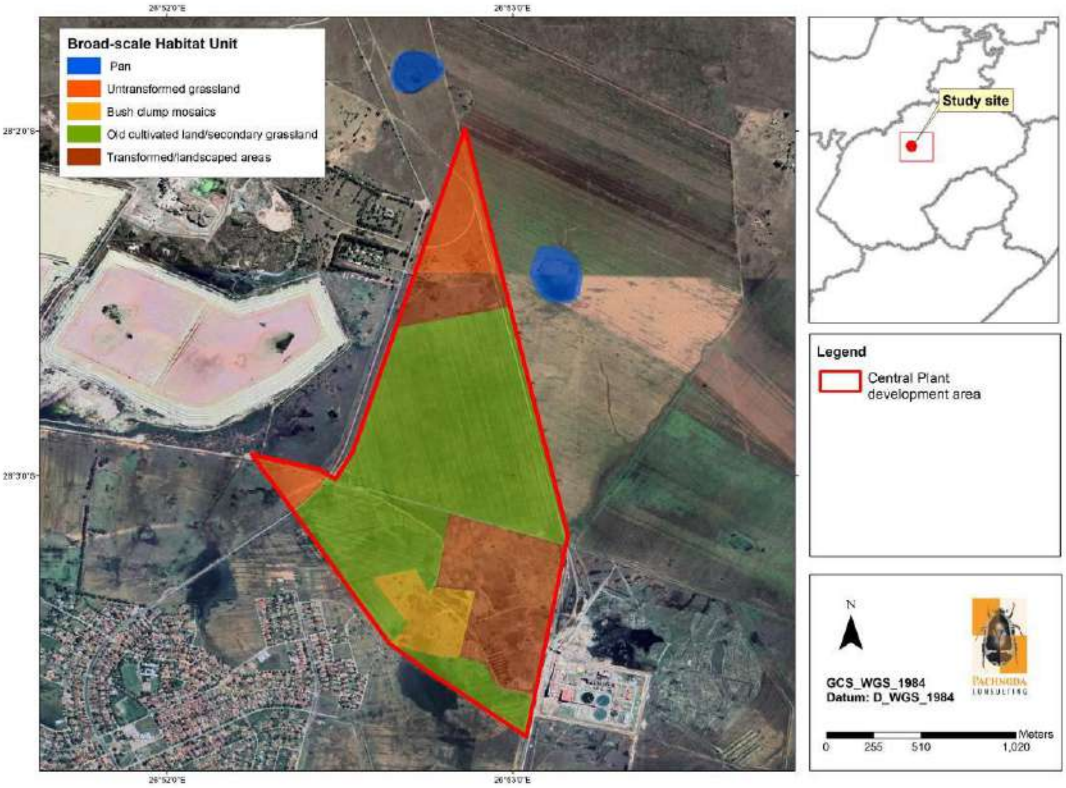

Figure 10: A map illustrating the avifaunal habitat types on the study site.


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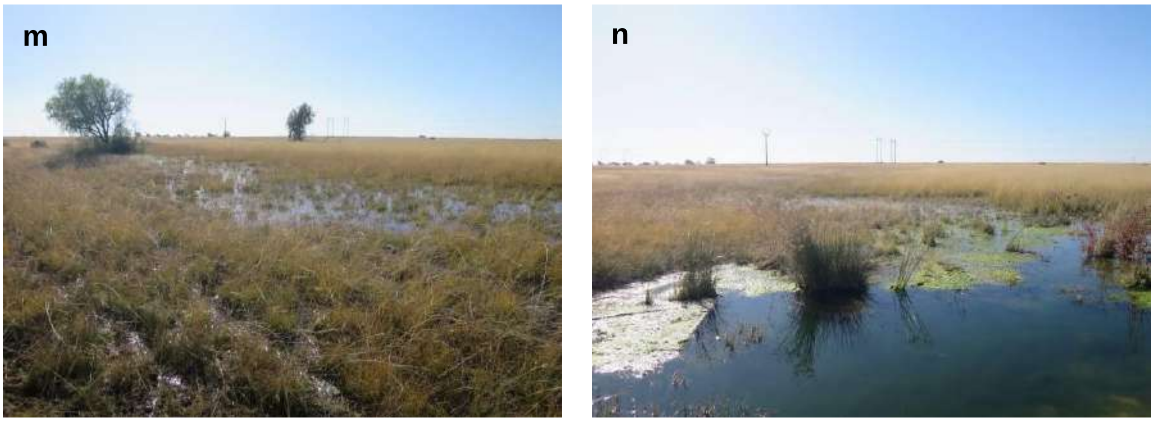

Figure 11: A collage of images illustrating examples of avifaunal habitat types observed on the study area: (a - d) Untransformed grassland (e - f) bush clump mosaics, (g - j) secondary grassland on old cultivated land, (k - l) transformed and landscaped land and (m - n) a nearby inundated pan located north of the study site.

4.2 Species Richness and Summary statistics

Approximately 152 bird species are expected to occur in the study area (refer to Appendix 1 and Table 1). The expected richness was inferred from the South African Bird Atlas Project (SABAP1 & SABAP2)[1] (Harrison et al., 1997; www.sabap2.birdmap.africa) and the presence of suitable habitat in the study area. This equates to 15 % of the approximate 987[2] species listed for the southern African subregion[3] (and approximately 17 % of the 871 species recorded within South Africa[4]). The average number of species for each full protocol card submitted (for observation of two hours or more) is 50.2 species (range = 25 - 82 species).

According to field observations, the total number of species observed on the study area is *ca*. 85 species (see Appendix 1). On a national scale, the species richness per pentad on the study area is considered to be moderate to high (refer to Figure 12).

According to Table 1, the study area is poorly represented by biome-restricted[5] (see Table 2) and local endemic bird species. Of the 152 bird species expected to occur in the study area, only five are threatened or near threatened species, five are local near-endemic species, while it was evident that local endemic species was represented by only two species. In addition, the occurrence of threatened and near threatened bird species was low, with only the vulnerable Lanner Falcon (*Falco biarmicus*) observed during June 2022. Furthermore, 11 southern African endemics and 11 regional near-endemic species were confirmed on the study site and the

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[1] The expected richness statistic was derived from the pentad grid 2800_2650 (including adjacent 8 grids) totalling 154 bird species (based on 43 submitted cards, 31 being full protocol cards and 12 being ad hoc cards).

2 *sensu* www.zestforbirds.co.za (Hardaker, 2020) including four recently confirmed bird species (vagrants).

3 A geographical area south of the Cunene and Zambezi Rivers (includes Namibia, Botswana, Zimbabwe, southern Mozambique, South Africa, eSwatini and Lesotho).

4 With reference to South Africa (including Lesotho and eSwatini (BirdLife South Africa, 2022).

[5] A species with a breeding distribution confined to one biome. Many biome-restricted species are also endemic to southern Africa.

immediate surroundings (Table 3). Waterbird species were highly irregular on the study site with most of the observations obtained from nearby inundated pans/depressions north of the study site containing taxa such as Cape Shoveller (*Anas smithii*), Yellow-billed Duck (*A. undulata*), Red-billed Teal (*A. erythrorhyncha*), Southern Pochard (*Netta erythrophthalma*), Little Grebe (*Tachybaptus ruficollis*), Common Moorhen (*Gallinula chloropus*) and Red-knobbed Coot (*Fulica cistata*).

Table 1: A summary table of the total number of species, Red listed species (according to Taylor *et al*., 2015 and the IUCN, 2022), endemics and biome-restricted species (Marnewick *et al*., 2015) expected (*sensu* SABAP1 and SABAP2) to occur in the study site and immediate surroundings.

Description	Expected Richness Value (study area and surroundings)***	Observed Richness Value (study area)****
Total number of species*	152 (17 %)	85 (56 %)
Number of Red Listed species*	5 (4 %)	1 (20 %)
Number of biome-restricted species – Zambezian and Kalahari-Highveld Biomes*	3 (21 %)	3 (100 %)
Number of local endemics (BirdLife SA, 2022)*	2 (5 %)	1 (50 %)
Number of local near-endemics (BirdLife SA, 2022)*	5 (17 %)	4 (80 %)
Number of regional endemics (Hockey *et al.,* 2005)**	14 (13 %)	11 (79 %)
Number of regional near-endemics (Hockey *et al.,* 2005)**	14 (23 %)	11 (79 %)

* only species in the geographic boundaries of South Africa (including Lesotho and eSwatini) were considered.
** only species in the geographic boundaries of southern Africa (including Namibia, Botswana, Zimbabwe and Mozambique south of the Zambezi River) were considered
*** Percentage values in brackets refer to totals compared against the South African avifauna (*sensu* BirdLife SA, 2022).
**** Percentage values in brackets refer to totals compared against the expected number of species in the project area.

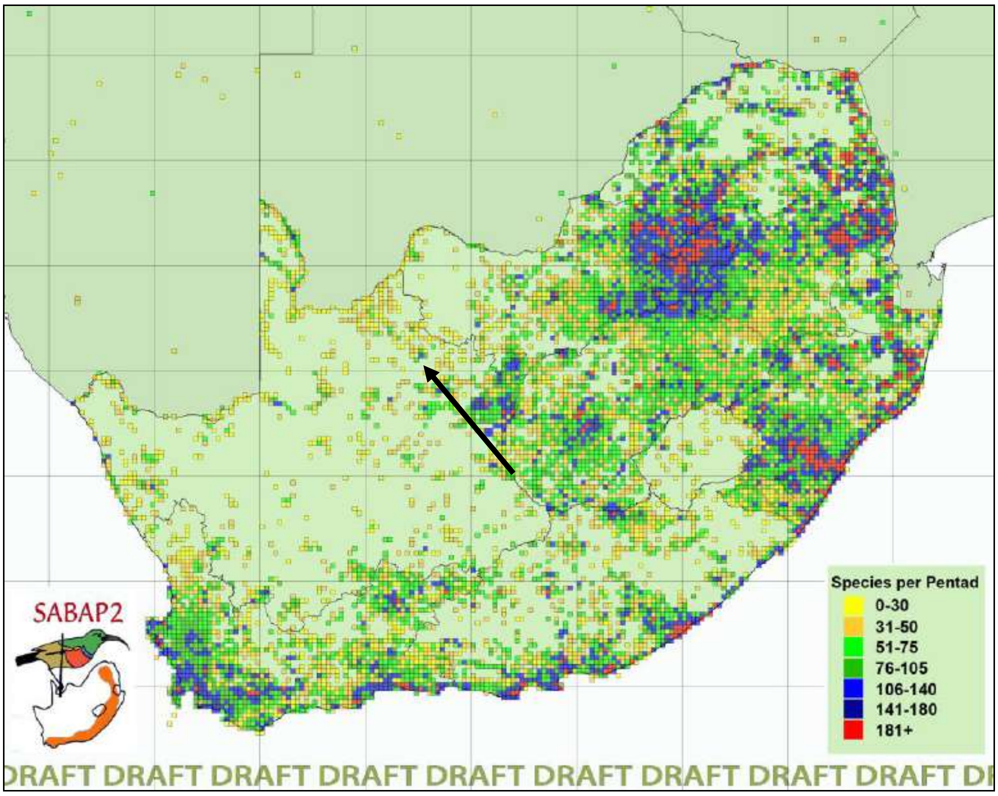

Figure 12: The bird species richness per pentad grid in comparison to the broader study area (see arrow) (map courtesy of SABAP2 and the Animal Demography Unit). According to the SABAP2 database, the study area hosts between 141 and 180 bird species.

Table 2: Expected biome-restricted species (Marnewick *et al*, 2015) likely to occur on the study area.

Species	Kalahari-Highveld	Zambezian	Expected Frequency of occurrence
Kalahari Scrub-robin (*Cercotrichas paena)*	X		Fairly Common
White-throated Robin-chat (*Cossypha humeralis*))		X	Uncommon (overlooked)
White-bellied Sunbird (*Cinnyris talatala*)		X	Uncommon

Table 3: Endemic bird species and species of conservation concern occurring in the broader study area which could collide and/ or become displaced by the proposed PV infrastructure.

Common Name	Scientific name	Regional Status	Global Status	Observed (June/July 2022)	Collision with power lines	Collision with PV panels	Displacement (disturbance & loss of habitat)
South African Shelduck	*Tadorna cana*	End		1	1	1	
Cape Shoveller	*Anas smithii*	End		1	1	1	

Common Name	Scientific name	Regional Status	Global Status	Observed (June/July 2022)	Collision with power lines	Collision with PV panels	Displacement (disturbance & loss of habitat)
Northern Black Korhaan	*Afrotis afraoides*	End		1	1		1
White-backed Mousebird	*Colius colius*	End		1			1
Karoo Thrush	*Turdus smithi*	End					1
Ant-eating Chat	*Myrmecocichla formicivora*	End		1			1
Pied Starling	*Lamprotornis bicolor*	End		1			1
Cape Longclaw	*Macronyx capensis*	End		1			1
Fiscal Flycatcher	*Sigelus silens*	End		1			1
Fairy Flycatcher	*Stenostira scita*	End		1			1
White-throated Robin-chat	*Cossypha humeralis*	End		1			1
South African Cliff Swallow	*Petrochelidon spilodera*	End					1
Cape White-eye	*Zosterops virens*	End					1
Orange River White-eye	*Zosterops pallidus*	End		1			1
Pale Chanting Goshawk	*Melierax canorus*	N-end			1		
Orange River Francolin	*Scleroptila gutturalis*	N-end			1		1
Acacia Pied Barbet	*Tricholaema leucomelas*	N-end		1			1
Eastern Clapper Lark	*Mirafra fasciolata*	N-end					1
Pink-billed Lark	*Spizocorys conirostris*	N-end		1			1
African Red-eyed Bulbul	*Pycnonotus nigricans*	N-end		1			1
Kalahari Scrub Robin	*Cercotrichas paena*	N-end		1			1
Chestnut-vented Warbler	*Curruca subcoerulea*	N-end		1			1
Pririt Batis	*Batis pririt*	N-end		1			1
Cape Sparrow	*Passer melanurus*	N-end		1			1
Scaly-feathered Weaver	*Sporopipes squamifrons*	N-end		1			1
Red-headed Finch	*Amadina erythrocephala*	N-end		1			1
Yellow Canary	*Crithagra flaviventris*	N-end		1			1
Cloud Cisticola	*Cisticola textrix*	N-end		1			1
Secretarybird	*Sagittarius serpentarius*	EN	EN		1		1
Lesser Flamingo	*Phoeniconaias minor*	NT	NT		1	1	
Greater Flamingo	*Phoenicopterus roseus*	NT			1	1	
Black Stork	*Ciconia ciconia*	VU			1		
Falcon, Lanner	*Falco biarmicus*	VU		1	1		
	Totals:	**33**	**2**	**23**	**10**	**4**	**26**

Threatened and near threatened species are indicated in red
CR - Critically endangered, EN - endangered, VU - vulnerable, NT - near threatened
End - southern African endemic
N-end - southern African near-endemic

Prior to further analyses where species richness values are considered, it is imperative to determine if all bird species present were sufficiently sampled. Species accumulation curves (SAC) provide a means to examine data and sampling efficacy. For this project the species accumulation curves (SAC) for the point count data were generated using the software program Estimates S (version 9) with 100 randomizations (as recommended in Colwell, 2013). Curves were generated for the full data set (all point counts). Sampling sufficiency was determined by establishing whether a point had been reached where a line representing one new sample adding one new species was tangent to the curve (Brewer & McCann, 1982). The Michaelis-Menten equation (Soberôn & Llorente 1993) was fitted to the predicted number of species using Estimates S (Raaijmakers, 1987). A satisfactory level of sampling was achieved if 90 % of the bird species were detected, and hence predicted by the model (Moreno & Halffter, 2000).

The species accumulation curve (SAC) reached an asymptote at approximately 18 point counts (Figure 13). The sampling captured approximately 71% of the number of species predicted by the Michaelis-Menten model at 18 point counts. Approximately 76% of the species was captured by 24 counts. Sampling effort was considered sufficient and recorded most of the species present on the study area during the respective survey sessions.

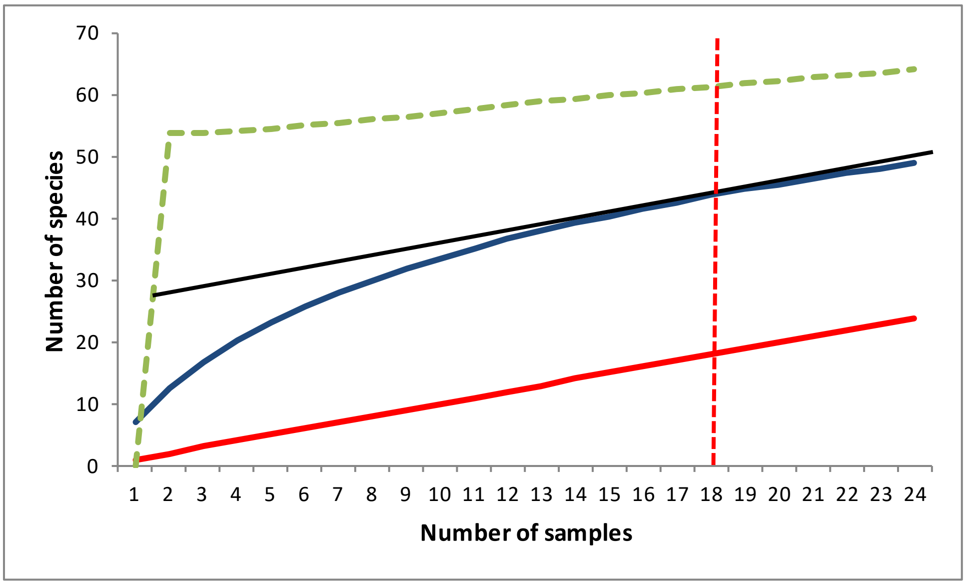

Figure 13: The species accumulation curve (SAC) (red line) for bird points sampled during the June 2022 and July 2022 survey sessions. The blue line represents an accumulation of one species for every additional point count. The black line is parallel to the blue one and is tangent to the SAC approximately after 18 counts (as represented by the vertical red stippled line). The green stippled line represents the Michaelis-Menten curve.

4.3 Bird species of conservation concern

Table 4 provides an overview of bird species of conservation concern that could occur on the development area based on their historical distribution ranges and the presence of suitable habitat. According to Table 4, a total of five species have been recorded in the wider study area (sensu SABAP2) which include one globally threatened species, one globally near threatened species, two regionally threatened species and one regionally near threatened species.

It is evident from Table 4 that these species occur at low reporting rates (< 5% for full protocol cards), which suggests that these species are highly irregular visitors to the study site. The occurrence of most of these species on the study area (sensu pentad grid 2800_2650) was based on single observations which confirm the low probability for these species to occur.

However, the vulnerable Lanner Falcon (*Falco biarmicus*) was observed flying in a north-easterly direction to a series of pylon structures on 07 June 2022 (Figure 14). The status of this species on the study area remains uncertain, although it is considered to be an occasional foraging visitor to the area.

Both the globally near threatened Lesser Flamingo (*Phoeniconaias minor*) and the regionally near threatened Greater Flamingo (*Phoenicopterus roseus*) have been observed from pans and dams in the wider study area. These species are regarded as regular foraging visitors to the nearby pans and dams although these species are probably absent on the physical study site due to the absence of any suitable habitat on the study site. Nevertheless, birds dispersing or commuting between the nearby pans and dams could potentially fly over the study site and could interact (collide) with the PV panels and associated electrical infrastructure.

Table 4: Bird species of conservation concern that could utilise the study area based on their historical distribution range and the presence of suitable habitat. Red list categories according to the IUCN (2022)* and Taylor et al. (2015)**.

Species	Global Conservation Status*	National Conservation Status**	SABAP2 reporting rate	Preferred Habitat	Potential Likelihood of Occurrence
Falco biarmicus (Lanner Falcon)	-	Vulnerable	9.52	Varied, but prefers to breed in mountainous areas although also using old disused mine voids.	An occasional foraging visitor to the study site. One individual was observed on 07 June 2022 while flying in a north-easterly direction toward existing pylon structures (see Figure 14).
Ciconia ciconia (Black Stork)	-	Vulnerable	4.76	Breeds in mountainous regions. Preferred foraging habitat include inundated pans and large impoundments.	Probably absent on the physical study site due to the absence of suitable habitat. Birds dispersing between pans could potentially fly over the site and may interact with the PV panels en electrical infrastructure. It is only known from a single observation on the study area (19 January 2022).
Phoeniconaias minor (Lesser Flamingo)	Near-threatened	Near-threatened	-	Restricted to large saline pans and other inland water bodies containing cyanobacteria.	Probably a regular foraging visitor to the nearby pans and dams. Probably absent on the physical study site due to the absence of suitable habitat. Birds dispersing between the pans and dams in the area

Species	Global Conservation Status*	National Conservation Status**	SABAP2 reporting rate	Preferred Habitat	Potential Likelihood of Occurrence
					could potentially fly over the site and may interact with the PV panels en electrical infrastructure.
Phoenicopterus roseus (Greater Flamingo)	-	Near-threatened	4.76	Restricted to large saline pans and other inland water bodies.	Probably a regular foraging visitor to the nearby pans and dams. Probably absent on the physical study site due to the absence of suitable habitat. Birds dispersing between the pans and dams in the area could potentially fly over the site and may interact with the PV panels en electrical infrastructure.
Sagittarius serpentarius (Secretarybird)	Endangered	Endangered	4.76	Prefers open grassland or lightly wooded habitat.	A highly irregular foraging visitor and probably absent on the study site. Historically displaced due to anthropogenic activities.

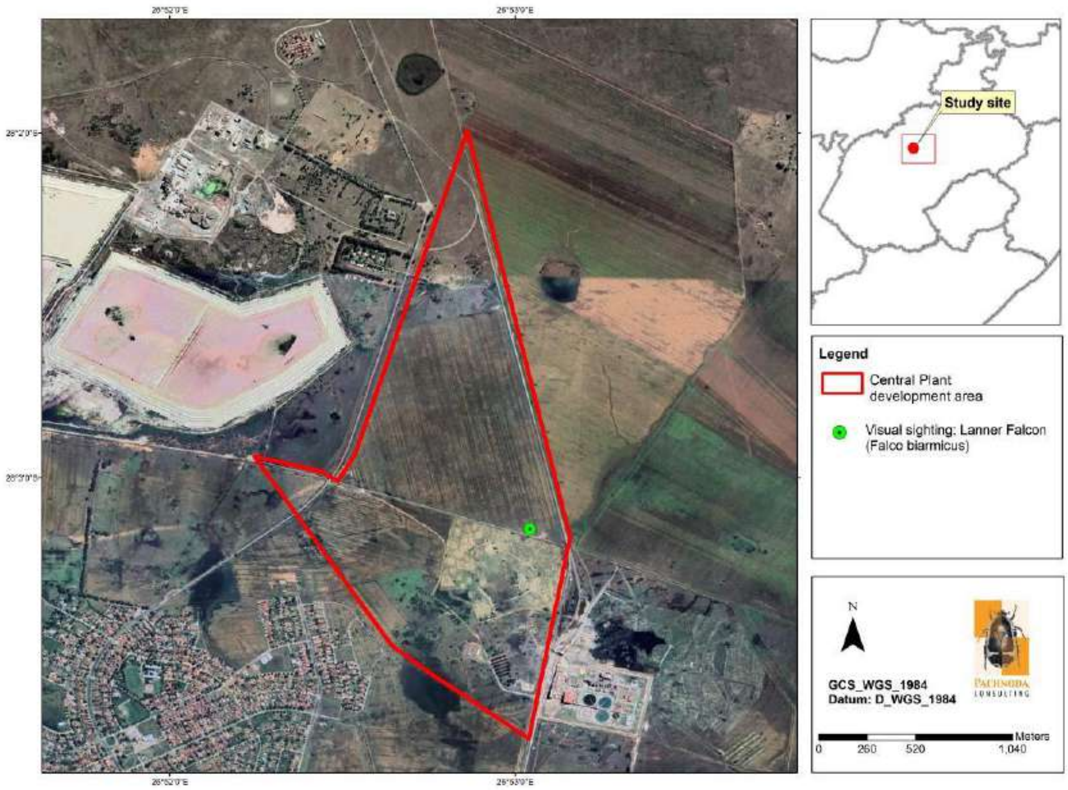

Figure 14: A map illustrating the occurrence of the vulnerable Lanner Falcon (*Falco biarmicus*) on the study site.

4.4 Bird Assemblage Structure and Composition

4.4.1 Summary of point counts

A total of 49 bird species and a total abundance of 1899 individuals[6] were recorded from 12 bird points (representing two replicative surveys) located on the study site. The data provides an estimate of the bird richness and their numbers on the study site and immediate surroundings obtained during two independent survey sessions. A mean of 10.08 species and 158.29 individuals were recorded per point count. The highest number of species recorded from a point count was between 22 species (from bush clump mosaics) and the highest estimated number of bird individuals was 1117.5 individuals (from the margins of an inundated pan). The lowest number of species and individuals were respectively four species and four individuals (from open secondary grassland). The mean frequency of occurrence of a bird species in the study area was 20.58 % and the median was 16.67%, while the most common value (mode) was 8.33%. The latter represents those species that were encountered in only one point count. Three species occurred in 50% or more of the counts (c. Crowned Lapwing *Vanellus coronatus,* Ring-necked Dove *Streptopelia capicola* and

[6] The high number of individuals was represented by large flocks of foraging (non-breeding) Red-billed Quelea (*Quelea quelea*).

African Pipit *Anthus cinnamomeus*), while nine species occurred in 40% or more of the counts (Table 5).

Table 5: Bird species with a frequency of occurrence greater than 50% observed on the study area (according to 12 counts).

Species	Frequency (%)	Species	Frequency (%)
Crowned Lapwing (*Vanellus coronatus*)	66.67	Laughing Dove (*Spilopelia senegalensis*)	41.67
Ring-necked Dove (*Streptopelia capicola*)	66.67	Red-capped Lark (*Calandrella cinerea*)	41.67
African Pipit (*Anthus cinnamomeus*)	58.33	Southern Fiscal (*Lanius collaris*)	41.67
Cape Sparrow (*Passer melanurus*)	41.67	White-browed Sparrow-weaver (*Plocepasser mahali*)	41.67
Chestnut-vented Warbler (*Curruca subcaerulea*)	41.67		

4.4.2 Summary of richness and average abundance (per point count)

Displacement of birds by the proposed infrastructure is one of the impacts that is anticipated to occur. By mapping the spatial distribution of the number of species and average abundance values obtained from each point count, it is possible to predict where displacement of birds will be more intensive. According to Figure 15 and Figure 16 it is evident that a high to moderate number of bird species occur on bush clump mosaics, followed by inundated pans and untransformed grassland. High bird numbers (number of individuals) were observed from the margins of inundated pans. The presence of tall canopy tree cover was responsible for an elevated number of bird species, while the presence of surface water, especially during the dry season was responsible for high bird numbers. Therefore, the potential displacement of birds due to the loss of habitat during construction is likely to occur at habitat which features the availability of surface water and the occurrence of tree canopy cover.

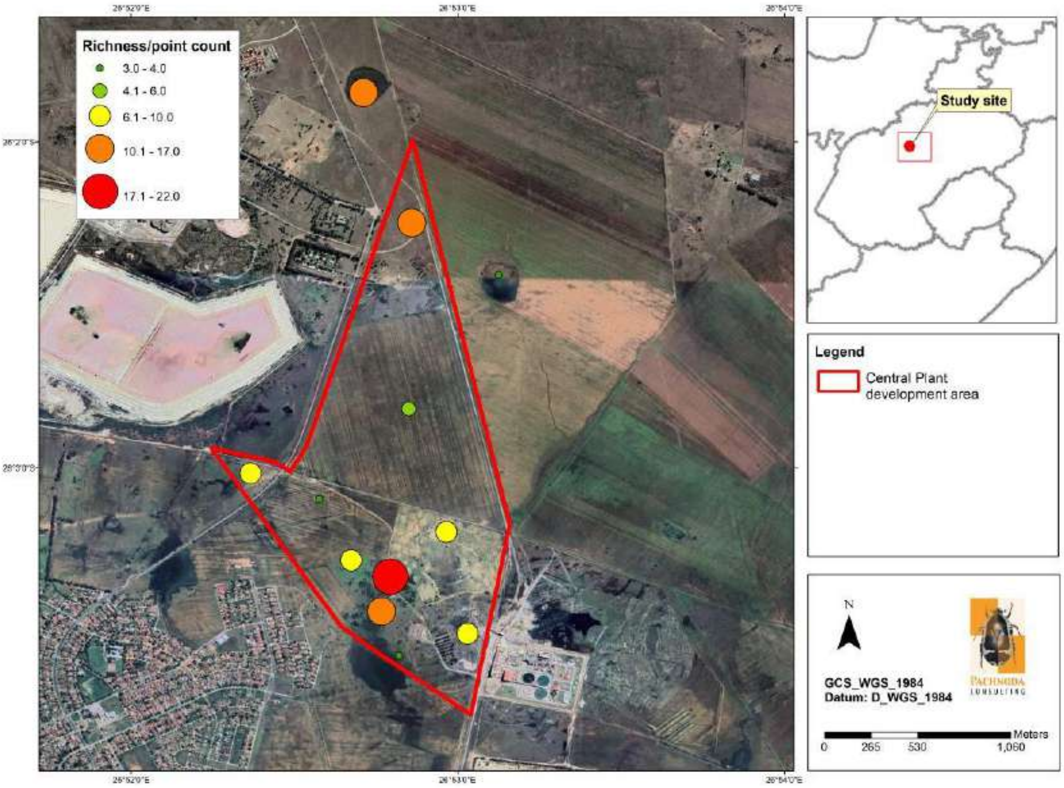

Figure 15: A map of the study area illustrating the spatial distribution of bird richness values (number of species) obtained for each point count.

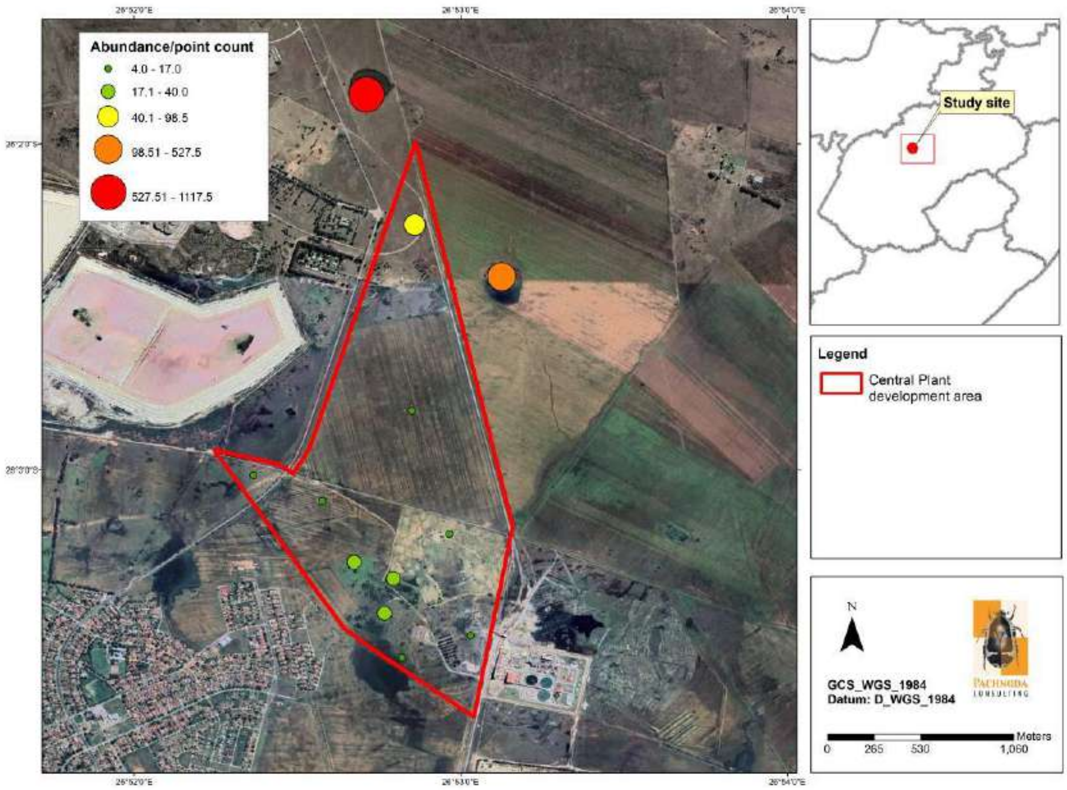

Figure 16: A map of the study area illustrating the distribution of bird abundance values (average number of individuals) obtained for each point count.

4.4.3 Dominance and typical bird species

The dominant (typical) species on the study area are presented in Table 6. Only those species that cumulatively contributed to more than 90% to the overall similarity between the point counts are presented.

The three most typical bird species on the study area include the Crowned Lapwing (*Vanellus coronatus*), Ring-necked Dove (*Streptopelia capicola*) and African Pipit (*Anthus cinnamomeus*). These species are considered widespread species in the broader study area and occur in most of the habitat types that area present. These species are also highly tolerant of transformation events and were prominent on the secondary grassland habitat. It is also evident from Table 6 that the typical bird assemblage is predominantly represented by insectivores (insect-eating) and by granivores (seed-eating taxa).

Table 6: Typical bird species on the study area.

Species	Av.Abundance	Consistency (Sim/SD)	Contribution (%)	Primary Trophic Guild
Crowned Lapwing (*Vanellus coronatus*)	1.17	0.72	17.23	Insectivore: ground gleaner

Ring-necked Dove (*Streptopelia capicola*)	2.50	0.74	14.54	Granivore: ground gleaner
African Pipit (*Anthus cinnamomeus*)	0.42	0.60	10.93	Insectivore: ground gleaner
Red-billed Quelea (*Quelea quelea*)	142.08	0.29	9.35	Granivore: upper to lower canopy gleaner
Red-capped Lark (*Calandrella cinerea*)	0.83	0.38	7.86	Granivore and insectivore: ground gleaner
Laughing Dove (*Spilopelia senegalensis*)	2.21	0.41	5.83	Granivore: ground gleaner
White-browed Sparrow-weaver (*Plocepasser mahali*)	1.17	0.41	5.01	Granivore: ground gleaner
Southern Fiscal (*Lanius collaris*)	0.42	0.39	4.41	Insectivore and carnivore: upper canopy foliage gleaner

4.4.4 Composition and diversity

Multidimensional scaling and hierarchical agglomerative clustering ordination of bird abundance values obtained from 12 point counts on the study area differentiate between two discrete bird associations (Global R= 0.21, p=0.12; Figure 17), with statistically significant differences due to the presence of surface water and terrestrial "dryland" habitat. The terrestrial habitat units contain another two associations based on floristic structure. These include an association on open grassland and an association pertaining tree canopy cover.

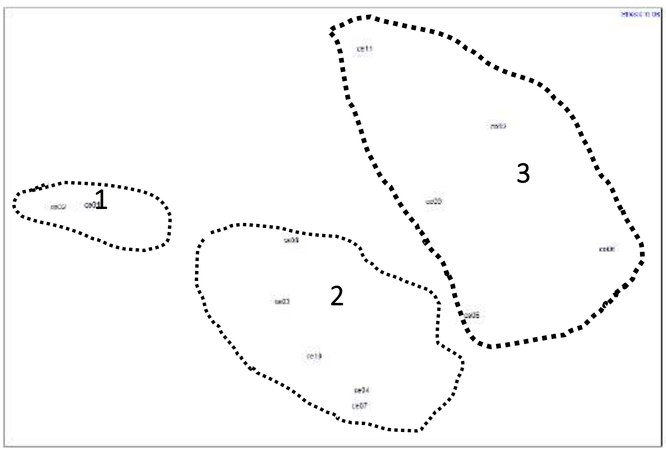

Figure 17: A two-dimensional non-metric multidimensional scaling ordination (stress=0.08) of the relative abundances of bird species based on Bray-Curtis similarities obtained from 12 point counts on the project area. It differentiates between the following bird associations: (1) an association on inundated pans, an (2) association pertaining tree canopy cover and (3) an association confined to grassland (in the absence of tree cover).

The following bird associations are relevant to the study site and immediate surroundings:

1. Association on inundated pans

Dominant species: Red-billed Quelea (*Quelea quelea*), Levaillant's Cisticola (*Cisticola tinniens*) and Long-tailed Widowbird (*Euplectes progne*).

Indicator species[7]: Mainly waterbirds such as Red-knobbed Coot (*Fulica cristata*), Reed Cormorant (*Microcarbo africanus*), Little Grebe (*Tachybaptus ruficollis*) and Common Moorhen (*Gallinula chloropus*).

2. Association on open grassland in the absence of any tree cover

Dominant species: Red-capped Lark (*Calandrella cinerea*), Crowned Lapwing (*Vanellus coronatus*), African Pipit (*Anthus cinnamomeus*), Desert Cisticola (*Cisticola aridulus*) and Ant-eating Chat (*Myrmecocichla formicivora*).

Indicator species: Cape Longclaw (*Macronyx capensis*), Northern Black Korhaan (*Afrotis afraoides*) and Spike-heeled Lark (*Chersomanes albofasciata*).

3. Association on habitat with a prominent tree canopy cover

Dominant species: Ring-necked Dove (*Streptopelia capicola*), White-browed Sparrow-weaver (*Plocepasser mahali*), Chestnut-vented Warbler (*Curruca subcoerulea*), Southern Masked Weaver (*Ploceus velatus*) and Yellow Canary (*Crithagra flaviventris*).

Indicator species: Acacia Pied Barbet (*Tricholaema leucomelas*), Kalahari Scrub-robin (*Cercotrichas paena*), Cape Starling (*Lamprotornis nitens*), African Red-eyed Bulbul (*Pycnonotus nigricans*) and Black-throated Canary (*Crithagra atrogularis*).

The highest number of bird species on the study area was observed from habitat with a high prevalence of tree/woody cover, while the highest number of bird individuals was observed from the nearby pans (Table 7). The lowest number of bird species was recorded from the pans, while the lowest number of bird individuals occurred on grassland habitat.

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[7] Indicator species refers to a species with high numbers that is restricted to a particular habitat.

Table 7: A summary of the observed species richness and number of bird individuals confined to the bird associations on the study area.

Bird Association	Number of species	Number of Individuals	Shannon Wiener Index H'(log_e)
Pans	15	822.5	0.09
Grassland	17	9.5	2.51
Bush clump and prevalence of tree cover	35	41.1	2.41

4.5 Passerine bird densities

Thirty-two passerine bird species were recorded from 12 point counts on the study area (during two replicative surveys). The study area comprises of approximately 8.97 species.ha^{-1} (Appendix 2). The average density per hectare is 193.75 birds.ha^{-1} and ranges between 3.21 birds.ha^{-1} to 1421.79 birds.ha^{-1}. The high density of birds.ha^{-1} was explained by the presence of large foraging flocks of Red-billed Quelea (*Quelea quelea*).

4.6 Movements/dispersal of Collision-prone birds

The only deterministic daily flight routes were observed for waterbirds dispersing between the two pans on the northern part on the study site (Figure 18). Although not observed, it is possible that other waterbirds taxa, especially migrating flamingo species could fly over the study site. Flamingos migrate invariably at night, which makes predictions regarding their movements on the study area difficult. However, most of the large pans are located north and north-west of the study site where a high rate of dispersal is predicted for flamingo taxa between the pans and water features.

In addition, the home ranges of approximately four and five pairs of Northern Black Korhaan (*Afrotis afraoides*) correspond to the study site (Figure 18). These individuals have a high probability to become displaced due to the loss of habitat during the construction phase.

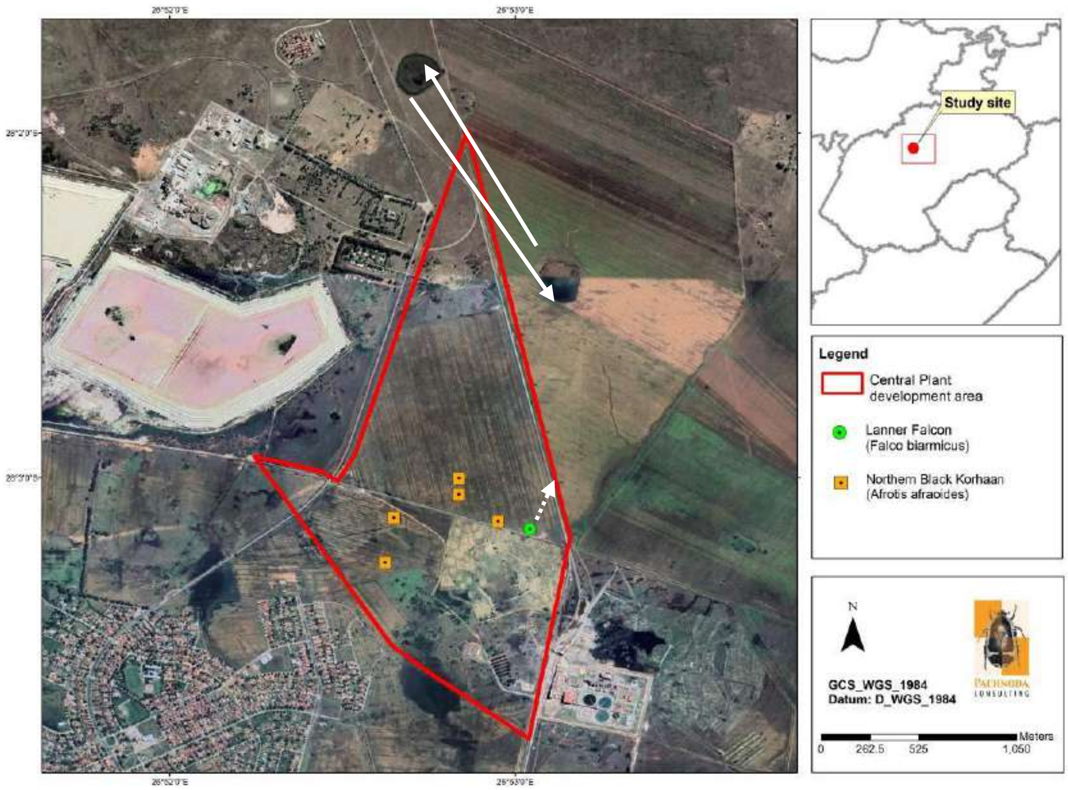

Figure 18: A map of the study site illustrating the occurrence and movements of collision-prone birds. Solid arrows illustrates the movements/dispersal of waterbirds between two pans,

4.7 Avifaunal sensitivity

A sensitivity map was compiled, illustrating habitat units comprising of potential sensitive elements based on the following arguments (Figure 19):

Areas of high sensitivity

The pans and their respective buffers are of high sensitivity. These features provide habitat for a variety of collision-prone bird species which include many waterbird and shorebird taxa. In addition, most of the pans in the region support large congregations of waterfowl and shorebird taxa, including globally and regionally threatened and near threatened species (e.g. flamingo taxa). These pans are also important from a functional and dynamic perspective at the landscape level since it forms part of an "inter-connected" system or "stepping stones" within the regional catchment, meaning that environmental conditions at these pans (e.g. water levels, salinity, food availability, availability of shoreline habitat) are constantly changing. Therefore, none of the pans within the study area are similar to each, thereby providing a continuous supply of resources for waterbirds. The placement of electrical infrastructure and PV panels in close proximity to these pans/dams as well as on areas where the frequency of fly-overs by waterbirds are high could increase potential avian collisions with the infrastructure.

Areas of medium sensitivity

Areas of medium sensitivity include the bush clump mosaics and untransformed grassland units. Both these units contained fairly high numbers of bird species when compared to the transformed and secondary grasslands.

Areas of low sensitivity

These habitat units are represented by transformed habitat types and include the secondary grasslands and landscaped/manicured areas.

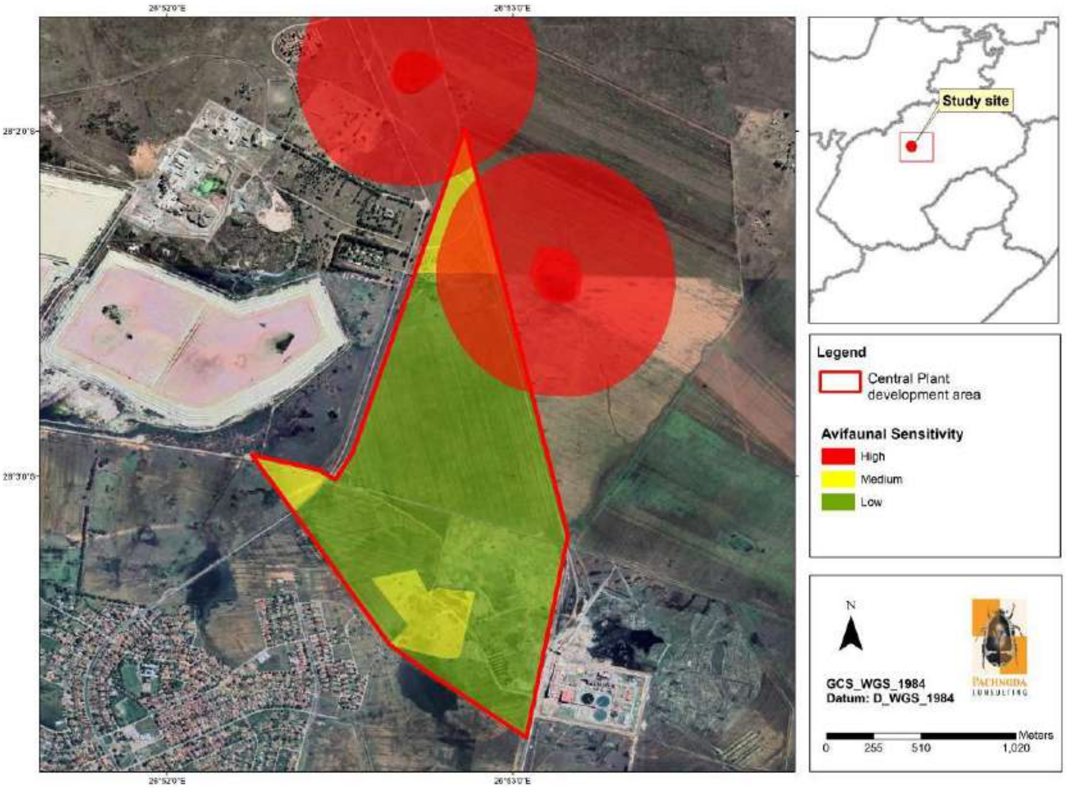

Figure 19: A map illustrating the avifaunal sensitivity of the study site based on habitat types supporting bird taxa of conservation concern and important ecological function (the pans include a 500m buffer area which should be viewed as sensitive).

4.8 Overview of Avian Impacts at Solar Facilities

4.8.1 Background to solar facilities and their impact on birds

Birds are mobile, and are therefore also more readily affected by solar facilities than other taxonomic groups (e.g. mammals). In fact, birds are also vulnerable to impacts caused by other types of energy facilities such as overhead power lines and wind farms. Little information is available on the impacts of solar energy facilities on birds although Gunerhan *et al.* (2009), McCrary *et al.* (1986), Tsoutsos *et al.* (2005) and the recent investigation reports on bird fatalities in the USA by Kagen *et al*. (2014) and Walston *et al*. (2016) provide discussions thereof. These studies have shown that avian fatalities vary greatly between the geographic positions of the solar facilities and also depend on the type of solar facility. In addition, very few of the large solar facilities in operation undertake systematic monitoring of avian fatalities, which explains the lack of detailed information of avian impacts. According to these studies conducted at both Concentrated Solar Power (CSP) and PV facilities, avian incidental fatalities range from 14 to over 180 birds which were summarised over a survey period conducted during one to three years. According to the Walston *et al.* (2016) assessment, the average annual mortality rate for known utility-scale solar facilities (the annual number of estimated bird deaths per megawatt of electrical capacity) is 2.7, and 9.9 for known and unknown fatalities (which include carcasses found on the project site of which the death is not known). McCrary *et al.* (1986) found an average rate of mortality of 1.9-2.2 birds per week affecting 0.6-0.7% of the local bird population. However, most of the avian fatalities at these solar facilities are also probably underestimated since 10-30% of dead birds are removed by scavengers before being noted. From these analyses and assessments it was evident that:

- Medium levels of bird fatalities occur at PV sites when compared to CSP sites (due to solar flux-based mortalities associated with CSP sites).
- Approximately 81 % of all avian mortalities were caused by collisions, including collisions with electrical distribution lines.
- Most of the mortalities were small passerines (especially swallows).
- Fatalities at these solar facilities also include waterbirds (e.g. grebes, herons and gulls) which were probably attracted by the apparent "lake effect" caused by the reflective surface of the PV panels.
- Approximately 10-11 % of the fatalities consists of waterbirds, but could be as high as 49 % at certain facilities.
- It is unclear if the "lake effect" caused by the panels (at PV facilities) or mirrors (at CSP facilities) are the main cause of birds colliding or interacting with the infrastructure (since both waterbirds and other passerines are colliding with the infrastructure).
- Most of the fatalities are of resident birds as opposed to migratory species.

In a review report by Harrison *et al.* (2016), an attempt was made to provide evidence of the impacts caused by solar PV facilities alone (not combined with CSP facilities) on birds in the UK. These authors reviewed approximately 420 scientific documents, including 37 so-called "grey" literature from non-government and government organisations for any evidence relating to the ecological impacts of solar PV facilities. Their main findings were as follows:

- The majority of the documents were not relevant and peer-reviewed documents of experimental scientific evidence on avian fatalities were non-existent.
- Results based on carcass searches suggest that the bird collision risk at PV developments are low, although these studies did not take collision by overhead power lines into account.
- Many of the documents recommended that PV developments in close proximity to protected areas should be avoided.
- The PV panels reflect polarised light, which can attract polarotactic insects with potential impact to their reproductive biology. In addition, the polarising effect of the PV panels may also induce drinking behaviour in some birds, which may mistake the panels for water.
- They conclude that impact assessment reports should consider taxon-specific requirements of birds and their guilds.

4.8.2 Impacts of PV solar facilities on birds

The magnitude and significance of impacts to birds caused by solar facilities will depend on the following factors:

- The geographic locality of the planned solar facility;
- The size or surface extent of the solar facility;
- The type of solar facility (according to the technologies applied, e.g. PV or CSP); and
- The occurrence of collision-prone bird species (which are often closely related to the locality of the solar facility).

Any planned solar facility corresponding to an area with many threatened, range-restricted or collision-prone species will have a higher impact on these birds. In addition, any planned solar facility located in close proximity to important flyways, wetland systems or roosting/nesting sites used by the aforementioned species will have a higher impact.

The main impacts associated with PV solar facilities include (Jenkins *et al*., 2017):

- The loss of habitat and subsequent displacement of bird species due to the ecological footprint required during construction;
- Disturbances caused to birds during construction and operation;

- Direct interaction (collision trauma) by birds with the surface infrastructure (photovoltaic panels) caused by polarised light pollution and/or waterbirds colliding with the panels (as they are mistaken for waterbodies);
- Collision with associated infrastructure (mainly overhead power lines and reticulation); and
- Attracting novel species to the area (owing to the artificial provision of new habitat such as perches and shade) which could compete with the residing bird population.

4.9 Impacts associated with the Harmony Central Plant Solar PV Facility

Table 8 provides a summary of the impacts anticipated and quantification thereof.

4.9.1 Loss of habitat and displacement of birds

Approximately 33.6 ha will be cleared of vegetation and habitat to accommodate the panel arrays and associated infrastructure. Clearing of vegetation will inevitably result in the loss of habitat and displacement of bird species. From the results, approximately 3.21 species.ha^{-1} and approximately 22.69 birds.ha^{-1} will become displaced should the activity occur (as per Jenkins et al., 2017). Displacement will mainly affect regional endemic passerine and smaller non-passerine species inhabiting the bush clump mosaics of medium avifaunal sensitivity. In addition, at least four to five pairs of Northern Black Korhaan will also become displaced. However, the impact is not considered to be high since most of the habitat types are transformed or represented by early successional stages.

The following bird species are most likely to be impacted by the loss of habitat due to their habitat requirements, endemism and conservation status (although not limited to) due to the proposed development:

- Northern Black Korhaan (*Afrotis afraoides*);
- Kalahari Scrub Robin (*Cercotrichas paena*);
- White-backed Mousebird (*Colius colius*);
- Cloud Cisticola (Cisticola textrix);
- Pririt Batis (*Batis pririt*);
- White-throated Scrub-robin (*Cossypha humeralis*) - previously overlooked;
- Orange River Francolin (*Scleroptila gutturalis*); and potentially also
- Lanner Falcon (*Falco biarmicus*).

4.9.2 Creation of "new" avian habitat and bird pollution

It is possible that the PV infrastructure (during operation) could attract bird species which may occupy the site or interact with the local bird assemblages in the wider region. These include alien and cosmopolitan species, as well as aggressive omnivorous passerines which could displace other bird species from the area:

- House Sparrow (*Passer domesticus*);
- Common Myna (*Acridotheres tristis*);
- Pied Crow (*Corvus albus*); and
- Speckled Pigeon (*Columba guinea*).

The infrastructure may attract large numbers of roosting columbid taxa, especially Speckled Pigeons (*Columba guinea*), which may result in avian "pollution" through excreta, thereby fouling the panel surfaces. The impact is manageable and will result in a low significance.

4.9.3 Collision trauma caused by photovoltaic panels (the "lake-effect")

The presence of pans/impoundments in close proximity to the study site increases the risk of waterbirds and shorebird taxa interacting with the proposed PV panels. Placement of the proposed PV panels will be critical and should preferably correspond to the southern part of the study site whereby appropriate bird deterrent devices should be installed at strategic localities. These should include a combination of rotating flashers/reflectors, including diverters which emit light during night time to increase the visibility of the infrastructure for birds such as flamingos which tend to disperse during the night. Post construction monitoring to quantify mortalities will be important during to early operational phase in order to determine "hotspot" (areas where high mortalities are prevalent) areas which may require additional mitigation measures.

Desktop results and site observations show that the following species could interact with the panel infrastructure:

- South African Shelduck (*Tadorna cana*);
- Egyptian Goose (*Alopochen aegyptiaca*);
- Spur-winged Goose (*Plectropterus gambiensis*);
- Yellow-billed Duck (*Anas undulata*);
- White-faced Duck (*Dendrocygna viduata*);
- Red-billed Teal (*Anas erythrorhynchus*);
- Cape Teal (*Anas capensis*);
- Cape Shoveller (*Anas smithii*);
- Glossy Ibis (*Plegadis falcinellus*);
- Black-winged Stilt (*Himantopus himantopus*);
- Three-banded Plover (*Charadrius tricollaris*); and potentially also
- Greater Flamingo (*Phoenicopterus roseus*);
- Lesser Flamingo (*Phoeniconaias minor*);
- White-breasted Cormorant (*Phalacrocorax lucidus*)
- Reed Cormorant (*Microcarbo africanus*);
- African Sacred Ibis (*Threskiornis aethiopicus*) and potentially also
- Little Grebe (*Tachybaptus ruficollis*);
- Black-headed Heron (*Ardea melanocephala*);

- Red-knobbed Coot (*Fulica cristata*);
- Grey Heron (*Ardea cinerea*);
- Little Egret (*Egretta garzetta*);
- African Darter (*Anhinga rufa*);
- Hamerkop (*Scopus umbretta*);
- Common Moorhen (*Gallinula chloropus*) and
- African Spoonbill (*Platalea alba*).

4.9.4 Interaction with overhead powerlines and reticulation

The grid connection will tie-in to the Harmony North (6.6/44kV) substation. However, a number of existing overhead powerlines also occur on the study site (see Figure 1) and it is highly recommended that the proposed grid corridor be placed alongside an existing powerline which will greatly increase the visibility of the lines, and thereby reduce the potential for collision-prone bird species to interact with the powerlines. Impacts with powerlines include the following:

- *Electrocution*

Electrocution happens when a bird bridges the gap between the live components or a combination of a live and earth component of a power line, thereby creating a short circuit. This happens when a bird, mainly a species with a fairly large wingspan attempts to perch on a tower or attempts to fly-off a tower. Many of these species include vultures (of the genera *Gyps* and *Torgos*) as well as other large birds of prey such as the Martial Eagle (*Polemaetus bellicosus*) (Ledger & Annegarn, 1981; Kruger, 1999; Van Rooyen, 2000). These species will attempt to roost and even breed on the tower structures if available nesting platforms are a scarce commodity in the area. Other types of electrocutions happen by means of so-called “bird-streamers”. This happens when a bird, especially when taking off, excretes and thereby causes a short-circuit through the fluidity excreta (Van Rooyen & Taylor, 1999).

Large transmission lines (from 220 kV to 765 kV) are seldom a risk of electrocution, although smaller distribution lines (88 – 132kV) pose a higher risk. However, for this project, the design of the pylon is an important consideration in preventing bird electrocutions.

Collision

Collisions with earth wires have probably accounted for most bird-powerline interactions in South Africa. In general, the earth wires are much thinner in diameter when compared to the live components, and therefore less visible to approaching birds. Many of the species likely to be affected include heavy, large-bodied terrestrial species such as bustards, korhaans and a variety of waterbirds that are not very agile or manoeuvrable once airborne. These species, especially those with the habit of flying with outstretched necks (e.g. most species of storks) find it difficult to make a sudden change in direction while flying – resulting in the bird flying into the earth wires.

Areas where bird collisions are likely to be high could be ameliorated by marking the lines with appropriate bird deterrent devices such as “bird diverters” and “flappers” to increase the visibility of the lines.

- *Physical disturbances and habitat destruction caused during construction and maintenance*

It is anticipated that part of the powerline servitude will be cleared of vegetation. In addition, construction activities go hand in hand with high ambient noise levels. Although construction is considered temporary, many species will vacate the area during the construction phase and will become temporarily displaced.

Table 8: The quantification of impacts associated with the proposed PV facility and its infrastructure.

1. Nature:
Losses of natural habitat and displacement of birds through physical transformation, modifications, removals and land clearance. This impact is mainly restricted to the construction phase and is permanent.

PV Layout (and associated infrastructure)	**Without mitigation**	**With mitigation**
Extent	Local (2)	Local (2)
Duration	Long-term (4)	Long-term (4)
Magnitude	Low (4)	Low (4)
Probability	Definite (5)	Probable (3)
Significance	**Medium (50)**	**Medium (30)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes, to some extent	Yes, to some extent

Mitigation:
It is difficult to mitigate against the loss of habitat since clearing of vegetation (or habitat) will be required for the infrastructure associated with the project. Both the PV facility and associated infrastructure occur predominantly on habitat types of low to medium sensitivity. The best practicable mitigation will be to consolidate infrastructure (e.g. proposed powerline) to areas where existing impacts occur (e.g. placing the proposed powerline alongside existing powerlines).

Residual:
Decreased bird species richness, low evenness values and subsequent loss of avian diversity on a local scale. The impact will also result in increased fragmentation of habitat.

2. Nature:
The creation of novel or new avian habitat for commensal bird species or superior competitive species. This is expected to occur during the operation phase of the facility.

PV Layout (and associated infrastructure)	Without mitigation	With mitigation
Extent	Footprint (1)	Footprint (1)
Duration	Medium-term (3)	Medium-term (3)
Magnitude	Minor (2)	Minor (2)
Probability	Probable (3)	Improbable (2)
Significance	**Low (18)**	**Low (12)**
Status (positive or negative)	Negative	Negative
Reversibility	Moderate	Moderate
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes, with experimentation	Yes
Mitigation: Apply bird deterrent devices and remove nest structures constructed on infrastructure associated with the PV facility under the guidance of the ECO.		
Residual: Secondary displacement by competitive bird species such as crows and increased fecundity rate for commensal bird species that are adapted to anthropogenic activities. The impact is regarded as low.		

3. Nature: Avian collision impacts related to the PV facility during the operation phase (collision with the PV panels).		
PV Layout (and associated infrastructure)	**Without mitigation**	**With mitigation**
Extent	Local (2)	Local (2)
Duration	Long-term (4)	Long-term (4)
Magnitude	High (8)	Moderate (6)
Probability	Highly Probable (4)	Probable (3)
Significance	**Medium (56)**	**Medium (36)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes, potential loss of endemic/near-endemic waterfowl and waterbird species.	Yes, potential loss of endemic/near-endemic waterfowl and waterbird species.
Can impacts be mitigated?	Yes, with experimentation	Yes, with experimentation
Mitigation: Apply bird deterrent devices such as rotating flashers/reflectors to the panels for birds that may mistake the panels for open water and to prevent them from landing on the panels - these should be placed at panels nearest (facing) to pans and other water features. Bird deterrent devices should also include light-emitting devices to increase the visibility of the PV infrastructure for waterbird species that migrate at night (e.g. flamingo species). Security/CCTV cameras may be installed to quantify mortalities (cameras are also installed along the perimeter fence for security measures and may also prove to be effective to quantify mortalities). Buffer pans by at least 500m (arrays should be positioned at least 500m away from pans). If post-construction monitoring predicts and/or confirms any bird mortalities, an option is to employ video cameras at selected areas to document bird mortalities and to conduct direct observations and carcass searches on a regular and systematic basis.		
Residual: Direct mortality is possible and may still occur irrespective of applied mitigation measures. Regular and systematic monitoring is proposed to assess the efficacy of applied mitigation and further research and testing is suggested to improve mitigation measures (e.g. bird deterrent devices). The residual impact is regarded as moderate.		

4. Nature: Avian collision impacts related to overhead power lines during operation.		
Grid Corridor	**Without mitigation**	**With mitigation**
Extent	Local (2)	Local (2)
Duration	Long-term (4)	Long-term (4)
Magnitude	Moderate (6)	Minor (2)
Probability	Probable (3)	Probable (3)
Significance	**Medium (36)**	**Low (24)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes (to some extent), owing to the potential loss of collision-prone waterbird species.	Yes
Can impacts be mitigated?	Yes	Yes
Mitigation: Apply bird deterrent devices to the power lines and make use of "bird-friendly" pylon structures. To aid post-construction monitoring and/or monitoring of bird mortality rates, it is advised to conduct direct observations and carcass searches on a regular and systematic basis. Collisions will be reduced if the corridor is placed alongside existing powerlines.		
Residual: Direct mortality is possible and may still happen irrespective of applied mitigation measures. The residual impact will be low.		

5. Nature: Avian electrocution related to the new distribution lines during operation.		
Grid Corridor	**Without mitigation**	**With mitigation**
Extent	Local (2)	Local (2)
Duration	Long-term (4)	Long-term (4)
Magnitude	Low (4)	Minor (2)
Probability	Probable (3)	Probable (3)
Significance	**Low (30)**	**Low (24)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes (to some extent), owing to the potential loss of collision-prone waterbird species.	Yes (to some extent), owing to the potential loss of collision-prone waterbird species.
Can impacts be mitigated?	Yes, to some extent	Yes, to some extent
Mitigation: Make use of bird-friendly pylons and bird guards as recommended by EWT. Align corridor alongside existing powerlines.		
Residual: Direct mortality is possible and may still happen irrespective of applied mitigation measures. The residual impact will be low.		

4.9.5 Collision-prone bird species

A total of 51 collision-prone bird species have been recorded in the wider study area, of which 13 species are birds of prey and 29 are waterbirds/shorebird taxa (Table 9).

According to Table 9, it is evident that the number of potential collision-prone waterbird and shorebird taxa that could occur in the study area is high (c. 57% of the total number of collision-prone bird species recorded in the area).

Table 9: Collision-prone bird species expected to be present on the study area and inferred from the South African Atlas Project (SABAP2).

Common Name	Scientific Name	SABAP2 Reporting Rate			
		Full Protocol (%)	Number of cards	Ad Hoc Protocol (%)	Number of cards
African Darter	*Anhinga rufa*	0.00	0	4.55	1
African Fish Eagle	*Haliaeetus vocifer*	4.76	1	0.00	0
African Harrier-Hawk	*Polyboroides typus*	4.76	1	0.00	0
African Sacred Ibis	*Threskiornis aethiopicus*	33.33	7	0.00	0
African Spoonbill	*Platalea alba*	4.76	1	0.00	0
Amur Falcon	*Falco amurensis*	4.76	1	0.00	0
Black Stork	*Ciconia nigra*	4.76	1	0.00	0
Black-headed Heron	*Ardea melanocephala*	14.29	3	0.00	0
Black-winged Kite	*Elanus caeruleus*	52.38	11	0.00	0
Black-winged Stilt	*Himantopus himantopus*	4.76	1	0.00	0
Cape Shoveler	*Spatula smithii*	9.52	2	0.00	0
Common Buzzard	*Buteo buteo*	19.05	4	0.00	0
Common Moorhen	*Gallinula chloropus*	28.57	6	0.00	0
Egyptian Goose	*Alopochen aegyptiaca*	47.62	10	13.64	3
Gabar Goshawk	*Micronisus gabar*	0.00	0	4.55	1
Glossy Ibis	*Plegadis falcinellus*	57.14	12	0.00	0
Greater Flamingo	*Phoenicopterus roseus*	4.76	1	0.00	0
Greater Kestrel	*Falco rupicoloides*	4.76	1	0.00	0
Grey Heron	*Ardea cinerea*	28.57	6	0.00	0
Hadada Ibis	*Bostrychia hagedash*	95.24	20	50.00	11
Hamerkop	*Scopus umbretta*	4.76	1	4.55	1
Helmeted Guineafowl	*Numida meleagris*	61.90	13	9.09	2
Lanner Falcon	*Falco biarmicus*	9.52	2	0.00	0
Lesser Kestrel	*Falco naumanni*	19.05	4	0.00	0
Lesser Flamingo	*Phoeniconaias minor*	n/a			
Little Egret	*Egretta garzetta*	4.76	1	0.00	0
Little Grebe	*Tachybaptus ruficollis*	38.10	8	0.00	0
Northern Black Korhaan	*Afrotis afraoides*	61.90	13	4.55	1
Orange River Francolin	*Scleroptila gutturalis*	19.05	4	0.00	0
Pale Chanting Goshawk	*Melierax canorus*	4.76	1	0.00	0
Pied Crow	*Corvus albus*	19.05	4	0.00	0
Purple Heron	*Ardea purpurea*	4.76	1	0.00	0
Red-billed Teal	*Anas erythrorhyncha*	28.57	6	0.00	0
Red-knobbed Coot	*Fulica cristata*	66.67	14	0.00	0
Reed Cormorant	*Microcarbo africanus*	57.14	12	0.00	0
Rock Kestrel	*Falco rupicolus*	14.29	3	0.00	0

Common Name	Scientific Name	SABAP2 Reporting Rate			
		Full Protocol (%)	Number of cards	Ad Hoc Protocol (%)	Number of cards
Secretarybird	*Sagittarius serpentarius*	4.76	1	0.00	0
South African Shelduck	*Tadorna cana*	28.57	6	0.00	0
Southern Pochard	*Netta erythrophthalma*	19.05	4	0.00	0
Speckled Pigeon	*Columba guinea*	90.48	19	63.64	14
Spur-winged Goose	*Plectropterus gambensis*	14.29	3	0.00	0
Squacco Heron	*Ardeola ralloides*	4.76	1	0.00	0
Swainson's Spurfowl	*Pternistis swainsonii*	61.90	13	27.27	6
Three-banded Plover	*Charadrius tricollaris*	33.33	7	0.00	0
Western Barn Owl	*Tyto alba*	0.00	0	4.55	1
Western Cattle Egret	*Bubulcus ibis*	90.48	19	13.64	3
Whiskered Tern	*Chlidonias hybrida*	38.10	8	0.00	0
White Stork	*Ciconia ciconia*	0.00	0	4.55	1
White-faced Whistling Duck	*Dendrocygna viduata*	33.33	7	4.55	1
Wood Sandpiper	*Tringa glareola*	4.76	1	0.00	0
Yellow-billed Duck	*Anas undulata*	52.38	11	0.00	0

4.10 Cumulative Impacts

Cumulative impacts are defined as impacts that result from additional or incremental activities caused by past or present actions together with the current project. Therefore, cumulative impacts are those that will affect the general avifaunal community on the study area due to other planned solar farm projects and electrical infrastructure in the region.

Another PV facility (Harmony One Plant Solar PV facility) of 30MW on 75ha of land is planned approximately 10km north-west of the proposed Harmony Central Plant Solar PV facility.

The cumulative impacts are likely to increase the displacement and loss of habitat. In addition while the grid connection (via overhead powerlines) of these facilities could potentially contribute towards bird strikes with powerlines and avian mortalities due to collision in the region.

A summary of the cumulative impacts is provided in Table 10.

Table 10: A summary of the cumulative impacts.

1. Nature: Regional losses of natural habitat and subsequent displacement of birds.		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	Local (2)	Local and immediate surroundings (3)

Duration	Long-term (4)	Long-term (4)
Magnitude	Low (4)	Low (4)
Probability	Probable (3)	Probable (3)
Significance	**Medium (30)**	**Medium (33)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Loss of resources?	Yes	Yes
Can impacts be mitigated?	No	
Confidence in findings: High.		
Mitigation: It is difficult to mitigate against the loss of habitat without considering alternative sites. The best practicable mitigation will be to consolidate infrastructure to areas where existing impacts occur (e.g. placing the proposed powerline alongside existing powerlines).		
2. Nature: Avian collision impacts related to the PV facility during the operational phase (collision with the PV panels).		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	Local (2)	Local (2)
Duration	Long-term (4)	Long-term (4)
Magnitude	Moderate (6)	High (8)
Probability	Probable (3)	Highly Probable (4)
Significance	**Medium (36)**	**Medium (60)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes (to some extent), owing to the potential loss of waterbird taxa.	Yes (to some extent), owing to the potential loss of waterbird taxa and potential threatened and near threatened waterbird taxa
Can impacts be mitigated?	Yes, to some extent	Yes, to some extent
Confidence in findings: Low.		
Mitigation: Apply bird deterrent devices to the panels for birds that may mistake the panels for open water and to prevent them from landing on the panels. To aid post-construction monitoring and/or monitoring of bird mortality rates, it is advised to employ video cameras to document any bird mortalities and to conduct direct observations and carcass searches on a regular and systematic basis.		
3. Nature: Avian collision impacts related to the powerline reticulation and new distribution lines during operation.		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	Local (2)	Local (2)
Duration	Long-term (4)	Long-term (4)
Magnitude	Minor (2)	Moderate (6)
Probability	Probable (3)	Probable (3)
Significance	**Low (24)**	**Medium (39)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low

Irreplaceable loss of resources?	Yes (to some extent), owing to the potential loss of waterbird taxa.	Yes (to some extent), owing to the potential loss of waterbird taxa and potential threatened and near threatened waterbird taxa
Can impacts be mitigated?	Yes, to some extent	Yes, to some extent
Confidence in findings: High.		
Mitigation: Apply bird deterrent devices to the power line and make use of "bird-friendly" pylon structures. **Allow for construction of new powerlines parallel to existing lines**. To aid post-construction monitoring and/or monitoring of bird mortality rates, it is advised to conduct direct observations and carcass searches on a regular and systematic basis. As a priority, all new power lines should be marked with bird diverters.		
4. Nature: Avian electrocution related to the powerline reticulation and new distribution lines during operation.		

	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	Local (2)	Local (2)
Duration	Long-term (4)	Long-term (4)
Magnitude	Minor (2)	Low (4)
Probability	Probable (3)	Probable (3)
Significance	**Low (24)**	**Low (30)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes (to some extent), owing to the potential loss of waterbird taxa.	Yes (to some extent), owing to the potential loss of waterbird taxa and potential threatened and near threatened waterbird taxa
Can impacts be mitigated?	Yes, to some extent	
Confidence in findings: Moderate.		
Mitigation: Apply bird deterrent devices to the power line and make use of "bird-friendly" pylon structures. As a priority, all new power lines should be marked with bird diverters. Make use of bird-friendly pylons and bird guards. **Position electrical infrastructure in close proximity to existing infrastructure**.		

4.11 Recommended avifaunal mitigation

4.11.1 Loss of habitat and displacement bird taxa

It is difficult to mitigate against the loss of habitat when fixed infrastructure is applied. However, proper site selection of the facility is key to reducing the predicted impacts.

The following mitigation measures are proposed:

- Concentrate all surface infrastructure on habitat of medium to low avifaunal sensitivity. The development footprint of the various individual facilities must be kept as small as possible and sensitive habitats must be avoided.

- Where possible, existing access roads should be used and the construction of new roads should be kept to a minimum.
- Prevent an overspill of construction activities into areas that are not part of the proposed construction site.
- Use indigenous plant species native to the study area during landscaping and rehabilitation.
- All internal electrical reticulation should be placed underground, while the alignment of the power line and substation should be placed parallel to existing powerlines lines.

4.11.2 Creation of "new" avian habitat and bird pollution

The following mitigation measures are proposed:

- Apply bird deterrent devices at selective areas (for example at the corners and middle part of the facility) to the PV panels to discourage birds from colonising the infrastructure or to discourage birds from constructing nests. These could include visual or bio-acoustic deterrents such as highly reflective rotating devices, anti-perching devices such as bird guards, scaring or chasing activities involving the use of trained dogs or raptors and/or netting. Nests should be removed when nest-building attempts are noticed under the guidance of the ECO.
- Reduce or minimise the use of outdoor lighting to avoid attracting birds to the lights or to reduce potential disorientation to migrating birds.
- Use indigenous plant species native to the study area during landscaping and rehabilitation.

4.11.3 Collision trauma caused by photovoltaic panels (the "lake-effect")

The following mitigation measures are proposed:

- Apply bird deterrent devices to the panels at selective areas (for example at the corners and middle part of the facility as well as arrays facing in the direction of pans ands other water features) to discourage birds from colonising/colliding with the infrastructure. These could include visual or bio-acoustic deterrents such as highly reflective rotating devices, flashers, anti-perching devices such as bird guards, scaring or chasing activities involving the use of trained dogs or raptors and/or netting. The devices should also include light-emitting devices to increase the visibility of the PV infrastructure for waterbird species that migrate at night (e.g. flamingo species). An option is to employ video cameras at selected areas to document bird mortalities.
- Buffer pans by at least 500m (arrays should be positioned at least 500m away from pans).

- Apply systematic reflective/dynamic markers to the boundary fence to increase the visibility of the fence for approaching birds (e.g. korhaan taxa) and to avoid potential bird collisions with the fence structure.
- Reduce or minimise the use of outdoor lighting to avoid attracting birds to the lights or to reduce potential disorientation to migrating birds.

4.11.4 Power line interaction: collision and electrocution with power lines

The following mitigation measures are proposed:

- All internal electrical infrastructure and cabling should be placed underground.
- Position the proposed grid connection alongside existing powerline servitudes.
- EWT should be consulted on an appropriate pylon design to be used for the project (if pylons are to be used). In general, the proposed pylon design must incorporate the following design parameters:
    - The clearances between the live components should be as wide as possible within the design limitations/capabilities of the power line.
    - The height of the tower should allow for unrestricted movement of terrestrial birds between successive pylons.
    - The live components should be “bundled” to increase the visibility for approaching birds.
    - “Bird streamers” should be eliminated by discouraging birds from perching above the conductors. In addition, conductors should be strung below the pole to avoid bridging the air gap by perching birds of prey.

It is therefore recommended that the pylon design incorporates "features as illustrated in Figure 20[8].

From Figure 20 it is clear that perching by birds is discouraged by the addition of diagonal crossbars or by doing away with the crossbars that holds the conductors in place. Bird “streamers” are also eliminated by fitting the poles with bird guards/spikes above the conductors. However, safe perching is facilitated by the fitment of a horizontal bar on top of the pole structure without the risk of electrocution (due to the perpendicular orientation of the bar relative to the conductors).

[8] Please note that these are examples of recommended pylon designs. These are taken from steel monopole pylons.

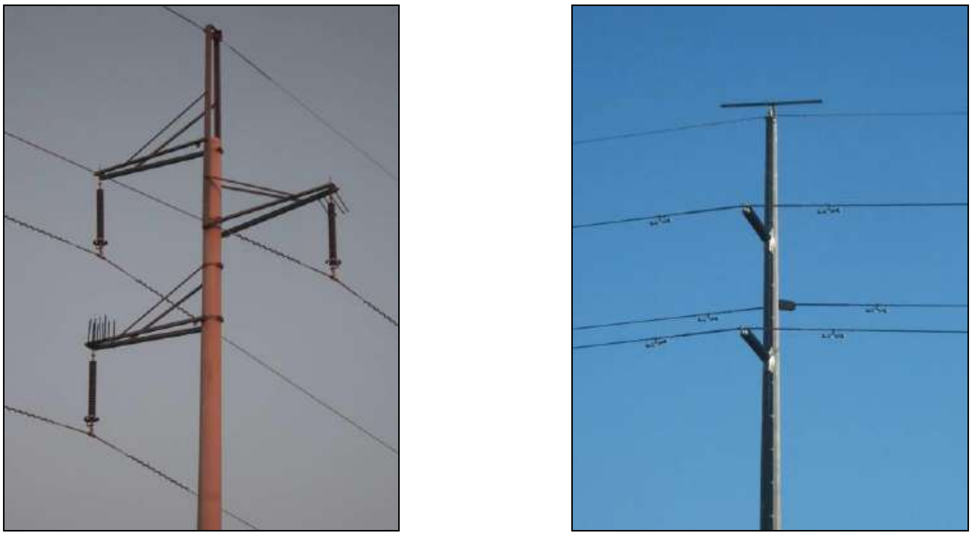

Figure 20: Two bird-friendly tower designs to be considered for the current project.

- All new and planned power lines should be fitted with bird flight diverters (see Figure 21). For the current project it is proposed that the overhead powerlines consider the fitment of dynamic devices such as the "Viper live bird flapper" and nocturnal LED solar-charged bird diverters owing to potential nocturnal flyovers by flamingo taxa.

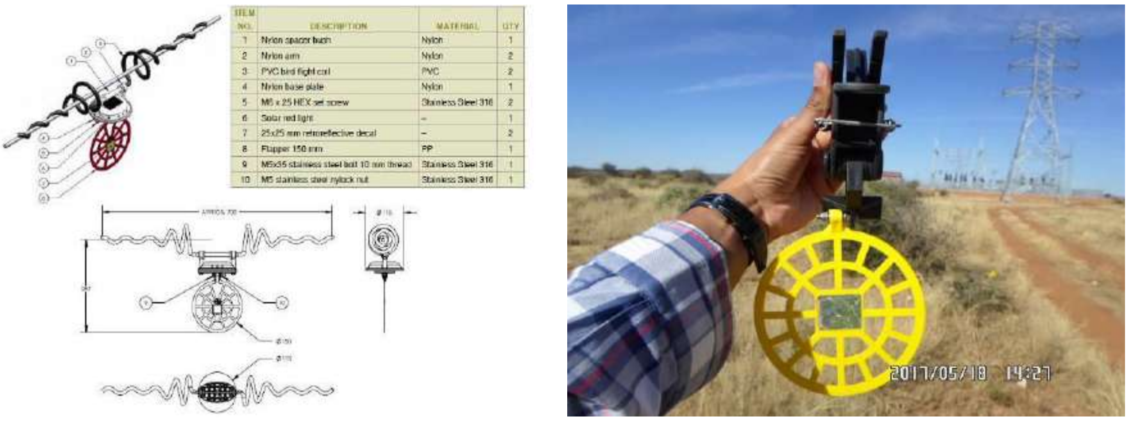

Figure 21: Examples of bird flight diverters to be used on the power lines: Nocturnal LED solar-charged bird diverter (left) and Viper live bird flapper (right).

4.11.5 General mitigation measures

- All construction sites/areas must be demarcated on site layout plans (preferably), and no construction personnel or vehicles may leave the demarcated area except those authorised to do so. Those areas surrounding the construction sites that are not part of the demarcated development area should be considered as “no-go” areas for employees, machinery or even visitors.

- All road networks must be planned with care to minimise dissection or fragmentation of important avifaunal habitat type. Where possible, the use of existing roads is encouraged.
- Open fires is strictly prohibited and only allowed at designated areas.
- Killing or poaching of any bird species should be avoided by means of awareness programs presented to the labour force. The labour force should be made aware of the conservation issues pertaining to the bird taxa occurring on the study site. Any person found deliberately harassing any bird species in any way should face disciplinary measures, following the possible dismissal from the site.
- Checks must be carried out at regular intervals to identify areas where erosion is occurring. Appropriate remedial action, including the rehabilitation of eroded areas should be undertaken.

4.12 Suggested monitoring and Environmental Management Plan

Information on collision trauma (bird mortalities) and the displacement of birds caused by PV solar facilities is insufficient. Therefore, as per the guidelines of Jenkins *et al.* (2017) it is highly recommended that post construction monitoring be implemented to augment existing data:

- At least one additional pre-construction survey is recommended, consisting of a minimum of 2 days which is necessary to inform the final EMPr during operation. The survey should coincide with the peak wet season when most of the nearby wetland features in the wider study region are inundated.
- A post-construction survey during operation with a minimum of 2 x 3-5 day surveys over a six month period (including the peak wet season). The surveys aim to obtain mortality data from birds colliding with the panels to advise on appropriate mitigation measures to be implemented to reduce potential bird mortalities. The surveys should be conducted in a regular and systematic manner by means of direct observations (and the use of installed video cameras) and carcass searches. A management programme must be compiled to assess the efficacy of applied mitigation measures and consult or change measures to reduce on-going mortalities when detected. Additional mitigation measures should be tested or applied, especially if mortalities include species of conservation concern.
- It is possible that mortalities due to collision will occur at the powerlines even after mitigation. The post-construction monitoring (during operation) should also quantify mortalities caused by the powerline network. Monitoring should be implemented once a month for at least one year. All searches should be done on foot. A management programme must be compiled to assess the efficacy of applied mitigation measures and consult or change measures to reduce on-going mortalities when detected. Additional mitigation measures should be tested or applied, especially if mortalities include species of conservation concern.

OBJECTIVE 1: Minimize potential collision trauma with infrastructure and augmenting existing information on bird interactions with solar infrastructure

Project Component/s	» PV panel arrays
Potential Impact	» Collision trauma caused by photovoltaic panels (the "lake-effect")
Activity/Risk Source	» Construction and operation of PV infrastructure
Mitigation: Target/Objective	» Zero bird mortalities due to collision trauma caused by PV panels

Mitigation: Action/Control	Responsibility	Timeframe
• Apply bird deterrent devices to the PV panels to discourage birds from colonising the infrastructure or to discourage birds from constructing nests. These could include visual or bio-acoustic deterrents such as highly reflective rotating devices, flashers, anti-perching devices such as bird guards, scaring or chasing activities involving the use of trained dogs or raptors and/or netting. Nests should be removed when nest-building attempts are noticed.	ECO & OM	Operation (on-going)
• Reduce or minimise the use of outdoor lighting to avoid attracting birds to the lights or to reduce potential disorientation to migrating birds.	ECO & OM	Operation (on-going)
• Use indigenous plant species native to the study area during landscaping and rehabilitation.	CER & ECO	Construction phase
• Implement post-construction monitoring and carcass surveys	OM & CER	Directly after construction and during operation - At least 2 surveys, each 3-5 days for a 6 month period
• Implement pre-construction monitoring protocols (as per Jenkins et al., 2017)	OM & CER	Prior to construction - At least 1 survey of 2 days (during wet season)
• Compile management programme to assess efficacy of mitigation and on-going research/trials	EM & OM	Operation (on-going)

Performance Indicator	Reduced statistical detection/observation of bird mortalities
Monitoring	• Implement at least one pre-construction survey consisting of a minimum of 2 days.

	• Implement post-construction surveys during operation with a minimum of 2 x 3-5 day surveys over a six month period (including the peak wet season). • Surveys should coincide with the peak wet season when most of the wetland features in the wider study region are inundated. • Obtain quantified data on waterbird richness and potential flyways, which will contribute towards our understanding of impacts related to collision trauma with the panels. • Obtain mortality data from birds colliding with the panels and advise on appropriate mitigation measures to be implemented to reduce potential bird mortalities. • Conduct post-construction monitoring in a systematic manner by means of direct observations and the use of installed video cameras and carcass searches. • Implement management programme to assess the efficacy of applied mitigation measures and consult or change measures to reduce on-going mortalities when detected. Additional mitigation measures should be tested or applied, especially if mortalities include birds of prey and species of conservation concern.

OBJECTIVE 2: Minimize collisions and electrocution associated with powerlines

Project Component/s	» Overhead powerlines
Potential Impact	» Collision and electrocution caused by powerlines
Activity/Risk Source	» Overhead powerlines
Mitigation: Target/Objective	» Reduced bird mortalities due to collision/electrocution

Mitigation: Action/Control	**Responsibility**	**Timeframe**
• Apply bird deterrent devices to all new powerlines	ECO & CER	Construction
• Implement post-construction monitoring and carcass surveys	OM & CER	Operation - once a month for at least one year
• Compile management programme to assess efficacy of mitigation and on-going research/trials	OM	Operation (on-going)
• Report mortalities (number, locality and species) to Electrical Energy Mortality Register at EWT	OM	Operation (on-going)

Performance Indicator	Reduced statistical detection/observation of bird mortalities
Monitoring	• Implement post-construction monitoring to quantify bird mortalities caused by the powerline network. All searches should be done on foot. • Compile a management programme to assess the efficacy of applied

	mitigation measures and consult or change measures to reduce on-going mortalities when detected. Additional mitigation measures should be tested or applied, especially if mortalities include birds of prey and species of conservation concern.

4.13 Opinion regarding the feasibility of the project

Pachnoda Consulting cc was requested by Savannah Environmental (Pty) Ltd on behalf of Harmony Gold Mining Ltd to compile an avifauna impact assessment report for the Harmony Central Plant Solar PV facility with a contracted capacity of up to 14MW located on a site approximately 11km south east of the town of Welkom in the Free State Province.

Five avifaunal habitat types were identified on the study site and surroundings, ranging from untransformed and secondary grassland, bush clump mosaics to transformed and landscape/manicured areas. The study site was also surrounded by a number of pans, which provided habitat for a high diversity of waterbird taxa. Approximately 152 bird species are expected to occur in the wider study area, of which 85 species were observed in the study area (during two surveys). The expected richness included five threatened or near threatened species, 14 southern African endemics and 14 near-endemic species. The vulnerable Lanner Falcon (*Falco biarmicus*) was observed on the study site (during a fly-over). Eleven southern African endemics and 11 near-endemic species were confirmed on the study site.

An evaluation of potential and likely impacts on the avifauna revealed that the impact significance was moderate to low after mitigation (depending on the type of impact). However, the risk for certain waterbirds (including flamingo taxa) colliding with the PV infrastructure remained eminent due to the presence of inundated pans in the study area. Post-construction monitoring was recommended along with the installation of appropriate bird diverters to minimise the potential risk of collision trauma in birds.

No fatal-flaws were identified during the assessment, although it was strongly recommended that the proposed mitigation measures and monitoring protocols (e.g. post construction monitoring) be implemented during the construction and operational phase of the project.

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Appendix 1: A shortlist of bird species expected to be present on the study area. The list provides an indication of the species occurrence according to SABAP2 reporting rates. The list was derived (and modified) from species observed in pentad grid 2800_2650 and the eight surrounding grids. The reporting rates include submissions made during June and July 2022.

#	Common Name	Scientific Name	Observed (June/July 2022)	SABAP2 Reporting Rate			
				Full Protocol (%)	Number of cards	Ad Hoc Protocol (%)	Number of cards
432	Acacia Pied Barbet	*Tricholaema leucomelas*	1	80.95	17	54.55	12
52	African Darter	*Anhinga rufa*		0.00	0	4.55	1
149	African Fish Eagle	*Haliaeetus vocifer*		4.76	1	0.00	0
171	African Harrier-Hawk	*Polyboroides typus*		4.76	1	0.00	0
418	African Hoopoe	*Upupa africana*		85.71	18	54.55	12
387	African Palm Swift	*Cypsiurus parvus*	1	52.38	11	4.55	1
682	African Paradise Flycatcher	*Terpsiphone viridis*		4.76	1	0.00	0
692	African Pipit	*Anthus cinnamomeus*	1	33.33	7	0.00	0
544	African Red-eyed Bulbul	*Pycnonotus nigricans*	1	90.48	19	59.09	13
81	African Sacred Ibis	*Threskiornis aethiopicus*	1	33.33	7	0.00	0
85	African Spoonbill	*Platalea alba*		4.76	1	0.00	0
576	African Stonechat	*Saxicola torquatus*	1	57.14	12	9.09	2
386	Alpine Swift	*Tachymarptis melba*		4.76	1	0.00	0
772	Amethyst Sunbird	*Chalcomitra amethystina*		52.38	11	50.00	11
119	Amur Falcon	*Falco amurensis*		4.76	1	0.00	0
575	Ant-eating Chat	*Myrmecocichla formicivora*	1	85.71	18	4.55	1
493	Barn Swallow	*Hirundo rustica*		42.86	9	4.55	1
159	Black Sparrowhawk	*Accipiter melanoleucus*		4.76	1	0.00	0
79	Black Stork	*Ciconia nigra*		4.76	1	0.00	0

#	Common Name	Scientific Name	Observed (June/July 2022)	SABAP2 Reporting Rate			
				Full Protocol (%)	Number of cards	Ad Hoc Protocol (%)	Number of cards
650	Black-chested Prinia	*Prinia flavicans*	1	66.67	14	4.55	1
431	Black-collared Barbet	*Lybius torquatus*	1	19.05	4	36.36	8
841	Black-faced Waxbill	*Brunhilda erythronotos*		4.76	1	0.00	0
55	Black-headed Heron	*Ardea melanocephala*	1	14.29	3	0.00	0
245	Blacksmith Lapwing	*Vanellus armatus*	1	80.95	17	13.64	3
860	Black-throated Canary	*Crithagra atrogularis*	1	57.14	12	18.18	4
130	Black-winged Kite	*Elanus caeruleus*	1	52.38	11	0.00	0
270	Black-winged Stilt	*Himantopus himantopus*		4.76	1	0.00	0
839	Blue Waxbill	*Uraeginthus angolensis*	1	42.86	9	4.55	1
714	Brown-crowned Tchagra	*Tchagra australis*	1	9.52	2	0.00	0
509	Brown-throated Martin	*Riparia paludicola*	1	14.29	3	0.00	0
695	Buffy Pipit	*Anthus vaalensis*		4.76	1	0.00	0
703	Cape Longclaw	*Macronyx capensis*	1	38.10	8	0.00	0
581	Cape Robin-Chat	*Cossypha caffra*	1	61.90	13	54.55	12
94	Cape Shoveler	*Spatula smithii*	1	9.52	2	0.00	0
786	Cape Sparrow	*Passer melanurus*	1	100.00	21	59.09	13
737	Cape Starling	*Lamprotornis nitens*	1	90.48	19	40.91	9
686	Cape Wagtail	*Motacilla capensis*	1	61.90	13	22.73	5
1172	Cape White-eye	*Zosterops virens*		4.76	1	9.09	2
450	Cardinal Woodpecker	*Dendropicos fuscescens*		4.76	1	0.00	0
658	Chestnut-vented Warbler	*Curruca subcoerulea*	1	42.86	9	18.18	4
631	Cloud Cisticola	*Cisticola textrix*	1	52.38	11	0.00	0
154	Common Buzzard	*Buteo buteo*		19.05	4	0.00	0
210	Common Moorhen	*Gallinula chloropus*	1	28.57	6	0.00	0

#	Common Name	Scientific Name	Observed (June/July 2022)	SABAP2 Reporting Rate			
				Full Protocol (%)	Number of cards	Ad Hoc Protocol (%)	Number of cards
734	Common Myna	*Acridotheres tristis*	1	95.24	20	54.55	12
421	Common Scimitarbill	*Rhinopomastus cyanomelas*		9.52	2	13.64	3
843	Common Waxbill	*Estrilda astrild*	1	4.76	1	0.00	0
439	Crested Barbet	*Trachyphonus vaillantii*	1	85.71	18	54.55	12
242	Crowned Lapwing	*Vanellus coronatus*	1	100.00	21	50.00	11
630	Desert Cisticola	*Cisticola aridulus*	1	42.86	9	0.00	0
352	Diederik Cuckoo	*Chrysococcyx caprius*		47.62	10	9.09	2
278	Double-banded Courser	*Rhinoptilus africanus*		9.52	2	0.00	0
1183	Eastern Clapper Lark	*Mirafra fasciolata*		4.76	1	0.00	0
89	Egyptian Goose	*Alopochen aegyptiaca*	1	47.62	10	13.64	3
404	European Bee-eater	*Merops apiaster*		42.86	9	0.00	0
678	Fairy Flycatcher	*Stenostira scita*	1	4.76	1	0.00	0
570	Familiar Chat	*Oenanthe familiaris*		61.90	13	22.73	5
665	Fiscal Flycatcher	*Melaenornis silens*	1	66.67	14	45.45	10
162	Gabar Goshawk	*Micronisus gabar*		0.00	0	4.55	1
83	Glossy Ibis	*Plegadis falcinellus*	1	57.14	12	0.00	0
86	Greater Flamingo	*Phoenicopterus roseus*		4.76	1	0.00	0
440	Greater Honeyguide	*Indicator indicator*		9.52	2	0.00	0
122	Greater Kestrel	*Falco rupicoloides*		4.76	1	0.00	0
502	Greater Striped Swallow	*Cecropis cucullata*	1	66.67	14	22.73	5
419	Green Wood Hoopoe	*Phoeniculus purpureus*		61.90	13	31.82	7
54	Grey Heron	*Ardea cinerea*		28.57	6	0.00	0
84	Hadada Ibis	*Bostrychia hagedash*	1	95.24	20	50.00	11
72	Hamerkop	*Scopus umbretta*		4.76	1	4.55	1

#	Common Name	Scientific Name	Observed (June/July 2022)	SABAP2 Reporting Rate			
				Full Protocol (%)	Number of cards	Ad Hoc Protocol (%)	Number of cards
192	Helmeted Guineafowl	*Numida meleagris*	1	61.90	13	9.09	2
784	House Sparrow	*Passer domesticus*	1	61.90	13	45.45	10
586	Kalahari Scrub Robin	*Cercotrichas paena*	1	28.57	6	0.00	0
1104	Karoo Thrush	*Turdus smithi*		85.71	18	54.55	12
351	Klaas's Cuckoo	*Chrysococcyx klaas*		0.00	0	4.55	1
114	Lanner Falcon	*Falco biarmicus*		9.52	2	0.00	0
317	Laughing Dove	*Spilopelia senegalensis*	1	95.24	20	59.09	13
706	Lesser Grey Shrike	*Lanius minor*		9.52	2	0.00	0
125	Lesser Kestrel	*Falco naumanni*		19.05	4	0.00	0
604	Lesser Swamp Warbler	*Acrocephalus gracilirostris*	1	4.76	1	0.00	0
646	Levaillant's Cisticola	*Cisticola tinniens*	1	52.38	11	4.55	1
59	Little Egret	*Egretta garzetta*		4.76	1	0.00	0
6	Little Grebe	*Tachybaptus ruficollis*	1	38.10	8	0.00	0
385	Little Swift	*Apus affinis*		52.38	11	31.82	7
852	Long-tailed Paradise Whydah	*Vidua paradisaea*		4.76	1	0.00	0
818	Long-tailed Widowbird	*Euplectes progne*	1	76.19	16	4.55	1
397	Malachite Kingfisher	*Corythornis cristatus*		23.81	5	0.00	0
318	Namaqua Dove	*Oena capensis*	1	28.57	6	0.00	0
637	Neddicky	*Cisticola fulvicapilla*	1	42.86	9	4.55	1
1035	Northern Black Korhaan	*Afrotis afraoides*	1	61.90	13	4.55	1
179	Orange River Francolin	*Scleroptila gutturalis*		19.05	4	0.00	0
1171	Orange River White-eye	*Zosterops pallidus*	1	76.19	16	50.00	11
165	Pale Chanting Goshawk	*Melierax canorus*		4.76	1	0.00	0
522	Pied Crow	*Corvus albus*	1	19.05	4	0.00	0

#	Common Name	Scientific Name	Observed (June/July 2022)	SABAP2 Reporting Rate			
				Full Protocol (%)	Number of cards	Ad Hoc Protocol (%)	Number of cards
394	Pied Kingfisher	*Ceryle rudis*		4.76	1	0.00	0
746	Pied Starling	*Lamprotornis bicolor*	1	71.43	15	4.55	1
490	Pink-billed Lark	*Spizocorys conirostris*	1	4.76	1	0.00	0
846	Pin-tailed Whydah	*Vidua macroura*		23.81	5	0.00	0
674	Pririt Batis	*Batis pririt*	1	4.76	1	0.00	0
57	Purple Heron	*Ardea purpurea*		4.76	1	0.00	0
844	Quailfinch	*Ortygospiza atricollis*	1	38.10	8	0.00	0
708	Red-backed Shrike	*Lanius collurio*		4.76	1	0.00	0
837	Red-billed Firefinch	*Lagonosticta senegala*		19.05	4	18.18	4
805	Red-billed Quelea	*Quelea quelea*	1	80.95	17	31.82	7
97	Red-billed Teal	*Anas erythrorhyncha*		28.57	6	0.00	0
488	Red-capped Lark	*Calandrella cinerea*	1	28.57	6	0.00	0
343	Red-chested Cuckoo	*Cuculus solitarius*		9.52	2	4.55	1
314	Red-eyed Dove	*Streptopelia semitorquata*	1	85.71	18	50.00	11
392	Red-faced Mousebird	*Urocolius indicus*	1	80.95	17	36.36	8
820	Red-headed Finch	*Amadina erythrocephala*	1	71.43	15	18.18	4
212	Red-knobbed Coot	*Fulica cristata*	1	66.67	14	0.00	0
453	Red-throated Wryneck	*Jynx ruficollis*		4.76	1	4.55	1
50	Reed Cormorant	*Microcarbo africanus*	1	57.14	12	0.00	0
316	Ring-necked Dove	*Streptopelia capicola*	1	95.24	20	59.09	13
940	Rock Dove	*Columba livia*		47.62	10	9.09	2
123	Rock Kestrel	*Falco rupicolus*		14.29	3	0.00	0
506	Rock Martin	*Ptyonoprogne fuligula*	1	19.05	4	0.00	0
458	Rufous-naped Lark	*Mirafra africana*	1	66.67	14	13.64	3

#	Common Name	Scientific Name	Observed (June/July 2022)	SABAP2 Reporting Rate			
				Full Protocol (%)	Number of cards	Ad Hoc Protocol (%)	Number of cards
460	Sabota Lark	*Calendulauda sabota*		4.76	1	0.00	0
789	Scaly-feathered Weaver	*Sporopipes squamifrons*	1	14.29	3	0.00	0
105	Secretarybird	*Sagittarius serpentarius*		4.76	1	0.00	0
504	South African Cliff Swallow	*Petrochelidon spilodera*		57.14	12	0.00	0
90	South African Shelduck	*Tadorna cana*	1	28.57	6	0.00	0
707	Southern Fiscal	*Lanius collaris*	1	95.24	20	4.55	1
4142	Southern Grey-headed Sparrow	*Passer diffusus*	1	47.62	10	13.64	3
803	Southern Masked Weaver	*Ploceus velatus*	1	95.24	20	54.55	12
102	Southern Pochard	*Netta erythrophthalma*	1	19.05	4	0.00	0
808	Southern Red Bishop	*Euplectes orix*	1	95.24	20	54.55	12
390	Speckled Mousebird	*Colius striatus*		52.38	11	36.36	8
311	Speckled Pigeon	*Columba guinea*	1	90.48	19	63.64	14
474	Spike-heeled Lark	*Chersomanes albofasciata*	1	28.57	6	0.00	0
88	Spur-winged Goose	*Plectropterus gambensis*	1	14.29	3	0.00	0
62	Squacco Heron	*Ardeola ralloides*		4.76	1	0.00	0
185	Swainson's Spurfowl	*Pternistis swainsonii*	1	61.90	13	27.27	6
238	Three-banded Plover	*Charadrius tricollaris*	1	33.33	7	0.00	0
851	Village Indigobird	*Vidua chalybeata*		14.29	3	4.55	1
735	Wattled Starling	*Creatophora cinerea*	1	42.86	9	22.73	5
359	Western Barn Owl	*Tyto alba*		0.00	0	4.55	1
61	Western Cattle Egret	*Bubulcus ibis*	1	90.48	19	13.64	3
305	Whiskered Tern	*Chlidonias hybrida*		38.10	8	0.00	0
80	White Stork	*Ciconia ciconia*		0.00	0	4.55	1
391	White-backed Mousebird	*Colius colius*	1	47.62	10	4.55	1

#	Common Name	Scientific Name	Observed (June/July 2022)	SABAP2 Reporting Rate			
				Full Protocol (%)	Number of cards	Ad Hoc Protocol (%)	Number of cards
763	White-bellied Sunbird	*Cinnyris talatala*	1	33.33	7	40.91	9
780	White-browed Sparrow-Weaver	*Plocepasser mahali*	1	100.00	21	59.09	13
100	White-faced Whistling Duck	*Dendrocygna viduata*		33.33	7	4.55	1
409	White-fronted Bee-eater	*Merops bullockoides*		4.76	1	4.55	1
383	White-rumped Swift	*Apus caffer*		57.14	12	36.36	8
495	White-throated Swallow	*Hirundo albigularis*		52.38	11	0.00	0
	White-throated Robin-chat	*Cossypha humeralis*		n/a			
599	Willow Warbler	*Phylloscopus trochilus*		0.00	0	4.55	1
264	Wood Sandpiper	*Tringa glareola*		4.76	1	0.00	0
866	Yellow Canary	*Crithagra flaviventris*	1	57.14	12	45.45	10
96	Yellow-billed Duck	*Anas undulata*	1	52.38	11	0.00	0
812	Yellow-crowned Bishop	*Euplectes afer*	1	38.10	8	9.09	2
629	Zitting Cisticola	*Cisticola juncidis*	1	47.62	10	0.00	0

Appendix 2: Preliminary density estimates of birds recorded from the study area during two independent surveys conducted during June 2022 and July 2022.

Species	ce01	ce02	ce03	ce04	ce05	ce06	ce07	ce08	ce09	ce10	ce11	ce12	Mean birds/ha
Ant-eating Chat	0	0	0	0	0	0	0	0	1	0	1	1	**0.03**
African Pipit	0	0	0.5	0	0.5	1	0.5	1	0.5	0	0	1	**0.04**
African Red-eyed Bulbul	0	0	0	0	0	0	0	0.5	0	0	0	0	**0.00**
Black-chested Prinia	0	0	0	2	0	0	2	0	1	0	0	0	**0.04**
Brown-crowned Tchagra	0	0	0	0.5	0	0	0	0	0	0	0	0	**0.00**
Black-throated Canary	1	0	0	0	0	0	0	0	0	2	0	0	**0.03**
Blue Waxbill	0	0	1	0	0	0	0	0	0	0	0	0	**0.01**
Cloud Cisticola	0	0	0.5	0	0	0	0	0	1	0	0	0	**0.01**
Cape Longclaw	0	0	0	0	0	1	0	0	1	0	0	0	**0.02**
Common Myna	0	0	0	0	0	0	1	0	0	0	0	0	**0.01**
Cape Sparrow	0	0	1	2	0	0	2	0	1	2	0	0	**0.07**
Cape Starling	0	0	0	1	0	0	1	0	0	0	0	0	**0.02**
Chestnut-vented Warbler	0	0	1	2	0	0	2	1	0	1	0	0	**0.06**
Common Waxbill	0.5	0	0	0	0	0	1	0	0	0	0	0	**0.01**
Desert Cisticola	0	0	0.5	0	1	0	0	0	0.5	0	1.5	0	**0.03**
Fairy Flycatcher	0	0	0	1	0	0	0	0	0	0	0	0	**0.01**
Green-winged Pytilia	0	0	1	0	0	0	0	0	0	0	0	0	**0.01**
Kalahari Scrub-robin	0	0	0	0.5	0	0	2	0	0	0	0	0	**0.02**
Levaillant's Cisticola	2	2	0	0	0	0	0	0	0	0	0	0	**0.04**
Long-tailed Widowbird	5	0.5	0	0	0	0	0	0	0	0	0	0	**0.05**
Neddicky	0	0	0	1	0.5	0	0	0	0	0	0	0	**0.01**
Red-capped Lark	0	0	1	0	2	1	0	0	2	0	0	4	**0.09**

Species	ce01	ce02	ce03	ce04	ce05	ce06	ce07	ce08	ce09	ce10	ce11	ce12	Mean birds/ha
Southern Fiscal	0	0	1	1	1	1	1	0	0	0	0	0	**0.04**
Spike-heeled Lark	0	0	0	0	0	0	0	0	0	0	0	1	**0.01**
Southern Masked Weaver	0	0	2	1	2	0	2.5	0	0	0	0	0	**0.07**
Southern Red Bishop	0	0	0	1	0	0	0.5	0	0	0	0	1	**0.02**
Red-billed Quelea	1100	525	75	0	0	0	0	5	0	0	0	0	**15.18**
Wattled Starling	0	0	0	0	0	0	3.5	0	0	0	0	0	**0.03**
White-browed Sparrow-weaver	0	0	4	4	0	0	4	1	0	1	0	0	**0.12**
White-throated Robin-chat	0	0	0	0	0	0	1	0	0	0	0	0	**0.01**
Yellow Canary	0	0	0.5	0	0	0	2.5	0	0	0.5	0	0	**0.03**
Zitting Cisticola	0.5	0	0	0	0	0	0	0	0	0	0	0	**0.00**
Number of individuals	1109	527.5	89	17	7	4	26.5	8.5	8	6.5	2.5	8	
Number of species	6	3	13	12	6	4	15	5	8	5	2	5	
Number of birds/ha	**1421.79**	**676.28**	**114.10**	**21.79**	**8.97**	**5.13**	**33.97**	**10.90**	**10.26**	**8.33**	**3.21**	**10.26**	
Number of species/ha	**7.69**	**3.85**	**16.67**	**15.38**	**7.69**	**5.13**	**19.23**	**6.41**	**10.26**	**6.41**	**2.56**	**6.41**	
Average number of birds/ha	**193.75**												
Average number of species/ha	**8.97**												