APPENDIX D

Specialist Reports (Including terms of reference)

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Report on the ecological and wetland assessment for the proposed Harmony Moab-Noligwa PV solar development situated near the town of Orkney, Free State Province.

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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 1.0**		
Title	**Report on the ecological and wetland assessment for the proposed Harmony Moab-Noligwa PV solar development situated near the town of Orkney, Free State Province.**		
Author	**DP van Rensburg (Pr.Sci.Nat)**		**Jul'22**

Executive Summary

The study area is situated approximately 10 km east of the small town of Orkney and to the south of the settlement of Vaal Reefs (Appendix A: Map 1). The study area is fairly large and is dominated by undulating grassland plains with gentle slopes that generally slopes toward the north and east, toward lower lying watercourses and wetlands. The extent of the study area is approximately 1500 hectares. A significant portion of this development area has however been transformed by the existing mining plants and infrastructure. However, the majority of the area is still dominated by natural grassland with some disturbance also being evident. A large wetland area is also present in the eastern portion, with a few small depression wetlands also occurring in the southern portion.

The study area is still largely dominated by natural grassland and which can broadly be divided into a northern and southern portion where the northern portion is dominated by Vaal Reefs Dolomite Sinkhole Woodland and also north of a large tarred road while the southern portion is dominated by Vaal-Vet Sandy Grassland and situated south of the tarred road (Appendix A: Map 1).

The majority of the site still consists of natural grassland which is still in a fairly good condition (Appendix A: Map 1). The surroundings as well as significant portions of the site has been affected and transformed by historical mining operations. 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 areas previously cleared for construction activities, portions transformed by ploughing for crop production and degraded areas associated with the mining operations which also includes areas of shallow excavations and rubble dumps. It is however inevitable that the development will also encroach into areas of natural grassland which will result in significant impacts.

Given the above descriptions of the natural vegetation the following areas of high sensitivity should be avoided as far as possible (Appendix A: Map 1 - 4):

- The Mispah Game Reserve covers a large portion of the southern portion of the site. This is a Private Nature Reserve which has been proclamated as a Protected Area (PA) under the National Environmental Management Protected Areas Act (NEMPAA of 2003). The area is listed as a Private Nature Reserve within the South Africa Protected & Conservation Areas Database (SAPAD) and was proclamated in 2001 (Notice 23 of 2001). Development within any protected area is highly unlikely since this is largely prevented by the NEMPAA and any management plan of the protected area. This PA has also been taken into account in determining the provincial and national conservation targets and development within this PA will also affect these conservation targets.
- Two large CBA 1 areas have been delineated by the Free State Biodiversity Management Plan. These CBA 1 areas have been identified as being crucial for meeting conservation targets for the Endangered Vaal-Vet Sandy Grassland occurring in this area but also to some extent the Vaal Reefs Dolomite Sinkhole Woodland in the area. These CBA 1 areas have been identified as being Irreplaceable in terms of meeting conservation targets.

- Portions of remaining Vaal-Vet Sandy Grassland also occur in the south east of the site but which do not form part of the Mispah Game Reserve or identified CBA areas. However, since this vegetation type is currently listed as Endangered (EN) these areas must still be afforded a High level of sensitivity. Development should investigate all alternatives to avoid this area and should only encroach into this area if no other alternative is available. This will however result in high impacts.
- A large wetland system transects the eastern portion of the site. This is clearly an importance water resource and will have a Very High level of sensitivity. It will not be possible to develop this system and should be completely excluded from development.

Since it is clear that the impact of the solar development will be high and will lead to irreversible transformation, the development area should be carefully determined, should focus on areas of lower sensitivity and should limit the extent of transformation as far as possible (Appendix A: Map 4). Current layout plans do indicate that areas of High Sensitivity are largely being avoided while mostly retaining development within areas of Moderate Sensitivity. Though this will still entail significant impacts, it will be significantly lower as opposed to the inclusion of areas of High Sensitivity.

Signs and tracks of mammals are fairly abundant on the site though the mammal population will be somewhat modified from the natural condition. Natural vegetation has a high carrying capacity for mammals which decreases significantly where mining or agriculture transforms this natural vegetation and in such transformed areas the mammal population is normally represented by a generalist mammal population. As indicated previously, the majority of this still consists of natural vegetation and accordingly the mammal population will also be largely natural in these areas.

It has been confirmed that Near Threatened Serval (*Leptailurus serval*) occurs in the development area it is clear that the proposed development will have a significant impact on it. According to the National Red List (2016) the several recommendations and mitigation should be implemented where this species will be affected.

The surface water features of the study area are dominated by a large valley bottom wetland system in the eastern portion of the site (Appendix A: Map 3). A few small depressions also occur in the south west of the site and within the Mispah Game Reserve.

Obligate wetland vegetation was utilised to determine the presence and border of wetland conditions (Appendix B). The vegetation survey indicated that obligate wetland vegetation dominates the valley bottom wetland system in the east of the site. The smaller depression wetlands in the south west of the site contained some obligate wetland vegetation though due to high levels of disturbance this was not as pronounced. However, soil samples conclusively confirmed the presence of wetland conditions in both the valley bottom wetland system and small depression wetlands (Appendix C). The large valley bottom wetland system in the east of the study area can be categorised as an unchanneled valley-bottom wetland (SANBI 2009).

Though the section of the wetland occurring on the site seems to still be largely intact and functional the upstream land uses, especially within the catchment will certainly have a significant impact on the wetland and is therefore likely to cause a significant level of modification of it. The survey has indicated that the valley bottom wetland system is affected by numerous impacts which result in a significant level of modification. A WET-Health determination was undertaken for the valley bottom 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 on the wetland. The EI&S of the valley bottom wetland system has been rated as being Moderate.

A Risk Assessment for the proposed solar facility which will affect the valley bottom wetland system in the eastern 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). In the event that development of solar facilities extends into the eastern portion of the site, these areas will be located in close proximity to this wetland system and in so doing are likely to result in some impacts on it, especially in terms of runoff and sedimentation (Appendix A: Map 3). However, current layout plans do indicate that the development will avoid the eastern portion of the development area which will significantly decrease the anticipated impact. The current layout plans indicate that portions of the development as well as associated grid connection powerline will be situated approximately 350 meters from this valley-bottom wetland system and given the clearance of vegetation and the large extent of the development is still likely to have an impact on it.

The large valley bottom wetland system is clearly the main wetland system in this area 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). Current layout plans do indicate that the eastern portion of the development area will be excluded though development will still occur within 350 meters of the edge of the wetland and is then still likely to have some impact on it. Given the distance between the wetland area and current development layout (approximately 350 meters), the anticipated risk will be low.

The impact significance has been determined and should development take place without mitigation it is anticipated that it will result in overall high impacts. This is a result of the largely natural condition of the area, the presence of areas of high conservation value and the fairly large extent of the proposed development (Appendix A: Map 4). Aspects which are expected to result in quite high impacts include the loss of the vegetation type in the area which includes Vaal-Vet Sandy Grassland (an Endangered system) as well as the loss of a large wetland system in the east of the site. Other moderate-high impacts also include the loss of protected plant species, increased infestation by exotic weeds, increased habitat fragmentation, the impact on mammals (which also includes a Near Threatened species) and the increased cumulative impact. Suitable mitigation as listed in previous paragraphs should enable the development to decrease many of these impacts to moderate levels. This will mostly be achieved by excluding areas of high conservation value as listed which will in turn decrease the severity of the impacts and will also decrease the extent and in so doing the anticipated impacts will be somewhat lower. Current layout plans do indicate that areas of High Sensitivity are being avoided while retaining development within areas of Moderate Sensitivity. Though this will still entail significant impacts, it will be significantly lower as opposed to the inclusion of areas of High Sensitivity. However, as indicated significant natural areas will still be transformed by the development and several of the impacts will remain significant especially the impacts on the vegetation type and biodiversity, the wetland system in the east of the site, habitat fragmentation, the mammal population in the area and the cumulative impact.

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Ecological and wetland assessment.

1. INTRODUCTION

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 10 km east of the small town of Orkney and to the south of the settlement of Vaal Reefs (Appendix A: Map 1). The study area is fairly large and is dominated by undulating grassland plains with gentle slopes that generally slopes toward the north and east, toward lower lying watercourses and wetlands. The extent of the study area is approximately 1500 hectares. A significant portion of this development area has however been transformed by the existing mining plants and infrastructure. However, the majority of the area is still dominated by natural grassland with some disturbance also being evident. A large wetland area is also present in the eastern portion, with a few small depression wetlands also occurring in the southern portion.

A site visit was conducted on 24 to 26 May 2022. The entire proposed development area, including terrestrial and riparian areas, was surveyed over the period of several days. 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 regime was present. This ensured accurate identification of watercourses and wetlands.

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.

1.1 Background of the development

The following summary has been provided by the applicant and provides a brief description of the planned development:

Harmony Moab Khotsong Operations (Pty) Ltd 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 development of a solar photovoltaic (PV) facility with a generating capacity of up to 100MW is proposed north of the Harmony Gold Moab Khotsong operations, approximately ~10km north of the town of Vierfontein within the Moqhaka Local Municipality and within the Fezile Dabi District Municipality, Free State Province.

The PV facility is located on:

- the Farm Anglo 593;
- Farm Hoekplaats 598;
- Farm Mispah 274;
- Portion 1 of Farm Zaaiplaats 190;
- Remaining Extent of Farm Doornkom Wes 446;
- Portions 1, 3, 4, 5, of Farm Chrystalkop 69;
- and the Remaining Extent of the Farm Zuiping 394,

The properties are owned by the Mine. The solar PV development will be known as Harmony Moab Khotsong Solar PV Facility.

The preferred site for the projects is on properties which are owned by Harmony Gold and are available for the proposed projects and is therefore deemed technically feasible by the project developer for such development to take place.

A project site considered to be technically suitable for the development of the solar PV facility, with an extent of approximately 1400ha, was identified. A development area of ~900ha was demarcated within this project site and allows an adequate footprint (~450ha) for the installation of a solar PV facility with a contracted capacity of up to 100MW, while allowing for the avoidance of environmental site sensitivities.

The full extent of the project site is to be evaluated in the Basic Assessment process to identify sensitivities. Site-specific studies and assessments will delineate areas of potential sensitivity within the identified study area. Once constraining factors have been confirmed, the layout of the solar PV facility within the development area can be planned to avoid sensitive environmental areas and features.

The infrastructure associated with the 100MW solar PV facility will include:

- PV modules and mounting structures.
- Inverters and transformers a SCADA room, and maintenance room.
- Cabling between the project components, to be laid underground where practical.
- Access roads, internal roads and fencing around the development area.
- Temporary and permanent laydown areas.
- Grid connection infrastructure including an on-site facility substation and a switching substation to be connected to the existing:
    - Vaalreefs Eleven Substation via a 3km overhead power line (located in the eastern corner of the site);
    - Southvaal Plant Substation via an up to 1km overhead power line (located in the western corner of the site);
    - and to the Southvaal Substation via a 2km overhead power line (located in the northern corner of the site).

The site is accessible via the R76 from Viljoenskroon which is south of the proposed site.

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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Professional registration:
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) and Vaal Reefs Dolomite Sinkhole Woodland (Gh 12). The former is currently listed as Endangered (EN) while the latter is Least Concern (LC) under the National List of Threatened Ecosystems (Notice 1477 of 2009) (National Environmental Management Biodiversity Act, 2004) (Appendix A: Map 1). The Vaal-Vet Sandy Grassland dominates the southern portion of the site and is visible as undulating grassland but characterised by fairly deep, sandy soils. These remaining natural portions of this grassland would also be regarded as being of high conservation value. The vegetation type is currently heavily affected by extensive transformation by agriculture, urban expansion and mining operations. The Vaal Reefs Dolomite Sinkhole Woodland dominates the northern portions of the site and is visible as undulating plains though here exposed low rocky ridges become evident, deeper sandy soils are absent and the grass composition also differs slightly by containing a higher proportion of sour grasses. The woodland component, associate with dolomite sinkholes is not well represented on the site although a few bush clumps were noted. This vegetation type is also heavily affected by transformation but not yet to such an extent as to warrant it being listed as a Threatened Ecosystem.

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 an Ecological Support Area 1 and 2 (ESA) which functions in support of the Vaal River which is situated approximately 1 km to the north of the site (Appendix A: Map 2). The development should therefore not result in compromising the functioning of this important system, i.e. increase runoff or degrade the area to such an extent that it influences the functioning of the Vaal River. Furthermore, the site also contains two prominent areas being regarded as Critical Biodiversity Areas 1 (CBA 1) situated in the centre and eastern portion of the site (Appendix A: Map 2). These CBA 1 areas have been identified as being crucial for meeting conservation targets for the Endangered Vaal-Vet Sandy Grassland occurring in this area but also to some extent the Vaal Reefs Dolomite Sinkhole Woodland in the area. These CBA 1 areas have been identified as being Irreplaceable, i.e. “A site that is irreplaceable or near-irreplaceable for meeting biodiversity targets. There are no or very few other options for meeting biodiversity targets for the features associated with the site. Such sites are therefore critical and they need to be maintained to ensure that features targets are achieved and that such features persist.” These portions of CBA’s occurring on the site will therefore have to be excluded from development in order to ensure they remain intact.

The study area is situated approximately 10 km east of the small town of Orkney and to the south of the settlement of Vaal Reefs (Appendix A: Map 1). The study area is fairly large and is dominated by undulating grassland plains with gentle slopes that generally slopes toward the north and east, toward lower lying watercourses and wetlands. The extent of the study area is approximately 1500 hectares. A significant portion of this development area has however been transformed by the existing mining plants and infrastructure. However, the majority of the area is still dominated by natural grassland with some disturbance also being evident. A large wetland area is also present in the eastern portion, with a few small depression wetlands also occurring in the southern portion.

As previously indicated, the study area is still largely dominated by natural grassland and which can broadly be divided into a northern and southern portion where the northern portion is dominated by Vaals Reefs Dolomite Sinkhole Woodland and also north of a large tarred road while the southern portion is dominated by Vaal-Vet Sandy Grassland and situated south of the tarred road (Appendix A: Map 1).

The southern portion is dominated by grassland dominated by Vaal-Vet Sandy Grassland and which is largely still intact (Appendix A: Map 1). A significant portion also consists of Vaal Reefs Dolomite Sinkhole Woodland though the transition between these two vegetation types is gradual. Portions of the grassland has previously been transformed though the majority of these have again been able to re-establish a fairly natural grass layer. However, a few smaller portions are still visibly degraded and transformed and these include a large woodlot of invasive Bluegum (*Eucalyptus camaldulensis*), oxidation ponds associated with mining operations, greenhouses and a small portion previously used as stockpiling/construction area. A large wetland system is also situated in the south eastern portion of the site which is a natural and important system (Appendix A: Map 3). These wetland areas will all be assessed in detail in the wetland assessment section of the report. A large portion of this southern portion of the site has previously been proclamated as the Mispah Game Reserve which has been registered as a Protected Area (PA) under the National Environmental Management Protected Areas Act (NEMPAA of 2003) (Appendix A: Map 2). The area is listed as a Private Nature Reserve within the South Africa Protected & Conservation Areas Database (SAPAD) and was proclamated in 2001 (Notice 23 of 2001). Development within any protected area is highly unlikely since this is largely prevented by the NEMPAA and any management plan of the protected area.

Figure 1: Natural grassland dominate the southern portion of the site and consist of a dense grass cover with fairly deep sandy soils.

Figure 2: Another view of the natural grassland in the southern portion of the site.

Figure 3: A fairly large woodlot of invasive Bluegum does cause transformation of a substantial portion of the natural grassland.

Figure 4: A large wetland system occurs in the south eastern portion of the site.

Figure 5: Location and boundaries of the Mispah Game Reserve (Yellow) situated in the study area (Red).

The northern portion is also dominated by grassland but which consists almost exclusively of Vaal Reeds Dolomite Sinkhole Woodland (Appendix A: Map 1). This grassland is also largely natural though significant disturbance is associated with areas of shallow excavations and overgrazing by domestic livestock. Though Vaal Reefs Dolomite Sinkhole Woodland is under significant development pressure, it is also not currently listed as a Threatened Ecosystem and will therefore have a slightly lower conservation value than the southern portion. The Vaal Reefs Dolomite Sinkhole Woodland is characterised by a well-developed grass layer and much higher degree of surface rock as well as at least some bush clumps establishing around sinkholes. For the study area these sinkholes are rare with only a few small bush clumps occurring in the area. The north western portion is visibly degraded by high levels of overgrazing by domestic livestock and also a substantial area which was previously used for dumping of spoil and rubble and also contains shallow excavations.

Figure 6: Natural grassland in the northern portion of the site is also largely intact with a dense grass cover.


Figure 7: Bush clumps associated with sinkholes are quite rare.


Figure 8: A significant portion of the north west of the site contains shallow excavations with invasive trees having become established there.

From the above paragraphs it is clear that the study area is still largely natural and dominated by dense grassland. However, several areas are affected by transformation and impacts (Appendix A: Map 4). The most notable transformation of the area is associated with the Moab and Noligwa mining operations which include extensive operational plants, tailings dumps and associated infrastructure such as roads, pipelines and powerlines. Other additional areas of transformation also include:

- A large portion in the south east of the site has been ploughed and is being used for crop cultivation. This portion is completely transformed and covers an area of approximately 60 hectares.

- A small area of approximately 3 hectares in the south east of the site was previously cleared of vegetation and used as a stockpile or construction yard. This area has now re-established a grass layer but is visibly degraded.

- A small area of approximately 3 hectares in the south east consist of a complex of greenhouses which is clearly a transformed area.

- A large woodlot of approximately 20 hectares is situated in the south western portion of the site and consists of the invasive Bluegum (*Eucalyptus camaldulensis*). This area also forms part of the Mispah Game Reserve but is clearly transformed.

- Along the south western border of the study area, a large tailings dam is situated. This dam also seeps toward the north east and into the study area. This seepage area is clearly quite degraded, most probably as a result of high salt concentrations. This results in the dominance of the dwarf shrub, *Stoebe plumosus*, a clear indicator of degraded grassland. Though these seepage areas are not necessarily transformed they are clearly quite degraded. This seepage area covers an area of approximately 7 hectares.

- A few oxidation ponds are situated along the northern border of the tailings dam situated along the south western border of the site. These and immediate surroundings has caused local transformation of the natural grassland and cover an area of approximately 30 hectares.

- A fairly large area (approximately 20 hectares) in the northern portion of the site consists of shallow excavations and dumps of rubble and spoil where invasive trees have also become established. These areas are completely transformed from the natural condition.

Figure 9: Relative areas of transformation in the study area (red) include; mining operations, plant and tailings (yellow), crop fields (light blue), stockpile area (dark green), greenhouses (light green), woodlot (pink), seepage (purple), oxidation ponds (blue) and excavations (orange) (Google Earth 2009).

Large portions of the area is also being utilised as communal grazing for domestic livestock. This does contribute toward significant impacts on the grassland vegetation and especially in the north western portion this leads to increased establishment of exotic weeds. This does however not lead to transformation of the vegetation but simply contributes toward disturbance.

The natural topography of the area is still largely intact and is dominated by undulating plains. Surface rock becomes more prominent in the northern portion and along low ridges while a few obscure sinkholes are also present. The topography has been modified in a few localised areas which include the mining operations and tailings areas, a cultivated field in the south east, a previous construction/stockpile area in the south east, oxidation ponds and surrounding disturbance in the south west and a large area of shallow excavations and rubble dumps in the northern portion of the site.

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 C2E004 (Potchefstroom). The site is located in an area with a rainfall of between 600 mm and 700 mm per annum with an average of 631.7 mm per year. Rainfall occurs largely as summer rainfall with an average annual evaporation of 1661 mm/annum. The surface water runoff in the area is therefore at least moderate which results in ample 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 Malmani Subgroup as well as the Vryheid Formation. The Malmani Subgroup forms part of the Chuniespoort Group of Transvaal Supergroup and is associated with dolomite, subordinate chert, minor carbonaceous shale, limestone and quartzite and this geology also corresponds to a large degree, with the Vaal Reeds Dolomite Sinkhole Woodland vegetation dominating the northern portion of the site. The Vryheid Formation forms part of the Ecca Group of the Karoo Supergroup and is associated with Fine- to coarse-grained sandstone and shale and this geology also corresponds to a large degree with the Vaal-Vet Sandy Grassland of the southern portion of the site.

As previously indicated, the terrestrial component of the study area, can roughly be divided into a northern and southern section largely based on a division between different vegetation types where the northern portion consists of Vaal Reefs Dolomite Sinkhole Woodland where a higher degree of surface rock is present with shallower soils while the southern portion consists of Vaal-Vet Sandy Grassland which contains deeper, sandy soils (Appendix A: Map 1). These areas are also roughly divided by a tarred road. These areas will be discussed separately in the below paragraphs and elements of conservation value indicated where these were observed.

Southern portion (Vaal-Vet Sandy Grassland – Deeper sandy soils) (Appendix A: Map 1)

The southern portion of the site, is still largely natural and dominated by a well-developed grass layer (Appendix A: Map 1). Areas of local transformation include the mining operations, oxidation ponds, agricultural crop fields, a woodlot of exotic trees and smaller areas of temporary transformation. In transformed areas the natural vegetation is clearly no longer present or consists of pioneer species while those areas that remain largely natural are still dominated by climax grasses indicating a fairly good condition. Exotic weeds are present and may also become abundant around disturbed or transformed areas. It is also notable that the southern portion contains a higher degree of sweet grassland (highly palatable grasses adapted to sandier soils). The boundary between the southern Vaal-Vet Sandy Grassland and northern Vaal Reefs Dolomite Sinkhole Woodland is also not clearcut and the two transitions into the other and may also occur as interspersed patches.

The vegetation composition in the southern portion confirms a largely natural vegetation type in a fairly good condition. The grass layer is dominated by climax grasses with a prominent herbaceous component also present. Climax grasses include *Themeda triandra, Triraphis andropogonoides, Eragrostis lehmanniana, Urelytrium agropyroides, Loudetia simplex, Anthephora pubescens, Brachiaria serrata, Digitaria eriantha* and *Eragrostis curvula*. Where disturbance is evident in areas which were previously cleared of vegetation or where other disturbances such as overgrazing has occurred, the grass layer does contain an increase in pioneer grasses such as *Cynodon dactylon, Pogonarthria squarrosa, Eragrostis gummiflua, Perotis patens* and *Aristida canescens*. Though these pioneer grasses would also be present in areas where the vegetation is in a good condition, an abundance does indicate disturbance as was observed in some areas. A prominent herbaceous component is also present and includes *Helichrysum callicomum, Hermannia geniculata, Delosperma herbeum, Selago densiflora, Helichrysum caespititum, Selago burkei, Felicia muricata, Dicoma macrocephala, Ruschia hamata, Barleria macrostegia, Euphorbia striata, Helichrysum nudifolium* and *Ipomoea crassipes*. Where disturbance has occurred herbs such as *Polydora poskeana, Ursinia nana* and *Nidorella resedifolia* may also be locally abundant. The deeper sandy soils associated with this vegetation type also promote the establishment of geophytic species, i.e. plants with an underground storage organ. These include plants such as *Orthanthera jasminiflora, Trachyandra laxa, Boophone distichia, Acanthosicyos naudinianus, Pentharhinum insipidum, Raphionacme velutina, Babiana bainesii* and *Schixocarpus nervosus*. An unidentified orchid species, *Satyrium sp*. was also noted and though it cannot be identified to species level due to the absence of an inflorescence it is most likely of high conservation value. A protected succulent, *Aloe greatheadii* is also present as scattered clumps. It was noted that the dwarf shrub, *Stoebe plumosus*, was present in this grassland, where previous transformation has occurred or where high levels of disturbance is evident such as the seepage from the tailings dam in the south west of the site, that this species becomes dominant. This plant is a well known indicator of previously transformed grassland and can be used to indicate degraded areas. Exotic weeds were also prominent in areas of disturbance and included *Bidens bipinnata* and *Tagetes minuta*.

Many of the plants listed in the previous paragraph are also regarded as protected within the Free State Province (Appendix B). These include *Helichrysum spp., Euphorbia striata, Orthanthera jasminiflora, Boophone distichia, Pentharhinum insipidum, Schixocarpus nervosus, Satyrium sp., Raphionecma velutina, Babiana bainesii* and *Aloe greatheadii.* Where any of the herbaceous protected species will be affected by the development, permits will have to be obtained for their removal. Where the development will affect geophytic or succulent species, permits will also have to be obtained, but affected plants transplanted to adjacent areas where they will remain unaffected.

From the vegetation description of the southern portion of the site dominated by Vaal-Vet Sandy Grassland it would seem to be largely intact and in a fairly good condition (Appendix A: Map 1). Signs of disturbance are however also evident and areas where previous clearance of the vegetation had occurred are clearly degraded. The species diversity is moderate although the area does also contain a significant number of protected plant species which will contribute towards its conservation value (Appendix B). However, the vegetation here is dominated by Vaal-Vet Sandy Grassland, an Endangered (EN) vegetation type which would therefore have at least a High level of sensitivity (Appendix A: Map 4). In addition, several factors further contribute towards its conservation value which include the Mispah Game Reserve, a proclamated Protected Area (PA) and sections having been listed as Critical Biodiversity Area 1 (CBA 1) and are characterised as irreplaceable. This will contribute to an even higher level of sensitivity (Appendix A: Map 2 & 4).

Figure 10: A well-developed grassland dominated the southern portion of the site where sandy soils are also evident.

Figure 11: Another view of the extensive grassland in the southern portion of the site, note the undulating terrain.

Figure 12: Where higher levels of disturbance becomes evident, exotic weeds (red) are more abundant.

Northern portion (Vaal Reeds Dolomite Sinkhole Woodland – Rocky outcrops) (Appendix A: Map 1)

The northern portion of the site, is also still largely natural and dominated by a well-developed grass layer (Appendix A: Map 1). Here a few scattered bush clumps are also present, associated with dolomite sinkholes. Rocky outcrops are also present along the higher lying areas which also promote the establishment of shrubs. Areas of local transformation include the mining operations, tailing dumps and fairly extensive areas of shallow excavations and rubble dumps. In these transformed areas the natural vegetation has been quite heavily degraded and exotic and invasive weeds and trees are prominent. However, the majority of this portion is still largely natural and dominated by climax grasses indicating a fairly good condition. Large areas, especially the western portion of the site is also being used as communal grazing for domestic livestock and this does contribute to the establishment of exotic weeds. It is also notable that this portion contains a higher degree of sour grassland (unpalatable grasses dominate in rockier soils). The boundary between the southern Vaal-Vet Sandy Grassland and northern Vaal Reefs Dolomite Sinkhole Woodland is also not clearcut and the two transitions into the other and may also occur as interspersed patches.

The vegetation in the northern portion confirms a largely natural vegetation type in a fairly good condition. The grass layer is dominated by climax grasses with a prominent herbaceous component also present. Climax grasses include *Hyparrhenia hirta, Harpochloa falx, Trachypogon spicatus, Cymbopogon pospischillii, Themeda triandra* and *Cymbopogon excavatus.* These are mostly sour grasses natural to this vegetation type and can be used to differentiate it from the Vaal-Vet Sandy Grassland to the south. Where disturbance is higher, such as overgrazed areas, the grass layer does contain an increase in pioneer grasses such as *Cynodon dactylon, Eragrosis gummiflua, Stipagrostis uniplumis* and *Sporobolus discosporus*. Though these pioneer grasses would also be present in areas where the vegetation is in a good condition, an abundance does indicate disturbance as was observed in some areas. A prominent herbaceous component is also present and includes *Helichrysum callicomum, Senecio coronatus, Limeum viscosum, Indigofera sp., Hilliardiella eleagnioides, Lasiosiphon sericocephalus, Vigna sp., Indigofera daleoides, Lippia scaberrima, Dicoma anomala* and *Chascanum pinnatifidum*. Where disturbance has occurred herbs such as *Acrotome inflata* and *Nidorella resedifolia* may also be locally abundant. The exposed rocky areas and shallower soils also promote the establishment of a variety of other growth forms such as dwarf shrubs, *Triumfetta sonderi,* ferns, *Pellaea calomelanos* and small succulents, *Crassula lanceolata, Crassula capitella* and *Kalanchoe rotundifolia*. As previously indicated, the vegetation type also integrates gradually with the Vaal-Vet Sandy Grassland and areas with deeper soils are also common. Here geophytic (plants with an underground storage organ) and suffrutices (plants with an extensive belowground stem network) species are also abundant and include *Hypoxis hemerocallidae, Ledebouria sp., Elephanthorrhiza elephantina, Pygmaeothamnus zeyheri, Chlorophytum sp., Babiana bainesii, Drimia platyphylla, Crinum graminicola, Raphionacme velutina* and *Ziziphus zeyheriana*. The rocky areas, including any rare sinkholes, also contribute to the establishment of small trees and shrubs which include *Gymnosporia buxiifolia, Asparagus larcinus, Ziziphus mucronata, Searsia pyroides, Celtis africana, Clematis brachiata, Vachellia erioloba, Vachellia karroo, Grewia flava* and *Searsia lancea*. Of these, *V. erioloba* (Camel Thorn) is also listed as a protected tree but is only represented by a few small specimens which therefore have a limited conservation value. The dwarf shrub, *Stoebe plumosus*, was present in this grassland and though it is a natural component of the grassland, can become abundant where disturbance is high. Exotic weeds can be abundant in disturbed areas and include *Physalis viscosa* and *Achyranthes aspera*.

Many of the plants listed in the previous paragraph are also regarded as protected within the Free State Province (Appendix B). These include *Helichrysum callicomum, Babiana bainesii, Crinum graminicola, Raphionacme velutina* and *Vachellia erioloba*. Where any of the herbaceous and tree protected species will be affected by the development, permits will have to be obtained for their removal. Where the development will affect geophytic or succulent species, permits will also have to be obtained, but affected plants transplanted to adjacent areas where they will remain unaffected.

As previously indicated, a large area is affected by shallow excavations and rubble dumps and here the vegetation has become dominated by weeds and invasive trees (Appendix B). Invasive trees are abundant and include *Melia azedarach, Eucalyptus camaldulensis, Gleditsia triacanthos, Nicotiana glauca, Acacia baileyana* and *Tamarix chinensis*. Invasive grasses such as *Pennisetum setaceum* and invasive succulents such as *Opuntia ficus-indica* are also abundant. Indigenous pioneer grasses are also abundant and include *Melinis repens* while a few indigenous trees have also become established including *Vachellia karroo* and *Searsia lancea*. As can be seen, this portion of the site is almost completely transformed and degraded while invasive plants are also likely to spread into the surrounding natural areas.

From the vegetation description of the northern portion of the site dominated by Vaal Reefs Dolomite Sinkhole Woodland it would seem to be largely intact and in a fairly good condition (Appendix A: Map 1). Areas of transformation are present, notably the mining plant and surrounding shallow excavations and rubble dumps while overgrazing may also lead to local disturbance in the north western portion of the site. The species diversity is moderate although the areas does also contain a significant number of protected plant species which will contribute towards its conservation value. Though the vegetation is subjected to significant transformation pressures it is not yet sufficient for it to be regarded as a Threatened Ecosystem. The northern portion of the site would therefore be regarded as generally of Moderate sensitivity. However, a significant portion has also been listed as Critical Biodiversity Area 1 (CBA 1) and has been identified as irreplaceable in terms of the biodiversity management plan (Appendix A: Map 2 & 4). These areas will therefore be regarded as having a very high conservation value since are considered as essential to meeting conservation targets for the respective vegetation types.

Figure 13: The northern portion of the site is also dominated by a well-developed grass layer.

Figure 14: Another view of the extensive grassland habitat in the northern portion of the site.

Figure 15: A few scattered bush clumps occur in the northern portion of the site around sinkholes and rocky outcrops.

Figure 16: Rocky outcrops promote the establishment of a variety of different growth forms.

Figure 17: Invasive trees dominate an area of shallow excavations and rubble dumps in the northern portion of the site.

Conclusions

From the description of the area given above it is clear that the majority of the site still consists of natural grassland which is still in a fairly good condition (Appendix A: Map 1). The surroundings as well as significant portions of the site has been affected and transformed by historical mining operations. 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 areas previously cleared for construction activities, portions transformed by ploughing for crop production and degraded areas associated with the mining operations which also includes areas of shallow excavations and rubble dumps. It is however inevitable that the development will also encroach into areas of natural grassland which will result in significant impacts.

Given the above descriptions of the natural vegetation the following areas of high sensitivity should be avoided as far as possible (Appendix A: Map 1 - 4):

- The Mispah Game Reserve covers a large portion of the southern portion of the site. This is a Private Nature Reserve which has been proclamated as a Protected Area (PA) under the National Environmental Management Protected Areas Act (NEMPAA of 2003). The area is listed as a Private Nature Reserve within the South Africa Protected & Conservation Areas Database (SAPAD) and was proclamated in 2001 (Notice 23 of 2001). Development within any protected area is highly unlikely since this is largely prevented by the NEMPAA and any management plan of the protected area. This PA has also been taken into account in determining the provincial and national conservation targets and development within this PA will also affect these conservation targets.

- Two large CBA 1 areas have been delineated by the Free State Biodiversity Management Plan. These CBA 1 areas have been identified as being crucial for meeting conservation targets for the Endangered Vaal-Vet Sandy Grassland occurring in this area but also to some extent the Vaal Reefs Dolomite Sinkhole Woodland in the area. These CBA 1 areas have been identified as being Irreplaceable in terms of meeting conservation targets.
  - The development should therefore exclude these CBA areas from development.
  - Where no alternative is possible and development needs to encroach into these CBA areas, alternative CBA areas will have to be identified in order to still meet conservation targets. Given that these CBA areas have been identified as irreplaceable this will not be easily attainable.

- Portions of remaining Vaal-Vet Sandy Grassland also occur in the south east of the site but which do not form part of the Mispah Game Reserve or identified CBA areas. However, since this vegetation type is currently listed as Endangered (EN) these areas must still be afforded a High level of sensitivity. Development should investigate all alternatives to avoid this area and should only encroach into this area if no other alternative is available. This will however result in high impacts.

- A large wetland system transects the eastern portion of the site. This is clearly an important water resource and will have a Very High level of sensitivity. It will not be possible to develop this system and should be completely excluded from development. A suitable buffer should also determined and retained around this wetland system. A detailed assessment of this wetland will be conducted in the wetland assessment section of the study.

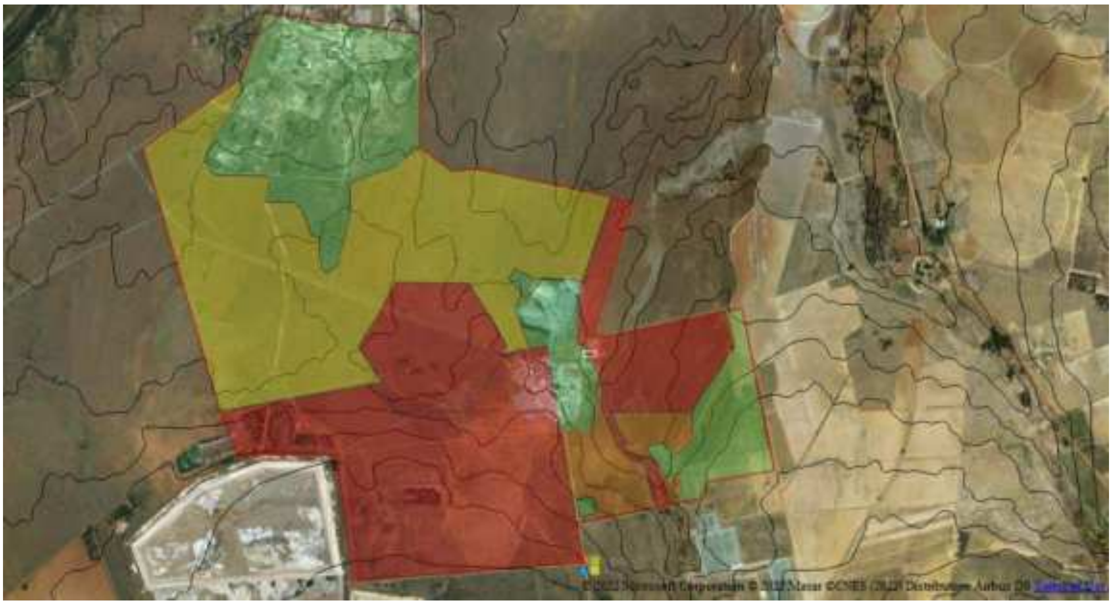

Figure 18: Areas of conservation importance include the Mispah Game Reserve, prominent CBA 1 area and a wetland system in the south eastern portion of the site (red). Remaining portions of Vaal-Vet Sandy Grassland are also of high conservation value (orange) while remaining natural grassland is at least of moderate importance (yellow). Areas regarded as transformed as indicated as green.

Since it is clear that the impact of the solar development will be high and will lead to irreversible transformation, the development area should be carefully determined, should focus on areas of lower sensitivity and should limit the extent of transformation as far as possible. Current layout plans do indicate that areas of High Sensitivity are largely being avoided while mostly retaining development within areas of Moderate Sensitivity. Though this will still entail significant impacts, it will be significantly lower as opposed to the inclusion of areas of High Sensitivity. Furthermore, numerous protected plant species has been identified in the study area (Appendix B). These include the protected succulent and geophytic species, *Euphorbia striata, Orthanthera jasminiflora, Boophone distichia, Pentharhinum insipidum, Schizocarpus nervosus, Satyrium sp., Raphionecma velutina, Babiana bainesii, Aloe greatheadii, Crinum graminicola,* and *Vachellia erioloba*. Where development will affect these species, the necessary permits should be obtained and a significant proportion of these transplanted to adjacent areas where they will remain unaffected. In addition, there are also a few protected herbaceous plants (*Helichrysum spp.*) and a few specimens of the protected *Vachellia erioloba* (Camel Thorn). Where any of these will require removal, the necessary permits should be obtained to do so.

In addition, the area also contains many invasive trees, especially in the transformed excavations in the northern portion of the site, 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 mammals (actual & possible)

Signs and tracks of mammals are fairly abundant on the site though the mammal population will be somewhat modified from the natural condition. Natural vegetation has a high carrying capacity for mammals which decreases significantly where mining or agriculture transforms this natural vegetation and in such transformed areas the mammal population is normally represented by a generalist mammal population. As indicated previously, the majority of this still consists of natural vegetation and accordingly the mammal population will also be largely natural in these areas. The mammal population in natural areas would however still be somewhat modified as a result of the surrounding fragmentation of habitat which affects the population dynamics and migration of mammals. Other impacts such as roads, herding, trapping and the proximity of mining activities would also further impact on mammals, especially reclusive and rare mammals dependant on pristine habitats. 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. The site would therefore have a significant impact on the likelihood of such rare and endangered species occurring in the area, there is however still a likelihood that remaining natural areas may harbour species of high conservation value.

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 wetland system in the eastern portion of the site. Although surrounding mining operations and associated impacts will affect the mammals along the wetland as well, it will still be able to sustain a higher bio-load which in turn supports a larger mammal population and it is likely that the mammal population along the wetland will be substantial. Development in close proximity to this wetland will therefore have a significantly higher impact.

The mammal survey of the site was conducted by means of active searching, camera traps 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.

- Scat of Porcupines (*Hystrix africaeaustralis*) were noted in several areas. This is also a generalist species, widespread and common in almost all natural areas.

- Several burrows of small mammals were noted which could not be identified but do indicate a significant mammal population in the area.

- Several burrows and excavation of Aardvark (*Oryteropus afer*) occur in the study area. This is also a fairly widespread and common species but is highly reclusive and is also listed as a protected species and is therefore of significant conservation value.

- Several observations of Steenbok (*Raphicerus campestris*) and Common Duiker (*Sylvicapra grimmia*) were also made. These species are both widespread but confined to fairly natural or agricultural areas and generally avoid urban areas.

- Springhare (*Pedetes capensis*) is also common in the area and also indicate a significant prey base for larger carnivores. This species is widespread but confined to natural areas with deeper sandy soils.

- A Slender Mongoose (*Galerella sanguinea*) was also observed. Although also fairly widespread it is a less common species and requires natural vegetation in a fairly good condition. It also contributes toward and indicates a significant mammal diversity.

- Tracks of a large canid carnivore were observed which is likely 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.

- A Cape Hare (*Lepus capensis*) was also observed in the study area. This is also a widespread species but is dependent on open grassland habitats.

- A Serval (*Leptailurus serval*) was also observed in the western portion of the site. This is a rare species which is dependant on the close proximity of watercourses and wetlands. It is also Red Listed as a Near Threatened (NT) species due to the decline in suitable habitat.

These species identified on the site indicate a significant diversity, which although dominated by widespread and generalist species, also contain species of higher conservation value. This also indicates that although the mammal population will be somewhat modified, it remains likely that other species of high conservation value will still be present.

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 it is inevitable that the development will involve the transformation of natural grassland this contributes significantly toward habitat loss which in turn will result in a high impact on the mammal population. This also indicates the need to take extra care in determining the development area, which should focus on areas of lower sensitivity, should exclude areas of high sensitivity and the wetland system in the eastern portion of the site and should limit the extent of transformation as far as possible. Current layout plans do indicate that areas of High Sensitivity are largely being avoided while mostly retaining development within areas of Moderate Sensitivity. Though this will still entail significant impacts, it will be significantly lower as opposed to the inclusion of areas of High Sensitivity.

It is also considered likely that several mammal species were overlooked during the survey and it may also be likely that other rare and endangered species may be present on 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.

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).

Scientific name	Common name	Status
Damaliscus lunatus lunatus	(Southern African) Tsessebe	**Vulnerable (VU)**
Hippotragus equinus	Roan Antelope	**Endangered (EN)**
Pelea capreolus	Vaal Rhebok	**Near Threatened (NT)**
Atelerix frontalis	Southern African Hedgehog	**Near Threatened (NT)**
Felis nigripes	Black-footed Cat	**Vulnerable (VU)**
Leptailurus serval	Serval	**Near Threatened (NT)**
Hyaena brunnea	Brown Hyena	**Near Threatened (NT)**
Otomys auratus	Southern African Vlei Rat (Grassland type)	**Near Threatened (NT)**
Aonyx capensis	African Clawless Otter	**Near Threatened (NT)**
Mystromys albicaudatus	African White-tailed Rat	**Vulnerable (VU)**
Crocidura mariquensis	Swamp Musk Shrew	**Near Threatened (NT)**

The survey has indicated that though the mammal population will consist largely of widespread, generalist species, it remains possible that some of these Red Listed species may occur in the area. The Serval has already been confirmed to be present and it is therefore likely that other threatened mammals may also occur.

Table 3: Likely mammal species in the region.

Family	Scientific name	Common name	Status
Bathyergidae	*Cryptomys hottentotus*	Southern African Mole-rat	Least Concern
Bovidae	*Aepyceros melampus*	Impala	Least Concern
	Alcelaphus buselaphus caama	Red Hartebeest	Least Concern
	Antidorcas marsupialis	Springbok	Least Concern
	Connochaetes gnou	Black Wildebeest	Least Concern
	Connochaetes taurinus	Blue Wildebeest	Least Concern
	Damaliscus lunatus lunatus	(Southern African) Tsessebe	**Vulnerable**
	Damaliscus pygargus phillipsi	Blesbok	Least Concern
	Damaliscus pygargus pygargus	Bontebok	Vulnerable
	Hippotragus equinus	Roan Antelope	**Endangered**
	Hippotragus niger	Sable Antelope	Least Concern
	Kobus ellipsiprymnus	Waterbuck	Least Concern
	Oryx gazella	Gemsbok	Least Concern
	Pelea capreolus	Vaal Rhebok	**Near Threatened**

	Raphicerus campestris	Steenbok	Least Concern
	Redunca arundinum	Southern Reedbuck	Least Concern
	Redunca fulvorufula	Mountain Reedbuck	Least Concern
	Sylvicapra grimmia	Bush Duiker	Least Concern
	Syncerus caffer	African Buffalo	Least Concern
	Taurotragus oryx	Common Eland	Least Concern
	Tragelaphus angasii	Nyala	Least Concern
	Tragelaphus scriptus	Bushbuck	Least Concern
	Tragelaphus strepsiceros	Greater Kudu	Least Concern
Canidae	*Canis mesomelas*	Black-backed Jackal	Least Concern
	Otocyon megalotis	Bat-eared Fox	Least Concern
	Vulpes chama	Cape Fox	Least Concern
Cercopithecidae	*Chlorocebus pygerythrus*	Vervet Monkey	Least Concern
	Papio ursinus	Chacma Baboon	Least Concern
Cervidae	*Dama dama*	Fallow Deer	Introduced
Equidae	*Equus quagga*	Plains Zebra	Least Concern
	Equus zebra	Mountain Zebra	
Erinaceidae	*Atelerix frontalis*	Southern African Hedgehog	**Near Threatened**
Felidae	*Caracal caracal*	Caracal	Least Concern
	Felis catus	Domestic Cat	Introduced
	Felis nigripes	Black-footed Cat	**Vulnerable**
	Leptailurus serval	Serval	**Near Threatened**
	Panthera leo	Lion	Least Concern
Giraffidae	*Giraffa giraffa giraffa*	South African Giraffe	Least Concern
Gliridae	*Graphiurus (Graphiurus) platyops*	Flat-headed African Dormouse	Data deficient
Herpestidae	*Atilax paludinosus*	Marsh Mongoose	Least Concern
	Cynictis penicillata	Yellow Mongoose	Least Concern
	Herpestes sanguineus	Slender Mongoose	Least Concern
	Ichneumia albicauda	White-tailed Mongoose	Least Concern
	Suricata suricatta	Meerkat	Least Concern
Hyaenidae	*Hyaena brunnea*	Brown Hyena	**Near Threatened**
	Proteles cristata	Aardwolf	Least Concern
Hystricidae	*Hystrix africaeaustralis*	Cape Porcupine	Least Concern
Leporidae	*Lepus capensis*	Cape Hare	Least Concern
	Lepus saxatilis	Scrub Hare	Least Concern
	Pronolagus randensis	Jameson's Red Rock Hare	Least Concern
Macroscelididae	*Elephantulus myurus*	Eastern Rock Elephant Shrew	Least Concern
Molossidae	*Chaerephon pumilus*	Little Free-tailed Bat	Least Concern
	Tadarida aegyptiaca	Egyptian Free-tailed	Least Concern

		Bat	
Muridae	*Aethomys ineptus*	Tete Veld Aethomys	Least Concern
	Aethomys namaquensis	Namaqua Rock Mouse	Least Concern
	Gerbilliscus brantsii	Highveld Gerbil	Least Concern
	Gerbilliscus leucogaster	Bushveld Gerbil	Least Concern
	Mastomys sp.	Multimammate Mice	
	Mastomys coucha	Southern African Mastomys	Least Concern
	Mastomys natalensis	Natal Mastomys	Least Concern
	Mus (Nannomys) indutus	Desert Pygmy Mouse	Least Concern
	Mus (Nannomys) minutoides	Southern African Pygmy Mouse	Least Concern
	Otomys auratus	Southern African Vlei Rat (Grassland type)	**Near Threatened**
	Rhabdomys pumilio	Xeric Four-striped Grass Rat	Least Concern
Mustelidae	*Aonyx capensis*	African Clawless Otter	**Near Threatened**
	Ictonyx striatus	Striped Polecat	Least Concern
	Mellivora capensis	Honey Badger	Least Concern
Nesomyidae	*Dendromus melanotis*	Gray African Climbing Mouse	Least Concern
	Mystromys albicaudatus	African White-tailed Rat	**Vulnerable**
	Saccostomus campestris	Southern African Pouched Mouse	Least Concern
Orycteropodidae	*Orycteropus afer*	Aardvark	Least Concern
Pedetidae	*Pedetes capensis*	South African Spring Hare	Least Concern
Procaviidae	*Procavia capensis*	Cape Rock Hyrax	Least Concern
Rhinolophidae	*Rhinolophus clivosus*	Geoffroy's Horseshoe Bat	Least Concern
Sciuridae	*Paraxerus cepapi*	Smith's Bush Squirrel	Least Concern
	Xerus inauris	South African Ground Squirrel	Least Concern
Soricidae	*Crocidura mariquensis*	Swamp Musk Shrew	**Near Threatened**
	Myosorex varius	Forest Shrew	Least Concern
	Suncus varilla	Lesser Dwarf Shrew	Least Concern
Suidae	*Phacochoerus africanus*	Common Warthog	Least Concern
	Potamochoerus larvatus koiropotamus	Bush-pig (subspecies koiropotamus)	Least Concern
Thryonomyidae	*Thryonomys swinderianus*	Greater Cane Rat	Least Concern

Vespertilionidae	*Miniopterus natalensis*	Natal Long-fingered Bat	Least Concern
	Myotis tricolor	Temminck's Myotis	Least Concern
	Neoromicia capensis	Cape Serotine	Least Concern
Viveridae	*Genetta maculata*	Common Large-spotted Genet	Least Concern
	Genetta genetta	Common Genet	Least Concern
	Genetta tigrina	Cape Genet (Cape Large-spotted Genet)	Least Concern

From historical records (Table 3) it is evident that the area contains a large amount of mammals and numerous Red Listed mammals. Many of the larger mammals are however historical records and would only be found within conservation areas, they are not of consequence to the development. The smaller Red Listed mammal species may still occur in the area, including the Black-footed Cat (*Felis nigripes*), Serval (*Leptailurus serval*), Southern African Vlei Rat (*Otomys auratus*), Hedgehog (*Atelerix frontalis*), Swamp Musk Shrew (*Crocidura ariquensis*), Brown Hyena (*Hyaena brunnea*), Cape Clawless Otter (*Aonyx capensis*) and African White-tailed Rat (*Mystromys albicaudatus*). As indicated, the Serval listed as Near Threatened (NT) has already been confirmed to occur on the site. It therefore remains likely some of the other Red Listed mammals may also occur in the area.

Since it has been confirmed that NT Serval occurs in the development area it is clear that the proposed development will have a significant impact on it. According to the National Red List (2016) the following recommendations and mitigation should be implemented where this species will be affected:

- Natural habitat should be conserved as far as possible. Managers and landowners must avoid wetland loss and should retain natural grassland areas in a good condition.

- The Serval population on the site should be monitored to determine abundance and trends and to determine the impact that development has on the population dynamics. Monitoring should also include the implementation of fixed camera traps for long term monitoring. Due to their specialised habitat requirements at small spatial scales, they may serve as a useful ecosystem indicator of the effect of habitat fragmentation in transformed landscapes.

- Monitoring of the Serval population must be introduced as a compliance measure in Environmental Impact Assessment reports.

- The development site should incorporate the long-term persistence of Serval and associated habitats into onsite biodiversity management practices. Buffer habitats could be modelled based on minimum wetland size and available cover.

Figure 19: Tracks and signs of mammals on the site include clockwise from top left; Ground squirrels (*Xerus inauris*), burrow of an unidentified small mammal, a soil mound of the Common molerat (*Cryptomys hottentotus*), sighting of a Common Duiker (*Sylvicapra grimmia*), spoor of a Springhare (*Pdedetes capensis*), scat of Porcupine (*Hystrix africaeaustralis*), track of a small antelope and Burrow of an Aardvark (*Orycteropus afer*),.


Figure 20: The following mammals had been recorded by means of camera traps, from top to bottom; Slender Mongoose (*Galerella sanguinea*), Cape Hare (*Lepus capensis*), Steenbok (*Raphicerus campestris*) and Serval (*Leptailurus serval*).

4.3 Wetland Assessment

4.3.1 Introduction

The surface water features of the study area are dominated by a large valley bottom wetland system in the eastern portion of the site (Appendix A: Map 3). A few small depressions also occur in the south west of the site and within the Mispah Game Reserve. The assessment will focus on the large valley bottom system, clearly being the most important and most likely to be affected by the development, though will also include an overview of the small depressions in the south west of the site.

As indicated, a large valley bottom wetland system occurs in the eastern portion of the site and will likely be affected by the proposed development (Appendix A: Map 3). This is a seasonal system which flows mostly during the rainy season but did still illustrate an active hydrological regime at the time of the survey. The wetland transects the site from south to north and originates approximately 5 km to the south of the site. The catchment is also situated in agricultural areas used for crop production which will have a large impact on it though where it occurs on the site is still naturally functioning and provides ample wetland habitat which will provide unique habitats and will provide vital downstream ecological functions.

Three small depression wetlands are situated in the south west of the site and are included within the Mispah Game Reserve and are therefore highly unlikely to be affected by the development (Appendix A: Map 3). They will however be discussed in overview in order to provide a comprehensive ecological overview of the entire study area. These depressions are clearly affected by a tailings dam located approximately 350 meters to the west of these depressions and which cause seepage in the direction of these pans and which clearly has a high impact on them. These pans have become nutrient enriched which cause a large modification of their vegetation structure.

Current wetland resources including the National Wetland Map 5 (NWM 5) and the South African Inventory of Inland Aquatic Ecosystems (SAIIAE) also indicate a few other wetland areas likely to occur in the area (Appendix A: Map 1). The survey also sampled these areas and confirmed that no wetland conditions are present in these areas. They do not form part of any watercourse, wetland or surface water feature and are therefore not relevant for the development. The results will however be included in overview in order to confirm that these areas were surveyed and confirmed to be devoid of wetland conditions.

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.

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 wetland systems on the site 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 valley bottom wetland 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 small depression wetlands and along three lateral transects of the larger valley bottom 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 dominates the valley bottom wetland system in the east of the site (Appendix A: Map 3). The smaller depression wetlands in the south west of the site contained some obligate wetland vegetation though due to high levels of disturbance this was not as pronounced (Appendix A: Map 3). However, soil samples conclusively confirmed the presence of wetland conditions in both the valley bottom wetland system and small depression wetlands. The area has a slight slope toward the Vaal River situated to the north of the site though in general the topography is fairly flat and dominated by undulating terrain. Coupled with a moderate rainfall and surface runoff this causes the formation of gentler flowing systems such as valley bottom wetlands and depressions, as apposed to faster flowing streams occurring in foothills and mountainous terrain.

4.3.3 Classification of wetland systems

The wetland conditions identified within the valley bottom wetland system and small depressions in the study area can be classified into a specific wetland type.

The large valley bottom wetland system in the east of the study area can be categorised as an unchanneled valley-bottom wetland (SANBI 2009):

“a mostly flat valley-bottom wetland area without a major channel running through it, characterised by an absence of distinct channel banks and the prevalence of diffuse flows, even during and after high rainfall events. Water inputs are typically from an upstream channel, as the flow becomes dispersed, and from adjacent slopes (if present) or groundwater. Water generally moves through the wetland in the form of diffuse surface flow and/or interflow (with some temporary containment of water in depressional areas), but the outflow can be in the form of diffuse or concentrated surface flow. Infiltration and evaporation from unchanneled valley-bottom wetlands can be significant, particularly if there are a number of small depressions within the wetland area. Horizontal, unidirectional diffuse surface-flow tends to dominate in terms of the hydrodynamics.”

This is considered an accurate description of this wetland system in the east of the study area. It is situated in a lower lying shallow valley and though it is linear, it clearly does not contain a defined channel or channel banks. Furthermore, surface flow is clearly diffuse and not concentrated. The portion of this valley-bottom wetland situated on the site is still largely intact though it is clear that upstream and downstream of the site there are many pronounced impacts that will affect its functioning.

The small depressions in the south west of the study area can be categorised as depression wetlands (SANBI 2009):

"A depression wetland is a basin shaped area with a closed elevation contour with an increase in depth from the perimeter to the central areas that allows for the accumulation of surface water (i.e. it is inward draining). It may also receive sub-surface water. An outlet is usually absent. Dominant water sources are precipitation, ground water discharge, interflow and (diffuse or concentrated) overland flow. For 'depressions with channeled inflow', concentrated overland flow is typically a major source of water for the wetland, whereas this is not the case for 'depressions without channeled inflow'. Dominant hydrodynamics are (primarily seasonal) vertical fluctuations. Depressions may be flatbottomed (in which case they are often referred to as 'pans') or round-bottomed (in which case they are often referred to as 'basins') and may have any combination of inlets and outlets or lack them completely. For 'exorheic depressions', water exits as concentrated surface flow while, for 'endorheic depressions', water exits by means of evaporation and infiltration."

This is an accurate description of these pans and their functioning. They are all circular forming a very shallow but discernible depression in the landscape (Appendix A: Map 3). These pans are all endorheic (without outflow).

4.2.4 Description of watercourses and wetlands

The study area contains the main, valley bottom wetland in the east of the site with a few small depression wetlands also occurring in the south west (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:	**Coordinates of sampling:**	**Flow regime:**
#1 Unchanneled valley bottom wetland – Main wetland in the east of the site	S 26.992289°, E 26.808740° S 26.988173°, E 26.805267° S 26.982773°, E 26.807467°	Seasonal
Description of watercourse: The largest and most significant surface water feature in the area. This valley bottom wetland is a large system which originates approximately 5 km to the south of the site and then flows into the Vaal River about 4 km to the north of the site. The wetland therefore transects the eastern portion of the site and flows from south to north through it. The wetland is clearly an unchanneled system which does not have a defined main channel and banks though flow is still unidirectional from south to north. The width of the wetland can also be quite broad and while varying in width over its course, may be as wide as 100 meters in some areas. The wetland is largely fed by the upper reaches while inflow from the side slopes are also likely. Development around this wetland is therefore also likely to directly affect 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 upstream catchment is utilised for agricultural crop production and these fields will undoubtedly contribute to significant impacts on the wetland. This will include increased surface runoff rates due to the absence of vegetation and high concentrations of fertiliser runoff as well as some herbicide and pesticide contamination. Other impacts also include several road crossings which will act as flow obstructions and large woodlots of exotic trees which will decrease the groundwater inflow into the wetland. The wetland is clearly situated in a low lying shallow valley and in terms of topography clearly supports the formation of a wetland system and also aids in accurate delineation of the system. Vegetation within the wetland is also dominated by obligate wetland sedges and grasses which also confirm the presence of saturated soils. Surface water was still visible during the survey and also indicates that the system is at least seasonal in terms of its active hydrological regime. 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: *Setaria sphacelatum* (FW), *Eragrostis lappula* (OW), **Verbena bonariensis, *Veronica anagalis-aquatica, *Oenothera rosea, Agrostis lachnantha* (OW), *Scirpoides burkei.* Wetland border: *Triumfetta soderi, Asparagus larcinus, Hyparrhenia hirta, Ziziphus mucronata, Eragrostis gummiflua, Cynodon dactylon, Hypoxis hemerocallidae*		
Protected plant species: None observed.		
Soil sample:		

The wetland is clearly defined but clearly is devoid of a channel and banks. Here it is also quite narrow when passing through a rocky area.

The valley bottom wetland can become quite broad in some areas.

Wetland sedges and grasses dominate the wetland. Note the presence of surface water indicating it is at least seasonal.

View of the wetland from the surrounding area. It is clearly situated in a shallow valley with a linear flow pattern.

Watercourse name:	Coordinates of sampling:	Flow regime:
#2 Depression wetlands – series of three small wetlands in south west of the site	S 26.997414°, E 26.787146°	Seasonal

Description of watercourse:

A series of three quite small depression wetlands located in the south west of the site. These wetlands are all located adjacent to each other and have a diameter of approximately 80 meters. These wetland areas are clearly visible as shallow but distinct depressions in the landscape. They are mainly fed by runoff and groundwater inflow from the south west. A large tailings dam is also situated to the south west of these wetlands (approximately 350 meters) and it is clear that seepage from this tailings dam has a large effect on them. High salt concentrations are quite evident as a result of this seepage and the wetland itself is also modified by higher salt concentrations while the vegetation is also heavily degraded and dominated by exotic weeds. These wetland areas are however located in the south west of the site and within the Mispah Nature Reserve and if this reserve is excluded from development the three small depressions should also remain unaffected by default.

The small depression wetlands form shallow but distinct depressions in the landscape and the topography therefore promotes the establishment of wetland conditions. Vegetation within these depressions are however quite modified and dominated by exotic weeds. This is most likely a consequence of seepage from the adjacent tailings dam which causes elevated salt concentrations and nutrient enrichment. Soil samples do however conclusively confirm the presence of wetland conditions which indicate a seasonal zone of wetness within the wetland.

Dominant plant species:
Cyperus longus (OW), **Tegetes minuta, *Bidens bipinnata.*

Protected plant species:
None observed.

Soil sample:

The small depression wetlands are clearly visible as depressions.

Watercourse name:	Coordinates of sampling:	Flow regime:
#3 No wetland conditions	S 26.987061°, E 26.776743° S 26.965037°, E 26.771725°	No wetland conditions

Description of watercourse:
Current wetland resources including the National Wetland Map 5 (NWM 5) and the South African Inventory of Inland Aquatic Ecosystems (SAIIAE) also indicate two additional wetland areas likely to occur in the area. The survey also sampled these areas and confirmed that no wetland conditions are present in these areas. They do not form part of any watercourse, wetland or surface water feature and are therefore not relevant for the development. The following results also confirm that these areas were surveyed and confirmed to be devoid of wetland conditions:

- A circular seepage wetland is indicated to the north of the tailings dam in the south west of the site. This area contains a slight slope and soils consist of deep sandy soils without any soil wetness indicators. Vegetation is also dominated by grasses and pioneer herbs and while significant disturbance is evident, wetland conditions are clearly absent. This area does not contain any seepage, does not form any prominent component of the local surface water drainage and does not form a wetland or watercourse.
- There is a probability indicated of an elongated watercourses system transecting the north western corner of the site. However, the on-site survey confirmed no wetland conditions occurring here and a channel or drainage line is also clearly absent.

Sampling to the north of the tailnigs dam confirm the absence of wetland conditions.

North western corner of the site contain no watercourse or wetland conditions.

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 valley bottom wetland system in the eastern portion of the site. The small depressions wetlands in the south west of the site should remain unaffected by the development and will therefore not be relevant and their condition will not be determined. The valley bottom system in the east of the site is clearly the most prominent system and will likely be affected by the development. The determination of the condition of this wetland system is therefore also of importance. Therefore, a WET-Health determination will be done for this large valley bottom wetland 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 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	D

This wetland system has not been assessed by previous wetland spatial resources (Kleynhans 2000, Van Deventer *et al* 2018) and there is no baseline information available for it. The current assessment will therefore determine a baseline condition for this wetland and determine the degree of modification that surrounding impacts has caused on it. Though the section of the wetland occurring on the site seems to still be largely intact and functional the upstream land uses, especially within the catchment will certainly have a significant impact on the wetland and is therefore likely to cause a significant level of modification of it. Despite these modifications on the system, the wetland remains a sensitive system and any additional impacts on it should be prevented. There is a likelihood that the development will occur in close proximity to this wetland, in which case it will certainly have a significant impact on it, mostly in terms of increased runoff, erosion and sedimentation. Where development occurs in close proximity to this wetland, 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.

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

A large portion of the upper catchment of the wetland is currently used for agricultural crop production. A significant cropfield is also situated to the east of the wetland on the site. These removed the natural vegetation which promotes runoff while decreasing infiltration and in so doing increases surface erosion. This mainly increase the sediment load being deposited within the wetland and may, to some degree, also increase erosion in the catchment also contributing towards further sediment deposition. Coupled with the crop cultivation will also be fertiliser, pesticide and herbicide runoff. This will mainly have an impact on nutrient load which may influence the wetland vegetation and aquatic component of the wetland. Other smaller impacts associated with agriculture may also contribute to some impacts on the wetland. These may include the farming homestead, general surface disturbances and a woodlot of exotic trees. The catchment also contains a network of small dirt roads and tracks and these would also have a significant impact on the wetland. These act as obstructions to flow and will affect the hydrology of the wetland.

A large electrical substation is situated immediately upstream of the site. This area is dominated by impenetrable surfaces which will prevent infiltration of surface flow and will thus increase runoff into the wetland. A portion of the substation also encroached into this wetland and will have a further impact on the hydrology of the wetland and will also contribute toward direct wetland loss.

Mining operations are also situated in close proximity to the west of the wetland system (approximately 150 meters). It is also quite likely that this will contribute at least some impacts on the wetland. Most probably in some form of contaminated runoff from the plant. One source which is evident is a small Waste Water Treatment Works (WWTW) associated with the mining operations and which is located quite close to it (approximately 80 meters) and this WWTW also discharges treated effluent directly into the wetland. This point source discharge will undoubtedly have a significant impact on the wetland.

Figure 21: A recent aerial image of the wetland (red) which also indicates the prominent impacts in the catchment (Google Earth 2022). The catchment is dominated by ploughed fields

(purple) while natural grassland is also abundant (green) and other land uses include exotic tree woodlots (blue) and mining and electrical substation (light blue).

Figure 22: Large portions of the catchment has been transformed by dryland crop production.

Figure 23: Large woodlots of exotic Bluegum (*Eucalyptus camaldulensis*) area also common in the catchment and will have an effect on evapotranspiration ad runoff.

Figure 24: The mining operations also occur in the catchment of the wetland (red) and will undoubtedly also contribute toward impacts on it.

From the above described impacts it should be clear that the valley bottom wetland system is affected by numerous impacts which result in a significant level of modification. A WET-Health determination was undertaken for the valley bottom 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 on the wetland.

The EI&S of the valley bottom 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 modified 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 valley bottom wetland system is still largely intact and though at least moderately modified, it still provides many essential functions. Recent flooding in many regions of the country has highlighted the need to conserve wetlands which are natural flood attenuation systems and prevent flooding of downstream areas. The valley bottom wetland should be treated as a no-go area 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.

In addition, a suitable buffer for the valley bottom wetland system 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 21 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 valley bottom wetland system in the eastern 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). In the event that development of solar facilities extends into the eastern portion of the site, these areas will be located in close proximity to this wetland system and in so doing are likely to result in some impacts on it, especially in terms of runoff and sedimentation (Appendix A: Map 3). However, current layout plans do indicate that the development will avoid the eastern portion of the development area which will significantly decrease the anticipated impact. Furthermore, the development needs to ensure that it is compliant with all relevant legislation, especially in terms of its water use which is governed by the National Water Act (Act no 36 of 1998) (NWA). According to this act and with special relevance to the General Authorisation regulations for section 21(c) or (i) water uses (Notice 509 of 2016), any development which falls within the regulated area of a wetland system, a 500 m radius from the delineated boundary (extent) of any wetland or pan, requires application for the necessary authorisation from the Department of Water and Sanitation (DWS). The current layout plans indicate that portions of the development as well as associated grid connection powerline will be situated approximately 350 meters from this valley-bottom wetland system and given the clearance of vegetation and the large extent of the development is still likely to have an impact on it.

Several small depressions occur in the western portion of the site though are included within the Mispah Game Reserve and the development is unlikely to encroach into this area and these depressions will then be located outside the regulated 500 meters boundary from the development, they are not rated in terms of this risk assessment (Appendix A: Map 3).

The large valley bottom wetland system is clearly the main wetland system in this area 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). Current layout plans do indicate that the eastern portion of the development area will be excluded though development will still occur within 350 meters of the edge of the wetland and is then still likely to have some impact on it. The wetland and buffer zone 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 this wetland system. Given the distance between the wetland area and current development layout (approximately 350 meters), the anticipated risk will be low. However, since the catchment of the wetland lies largely within the proposed development area it will most likely have a significant impact on the runoff generated and inflow into the wetland. As a result, the development will have to 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.

Given the current layout plan, it is unlikely that infrastructure such as roads and powerlines will require crossing it and this was therefore not rated as a risk. However, should layout plans be modified and it become apparent that development will encroach in proximity to the wetland or other infrastructure require crossing this system, the impacts should be re-assessed and the risk matrix amended.

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 valley bottom wetland system.

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 valley-bottom wetland 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 development not encroach nearer than the current indicated 350 meters in proximity to the wetland system and is treated as no-go area, the anticipated risk should remain low. As the development will still occur in relatively close proximity to it, it will also be important to implement a comprehensive storm water management system.

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 valley bottom wetland system 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 still consists of natural grassland in a fairly good condition (Appendix A: Map 1). Where these areas of natural grassland will be affected by the development it will therefore result in significant impacts. The severity of this impact will also vary over the site in accordance with the differing conservation value of different portions of the site. As a result, the impact on the following areas of high conservation will be quite high (Appendix A: Map 4):

- The Mispah Game Reserve covers a large portion of the southern portion of the site. This is a Private Nature Reserve which has been proclaimed as a Protected Area (PA) under the National Environmental Management Protected Areas Act (NEMPAA of 2003). The area is listed as a Private Nature Reserve within the South Africa Protected & Conservation Areas Database (SAPAD) and was proclaimed in 2001 (Notice 23 of 2001). Development within any protected area is highly unlikely since this is largely prevented by the NEMPAA and any management plan of the protected area. This PA has also been taken into account in determining the provincial and national conservation targets and development within this PA will also affect these conservation targets.
- Two large CBA 1 areas have been delineated by the Free State Biodiversity Management Plan. These CBA 1 areas have been identified as being crucial for meeting conservation targets for the Endangered Vaal-Vet Sandy Grassland occurring in this area but also to some extent the Vaal Reefs Dolomite Sinkhole Woodland in the area. These CBA 1 areas have been identified as being Irreplaceable in terms of meeting conservation targets.
- Portions of remaining Vaal-Vet Sandy Grassland also occur in the south east of the site but which do not form part of the Mispah Game Reserve or identified CBA areas. However, since this vegetation type is currently listed as Endangered (EN) these areas must still be afforded a High level of sensitivity.

Should the development encroach into any of the above listed areas of high conservation value, the anticipated impact will be high (Appendix A: Map 4). The development should therefore, as far as possible, aim to avoid these areas in order to mitigate and decrease the anticipated impact. Current layout plans do indicate that areas of High Sensitivity are largely being avoided while mostly retaining development within areas of Moderate Sensitivity. Though this will still entail significant impacts, it will be significantly lower as opposed to the inclusion of areas of High Sensitivity. The remainder of the site, except areas as listed above, is dominated by Vaal Reefs Dolomite Sinkhole Woodland, a grassland vegetation type which, although it is also affected by significant transformation pressures, is not regarded as a Threatened Ecosystem and would therefore have a somewhat lower conservation value. However, the vegetation is still in a fairly good condition and still contains elements of conservation value. As a result, should development avoid areas of high conservation value and concentrate the development in these areas of moderate conservation value the impact will be lower but still significant. The solar development will also involve the clearance of a fairly large area and lead to irreversible transformation of the natural grassland and development should therefore be carefully planned, should focus on areas of lower sensitivity and should limit the extent of transformation as far as possible.

No Red Listed plant species could be identified on the site and the area is also not known to contain many such species though a few are still present in this region and a likelihood therefore remains that such a species may also be present on the site. However, given the large extent of the study area, it has been found to contain a fairly high number of protected plant species (Appendix B). These include the protected succulent and geophytic species, *Euphorbia striata, Orthanthera jasminiflora, Boophone distichia, Pentharhinum insipidum, Schizocarpus nervosus, Satyrium sp., Raphionecma velutina, Babiana bainesii, Aloe greatheadii, Crinum graminicola,* and *Vachellia erioloba*. Where development will affect these species, the necessary permits should be obtained and a significant proportion of these transplanted to adjacent areas where they will remain unaffected. In addition, there are also a few protected herbaceous plants (*Helichrysum spp.*) and a few specimens of the protected *Vachellia erioloba* (Camel Thorn). Where any of these will require removal, the necessary permits should be obtained to do so. Provided that this mitigation is successfully implemented, the anticipated impact should remain moderate to low.

A large valley bottom wetland system occurs in the eastern portion of the site and is likely to be affected by the development (Appendix A: Map 3). 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. However, current layout plans do indicate that the development will avoid the eastern portion of the development area which will significantly decrease the anticipated impact. The necessary mitigation should still be implemented to ensure no indirect impacts affect the wetland system. Development within 500 meters of this wetland system 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 it. Given the distance between the wetland area and current development layout (approximately 350 meters), the anticipated impact will be low. However, since the catchment of the wetland lies largely within the proposed development area it will most likely have a significant impact on the runoff generated and inflow into the wetland. As a result, the development will have to 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.

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 system in the eastern portion of 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 region is affected by high levels of transformation as a result of both mining operations and agricultural crop production which results in high levels of habitat fragmentation and the disruption of ecosystem processes. The proposed development will also require the transformation of fairly large areas consisting of natural grassland in fairly good condition and will therefore also significantly contribute toward this impact. The only mitigation that can be applied to decrease this impact is to restrict development to areas being of low sensitivity and should limit the extent of transformation as far as possible. Despite this mitigation it is highly likely that areas of moderate sensitivity will still be included in the development area and the resulting impact on habitat loss, fragmentation and the disruption of ecological processes will remain significant.

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 it is inevitable that the development will involve the transformation of natural grassland this contribute significantly toward habitat loss which in turn will result in a high impact on the mammal population. This also indicates the need to take extra care in determining the development area, which should focus on areas of lower sensitivity, should exclude areas of high sensitivity and the wetland system in the eastern portion of the site and should limit the extent of transformation as far as possible. Current layout plans do indicate that areas of High Sensitivity are largely being avoided while mostly retaining development within areas of Moderate Sensitivity. Though this will still entail significant impacts, it will be significantly lower as opposed to the inclusion of areas of High Sensitivity. 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 and agricultural activities and the cumulative impact that this has had is extensive. This is also clearly evident in the degree to which the local vegetation types, Vaal-Vet Sandy Grassland and Vaal Reefs Dolomite Sinkhole Woodland is regarded as being affected by development pressures. The assessment has also indicated that the area is still dominated by natural grassland in fairly good condition (Appendix A: Map 1). Therefore, should the proposed development further increase vegetation and habitat loss of natural areas it will have a high cumulative impact. The only mitigation which may decrease the cumulative impact to some degree would be the exclusion of areas identified as having a high conservation value (See previous paragraphs). This would entail the preservation of at least a portion of the remaining natural areas though since the development will still result in significant transformation of natural areas, the cumulative impact will remain significant.

The impact significance has been determined and should development take place without mitigation it is anticipated that it will result in overall high impacts. This is a result of the largely natural condition of the area, the presence of areas of high conservation value and the fairly large extent of the proposed development (Appendix A: Map 4). Aspects which are expected to result in quite high impacts include the loss of the vegetation type in the area which includes Vaal-Vet Sandy Grassland (an Endangered system) as well as the loss of a large wetland system in the east of the site. Other moderate-high impacts also include the loss of protected plant species, increased infestation by exotic weeds, increased habitat fragmentation, the impact on mammals (which also includes a Near Threatened species) and the increased cumulative impact. Suitable mitigation as listed in previous paragraphs should enable the development to decrease many of these impacts to moderate levels. This will mostly be achieved by excluding areas of high conservation value as listed which will in turn decrease the severity of the impacts and will also decrease extent and in so doing the anticipated impacts will be somewhat lower. Current layout plans do indicate that areas of High Sensitivity are largely being avoided while mostly retaining development within areas of Moderate Sensitivity. Though this will still entail significant impacts, it will be significantly lower as opposed to the inclusion of areas of High Sensitivity. However, as indicated significant natural areas will still be transformed by the development and several of the impacts will remain significant especially the impacts on the vegetation type and biodiversity, the wetland system in the east of the site, habitat fragmentation, the mammal population in the area and the cumulative impact.

Please refer to Appendix G for the impact methodology.

Nature: **Loss of vegetation and consequently habitat and species diversity as a result.**
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 still consists of natural grassland in a fairly good condition (Appendix A: Map 1). Where these areas of natural grassland will be affected by the development it will therefore result in significant impacts. The severity of this impact will also vary over the site in accordance with the differing conservation value of different portions of the site. As a result, the impact on the following areas of high conservation will be quite high (Appendix A: Map 4):

- The Mispah Game Reserve covers a large portion of the southern portion of the site. This is a Private Nature Reserve which has been proclamated as a Protected Area (PA) under the National Environmental Management Protected Areas Act (NEMPAA of 2003). The area is listed as a Private Nature Reserve within the South Africa Protected & Conservation Areas Database (SAPAD) and was proclamated in 2001 (Notice 23 of 2001). Development within any protected area is highly unlikely since this is largely prevented by the NEMPAA and any management plan of the protected area. This PA has also been taken into account in determining the provincial and national conservation targets and development within this PA will also affect these conservation targets.
- Two large CBA 1 areas have been delineated by the Free State Biodiversity Management Plan. These CBA 1 areas have been identified as being crucial for meeting conservation targets for the Endangered Vaal-Vet Sandy Grassland occurring in this area but also to some extent the Vaal Reefs Dolomite Sinkhole Woodland in the area. These CBA 1 areas have been identified as being Irreplaceable in terms of meeting conservation targets.
- Portions of remaining Vaal-Vet Sandy Grassland also occur in the south east of the site but which do not form part of the Mispah Game Reserve or identified CBA areas. However, since this vegetation type is currently listed as Endangered (EN) these areas must still be afforded a High level of sensitivity.

Should the development encroach into any of the above listed areas of high conservation value, the anticipated impact will be high (Appendix A: Map 4). The development should therefore, as far as possible, aim to avoid these areas in order to mitigate and decrease the anticipated impact. Current layout plans do indicate that areas of High Sensitivity are largely being avoided while mostly retaining development within areas of Moderate Sensitivity. Though this will still entail significant impacts, it will be significantly lower as opposed to the inclusion of areas of High Sensitivity. The remainder of the site, except areas as listed above, is dominated by Vaal Reefs Dolomite Sinkhole Woodland, a grassland vegetation type which, although it is also affected by significant transformation pressures, is not regarded as a Threatened Ecosystem and would therefore have a somewhat lower conservation value. However, the vegetation is still in a fairly good condition and still contains elements of conservation value. As a result, should development avoid areas of high conservation value and concentrate the development in these areas of moderate conservation value the impact will be lower but still significant. The solar development will also involve the clearance of a fairly large area and lead to irreversible transformation of the natural grassland and development should therefore be carefully planned, should focus on areas of lower sensitivity and should limit the extent of transformation as far as possible.

	Rating	Motivation	Significance
Prior to Mitigation			
Duration	5	Permanent transformation of vegetation	**High Negative (95)**
Extent	4	Large development area	
Magnitude	10	Loss of a Threatened Ecosystem	
Probability	5	Impact is unavoidable	
Mitigation/Enhancement Measures			
Mitigation: Should development avoid areas of high conservation value and concentrate the development			

in these areas of moderate conservation value the impact will be lower but still significant. The solar development will also involve the clearance of a fairly large area and lead to irreversible transformation of the natural grassland and development should therefore be carefully planned, should focus on areas of lower sensitivity and should limit the extent of transformation as far as possible.			
Post Mitigation/Enhancement Measures			
Duration	5	Permanent transformation of vegetation	**High Negative (64)**
Extent	3	Decreased development extent though still significant	
Magnitude	8	Loss of natural areas must be regarded as significant	
Probability	4	Loss of natural areas unavoidable	
Cumulative impacts: The area has a long history of transformation by mining and agricultural activities and the cumulative impact that this has had is extensive. This is also clearly evident in the degree to which the local vegetation types, Vaal-Vet Sandy Grassland and Vaal Reefs Dolomite Sinkhole Woodland is regarded as being affected by development pressures. The assessment has also indicated that the area is still dominated by natural grassland in fairly good condition (Appendix A: Map 1). Therefore, should the proposed development further increase vegetation and habitat loss of natural areas it will have a high cumulative impact. The only mitigation which may decrease the cumulative impact to some degree would be the exclusion of areas identified as having a high conservation value (See previous paragraphs). This would entail the preservation of at least a portion of the remaining natural areas though since the development will still result in significant transformation of natural areas, the cumulative impact will remain significant.			
Residual Risks: The solar development will involve the clearance of a fairly large area and lead to irreversible transformation of the natural grassland and residual impacts will remain high.			

Nature: **Loss of protected, rare or threatened plant species.**			
Impact description: No Red Listed plant species could be identified on the site and the area is also not known to contain many such species though a few are still present in this region and a likelihood therefore remains that such a species may also be present on the site. However, given the large extent of the study area, it has been found to contain a fairly high number of protected plant species (Appendix B). These include the protected succulent and geophytic species, *Euphorbia striata, Orthanthera jasminiflora, Boophone distichia, Pentharhinum insipidum, Schizocarpus nervosus, Satyrium sp., Raphionecma velutina, Babiana bainesii, Aloe greatheadii, Crinum graminicola,* and *Vachellia erioloba*. Where development will affect these species, the necessary permits should be obtained and a significant proportion of these transplanted to adjacent areas where they will remain unaffected. In addition, there are also a few protected herbaceous plants (*Helichrysum spp.*) and a few specimens of the protected *Vachellia erioloba* (Camel Thorn). Where any of these will require removal, the necessary permits should be obtained to do so. Provided that this mitigation is successfully implemented, the anticipated impact should remain moderate to low.			
	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	5	Permanent loss of protected species	**High Negative (68)**

Extent	4	Large development area	
Magnitude	8	High likelihood for the loss of protected species	
Probability	4	Many protected species known to occur on the site and therefore probability is high	
Mitigation/Enhancement Measures			
Mitigation: Where development will affect these species, the necessary permits should be obtained and a significant proportion of these transplanted to adjacent areas where they will remain unaffected. In addition, there are also a few protected herbaceous plants (*Helichrysum spp.*) and a few specimens of the protected *Vachellia erioloba* (Camel Thorn). Where any of these will require removal, the necessary permits should be obtained to do so. Provided that this mitigation is successfully implemented, the anticipated impact should remain moderate to low.			
Post Mitigation/Enhancement Measures			
Duration	5	Permanent loss of protected species	**Moderate Negative (39)**
Extent	2	Decreased development extent maintained within areas of moderate sensitivity	
Magnitude	6	Loss of fewer protected species, provided mitigation is successfully implemented	
Probability	3	Probable that at least some protected species will be lost	
Cumulative impacts: The area has a long history of transformation by mining and agricultural activities and the cumulative impact with regards to the loss of protected species is extensive. This is also clearly evident in the degree to which the local vegetation types, Vaal-Vet Sandy Grassland and Vaal Reefs Dolomite Sinkhole Woodland is regarded as being affected by development pressures. The assessment has also indicated that the area is still dominated by natural grassland in fairly good condition (Appendix A: Map 1). Therefore, should the proposed development further increase vegetation and habitat loss of natural areas it will also further increase the cumulative loss of protected species. The only mitigation which may decrease the cumulative impact to some degree would be the exclusion of areas identified as having a high conservation value and also implementing the transplanting of at least a portion of protected species on the site. This would entail the preservation of at least a portion of the remaining protected though since the development will still result in significant transformation of natural areas, the cumulative loss of protected species will still remain significant.			
Residual Risks: Despite comprehensive mitigation (dependant on this mitigation being successfully implemented) a residual loss of some protected species is still unavoidable.			

Nature: **Impacts on watercourses, wetlands or the general catchment.**
Impact description: A large valley bottom wetland system occurs in the eastern portion of the site and is likely to be affected by the development (Appendix A: Map 3). 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. However, current layout plans do indicate that the development will avoid the eastern portion of the development area which will significantly decrease the anticipated impact. The necessary mitigation should still be implemented to ensure no indirect impacts affect the wetland system. Development within 500 meters of this wetland system 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 it. Given the distance between the wetland area and current development layout (approximately 350 meters), the anticipated impact will be low.			
	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	5	Permanent transformation of wetland areas	**High Negative (95)**
Extent	4	Spill over of impacts into downstream areas	
Magnitude	10	Direct wetland loss	
Probability	5	Impact is unavoidable	
Mitigation/Enhancement Measures			
Mitigation: 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 it. Given the distance between the wetland area and current development layout (approximately 350 meters), the anticipated impact will be low. However, since the catchment of the wetland lies largely within the proposed development area it will most likely have a significant impact on the runoff generated and inflow into the wetland. As a result, the development will have to 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 transformation of at least the catchment of wetland areas	**Low Negative (22)**
Extent	3	Wetlands excluded from development though at least local impacts on wetland systems still anticipated	
Magnitude	3	Significant distance between development and wetland will decrease magnitude though some impacts still probable	
Probability	2	Given the distance between development and wetland area the probability will be lower	
Cumulative impacts: The area has a long history of transformation by mining and agricultural activities and the cumulative impact that this has had is extensive this also includes the impacts on wetlands in the area. The assessment has also indicated that the wetlands in the area are still largely intact (Appendix A: Map 1). Therefore, should the proposed development further increase wetland loss it will have a high cumulative impact. The only mitigation which may decrease the cumulative impact to would be the exclusion of wetland areas. This would entail the			

preservation of wetland areas though since the development will still result in significant transformation of natural areas, a residual cumulative impact will also still remain.
Residual Risks: Should these wetland areas be excluded from the development and measures as indicated implemented the anticipated impact will be lower, i.e. impacts on the catchment will remain significant which will also result in some residual impact on the wetland areas.

Nature: **The impact that the development will have on exotic weeds and invasive species, both current and anticipated conditions.**			
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.			
	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	4	Long-term infestation	**High Negative (80)**
Extent	4	Spreading of infestation into neighbouring areas	
Magnitude	8	Infestation of a Threatened Ecosystem	
Probability	5	Impact is unavoidable	
Mitigation/Enhancement Measures			
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.			
Post Mitigation/Enhancement Measures			
Duration	3	Limited duration if monitoring and eradication is maintained	**Moderate Negative (36)**
Extent	3	Limiting extent through monitoring and eradication	
Magnitude	6	Limited but unavoidable infestation	
Probability	3	Moderate probability remains	
Cumulative impacts: The area has a long history of transformation by mining and agricultural activities and significantly increases the cumulative impact of increased infestation by exotics. The assessment has also indicated that the area is still dominated by natural grassland in fairly good condition (Appendix A: Map 1). Therefore, should the proposed development further increase vegetation and habitat loss of natural areas and contribute to increased infestation it will have a high cumulative impact. The only mitigation which may decrease the cumulative			

impact to some degree would be the exclusion of areas identified as having a high conservation value. This would entail the decrease in transformation and consequently the cumulative impact of exotic weed infestation, however, the cumulative impact will remain significant.
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 system in the eastern portion of 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	4	Permanent modification of surface topography	**Moderate Negative (56)**
Extent	4	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	4	Permanent modification of surface topography	**Moderate Negative (33)**
Extent	3	Limiting extent through storm water management	
Magnitude	4	Limited magnitude due to the flat topography	
Probability	3	Unlikely to occur as long as storm water management is maintained	
Cumulative impacts: The area has a long history of transformation by mining and agricultural activities and the cumulative impact (including surface erosion) that this has had is extensive. The assessment has also indicated that the area is still dominated by natural grassland in fairly good condition which will limit the current erosion (Appendix A: Map 1). Therefore, should the proposed development further increase vegetation and habitat loss of natural areas it have a further significant cumulative impact on erosion in the area. The only mitigation which may decrease			

the cumulative impact to some degree would be the exclusion of areas identified as having a high conservation value. This would entail the decrease in transformation and consequently the cumulative impact of erosion, however, the cumulative impact will remain significant.
Residual Risks: Erosion may also have a significant impact on the wetland systems in the study area (including the Vaal River to the north of the site).

Nature: **Fragmentation of habitat, disruption of ecological connectivity and -functioning in terms of the surrounding areas.**			
Impact description: The region is affected by high levels of transformation as a result of both mining operations and agricultural crop production which results in high levels of habitat fragmentation and the disruption of ecosystem processes. The proposed development will also require the transformation of fairly large areas consisting of natural grassland in fairly good condition and will therefore also significantly contribute toward this impact. The only mitigation that can be applied to decrease this impact is to restrict development to areas being of low sensitivity and should limit the extent of transformation as far as possible. Despite this mitigation it is highly likely that areas of moderate sensitivity will still be included in the development area and the resulting impact on habitat loss, fragmentation and the disruption of ecological processes will remain significant.			
	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	5	Permanent loss and fragmentation of habitat	**High Negative (68)**
Extent	4	Large development area	
Magnitude	8	High impact due to fragmentation of a Threatened Ecosystem	
Probability	4	Highly likely to take place	
Mitigation/Enhancement Measures			
Mitigation: The only mitigation that can be applied to decrease this impact is to restrict development to areas being of low sensitivity and should limit the extent of transformation as far as possible. Despite this mitigation it is highly likely that areas of moderate sensitivity will still be included in the development area and the resulting impact on habitat loss, fragmentation and the disruption of ecological processes will remain significant.			
Post Mitigation/Enhancement Measures			
Duration	5	Permanent loss and fragmentation of habitat	**High Negative (64)**
Extent	3	Decreased development area, though still fairly large	
Magnitude	8	High impact due to fragmentation of a Threatened Ecosystem	
Probability	4	Highly likely to take place	
Cumulative impacts: The area has a long history of transformation by mining and agricultural activities and the cumulative impact that this has had is extensive. This is also clearly evident in the degree to which the local vegetation types, Vaal-Vet Sandy Grassland and Vaal Reefs Dolomite Sinkhole Woodland is regarded as being affected by development pressures. The assessment has also indicated that the area is still dominated by natural grassland in fairly good condition (Appendix			

A: Map 1). Therefore, should the proposed development further increase vegetation and habitat loss of natural areas it will have a high cumulative impact on habitat fragmentation. The only mitigation which may decrease the cumulative impact to some degree would be the exclusion of areas identified as having a high conservation value (See previous paragraphs). This would entail the preservation of at least a portion of the remaining natural areas though since the development will still result in significant transformation of natural areas, the cumulative impact will remain significant.
Residual Risks: The area is largely still dominated by natural grassland in fairly good condition and it is unavoidable that the development will result in transformation of a significant portion of natural grassland and consequently the residual impact on habitat fragmentation and the loss of ecosystem processes would remain significant.

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 it is inevitable that the development will involve the transformation of natural grassland this contribute significantly toward habitat loss which in turn will result in a high impact on the mammal population. This also indicates the need to take extra care in determining the development area, which should focus on areas of lower sensitivity, should exclude areas of high sensitivity and the wetland system in the eastern portion of the site and should limit the extent of transformation as far as possible Current layout plans do indicate that areas of High Sensitivity are largely being avoided while mostly retaining development within areas of Moderate Sensitivity. Though this will still entail significant impacts, it will be significantly lower as opposed to the inclusion of areas of High Sensitivity.			
	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	5	Given the largely natural development area and permanent loss of habitat the duration will be permanent	**High Negative (76)**
Extent	4	Extensive loss of natural areas	
Magnitude	10	High given the largely natural mammal population and presence of Red Listed species	
Probability	4	High given the largely natural mammal population and loss of habitat	
Mitigation/Enhancement Measures			
Mitigation: The development should focus on areas of lower sensitivity, should exclude areas of high sensitivity and the wetland system in the eastern portion of the site and should limit the extent of transformation as far as possible. Current layout plans do indicate that areas of High Sensitivity are largely being avoided while mostly retaining development within areas of Moderate Sensitivity. Though this will still entail significant impacts, it will be significantly lower as opposed to the inclusion of areas of High Sensitivity. Though this will still entail significant			

impacts, it will be significantly lower as opposed to the inclusion of areas of High Sensitivity. 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.

Near Threatened Serval (*Leptailurus serval*) occurs in the development area it is clear that the proposed development will have a significant impact on it. According to the National Red List (2016) the following recommendations and mitigation should be implemented where this species will be affected:

- Natural habitat should be conserved as far as possible. Managers and landowners must avoid wetland loss and should retain natural grassland areas in a good condition.
- The Serval population on the site should be monitored to determine abundance and trends and to determine the impact that development has on the population dynamics. Monitoring should also include the implementation of fixed camera traps for long term monitoring. Due to their specialised habitat requirements at small spatial scales, they may serve as a useful ecosystem indicator of the effect of habitat fragmentation in transformed landscapes.
- Monitoring of the Serval population must be introduced as a compliance measure in Environmental Impact Assessment reports.
- The development site should incorporate the long-term persistence of Serval and associated habitats into onsite biodiversity management practices. Buffer habitats could be modelled based on minimum wetland size and available cover

Post Mitigation/Enhancement Measures

Duration	5	Given the largely natural development area and permanent loss of habitat the duration will be permanent	**High Negative (72)**
Extent	3	Decreased development area, though still fairly large	
Magnitude	10	High given the largely natural mammal population and presence of Red Listed species	
Probability	4	High given the largely natural mammal population and loss of habitat	

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. The only mitigation which may decrease the cumulative impact to some degree would be the exclusion of areas identified as having a high conservation value. This would entail the preservation of at least a portion of the remaining natural areas though since the development will still result in significant transformation of natural areas, the cumulative impact on the mammal population will remain significant.

Residual Risks: Transformation of the indigenous vegetation on the site will result in a decrease in the mammal population size as available habitat decreases and consequently the residual impact will remain high.

Cumulative impact:

As previously indicated, the area has a long history of transformation by mining and agricultural activities and the cumulative impact that this has had is extensive. This is also clearly evident in the degree to which the local vegetation types, Vaal-Vet Sandy Grassland and Vaal Reefs Dolomite Sinkhole Woodland is regarded as being affected by development pressures. The assessment has also indicated that the area is still dominated by natural grassland in fairly good condition (Appendix A: Map 1). Therefore, should the proposed development further increase vegetation and habitat loss of natural areas it will have a high cumulative impact. The only mitigation which may decrease the cumulative impact to some degree would be the exclusion of areas identified as having a high conservation value (See previous paragraphs). This would entail the preservation of at least a portion of the remaining natural areas though since the development will still result in significant transformation of natural areas, the cumulative impact will remain significant.		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	4	4
Duration	5	4
Magnitude	10	8
Probability	5	4
Significance	**High (95)**	**High (64)**
Status (positive or negative)	Negative	Negative
Reversibility	Irreversible	Irreversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes – but limited	Yes – but limited
Confidence in findings: High		
Mitigation: The only mitigation which may decrease the cumulative impact to some degree would be the exclusion of areas identified as having a high conservation value (See previous paragraphs). This would entail the preservation of at least a portion of the remaining natural areas though since the development will still result in significant transformation of natural areas, the cumulative impact will remain significant.		

6. BIODIVERSITY SENSITIVITY RATING (BSR)

Habitat diversity and species richness:
The majority of the area is still dominated by natural vegetation and includes two different vegetation types, with a variety of habitats which include undulating plains, rocky outcrops, bush clumps, wetland areas and areas of deeper sandy soils. The habitat diversity in the area is therefore relatively high. Despite this high habitat diversity, species diversity remains moderate.

Presence of rare and endangered species:
No Red Listed plant species could be identified on the site and the area is also not known to contain many such species though a few are still present in this region and a likelihood therefore remains that such a species may also be present on the site. However, given the large extent of the study area, it has been found to contain a fairly high number of protected plant species (Appendix B). These include the protected succulent and geophytic species, *Euphorbia striata, Orthanthera jasminiflora, Boophone distichia, Pentharhinum insipidum, Schizocarpus nervosus, Satyrium sp., Raphionecma velutina, Babiana bainesii, Aloe greatheadii, Crinum graminicola,* and *Vachellia erioloba*.

Ecological function:
The ecological function of the site is still relatively intact though some modification is still evident. The site functions as habitat for a variety of fauna, supports specific vegetation types and the wetland systems forming part of the site also provides vital functions in terms of water transportation, wetland and aquatic habitats and bio-remediation. The majority of the area is still dominated by natural vegetation and therefore still retains the natural vegetation types, of which the Vaal-Vet Sandy Grassland is also an Endangered ecosystem (Appendix A: Map 1). As a result of this largely natural vegetation, the area also clearly still sustains a diverse mammal population which also includes Serval, a Near Threatened species. The wetland system in the east of the site has been shown to be moderately modified but is still considered a highly sensitive system (Appendix A: Map 3 & 4). Overall the ecological function of the study area is considered to be largely intact while also providing several important ecological functions.

Degree of rarity/conservation value:
The study area contains several areas of high conservation value and overall the site is rated as high (Appendix A: Map 1 - 4):

- The Mispah Game Reserve covers a large portion of the southern portion of the site. This is a Private Nature Reserve which has been proclaimed as a Protected Area (PA) under the National Environmental Management Protected Areas Act (NEMPAA of 2003). The area is listed as a Private Nature Reserve within the South Africa Protected & Conservation Areas Database (SAPAD) and was proclaimed in 2001 (Notice 23 of 2001). Development within any protected area is highly unlikely since this is largely prevented by the NEMPAA and any management plan of the protected area. This PA has also been taken into account in determining the provincial and national conservation targets and development within this PA will also affect these conservation targets.

- Two large CBA 1 areas have been delineated by the Free State Biodiversity Management Plan. These CBA 1 areas have been identified as being crucial for meeting conservation targets for the Endangered Vaal-Vet Sandy Grassland occurring in this area but also to some extent the Vaal Reefs Dolomite Sinkhole Woodland in the area. These CBA 1 areas have been identified as being Irreplaceable in terms of meeting conservation targets.
- Portions of remaining Vaal-Vet Sandy Grassland also occur in the south east of the site but which do not form part of the Mispah Game Reserve or identified CBA areas. However, since this vegetation type is currently listed as Endangered (EN) these areas must still be afforded a High level of sensitivity.
- A large wetland system transects the eastern portion of the site. This is clearly an importance water resource and will have a Very High level of sensitivity.

Percentage ground cover:
Overall, the percentage vegetation cover is regarded as moderately modified. The area is dominated by natural grassland with a fairly high percentage vegetation cover. However, overgrazing in some areas does decrease this cover to some extent. Other areas of clear transformation such as the cultivated cropfields, mining operations and woodlots of exotic trees also contribute toward a decreased vegetation cover but given the large extent of the area the overall vegetation cover remains moderate.

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. This is still largely the case on the site although areas of disturbance does increase the establishment of trees and shrubs though is restricted to fairly small areas.

Infestation with exotic weeds and invader plants:
In general, the natural areas in the study area are largely devoid of exotic weeds. However, where disturbance is present as well as those areas where transformation has occurred, exotic weeds and invasive trees have become established (Appendix B). These include *Bidens bipinnata, Tagetes minuta*, *Physalis viscosa, Achyranthes aspera*, *Melia azedarach, Eucalyptus camaldulensis, Gleditsia triacanthos, Nicotiana glauca, Acacia baileyana*, *Tamarix chinensis, Pennisetum setaceum* and *Opuntia ficus-indica.* 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:
Several portions of the site, notably the north western portion is being utilised as communal grazing and browsing for domestic livestock and there is therefore no structured grazing regime or stocking levels. Overall the amount of overgrazing is therefore considered to be at least moderate.

Signs of erosion:
The area is not affected by any pronounced erosion though moderate erosion is visible along some roads and areas of disturbance.

Terrestrial animals:

Signs and tracks of mammals are fairly abundant on the site though the mammal population will be somewhat modified from the natural condition. Natural vegetation has a high carrying capacity for mammals which decreases significantly where mining or agriculture transforms this natural vegetation and in such transformed areas the mammal population is normally represented by a generalist mammal population. As indicated previously, the majority of this still consists of natural vegetation and accordingly the mammal population will also be largely natural in these areas. The mammal population in natural areas would however still be somewhat modified as a result of the surrounding fragmentation of habitat which affected the population dynamics and migration of mammals. Other impacts such as roads, herding, trapping and the proximity of mining activities would also further impact on mammals, especially reclusive and rare mammals dependant on pristine habitats. 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. The site would therefore have a significant impact on the likelihood of such rare and endangered species occurring in the area, there is however still a likelihood that remaining natural areas may harbour species of high conservation value. The Serval has also already been confirmed to be present and it is therefore likely that other threatened mammals may also occur.

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		2	
Ecological function			1
Uniqueness/conservation value			1
Vegetation condition			
Percentage ground cover		2	
Vegetation structure			1
Infestation with exotic weeds and invader plants or encroachers		2	
Degree of grazing/browsing impact		2	
Signs of erosion		2	
Terrestrial animal characteristics			
Presence of rare and endangered species			1
Sub total	0	12	4
Total		16	

7. BIODIVERSITY SENSITIVITY RATING (BSR) INTERPRETATION

Table 7: Interpretation of Biodiversity Sensitivity Rating.

Site	Score	Site Preference Rating	Value
Harmony Moab-Noligwa PV Solar	16	Good condition	2

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

The site proposed for PV solar development has been rated as being in a Good Condition. This is a result of the area still being dominated by natural grassland in a fairly good condition. Areas of high conservation value and important ecological function also contribute toward this (Appendix A: Map 4). Given that the development will inevitably require the transformation of a significant portion of these natural areas, it will result in a significant level of impact.

The study area is situated approximately 10 km east of the small town of Orkney and to the south of the settlement of Vaal Reefs (Appendix A: Map 1). The study area is fairly large and is dominated by undulating grassland plains with gentle slopes that generally slopes toward the north and east, toward lower lying watercourses and wetlands. The extent of the study area is approximately 1500 hectares. A significant portion of this development area has however been transformed by the existing mining plants and infrastructure. However, the majority of the area is still dominated by natural grassland with some disturbance also being evident. A large wetland area is also present in the eastern portion, with a few small depression wetlands also occurring in the southern portion.

According to Mucina & Rutherford (2006) the area consists of Vaal-Vet Sandy Grassland (Gh 10) and Vaal Reefs Dolomite Sinkhole Woodland (Gh 12). The former is currently listed as Endangered (EN) while the latter is Least Concern (LC) under the National List of Threatened Ecosystems (Notice 1477 of 2009) (National Environmental Management Biodiversity Act, 2004) (Appendix A: Map 1). The Vaal-Vet Sandy Grassland dominated the southern portion of the site and is visible as undulating grassland but characterised by fairly deep, sandy soils. These remaining natural portions of this grassland would also be regarded as being of high conservation value. The vegetation type is currently heavily affected by extensive transformation by agriculture, urban expansion and mining operations. The Vaal Reefs Dolomite Sinkhole Woodland dominates the northern portions of the site and is visible as undulating plains though here exposed low rocky ridges become evident, deeper sandy soils are absent and the grass composition also differs slightly by containing a higher proportion of sour grasses. The woodland component, associate with dolomite sinkholes are not well represented on the site although a few bush clumps were noted. This vegetation type is also heavily affected by transformation but not yet to such an extent as to warrant it being listed as a Threatened Ecosystem.

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 an Ecological Support Area 1 and 2 (ESA) which functions in support of the Vaal River which is situated approximately 1 km to the north of the site (Appendix A: Map 2). The development should therefore not result in compromising the functioning of this important system, i.e. increase runoff or degrade the area to such an extent that it influences the functioning of the Vaal River. Furthermore, the site also contains two prominent areas being regarded as Critical Biodiversity Areas 1 (CBA 1) situated in the centre and eastern portion of the site (Appendix A: Map 2). These CBA 1 areas have been identified as being crucial for meeting conservation targets for the Endangered Vaal-Vet Sandy Grassland occurring in this area but also to some extent the Vaal Reefs Dolomite Sinkhole Woodland in the area. These CBA 1 areas have been identified as being Irreplaceable, i.e. "A site that is irreplaceable or near-irreplaceable for meeting biodiversity targets. There are no or very few other options for meeting biodiversity targets for the features associated with the site. Such sites are therefore critical and they need to be maintained to ensure that features targets are achieved and that such features persist." These portions of CBA's occurring on the site will therefore have to be excluded from development in order to ensure they remain intact.

The study area is still largely dominated by natural grassland and which can broadly be divided into a northern and southern portion where the northern portion is dominated by Vaals Reefs Dolomite Sinkhole Woodland and also north of a large tarred road while the southern portion is dominated by Vaal-Vet Sandy Grassland and situated south of the tarred road (Appendix A: Map 1). The southern portion is dominated by grassland dominated by Vaal-Vet Sandy Grassland and which is largely still intact. A significant portion also consists of Vaal Reefs Dolomite Sinkhole Woodland though the transition between these two vegetation types is gradual. Portions of the grassland has previously been transformed though the majority of these have again been able to re-establish a fairly natural grass layer. However, a few smaller portions are still visibly degraded and transformed and these include a large woodlot of invasive Bluegum (*Eucalyptus camaldulensis*), oxidation ponds associated with mining operations, greenhouses and a small portion previously used as stockpiling/construction area. The northern portion is also dominated by grassland but which consists almost exclusively of Vaal Reeds Dolomite Sinkhole Woodland. This grassland is also largely natural though significant disturbance is associated with areas of shallow excavations and overgrazing by domestic livestock. Though Vaal Reefs Dolomite Sinkhole Woodland is under significant development pressure, it is also not currently listed as a Threatened Ecosystem and will therefore have a slightly lower conservation value than the southern portion. The Vaal Reefs Dolomite Sinkhole Woodland is characterised by a well-developed grass layer and much higher degree of surface rock as well as at least some bush clumps establishing around sinkholes. The north western portion is visibly degraded by high levels of overgrazing by domestic livestock and also a substantial area which was previously used for dumping of spoil and rubble and also contains shallow excavations.

From the description of the area given above it is clear that the majority of the site still consists of natural grassland which is still in a fairly good condition (Appendix A: Map 1). The surroundings as well as significant portions of the site has been affected and transformed by historical mining operations. 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 areas previously cleared for construction activities, portions transformed by ploughing for crop production and degraded areas associated with the mining operations which also includes areas of shallow excavations and rubble dumps. It is however inevitable that the development will also encroach into areas of natural grassland which will result in significant impacts.

Given the above descriptions of the natural vegetation the following areas of high sensitivity should be avoided as far as possible (Appendix A: Map 1 - 4):

- The Mispah Game Reserve covers a large portion of the southern portion of the site. This is a Private Nature Reserve which has been proclaimed as a Protected Area

(PA) under the National Environmental Management Protected Areas Act (NEMPAA of 2003). The area is listed as a Private Nature Reserve within the South Africa Protected & Conservation Areas Database (SAPAD) and was proclamated in 2001 (Notice 23 of 2001). Development within any protected area is highly unlikely since this is largely prevented by the NEMPAA and any management plan of the protected area. This PA has also been taken into account in determining the provincial and national conservation targets and development within this PA will also affect these conservation targets.

- Two large CBA 1 areas have been delineated by the Free State Biodiversity Management Plan. These CBA 1 areas have been identified as being crucial for meeting conservation targets for the Endangered Vaal-Vet Sandy Grassland occurring in this area but also to some extent the Vaal Reefs Dolomite Sinkhole Woodland in the area. These CBA 1 areas have been identified as being Irreplaceable in terms of meeting conservation targets.
  - The development should therefore exclude these CBA areas from development.
  - Where no alternative is possible and development needs to encroach into these CBA areas, alternative CBA areas will have to be identified in order to still meet conservation targets. Given that these CBA areas have been identified as irreplaceable this will not be easily attainable.

- Portions of remaining Vaal-Vet Sandy Grassland also occur in the south east of the site but which do not form part of the Mispah Game Reserve or identified CBA areas. However, since this vegetation type is currently listed as Endangered (EN) these areas must still be afforded a High level of sensitivity. Development should investigate all alternatives to avoid this area and should only encroach into this area if no other alternative is available. This will however result in high impacts.

- A large wetland system transects the eastern portion of the site. This is clearly an importance water resource and will have a Very High level of sensitivity. It will not be possible to develop this system and should be completely excluded from development.

Since it is clear that the impact of the solar development will be high and will lead to irreversible transformation, the development area should be carefully determined, should focus on areas of lower sensitivity and should limit the extent of transformation as far as possible (Appendix A: Map 4). Current layout plans do indicate that areas of High Sensitivity are largely being avoided while mostly retaining development within areas of Moderate Sensitivity. Though this will still entail significant impacts, it will be significantly lower as opposed to the inclusion of areas of High Sensitivity. Furthermore, numerous protected plant species has been identified in the study area (Appendix B). These include the protected succulent and geophytic species, *Euphorbia striata, Orthanthera jasminiflora, Boophone distichia, Pentharhinum insipidum, Schizocarpus nervosus, Satyrium sp., Raphionecma velutina, Babiana bainesii, Aloe greatheadii, Crinum graminicola,* and *Vachellia erioloba*. Where development will affect these species, the necessary permits should be obtained and a significant proportion of these transplanted to adjacent areas where they will remain unaffected. In addition, there are also a few protected herbaceous plants (*Helichrysum spp.*) and a few specimens of the protected *Vachellia erioloba* (Camel Thorn). Where any of these will require removal, the necessary permits should be obtained to do so.

In addition, the area also contains many invasive trees, especially in the transformed excavations in the northern portion of the site, 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 fairly abundant on the site though the mammal population will be somewhat modified from the natural condition. Natural vegetation has a high carrying capacity for mammals which decreases significantly where mining or agriculture transforms this natural vegetation and in such transformed areas the mammal population is normally represented by a generalist mammal population. As indicated previously, the majority of this still consists of natural vegetation and accordingly the mammal population will also be largely natural in these areas. The mammal population in natural areas would however still be somewhat modified as a result of the surrounding fragmentation of habitat which affected the population dynamics and migration of mammals. Other impacts such as roads, herding, trapping and the proximity of mining activities would also further impact on mammals, especially reclusive and rare mammals dependant on pristine habitats. 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. The site would therefore have a significant impact on the likelihood of such rare and endangered species occurring in the area, there is however still a likelihood that remaining natural areas may harbour species of high conservation value.

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 it is inevitable that the development will involve the transformation of natural grassland this contribute significantly toward habitat loss which in turn will result in a high impact on the mammal population. This also indicates the need to take extra care in determining the development area, which should focus on areas of lower sensitivity, should exclude areas of high sensitivity and the wetland system in the eastern portion of the site and should limit the extent of transformation as far as possible. Current layout plans do indicate that areas of High Sensitivity are largely being avoided while mostly retaining development within areas of Moderate Sensitivity. Though this will still entail significant impacts, it will be significantly lower as opposed to the inclusion of areas of High Sensitivity.

Since it has been confirmed that Near Threatened Serval (*Leptailurus serval*) occurs in the development area it is clear that the proposed development will have a significant impact on it. According to the National Red List (2016) the following recommendations and mitigation should be implemented where this species will be affected:

- Natural habitat should be conserved as far as possible. Managers and landowners must avoid wetland loss and should retain natural grassland areas in a good condition.

- The Serval population on the site should be monitored to determine abundance and trends and to determine the impact that development has on the population dynamics. Monitoring should also include the implementation of fixed camera traps for long term monitoring. Due to their specialised habitat requirements at small spatial scales, they may serve as a useful ecosystem indicator of the effect of habitat fragmentation in transformed landscapes.

- Monitoring of the Serval population must be introduced as a compliance measure in Environmental Impact Assessment reports.

- The development site should incorporate the long-term persistence of Serval and associated habitats into onsite biodiversity management practices. Buffer habitats could be modelled based on minimum wetland size and available cover.

The surface water features of the study area are dominated by a large valley bottom wetland system in the eastern portion of the site (Appendix A: Map 3). A few small depressions also occur in the south west of the site and within the Mispah Game Reserve.

As indicated, a large valley bottom wetland system occurs in the eastern portion of the site and will likely be affected by the proposed development (Appendix A: Map 3). This is a seasonal system which flows mostly during the rainy season but did still illustrate an active hydrological regime at the time of the survey. The wetland transects the site from south to north and originates approximately 5 km to the south of the site. The catchment is also situated in agricultural areas used for crop production which will have a large impact on it though where it occurs on the site is still naturally functioning and provides ample wetland habitat which will provide unique habitats and will provide vital downstream ecological functions.

Current wetland resources including the National Wetland Map 5 (NWM 5) and the South African Inventory of Inland Aquatic Ecosystems (SAIIAE) also indicate a few other wetland areas likely to occur in the area (Appendix A: Map 1). The survey also sampled these areas and confirmed that no wetland conditions are present in these areas. They do not form part of any watercourse, wetland ort surface water feature and are therefore not relevant for the development. The results will however be included in overview in order to confirm that these areas were surveyed and confirmed to be devoid of wetland conditions.

Obligate wetland vegetation was utilised to determine the presence and border of wetland conditions (Appendix B). The vegetation survey indicated that obligate wetland vegetation dominates the valley bottom wetland system in the east of the site. The smaller depression wetlands in the south west of the site contained some obligate wetland vegetation though due to high levels of disturbance this was not as pronounced. However, soil samples conclusively confirmed the presence of wetland conditions in both the valley bottom wetland system and small depression wetlands (Appendix C). The large valley bottom wetland system in the east of the study area can be categorised as an unchanneled valley-bottom wetland (SANBI 2009).

The determination of the condition of the wetlands on the site will be confined to the large valley bottom wetland system in the eastern portion of the site (Appendix A: Map 3). The small depressions wetlands in the south west of the site should remain unaffected by the development and will therefore not be relevant and their condition will not be determined. Therefore, a WET-Health determination will be done for this large valley bottom wetland 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).

Though the section of the wetland occurring on the site seems to still be largely intact and functional the upstream land uses, especially within the catchment will certainly have a significant impact on the wetland and is therefore likely to cause a significant level of modification of it. The survey has indicated that the valley bottom wetland system is affected by numerous impacts which result in a significant level of modification. A WET-Health determination was undertaken for the valley bottom 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 on the wetland. The EI&S of the valley bottom wetland system has been rated as being Moderate.

A Risk Assessment for the proposed solar facility which will affect the valley bottom wetland system in the eastern 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). In the event that development of solar facilities extends into the eastern portion of the site, these areas will be located in close proximity to this wetland system and in so doing are likely to result in some impacts on it, especially in terms of runoff and sedimentation (Appendix A: Map 3). However, current layout plans do indicate that the development will avoid the eastern portion of the development area which will significantly decrease the anticipated impact. The current layout plans indicate that portions of the development as well as associated grid connection powerline will be situated approximately 350 meters from this valley-bottom wetland system and given the clearance of vegetation and the large extent of the development is still likely to have an impact on it.

The large valley bottom wetland system is clearly the main wetland system in this area 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). Current layout plans do indicate that the eastern portion of the development area will be excluded though development will still occur within 350 meters of the edge of the wetland and is then still likely to have some impact on it. Given the distance between the wetland area and current development layout (approximately 350 meters), the anticipated risk will be low.

The impact significance has been determined and should development take place without mitigation it is anticipated that it will result in overall high impacts. This is a result of the largely natural condition of the area, the presence of areas of high conservation value and the fairly large extent of the proposed development (Appendix A: Map 4). Aspects which are expected to result in quite high impacts include the loss of the vegetation type in the area which includes Vaal-Vet Sandy Grassland (an Endangered system) as well as the loss of a large wetland system in the east of the site. Other moderate-high impacts also include the loss of protected plant species, increased infestation by exotic weeds, increased habitat fragmentation, the impact on mammals (which also includes a Near Threatened species) and the increased cumulative impact. Suitable mitigation as listed in previous paragraphs should enable the development to decrease many of these impacts to moderate levels. This will mostly be achieved by excluding areas of high conservation value as listed which will in turn decrease the severity of the impacts and will also decrease the extent and in so doing the anticipated impacts will be somewhat lower. Current layout plans do indicate that areas of High Sensitivity are largely being avoided while mostly retaining development within areas of Moderate Sensitivity. Though this will still entail significant impacts, it will be significantly lower as opposed to the inclusion of areas of High Sensitivity. However, as indicated significant natural areas will still be transformed by the development and several of the impacts will remain significant especially the impacts on the vegetation type and biodiversity, the wetland system in the east of the site, habitat fragmentation, the mammal population in the area and the cumulative impact.

9. RECOMMENDATIONS

- Since it is clear that the impact of the solar development will be high and will lead to irreversible transformation, the development area should be carefully determined, should focus on areas of lower sensitivity and should limit the extent of transformation as far as possible. Current layout plans do indicate that areas of High Sensitivity are largely being avoided while mostly retaining development within areas of Moderate Sensitivity. Though this will still entail significant impacts, it will be significantly lower as opposed to the inclusion of areas of High Sensitivity.

- 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 1 - 4):

    - The Mispah Game Reserve covers a large portion of the southern portion of the site. This is a Private Nature Reserve which has been proclamated as a Protected Area (PA) under the National Environmental Management Protected Areas Act (NEMPAA of 2003).
    - Two large CBA 1 areas have been delineated by the Free State Biodiversity Management Plan. These CBA 1 areas have been identified as being crucial for meeting conservation targets for the Endangered Vaal-Vet Sandy Grassland occurring in this area but also to some extent the Vaal Reefs Dolomite Sinkhole Woodland in the area. These CBA 1 areas have been identified as being Irreplaceable in terms of meeting conservation targets.
        - The development should therefore exclude these CBA areas from development.
        - Where no alternative is possible and development needs to encroach into these CBA areas, alternative CBA areas will have to be identified in order to still meet conservation targets. Given that these CBA areas have been identified as irreplaceable this will not be easily attainable.
    - Portions of remaining Vaal-Vet Sandy Grassland also occur in the south east of the site but which do not form part of the Mispah Game Reserve or identified CBA areas. However, since this vegetation type is currently listed as Endangered (EN) these areas must still be afforded a High level of sensitivity. Development should investigate all alternatives to avoid this area and should only encroach into this area if no other alternative is available. This will however result in high impacts.
    - A large wetland system transects the eastern portion of the site. This is clearly an importance water resource and will have a Very High level of sensitivity. It will not be possible to develop this system and should be completely excluded from development and a 21 meter buffer around it also maintained (Appendix A: Map 3).

- The following recommendations and mitigation measures should be implemented in order to manage impacts on the valley bottom wetland in the east of the site (Appendix A: Map 3):

    - The wetland system as delineated should be completely excluded from the development area in order to ensure no impacts on it occurs (Appendix A: Map 3).
    - The wetland should be regarded as no-go area 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.
    - Given the current layout plan, it is unlikely that infrastructure such as roads and powerlines will require crossing it and this was therefore not rated as a risk. However, should layout plans be modified and it become apparent that development will encroach in proximity to the wetland or other infrastructure require crossing this system, the impacts should be re-assessed and the risk matrix amended.
    - 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 system.
    - 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 valley bottom wetland system 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 wetland. This should be conducted by a suitable qualified wetland specialist.
    - The necessary authorisations should be obtained from the Department of Water and Sanitation (DWS).

- As discussed in the report, the study area contains numerous protected species (Appendix B). These consist of protected trees, herbaceous species, succulents and geophytes. The following recommendations should be followed for protected species:

    - Where protected tree species (*Vachellia erioloba* – Camel Thorn) will be affected by the development, permits should be obtained from the relevant authority to remove them.
    - Where protected succulent/geophytic species will be affected by development, permits should be obtained and these transplanted to adjacent areas where they will remain unaffected.
    - These species are cryptic and inconspicuous and it is recommended that a walkthrough survey be conducted prior to an area being cleared. This should include identification and marking of all protected plants in such an area and should be performed by an ecologist or botanist.
    - The transplanting of these species should be overseen by an ecologist, botanist or other suitably qualified person.
    - Monitoring of the success of establishment should also be undertaken.

- 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.

- Near Threatened Serval (*Leptailurus serval*) occurs in the development area it is clear that the proposed development will have a significant impact on it. According to the National Red List (2016) the following recommendations and mitigation should be implemented where this species will be affected:

    - Natural habitat should be conserved as far as possible. Managers and landowners must avoid wetland loss and should retain natural grassland areas in a good condition.
    - The Serval population on the site should be monitored to determine abundance and trends and to determine the impact that development has on the population dynamics. Monitoring should also include the implementation of fixed camera traps for long term monitoring. Due to their specialised habitat requirements at small spatial scales, they may serve as a useful ecosystem indicator of the effect of habitat fragmentation in transformed landscapes.
    - Monitoring of the Serval population must be introduced as a compliance measure in Environmental Impact Assessment reports.
    - The development site should incorporate the long-term persistence of Serval and associated habitats into onsite biodiversity management practices. Buffer habitats could be modelled based on minimum wetland size and available cover.

- 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 area 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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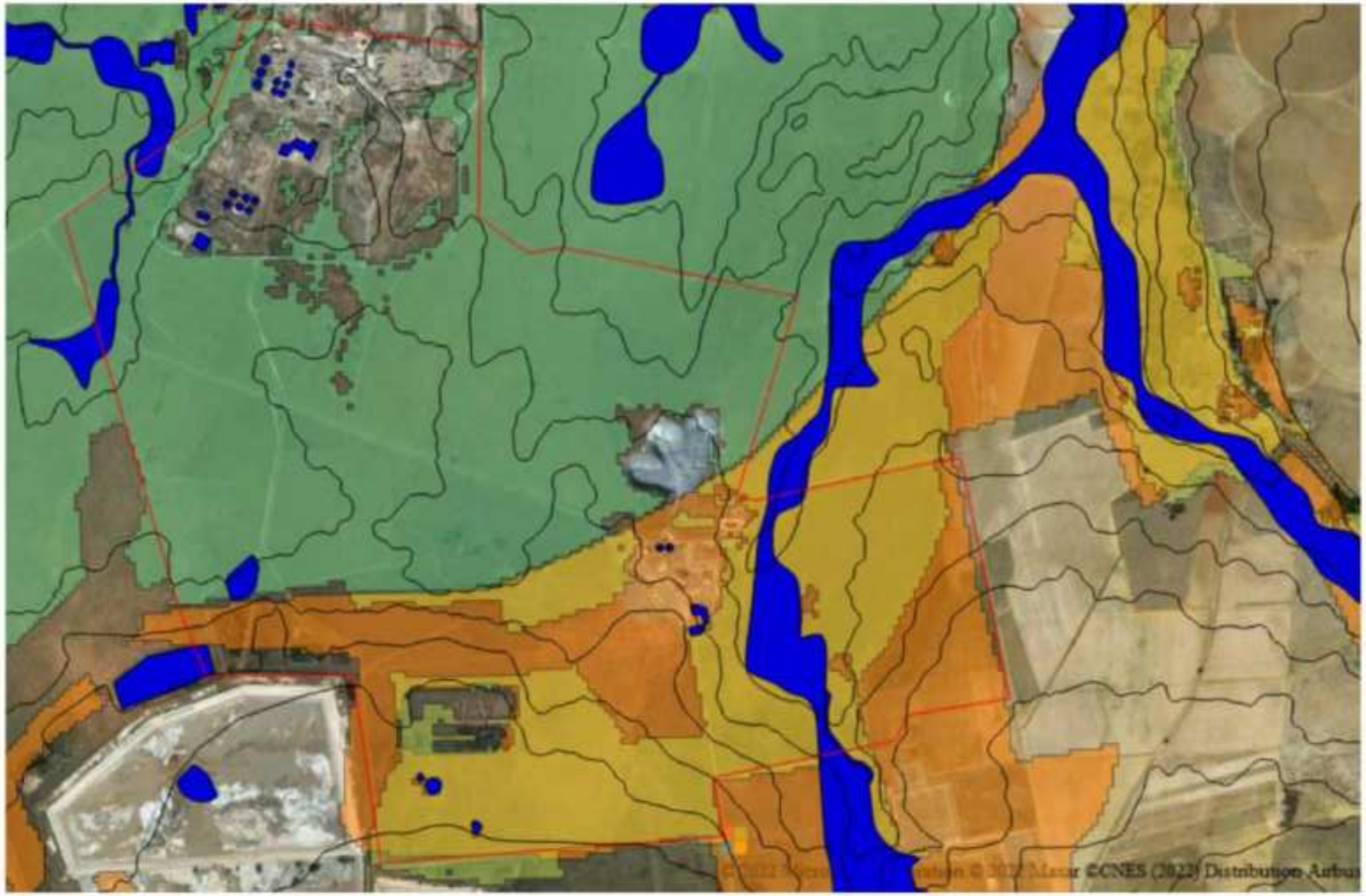
Annexure A: Maps

Locality map for the proposed Harmony Moab-Noligwa Plant PV solar development situated near the town of Orkney, Free State Province.



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Sunninghill
2157

Legend:

- Study area
- Surface contours
- Probable Wetlands
- Threatened Ecosystems
- Vaal-Vet Sandy Grassland
- Vaal Reefs Dolomite Sinkhole Woodland

Map Information

Spheroid: WGS 84

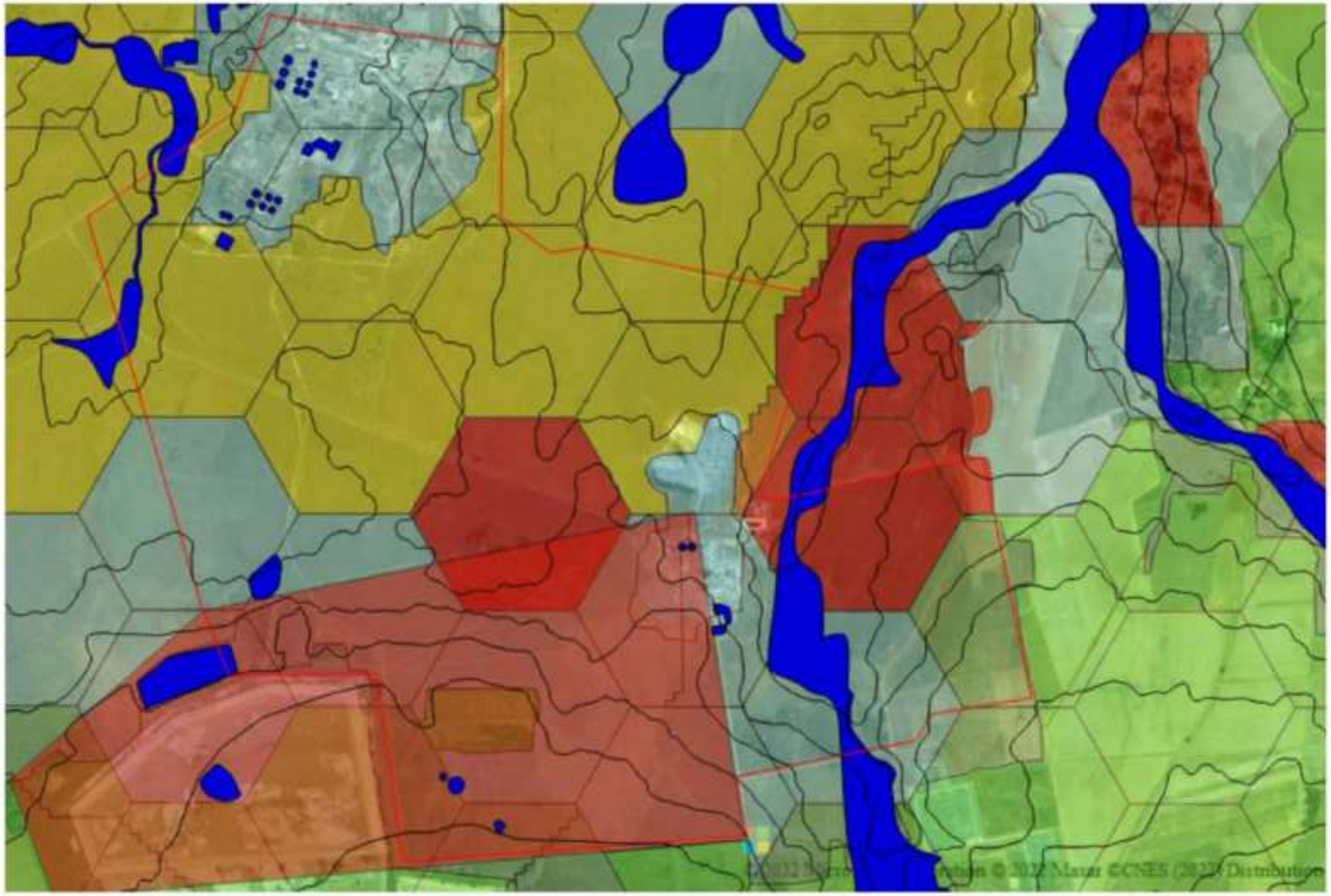
Quantum GIS

Scale: 1:37 000

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 Moab-Noligwa Plant PV solar development near the town of Orkney. The areas of remaining natural vegetation is indicated and it is notable that the majority of the site still consists of natural vegetation. Note also the the southern portion of the site is dominated by Vaal-Vet Sandy Grassland which is listed as a Threatened Ecosystem and is considered as Endanagered. The northern portion of the site is dominated by Vaal Reefs Dolomite Sinkhole Woodland. The probability of wetlands and watercoourses occurring in the area is also indicated by the National Wetland Map 5 and SAIIE wetland probability map. The large wetland area indiacted in the eastern portion fo the site is notable.

Free State Biodiversity Plan map for the proposed Harmony Moab-Noligwa Plant PV solar development situated near the town of Orkney, Free State Province.



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Legend:

- Study area
- Surface contours
- Probable Wetlands
- Critical Biodiversity Area 1
- Critical Biodiversity Area 2
- Ecological Support Area 1
- Ecological Support Area 2
- Degraded
- Other
- Mispah Game Reserve

Map Information

Spheroid: WGS 84

Quantum GIS

Scale: 1:37 000

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Map 2: Free State Biodiversity Plan map of the proposed Harmony Moab-Noligwa Plant PV solar development near the town of Orkney. The majority of the area is regarded as Ecological Support Areas 1 & 2 and aids in support of the Vaal River system to the north. The support function should be preserved by the development. Significant areas regarded as Critical Biodiversity Areas in the east and central portions of the site aim to preserve important vegetation types and area essential to meeting conservation targets. These areas will have a high conservation value and should be avoided by development. The Mispah Game Reserve is also indicated and covers a large portion of the south of the site. The area has been proclaimed as a Protected Area under the National Environmental Management Protected Areas Act.

Wetland delineation map for the proposed Harmony Moab-Noligwa Plant PV solar development situated near the town of Orkney, Free State Province.

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Legend:

- Study area
- Surface contours
- Delineated Wetland Areas
- 21-meter buffer
- Wetland sampling points

Map Information

Spheroid: WGS 84

Quantum GIS

Scale: 1:37 000

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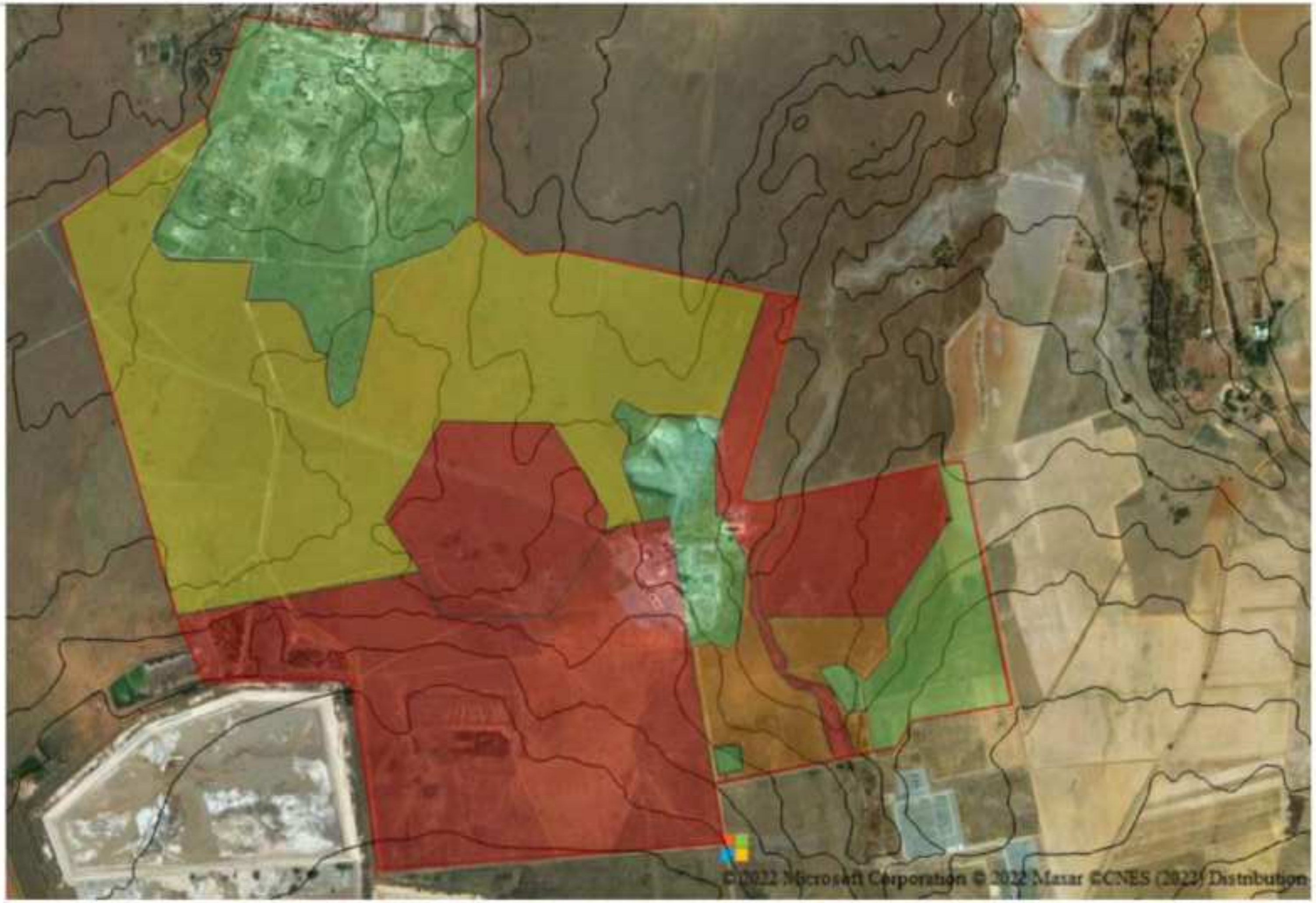
Map 3: Wetland delineation map of the proposed Harmony Moab-Noligwa Plant PV solar development near the town of Orkney. A large unchanneled valley bottom wetland system is situated in the eastern portion of the site and transects it from south to north. Three small depression wetlands are also located in the south west of the site. These wetland areas should all be excluded from the development and a 21 meter buffer also retained around them where the development occurs in close proximity. The wetland sampling points are also indicated.

Sensitivity delineation map for the proposed Harmony Moab-Noligwa Plant PV solar development situated near the town of Orkney, Free State Province.



Map 4: Sensitivity map of the proposed Harmony Moab-Noligwa Plant PV solar development near the town of Orkney. Areas of Very High sensitivity consist of the Mispah Game Reserve, Critical Biodiversity Areas and the wetland system in the east of the site. One area of High sensitivity in the east of the site includes the remaining portions of Vaal-Vet Sandy Grassland, an Endangered vegetation type and therefore of high conservation value. The remaining natural areas in the northern portion of the site consists of Vaal Reeds Dolomite Sinkhole Woodland and although it is not currently a threatened ecosystem, as a natural area, it remains at least Moderately sensitive. Areas of Low sensitivity are transformed and include the mining operations, greenhouses, cultivated fields and areas of vegetation clearance.

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Legend:

- Study area
- Surface contours
- Very High Sensitivity
- High Sensitivity
- Moderate Sensitivity
- Low Sensitivity

Map Information

Spheroid: WGS 84

Quantum GIS

Scale: 1:37 000

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Appendix B: Species list

Species indicated with an * are exotic.

Protected species are coloured orange and Red Listed species red.

Species	Growth form
**Acacia baileyana*	Tree
**Achyranthes aspera*	Herb
**Bidens bipinnata*	Herb
**Eucalyptus camaldulensis*	Tree
**Gleditsia triacanthos*	Tree
**Melia azedarach*	Tree
**Nicotiana glauca*	Tree
**Oenothera rosea*	Herb
**Opuntia ficus-indica*	Succulent
**Pennisetum setaceum*	Grass
**Physalis viscosa*	Herb
**Tagetes minuta*	Herb
**Tamarix chinensis*	Tree
**Verbenia bonariensis*	Herb
**Veronica anagalis-aquatica*	Herb
Acanthosicyos naudinianus	Creeper
Acrotome inflata	Herb
Agrostis lachnantha	Grass
Aloe greatheadii	Succulent
Anthephora pubescens	Grass
Aristida canescens	Grass
Asparagus larcinus	Shrub
Babiana bainesii	Geophyte
Barleria macrostegia	Herb
Boophone distichia	Geophyte
Brachiaria serrata	Grass
Celtis africana	Tree
Chascanum pinnatifidum	Herb
Chlorophytum sp.	Geophyte
Citrillus lanatus	Creeper
Clematis brachiata	Climber
Conyza podocephala	Herb
Crassula capitella	Succulent
Crassula lanceolata	Succulent
Crinum graminicola	Geophyte
Cybopogon pospischillii	Grass
Cymbopogon excavatus	Grass
Cynodon dactylon	Grass
Cyperus longus	Sedge
Delosperma herbeum	Succulent

Dicoma anomala	Herb
Dicoma macrocephala	Herb
Digitaria eriantha	Grass
Drimia platyphylla	Geophyte
Elephanthorrhiza elephantina	Suffrutex
Eragrostis curvula	Grass
Eragrostis gummiflua	Grass
Eragrostis lappula	Grass
Eragrostis lehmanniana	Grass
Euphorbia striata	Succulent
Felicia muricata	Dwarf shrub
Gomphrena celosioides	Herb
Grewia flava	Shrub
Gymnosporia buxiifolia	Shrub
Haplocarpha falx	Grass
Helichrysum caespititum	Herb
Helichrysum callicomum	Herb
Helichrysum nudifolium	Herb
Hermannia coccocarpa	Herb
Hermannia geniculata	Herb
Hilliardiella eleagnioides	Herb
Hyparrhenia hirta	Grass
Hypoxis hemerocallidae	Geophyte
Indigofera daleoides	Herb
Indigofera sp.	Herb
Ipmoea sp.	Herb
Ipomoea crassipes	Herb
Kalanchoe rotundifolia	Succulent
Lasiosiphon sericocephalus	Herb
Ledebouria sp.	Geophyte
Limeum viscosum	Herb
Lippia scaberrima	Herb
Loudetia simplex	Grass
Melinis repens	Grass
Nidorella resedifolia	Herb
Nolletia sp.	Dwarf shrub
Orthanthera jasminiflora	Creeper
Pellaea calomelanos	Fern
Pentarrhinum insipidum	Geophyte
Perotis patens	Grass
Pogonarthria squarrosa	Grass
Polydora poskeana	Herb
Pygmaeothamnus zeyheri	Suffrutex
Raphionacme velutina	Geophyte
Ruschia hamata	Succulent
Satyrium sp.	Geophyte

Schizocarpus nervosus	Geophyte
Scirpoides burkei	Sedge
Searsia lancea	Tree
Searsia pyroides	Shrub
Selago burkei	Herb
Selago densiflora	Herb
Senecio coronatus	Herb
Setaria sphacelatum	Grass
Sporobolus discosporus	Grass
Stipagrostis uniplumis	Grass
Stoebe plumosus	Dwarf shrub
Tephrosia sp.	Herb
Themeda triandra	Grass
Trachyandra laxa	Geophyte
Trachypogon spicatus	Grass
Tribulus terrestris	Herb
Triraphis andropogonoides	Grass
Triumfetta sonderi	Herb
Urelythrium agropyroides	Grass
Ursinia nana	Herb
Vachellia erioloba	Tree
Vachellia karroo	Tree
Vigna sp.	Herb
Ziziphus mucronata	Tree
Ziziphus zeyheriana	Suffrutex

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	Moab-Noligwa Valley-Bottom Wetland
Assessment Unit Name / No.	1
Assessor	DP van Rensburg
Date of Assessment	25/05/2022
HGM Type (Basic)	Unchannelled VB wetland UVB
HGM Type (Refined)	Unchannelled VB wetland UVB
Conceptual model	Water and sediment inputs from the topographically defined catchment are assumed to emanate largely from the catchment upstream of the wetland, with limited lateral inputs. For the the purposes of geomorphic and water quality assesments, a weighting of 70% is therefore allocated to impacts associated with the upstream catchment whereas impacts associated with lateral inputs only contribute 30% 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)	50
Upslope catchment size (Ha)	2551
Quaternary Catchment[1]	C24B
MAR (Mm3)	0.0
MAR per unit area (m3/Ha)	0.0
MAP (mm)	587
PET (mm)	1750
MAP:PET ratio	0.3
Vulnerability Factor	1.0
Hydrogeological Type Setting[2]	Karst landscape
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 obligate wetland grasses and sedges. Exotic weeds common but not abundant.
Number of dams in the catchment	0
Average surface area of dams (m2)	0
Perimeter of wetland (m)	10800
Perimeter-to-area ratio (m/ha)	216.0
Down-slope length of wetland (m)	3600
Elevation change over length (m)	22
Longitudinal Slope (%)	0.6%
Propensity to erode (Category)[3]	Moderate
Propensity to erode (Score)	0.8
Dominant sediment accumulation process	Clastic

WET-Health Level 2 assessment:
PES Summary

This worksheet provides an overall summary of the WET-Health Assessment that can be used for reporting purposes

	Wetland PES Summary			
Wetland name	**Moab-Noligwa Valley-Bottom Wetland**			
Assessment Unit	**1**			
HGM type	Unchannelled VB wetland			
Areal extent (Ha)	50.0 Ha			

Unadjusted (modelled) Scores

PES Assessment	Hydrology	Geomorphology	Water Quality	Vegetation
Impact Score	3.7	3.4	3.7	2.3
PES Score (%)	63%	66%	63%	77%
Ecological Category	C	C	C	C
Combined Impact Score	3.3			
Combined PES Score (%)	67%			
Combined Ecological Category	C			
Hectare Equivalents	33.3 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	4.9	3.4	3.7	2.3
PES Score (%)	51%	66%	63%	77%
Ecological Category	D	C	C	C
Trajectory of change				
Confidence (revised results)	Not rated	Not rated	Not rated	Not rated
Combined Impact Score	3.7			
Combined PES Score (%)	63%			
Combined Ecological Category	C			
Hectare Equivalents	31.4 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 valley-bottom wetland 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.	1	2	1	1	1.25	2	2	5.25	2	1	5	2	10	52.5	L	80	Provided that recommendations are implemented and that the development not encroach nearer than the current indicated 350 meters in proximity to the wetland system and is treated as no-go area, the anticipated risk should remain low. As the development will still occur in relatively close proximity to it, it will also be important to implement a comprehensive storm water management system.

Appendix F: Buffer Zone Determination

Name of Assessor	Darius van Rensburg	Project Details	Harmony Moab-Noligwa Solar Facility	Date of Assessment	25/05/2022

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	Unchannelled valley-bottom

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	601 - 800mm	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**
(51-300 ha)	Intermediate (6-10%)	3-5%	Moderately low	Intermediate (The remaining HGM types)
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	Moderate (Vulnerability score :4-5)	High (>9% of the area)	Intermediate
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	Intermediate (e.g. short vegetation with moderate natural plant diversity)	Intermediate (e.g. moderate natural plant diversity)	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)	High: Dense vegetation, with good basal cover (e.g. natural grass stands)			
Vegetation characteristics (Operational phase)	Low: Sparse vegetation cover with large areas of bare soil			
Soil permeability	High: Deep well-drained soils (e.g. sand and loamy sand).			
Topography of the buffer zone	Dominantly uniform topography: Dominantly smooth topography with few/minor concentrated flow paths to reduce interception.			

	Buffer Segment 1	**Buffer Segment 2**	**Buffer Segment 3**	**Buffer Segment 4**
Final aquatic impact buffer requirements (including practical management considerations)				
Construction Phase	**21**	**Not Assessed**	**Not Assessed**	**Not Assessed**
Operational Phase	**15**	**Not Assessed**	**Not Assessed**	**Not Assessed**
Final aquatic impact buffer requirement	**21**	**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)**

Nature: **[Outline and describe fully the impact anticipated as per the assessment undertaken]**			
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.			
	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	Short-term (1)	The construction period will last for less than one year	**Low Negative (18)**
Extent	Local (1)	Pressure will only be added on the local municipality to provide housing for outsourced construction workers	
Magnitude	Low (4)	The increase in demand for affordable accommodation should not be extensive as workers will primarily be sourced from the local communities.	
Probability	Probable (3)	The possibility of the impact on the provision of affordable accommodation is very low	
Mitigation/Enhancement Measures			
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.			
Post Mitigation/Enhancement Measures			
Duration	Short-term (1)	Pressure will only be added on the local municipality to provide housing for outsourced construction workers.	**Low Positive (8)**
Extent	Local (1)	The increase in demand for affordable accommodation should be mitigated if external construction crews are provided with onsite accommodation.	
Magnitude	Minor (2)	The possibility of the impact on the	

		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.		

Agricultural Assessment for the Proposed Harmony Moab Khotsong Solar PV Facility Project

Submitted by TerraAfrica Consult cc

Mariné Pienaar

15 September 2022

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1. Introduction

Terra-Africa Consult cc has been appointed by Savannah Environmental (Pty) Ltd, on behalf of Harmony Moab Khotsong Operations (Pty) Ltd (hereafter referred to as Moab), to undertake an agricultural assessment for the proposed construction of the solar PV facility near Viljoenskroon in the Free State (Figure 1).

Harmony Moab Khotsong Operations (Pty) Ltd 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 development of a solar photovoltaic (PV) facility with a generating capacity of up to 100MW is proposed north of the Harmony Gold Moab Khotsong operations, approximately ~10km north of the town of Vierfontein within the Moqhaka Local Municipality and within the Fezile Dabi District Municipality, Free State Province.

The PV facility is located on:

- the Farm Anglo 593;
- Farm Hoekplaats 598;
- Farm Mispah 274;
- Portion 1 of Farm Zaaiplaats 190;
- Remaining Extent of Farm Doornkom Wes 446;
- Portions 1, 3, 4, 5, of Farm Chrystalkop 69;
- and the Remaining Extent of the Farm Zuiping 394,

The solar PV development will be known as Harmony Moab Khotsong Solar PV Facility. The preferred site for the projects is available for the proposed projects and is therefore deemed technically feasible by the project developer for such development to take place.

2. Project description

A project site considered to be technically suitable for the development of the solar PV facility, with an extent of approximately 1400ha, was identified. A development area of ~900ha was demarcated within this project site and allows an adequate footprint (~450ha) for the installation of a solar PV facility with a contracted capacity of up to 100MW, while allowing for the avoidance of environmental site sensitivities.

The full extent of the project site is to be evaluated in the Basic Assessment process to identify sensitivities. Site-specific studies and assessments will delineate areas of potential sensitivity within the identified study area. Once constraining factors have been confirmed, the layout of the solar PV facility within the development area can be planned to avoid sensitive environmental areas and features.

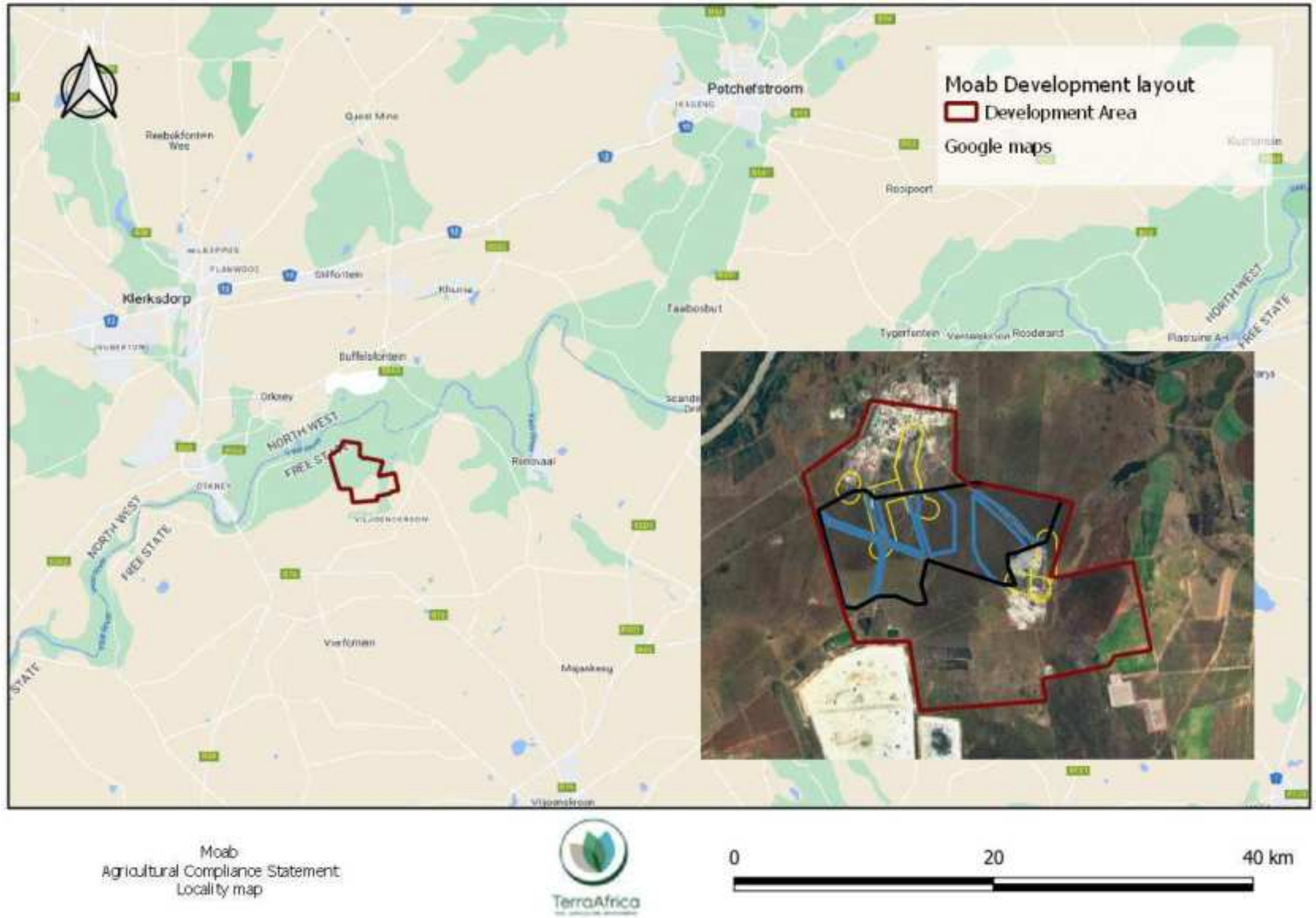

Figure 1: Locality of the Proposed Moab PV Facility project area and alternative grid connection solutions

3. Details of the specialist

The report is prepared by Mariné Pienaar of TerraAfrica Consult CC. 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 (see Appendix 2). 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.

The full details and contact details of the specialist is attached as Appendix 1 – Specialist Declaration of Independence.

4. Purpose and objectives of the compliance statement

The purpose of the Agricultural Compliance Statement, is to ensure that the sensitivity of the site from the perspective of agricultural production to the proposed development, is sufficiently considered. 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 in the form of photographs of the current land use and environmental sensitivity pertaining to the study field.
- All data and conclusions are submitted together with the Environmental Impact Assessment Report (prepared in accordance with the NEMA regulations) for the proposed project.

According to GNR 320, the agricultural compliance statement that is submitted must meet the following requirements, it must:

- be applicable to the preferred site and the proposed development footprint;
- confirm that the site is of “low” or “medium” sensitivity for agriculture; and
- indicate whether or not the proposed development will have an unacceptable impact on the agricultural production capability of the site.

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

Table 1 GNR 320 requirements of an Agricultural Compliance Statement (Low to Medium Sensitivity)

Requirement	Report reference
3.1. The compliance statement must be prepared by a soil scientist or agricultural specialist registered with the SACNASP.	Page 3 & Appendix 2

3.2. The compliance statement must: 3.2.1. be applicable to the preferred site and proposed development footprint;	Section 9
3.2.2. confirm that the site is of "low" or "medium" sensitivity for agriculture; and	Section 10.5
3.2.3. indicate whether or not the proposed development will have an unacceptable impact on the agricultural production capability of the site.	Section 10.4 and Section 13
3.3. The compliance statement must contain, as a minimum, the following information: 3.3.1. contact 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;	Page 3, Appendices 1, 2 and 3
3.3.2. a signed statement of independence;	Appendix 1
3.3.3. 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;	Figure 2
3.3.4. confirmation from the specialist that all reasonable measures have been taken through micro- siting to avoid or minimise fragmentation and disturbance of agricultural activities;	Section 12
3.3.5. a substantiated statement from the soil scientist or agricultural specialist on the acceptability, or not, of the proposed development and a recommendation on the approval, or not, of the proposed development;	Section 12
3.3.6. any conditions to which the statement is subjected;	Section 12
3.3.7. in the case of a linear activity, confirmation from the agricultural specialist or soil scientist, that in their opinion, based on the mitigation and remedial measures proposed, the land can be returned to the current state within two years of completion of the construction phase;	Not applicable
3.3.8. where required, proposed impact management outcomes or any monitoring requirements for inclusion in the EMPr; and	Section 11
3.3.9. a description of the assumptions made as well as any uncertainties or gaps in knowledge or data.	Section 8
3.4. A signed copy of the compliance statement must be appended to the Basic Assessment Report or Environmental Impact Assessment Report.	Submitted as part of final report

5. Terms of Reference

In addition to the requirements stipulated in GNR 320, the following Terms of Reference, as stipulated by Savannah, apply to the Agricultural Compliance Statement:

- to ensure a thorough assessment, that includes both the desktop assessment of databases and aerial photography; a description of the on-site verification of the agricultural potential of the area; and the soil forms present in the development area.
- identify and assess potential impacts on both agricultural potential and soil resulting from the proposed project.

- identify and describe potential cumulative soil, agricultural potential and land capability impacts resulting from the proposed project in relation to proposed and existing developments in the surrounding area; and
- recommend mitigation, management and monitoring measures, to minimise impacts and/or optimise benefits associated with the proposed project.

6. Legislative framework of the assessment

The report follows the protocols as stipulated for agricultural assessment in Government Notice 320 of 2020 (GNR 320). 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) (NEMA). It replaces the previous requirements of Appendix 6 of the Environmental Impact Assessment Regulations of NEMA.

In addition to the specific requirements of GN320 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 and the conservation of soil resources of the project area:

- the Conservation of Agricultural Resources Act (No 43 of 1983) (CARA) states that the degradation of the agricultural potential of soil is illegal. CARA requires the protection of land against soil erosion and the prevention of water logging and salinization of soils by means of suitable soil conservation works to be constructed and maintained. The utilization of marshes, water sponges and watercourses are also addressed; and
- the National Water Act (No 36 of 1998) (NWA) deals with the protection of water resources (i.e. wetlands and rivers). Hydric soils with wetland land capability are not part of the proposed development area and the NWA is therefore not applicable.

7. Agricultural Sensitivity

The combined Agricultural Sensitivity of the proposed project area was determined by using the National Environmental Screening Tool (www.screening.environment.gov.za). The screening report was generated by Savannah Environmental on 6 June 2022. The requirements of GNR 320 stipulate that a 50m buffered development envelope must be assessed with the screening tool. The map depicted in Figure **2** shows the agricultural sensitivity of the 1430ha development area; although only 545ha (development footprint) will be used for the proposed development. Additionally, a buffered area of at least 1km around the proposed development area is included.

The results provided by the screening tool indicate that the largest part of the development area consists of land with Medium agricultural sensitivity (refer to Figure **2**). Small areas with High agricultural sensitivity is scattered throughout the northern part and centre of the development area while the south-eastern corner also consists of High sensitivity. The development footprint area consists mainly of land with Medium agricultural sensitivity.

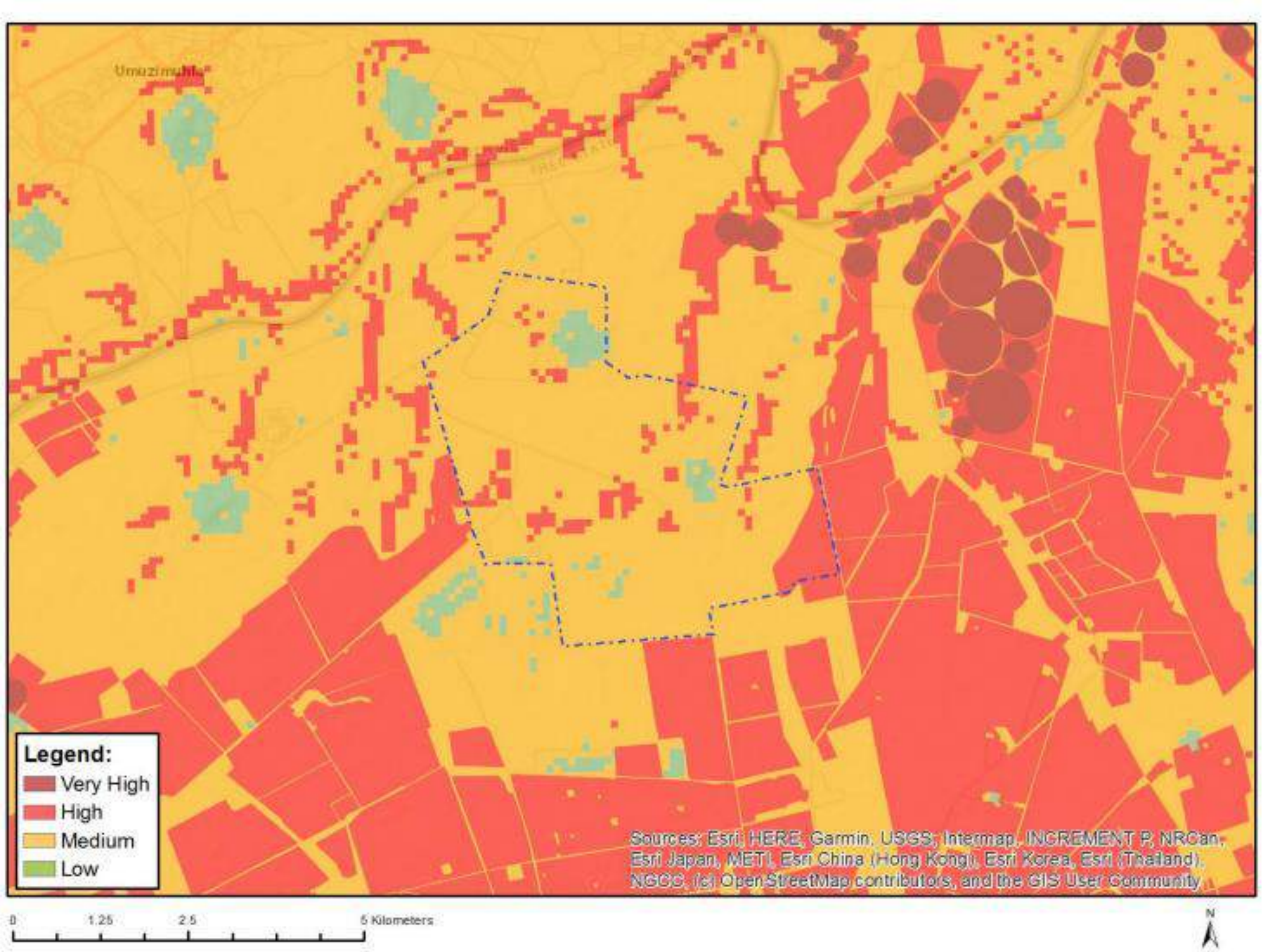

Figure 2 Agricultural Combined Sensitivity of the Moab PV Facility development area (generated by Savannah Environmental, 2022)

8. Methodology

The different steps that were followed to gather the information used for the compilation of this report is outlined below. The methodology is in alignment with the requirements of GNR 320.

8.1 Assessment of available data

The most recent aerial photography of the area available from Google Earth was obtained. The satellite imagery was used to analyse the terrain of the proposed project area and the surrounding area. The analysis considered the typical terrain units and landscape features, such as existing roads, farm infrastructure and areas where land degradation may be present. The proposed development area was also superimposed on three different raster data sets obtained from the National Department of Agriculture, Land Reform and Rural Development (DALRRD). The data sets are:

- The Refined Land Capability Evaluation Raster Data for South Africa that was developed using a spatial evaluation modelling approach (DALRRD, 2016).
- The long-term grazing capacity for South Africa 2018 that present the long-term grazing capacity of an area with the understanding that the veld is in a relatively good condition (South Africa, 2018).

8.2 Site assessment

The site visit was conducted on the 6th to the 8th of June 2022. The soil profiles were examined to a maximum depth of 1.2m using a hand-held auger. Observations on site were made regarding soil texture, structure, colour and soil depth at each survey point. The locality of each survey point is shown in . A cold 10% hydrochloric acid solution was used on site to test for the presence of carbonates in the soil. Qfield was used to the log the coordinates of each of the survey points. The soils are described using Soil Classification: A Natural and Anthropogenic System for South Africa (Soil Classification Working Group, 2018). It should be noted that development will only be taken place in the development footprint and thus not the entire development area. Figures below focus on the development footprint and grid connection corridor.

Other observations made during the site visit include recording the presence of farm buildings, cattle handling facilities and water troughs. The larger area around the study area was also assessed by driving through the area to gain an understanding of the agro ecosystem within which the study area functions. Photographic evidence of soil properties, current land uses and farm infrastructure were taken with a digital camera and presented in Section 9 of the report.

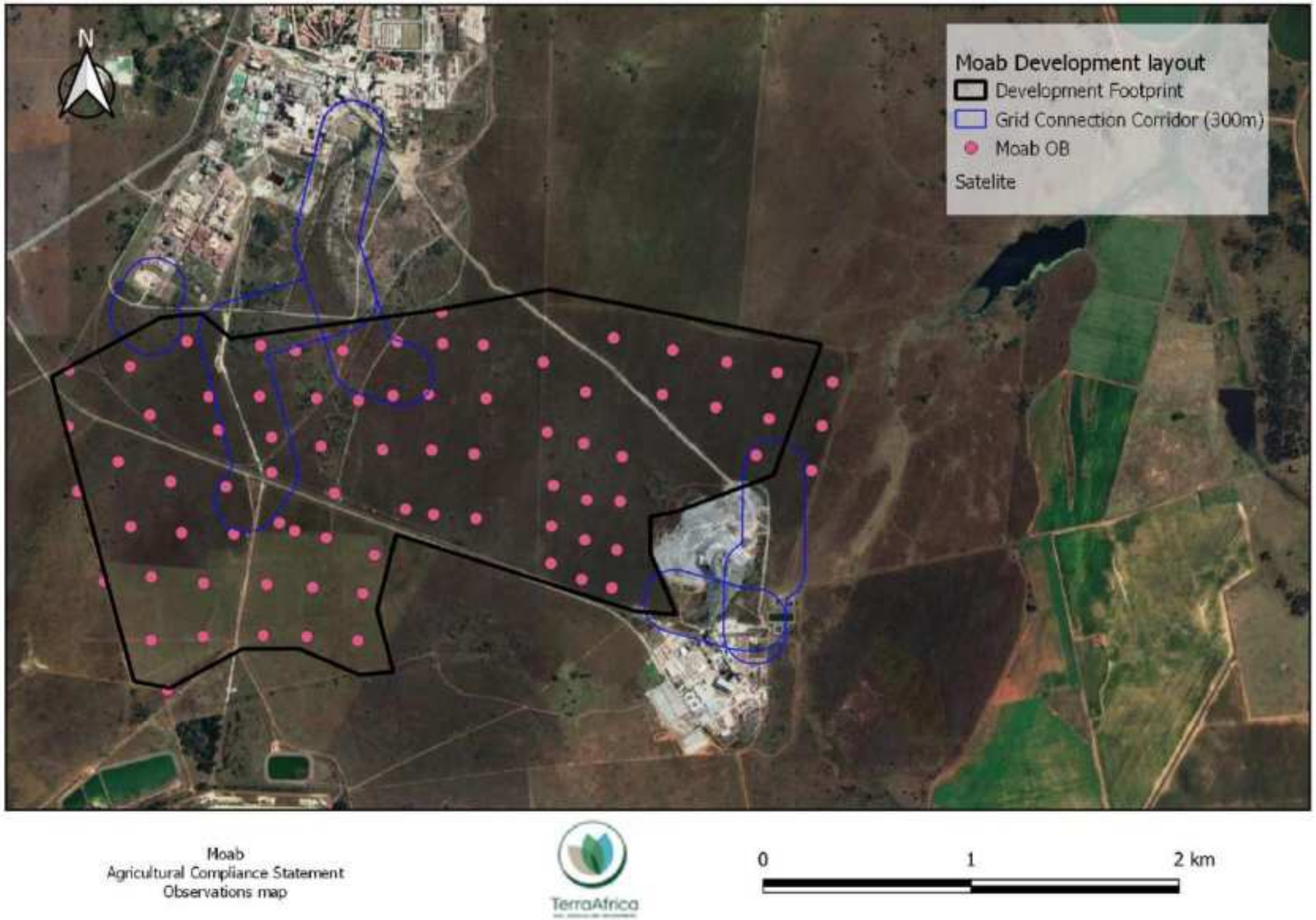

Figure 3 Locality of on-site soil classification and observation points within the Moab PV Facility development area and grid connection alternatives

8.3 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. Study gaps, limitations and assumptions

All assumptions made with the interpretation of the baseline results and anticipated impacts, are listed below:

- It is assumed that the development footprint will be within the project area of 545 ha that was assessed in this report.
- It is assumed that the development footprint will be fenced off and the 545 ha of land will be excluded as land available for any future farming activities; 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 limitations 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 infrastructure. Therefore, it is done as accurately as possible but must not be considered as absolute measures.

No other information gaps, limitations and assumptions have been identified.

10. Baseline description

10.1 Soil properties

The soil profiles classified within the Moab PV Facility development area consist of the Hutton, Glenrosa, Mispah, Vaalbos, Nkonkoni, Technosols and Clovelly soil forms. The positions of the soil forms are depicted in Figure **4** and a description of each soil form is provided following Figure **4**.

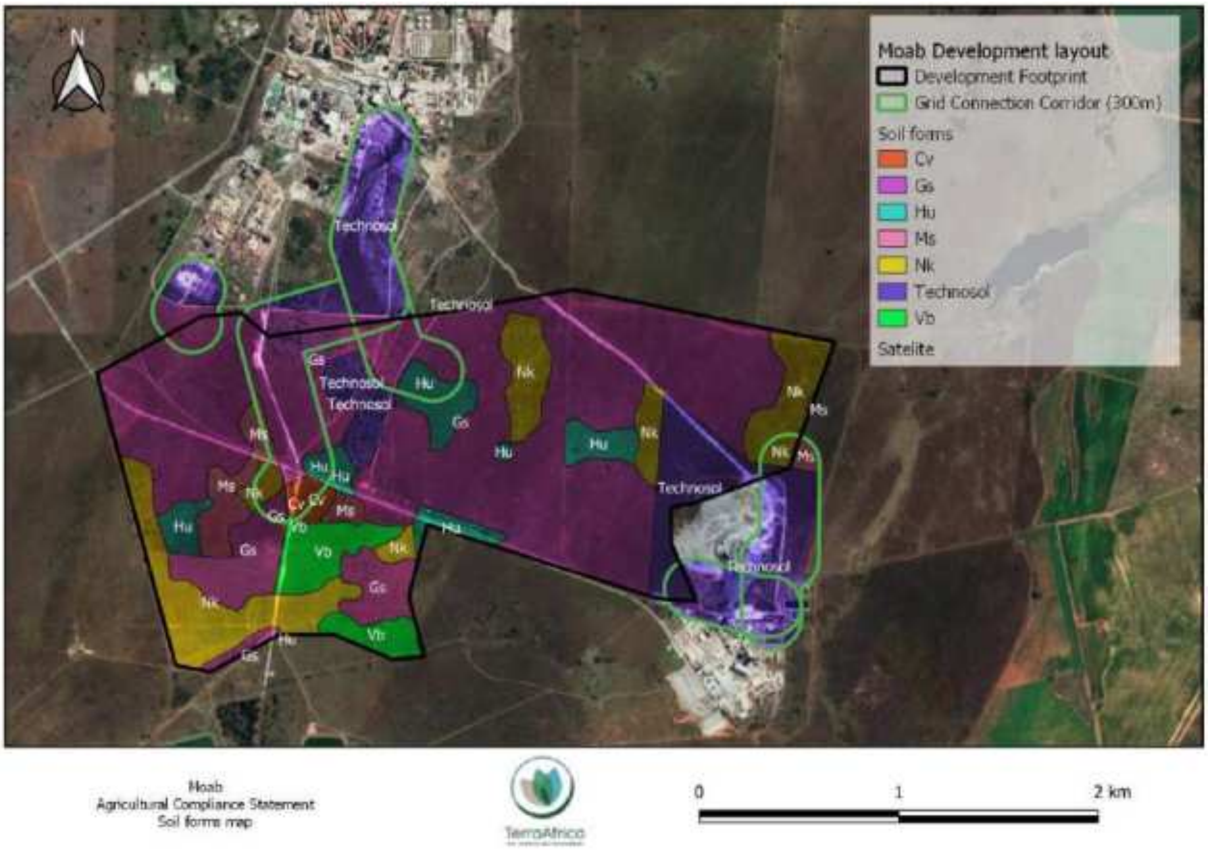

Figure 4 Soil classification map of the Moab PV Facility development area.

The soils in the survey area are dominated by shallow soils with the Glenrosa soil forms dominating the study area. The Hutton soil is found in a very small areas throughout the study area and had a depth of 1200 mm. The Hutton is luvic indicating an increase in clay with depth. The Nkonkoni is found on the western and southern boundaries as well as in the centre. The Nkonkoni have depth between 500 and 1000mm whereafter the lithic horizon occurred.

Vaalbos and Clovelly is found in the south western parts of the study area and covers a small area. Both the Vaalbos and Clovelly have dephs between 500 and 1000 mm respectively. The lithic horizon mainly consisted of iron ore. All soil forms have chromic topsoils indicating sufficient amount of organic carbon. The grid connection corridor primarily consists of transported Technosols, which is material intentionally transported by humans.

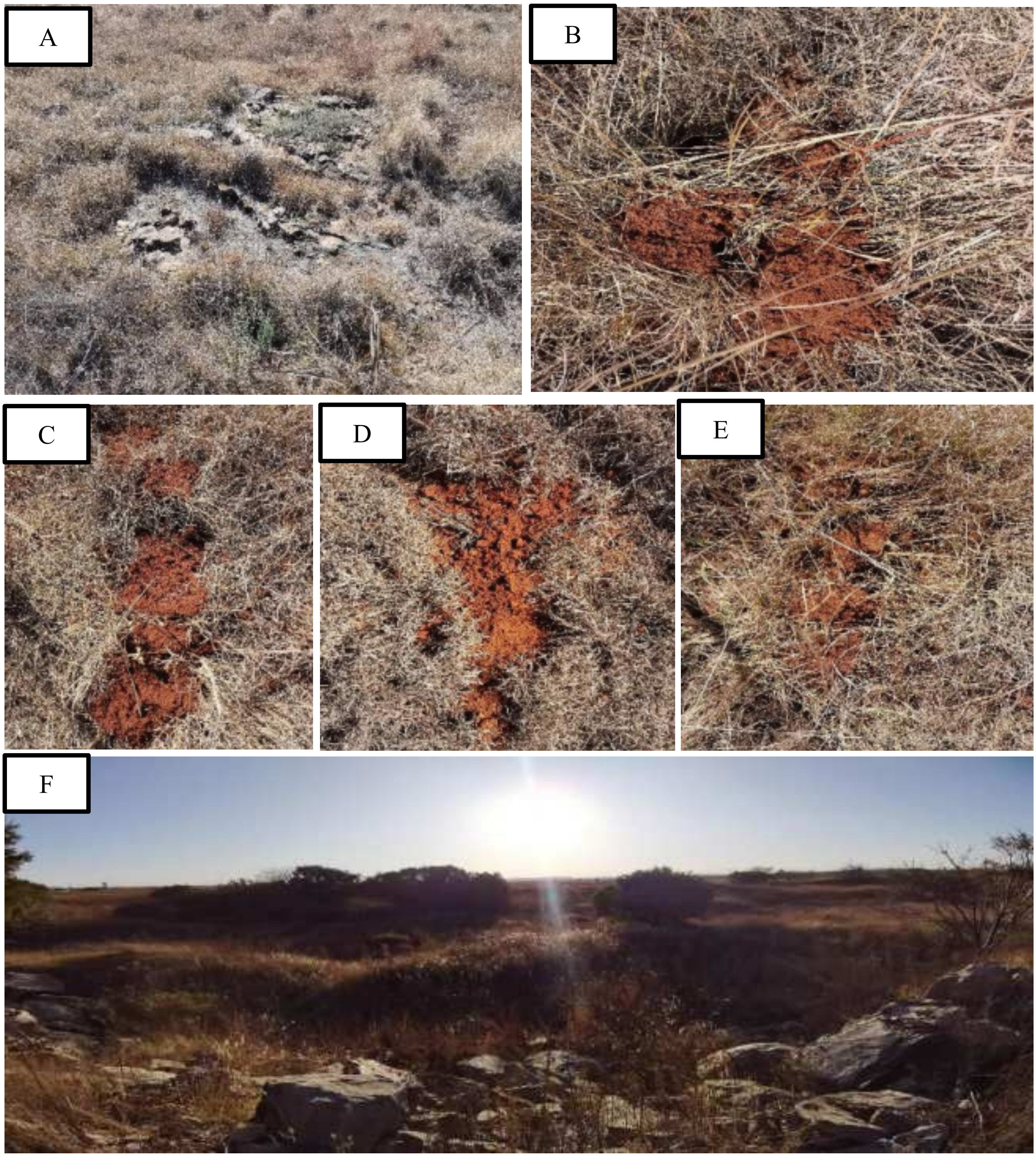

Figure 5 A-Mispah, B-Vaalbos, C-Hutton, D-Nkonkoni, E-Clovelly, F-Technosol

10.2 Land capability

The position of the different land capability classes within the development area are depicted in Figure **6**.

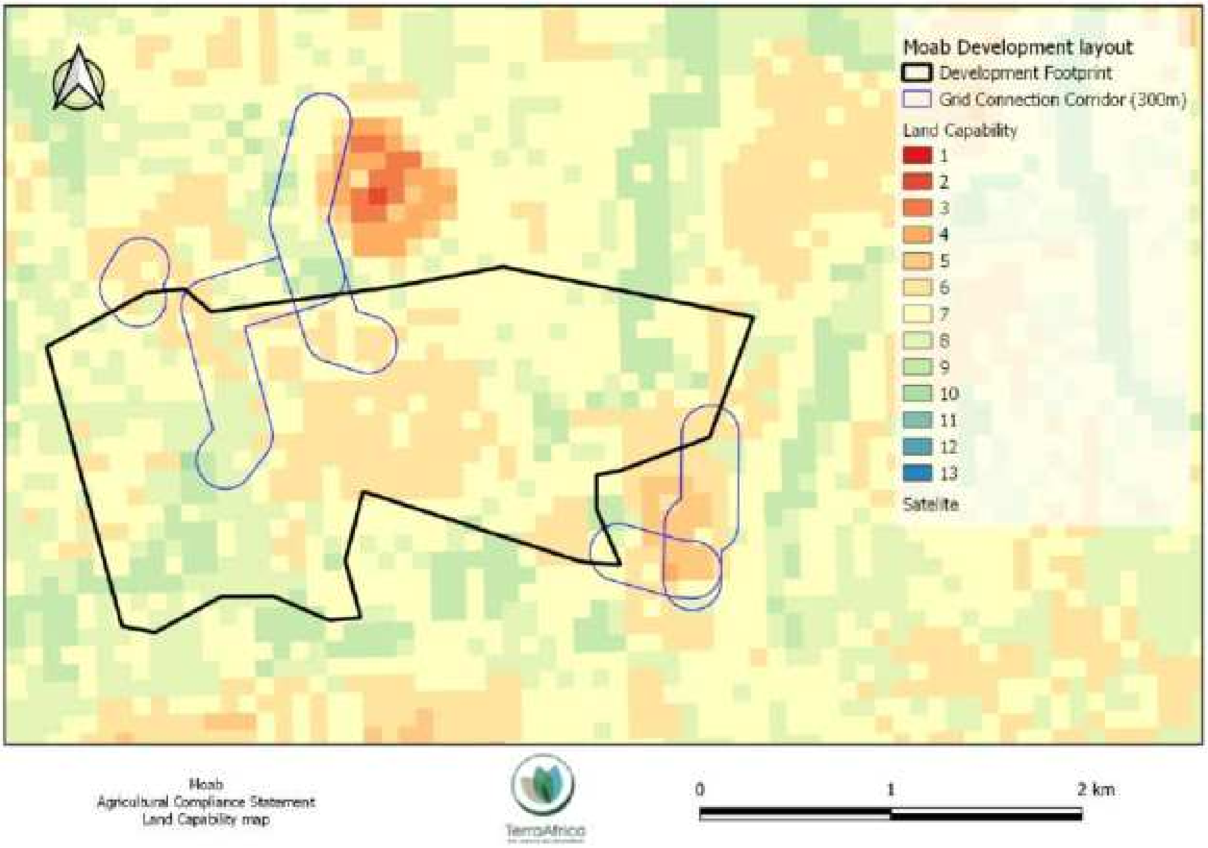

Figure 6 Land capability classification of the Moab PV Facility development area (data source: DALRRD, 2016)

The largest part of the Moab PV Facility development area consists of land with Moderate (Class 06 and 07) land capability. This land capability class is present within the entire center boundary of the development area while the eastern and western section of the boundary consists of land with Moderate-High (Class 08 and 09) land capability.

10.3 Agricultural potential

Following the classification of the soil and the consideration of the soil properties and limiting factors to rainfed crop production, the agricultural potential soil within the development area was determined. The agricultural potential of the area is depicted in Figure **7**.

The largest part of the total area assessed, has Low-Moderate agricultural potential (291.7ha). Low-Moderate agricultural potential has been assigned to the Glenrosa soil form. It is possible that the weathering of the shallow soils allows root penetration and water infiltration, which would increase the agricultural potential dramatically. The High agricultural potential is allocated to the Hutton, Vaalbos, Nkonkoni and Clovelly soil form due to its deep soil depth and was found in the north-western, southern and center part of the study area (102.5ha).

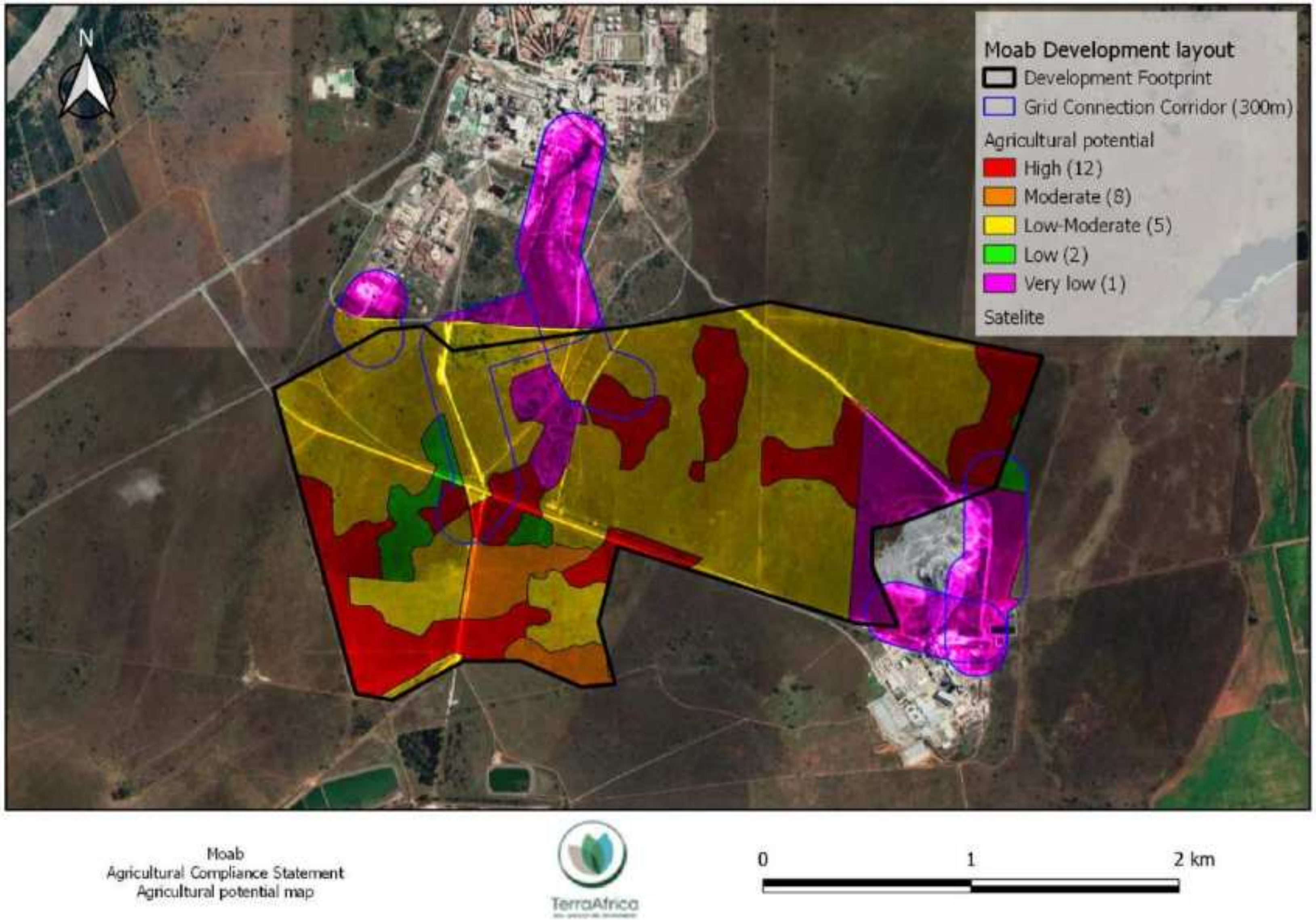

Figure 7 Agricultural Potential for the Proposed Moab PV Facility Project

Following the metadata layer obtained from DALRRD, the long-term grazing capacity of the entire project area is 7 ha/LSU (see Figure **8**). The ideal grazing capacity is an indication of the long-term production potential of the vegetation layer growing in an area. More specifically, it relates to its ability to maintain an animal with an average weight of 450 kg (defined as 1 Large Stock Unit (LSU)), with an average feed intake of 10 kg dry mass per day over the period of approximately a year. This definition includes the condition that this feed consumption should also prevent the degradation of the soil and the vegetation. The grazing capacity is therefore expressed in several hectares per LSU (ha/LSU) (DALRRD, 2018).

Using the long-term grazing capacity of 7ha/LSU, the Moab PV Facility development footprint and connection corridor of 545 ha can provide forage to 77 head of cattle. The grazing capacity is moderate in comparison to the grazing capacity of the rest of the country. The grass cover shows no signs of regular grazing.

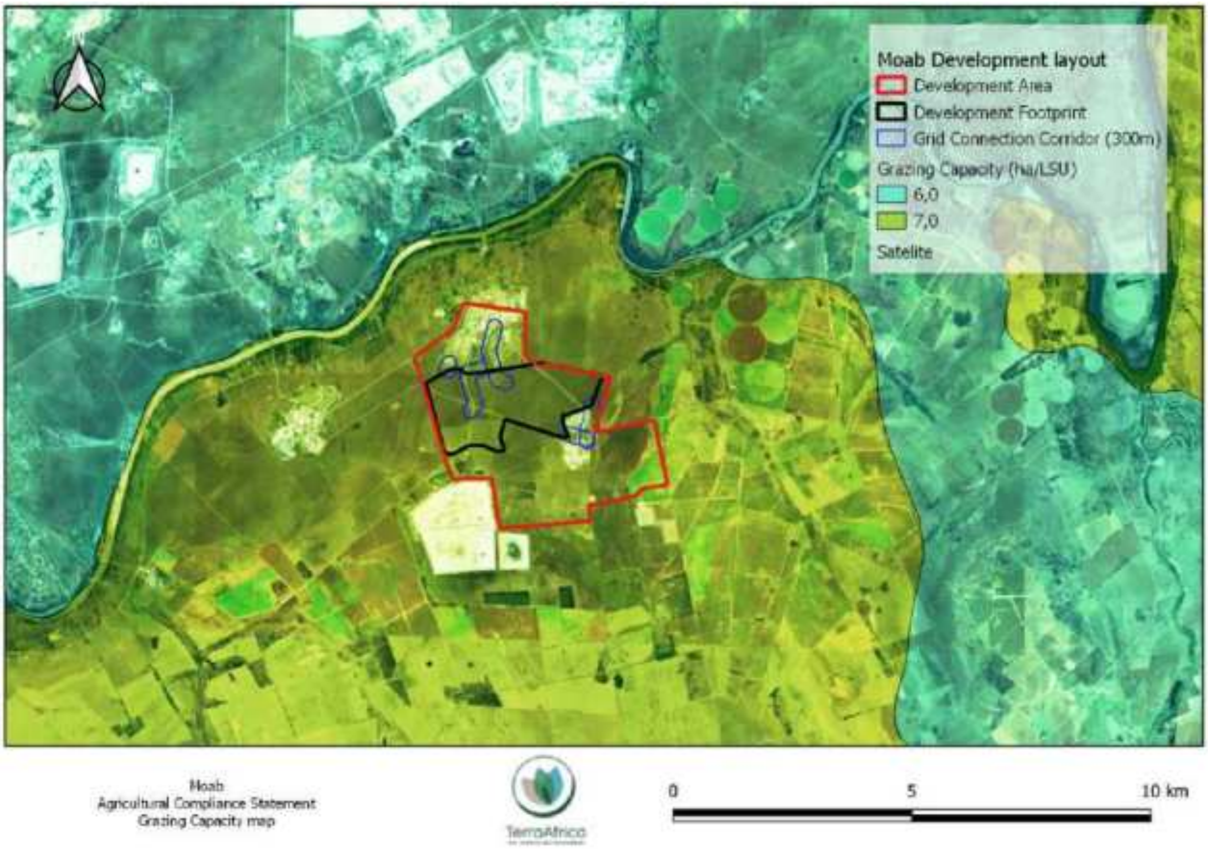

Figure 8 Grazing capacity of the Proposed Moab PV Facility project area and grid connection (data source: DALRRD, 2018).

The Low and Low-Moderate agricultural potential of the soils within the development area is confirmed by the South African National Land-Cover 2018 (SANLC 2018) (GeoTerraImage, 2018) data. The SANLC data shows that the main land use of the entire development footprint, is natural grassland. During the site verification visit, it was confirmed that the area consists of grassland and that there is no crop cultivation in the area.

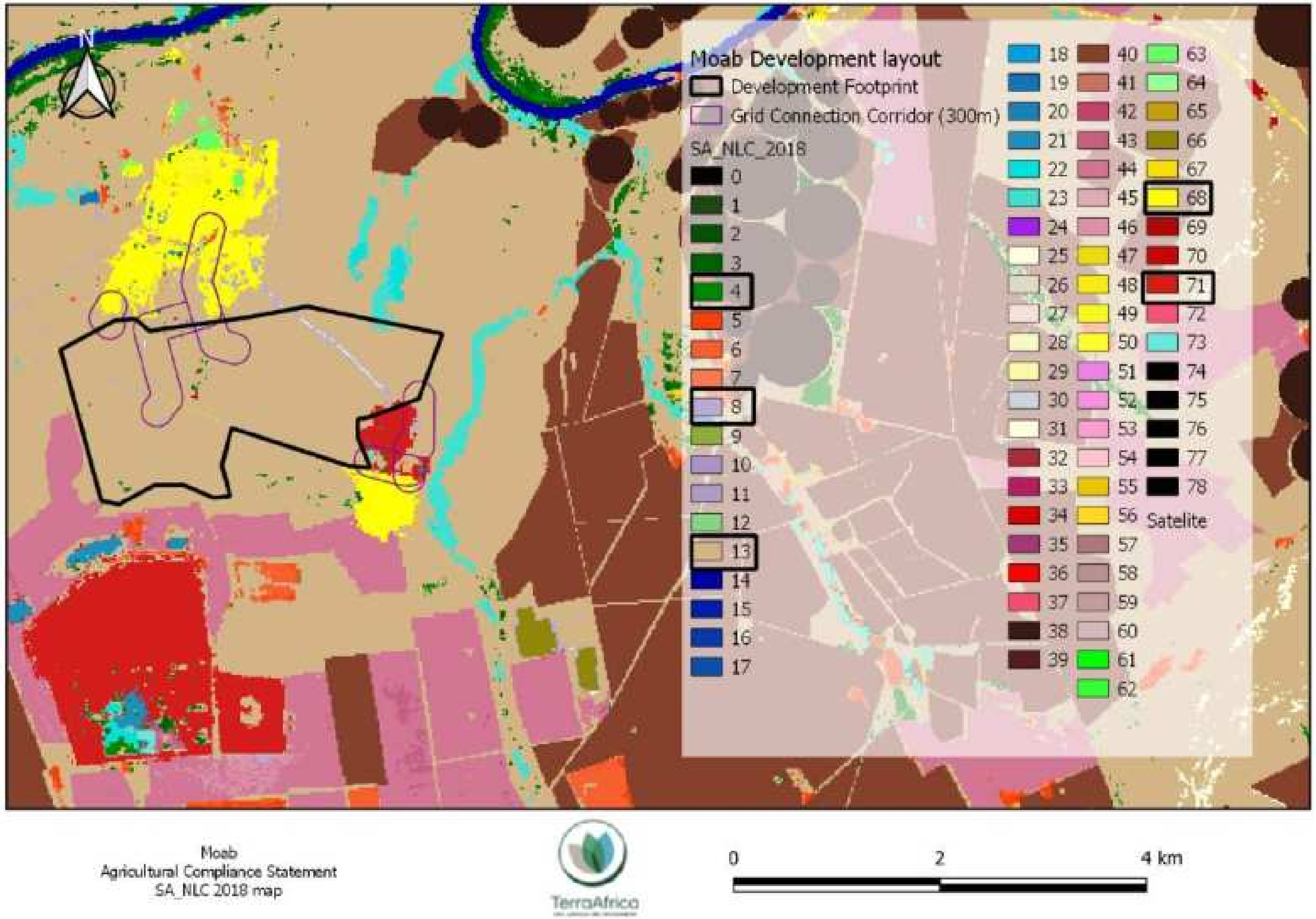

Figure 9 South Africa National Land-Cover (SANLC, 2018)[1]

[1] Land uses in the project area are highlighted in the legend

Table 2 Legend to figure 8 and description of the dominant land uses in the development area

No	Class name	Class Definition
4	Open woodland	Natural tall woody vegetation communities, with canopy cover ranging between 10 - 35%, and canopy heights exceeding 2.5 metres. Typically represented by open bush and woodland communities.
8	Low Shrubland (other regions)	Natural, low woody shrubland communities, where the total plant canopy cover is typically both dominant over any adjacent bare ground exposure, and the canopy height ranges between 0.2 – 2 metres. Note: this definition differs slightly from the equivalent gazetted class definition (i.e. total plant canopy cover ranges between 10 - 100%) in order to provide a more comparable content to the 1990 and 2013-14 SANLC datasets. If a tree or tall bush woody cover is evident it is typically < 0.1 % of total canopy cover. Typically representative of low, indigenous karoo-type vegetation communities, which have been identified using image-based spectral models, but which fall spatially
13	Natural Grassland	Natural and/or semi-natural indigenous grasslands, typically devoid of any significant tree or bush cover, and where the grassland component is typically dominant over any adjacent bare ground exposure. Note this this definition differs slightly fromthe equivalent gazetted class definition (i.e. total plant canopy cover ranges between 4 - 100%) in order to provide a more comparable content to the 1990 and 2013-14 SANLC datasets. Typically representative of low, grass-dominated vegetation communities in the Grassland and Savanna Biomes.
68	Mines: Surface Infrastructure	Built-up structures associated with the administration and/or industrial processing and extraction of mined resources. This class may be associated with either surface or sub-surface mining activities.
71	Mines: Waste (Tailings) & Resource Dumps	Non-vegetated, active or non-active mine generated material dumps or stockpiles, associated with both mine waste material (i.e. tailings dams) or mine generated resource stockpiles (i.e. coal stockpiles). Note that in some cases (especially coal mining) there may be some overlap/misrepresentation between mine-extraction pits and mine tailings, due to the challenge of separating these accurately

Figure 10 Photographic example of vegetation within the study area.

10.4 Sensitivity analysis

Following the consideration of all the desktop and gathered baseline data above, the findings of the report are not the same as the Environmental Screening Tool. The soil forms present within the project area are mainly of the Glenrosa soil form, which has a shallow soil depth of between 100-200mm. The area has historically not been used for crop production recently, as confirmed by the SA_NLC 2018 (see 9). No irrigation infrastructure, such as centre pivots or drip irrigation, are present within the project area and irrigated agricultural is currently not practiced in the area.

The area is not currently used for livestock farming although the Proposed Moab PV Facility project area can support 77 head of cattle at the long-term grazing capacity of 7ha/LSU (DALRRD, 2018). Considering the soil properties, land capability and agricultural potential of the development area, most of the area has **Low Agricultural Sensitivity** (see Figure **11)** with only 166ha having **Medium Agricultural Sensitivity**. Soil in the project area will have Low sensitivity, depending on the successful implementation of mitigation measures to prevent soil erosion, compaction, and pollution. The significance of the impacts and mitigation measures proposed are discussed in **Section 11**.

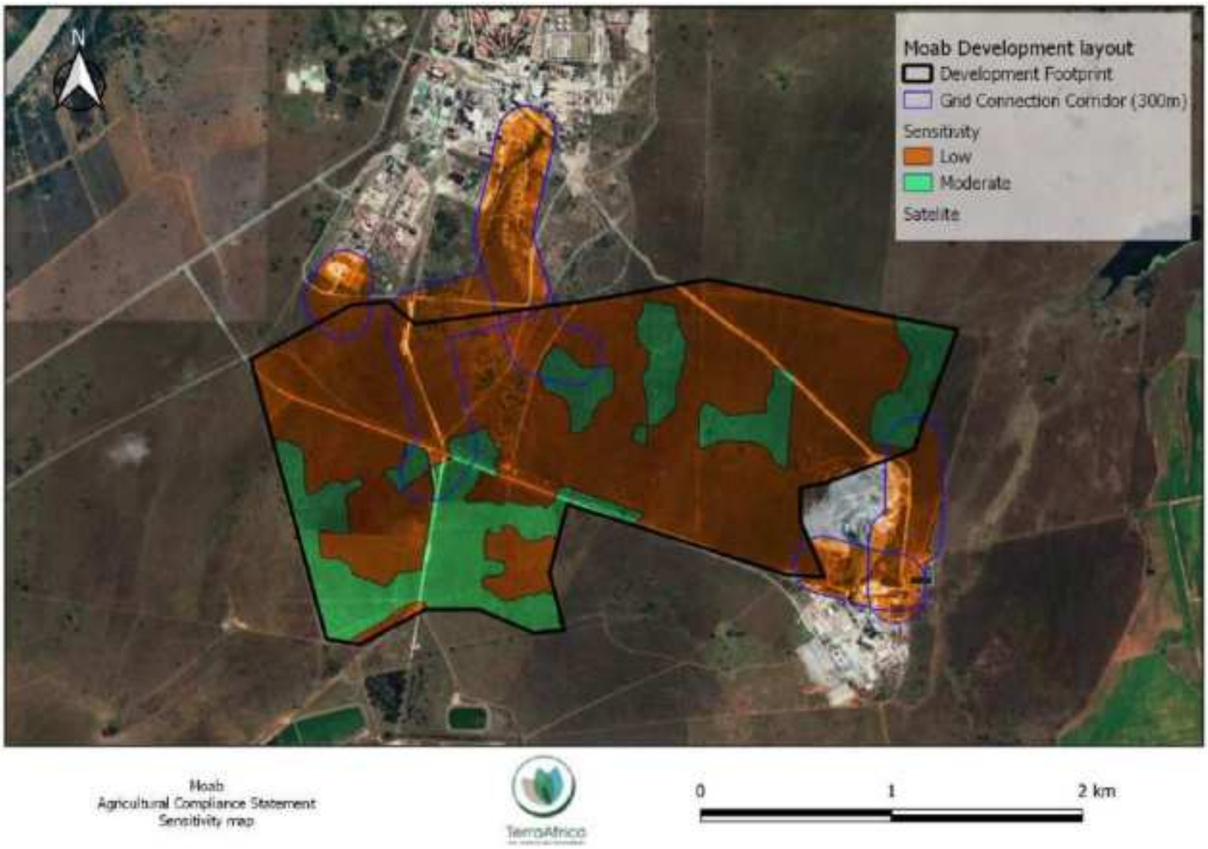

Figure 11 Agricultural sensitivity rating of the proposed Moab PV Facility facility development area and grid connection alternatives

11. Impact assessment

11.1 Project description

The infrastructure associated with the 100MW solar PV facility will include:

- PV modules and mounting structures.
- Inverters and transformers a SCADA room, and maintenance room.
- Cabling between the project components, to be laid underground where practical.
- Access roads, internal roads and fencing around the development area.
- Temporary and permanent laydown areas.
- Grid connection infrastructure including an on-site facility substation and a switching substation to be connected to the existing:
    - Vaalreefs Eleven Substation via a 3km overhead power line (located in the eastern corner of the site);
    - Southvaal Plant Substation via an up to 1km overhead power line (located in the western corner of the site);
    - and to the Southvaal Substation via a 2km overhead power line (located in the northern corner of the site).

The site is accessible via the R76 from Viljoenskroon which is south of the proposed site.

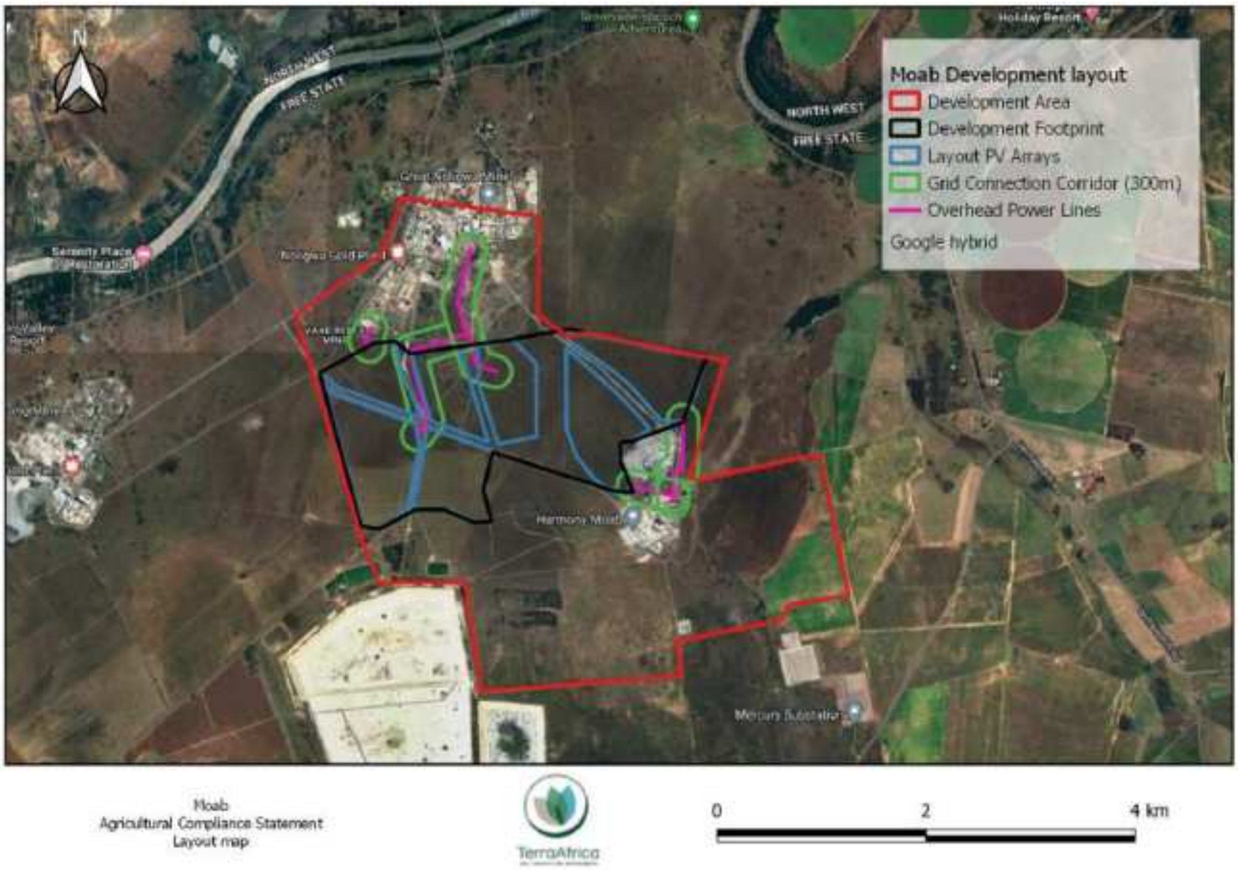

Figure 12 Layout of the Moab PV Facility's infrastructure

11.2 Impact significance rating

The most significant impacts of the proposed project on soil and agricultural productivity will occur during the construction phase when the vegetation is removed, and the soil surface is prepared for the delivery of materials and assembly of the infrastructure. During the operational phase, the risk remains that soil will be polluted by the waste generated 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 the rating of the significance of each of the impacts for each of the project phases.

11.2.1 Construction phase

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

Nature: Prior to construction of the project infrastructure, the PV development area will be fenced off and livestock farming will be excluded from the development footprint area.		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Medium duration (3)	Medium duration (3)
Magnitude	Moderate (6)	Low (4)
Probability	Definite (4)	Definite (4)
Significance	**Medium (40)**	**Medium (32)**
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. • 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 of the Moab PV Facility and Associated Infrastructure is considered medium.		
Cumulative Impacts: Any additional infrastructure development in support of the Moab 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, as the area falls within a region that experiences thunderstorms in the summer months and sometimes strong winds during the dry winter months, especially August and September.		
	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 (where the PV modules will be mounted) 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; and
- Stormwater channels must be designed to minimise soil erosion risk resulting from surface water runoff.

Residual Impacts:
The residual impact from the construction and operation of the project on the susceptibility to erosion is considered low.

Cumulative Impacts:
Any additional infrastructure development in support of the project will result in additional areas exposed to soil erosion through wind and water movement.

Impact: Soil compaction

Nature: The clearing and levelling of land for construction of the infrastructure will result in soil compaction. In the area where the access roads and substation will be constructed, topsoil will be removed, and the remaining soil material will be deliberately compacted to ensure a stable surface prior to construction.

	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;
- Materials must be off-loaded and stored in designated laydown areas;
- 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 project on soil compaction is considered low.

Cumulative Impacts:
Any additional infrastructure development in support of the project, 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. Potential spills and leaks from construction vehicles and equipment and 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; and
8. Any construction material remaining within the construction area once construction is completed.

	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;
- The construction site must be monitored by the Environmental Control Officer (ECO) to detect any early signs of fuel and oil spills and waste dumping;
- Ensure battery transport and installation by accredited staff / contractors; and
- 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 Moab PV facility and waste 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 project area daily. The following impacts on soil are 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 project area.		
	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 project, including the internal access roads, must regularly be monitored to detect early signs of soil erosion on-set; and • If soil erosion is detected, the area must be stabilised using geo-textiles and facilitated re-vegetation.		
Residual Impacts: The residual impact from the operation of the project 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 project will result in additional areas 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 and waste generation on site can result in soil pollution. Also, any spillages around the workshop area or damaged infrastructure, such as inverters and transformers, 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; and • Regularly monitor areas alongside the roads, parking area and workshop for any signs of oil, grease and fuel spillage or the presence of waste.		

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 Moab PV facility and waste 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 the risk of soil erosion will especially remain until the vegetation growth has re-established in the area where the project infrastructure was decommissioned.

11.3 Cumulative impact assessment and rating

"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[2].

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 project will result in:

- unacceptable risk;
- unacceptable loss;
- complete or whole-scale changes to the environment or sense of place; and
- unacceptable increase in impact.

The proposed project will be located within a 50km radius of five PV facilities that already have been granted Environmental Authorisation (see Figure **13**). These PV facilities are:

- Buffels Solar PV1 Solar Energy Facility
- Buffels Solar PV2 Solar Energy Facility
- Witkop Solar PV1 & PV2 Energy Facility
- Orkney Solar PV Energy Facility
- Kabi Vaalkop Solar PV Energy Facility

The cumulative impacts of the proposed project in addition to the authorised solar developments are rated and discussed below.

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

Table 3 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 4 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 Sections 11.2.1 and 11.2.2. above.		

Table 5 Assessment of cumulative impact of areas susceptible to soil compaction

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	Low (4)	Low (4)
Probability	Improbable (2)	Probable (3)
Significance	**Low (16)**	**Low (27)**
Status (positive/negative)	Negative	Negative

Reversibility	Low	Low
Loss of resources?	No	No
Can impacts be mitigated?	Yes	Yes
Confidence in findings: High.		
Mitigation: Each of the projects should adhere to the highest standards for soil compaction prevention and management, as defined in Sections 11.2.1 and 11.2.2 above.		

Table 6 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 Sections 11.2.1 and 11.2.2. above.		

12. Mitigation and management measures

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

<u>Prevention and management of soil erosion:</u>

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.	Environmental Officer / SHEQ division	During the entire construction, operational and decommissioning phases

• 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 is expected. • Re-establish vegetation along the access road to reduce the impact of run-off from the road surface.		

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 are 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 and waste generation 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.	Environmental Officer / SHEQ division	During the entire construction, operational and decommissioning phases

• Any waste generated during construction must be stored in 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.		

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.

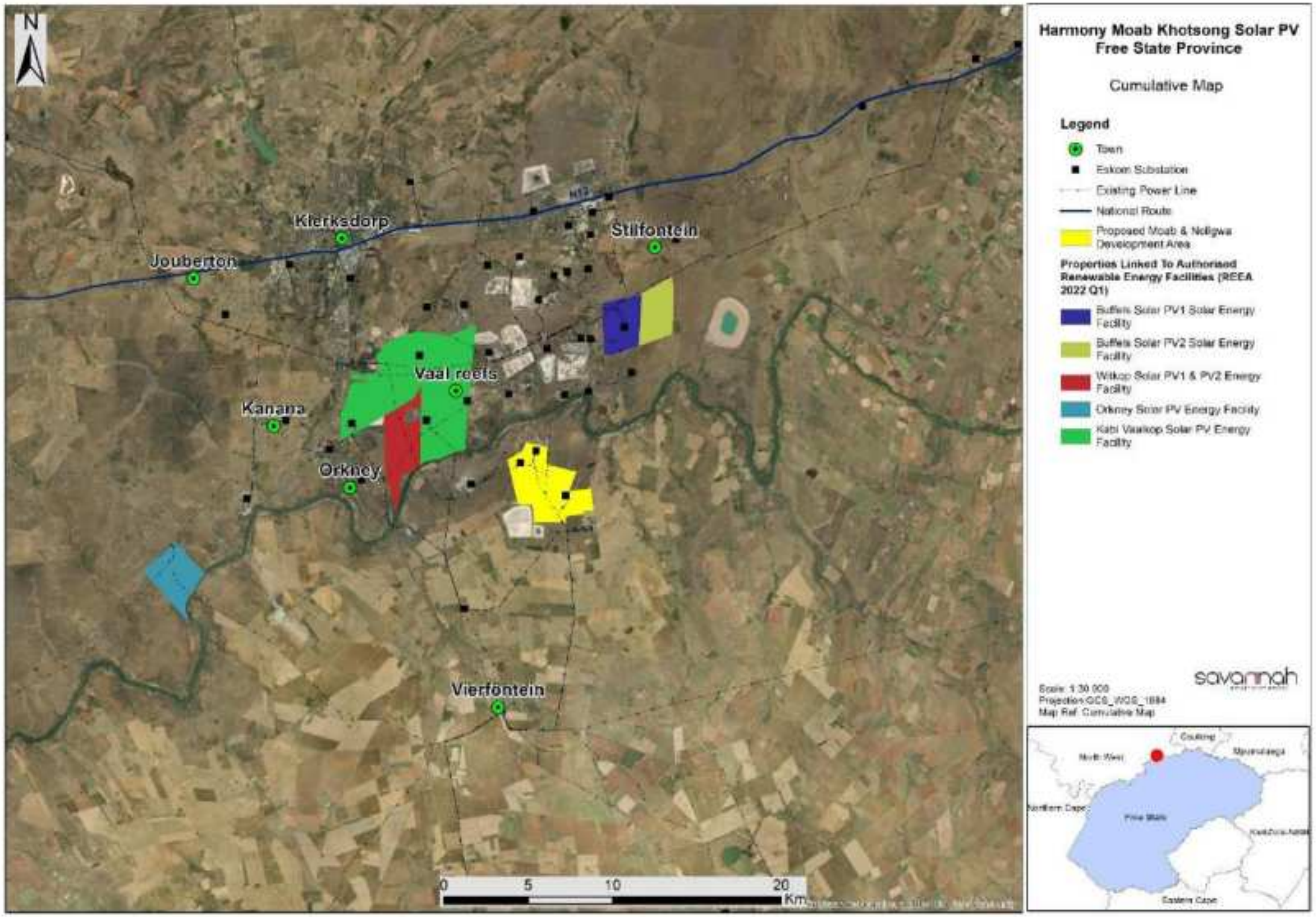

Figure 13 Renewable energy projects within a 50km radius around the proposed Moab PV Facility (source: Savannah Environmental, 2022)

13. Acceptability statement

Following the data analysis and impact assessment above, the proposed Moab PV Facility and Associated Infrastructure is considered an acceptable development within the development footprint area that was assessed for the purpose of compiling the Agricultural Assessment Report.

The soil forms present within the development footprint consist mostly of Glenrosa soil form which is shallow soils with depths between 100 and 200mm. The Glenrosa soils are assigned Low sensitivity to the proposed development. Areas with deeper soils are also present and these soils were assigned Medium sensitivity (166ha). There is no rainfed or irrigated crop production within the development footprint. There is also no irrigation infrastructure, such as centre pivots or drip irrigation, present within the project area. The grazing capacity (according to DALRRD, 2018), is 7ha/LSU, indicating that the proposed development area of 545ha has forage to feed 77 head of cattle.

The project infrastructure layout aims to avoid any crop fields and to be located directly next to the Harmony Moab Plant. I therefore confirm that 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 this application be considered favourably, permitting that the mitigation measures 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 project area that will be fenced off.

14. Reference list

Crop Estimates Consortium, 2019. *Field crop boundary data layer (NW province)*, 2019. Pretoria. Department of Agriculture, Land Reform and Rural Development.

Department of Agriculture, Land Reform and Rural Development, 2019. *High potential agricultural areas 2019 – Spatial data layer*, *North West Province*, 2021. Pretoria.

Department of Agriculture, Land Reform and Rural Development, 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.

Department of Agriculture, Land Reform and Rural Development, 2016. *National land capability evaluation raster data: Land capability data layer*, 2016. Pretoria.

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

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

APPENDIX 1 – DECLARATION OF INDEPENDENCE AND SPECIALIST DETAILS

1. SPECIALIST INFORMATION

Specialist Company Name:	TerraAfrica Consult CC			
B-BBEE	Contribution level (indicate 1 to 8 or non-compliant)	4	Percentage Procurement recognition	100%
Specialist name:	Mariné Pienaar			
Specialist Qualifications:	MSc. Environmental Science (Wits) ; BSc. (Agric) Plant Production (UP)			
Professional affiliation/registration:	SACNASP Registration No 400274/10 Soil Science Society of South Africa ; IAIAsa			
Physical address:	Farm Strydpoort 403, Ottosdal, 2610			
Postal address:	P.O. Box 433, Ottosdal			
Postal code:	2610	Cell:	082 828 3587	
Telephone:	082 828 3587	Fax:	N/A	
E-mail:	mpienaar@terraafrica.co.za			

2. DECLARATION BY THE SPECIALIST

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.

Signature of the Specialist

TerraAfrica Consult

Name of Company:

2022-07-08

Date

Details of Specialist, Declaration and Undertaking Under Oath

Page 2 of 3

APPENDIX 2 - CURRICULUM VITAE OF SPECIALIST

MARINÉ PIENAAR

Specialist Scientist

+2782-828-3587

mpienaar@terraafrica.co.za

linkedin.com/in/marinepienaar

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

MARINÉ PIENAAR
Specialist Scientist

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

MARINÉ PIENAAR

Specialist Scientist

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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reneejvr@cigroup.za.com

APPENDIX 3 – PROOF OF SACNASP REGISTRATION OF SPECIALIST

SACNASP
South African Council for Natural Scientific Professions

herewith certifies that

Mariné Pienaar

Registration Number: 400274/10

is a registered scientist

in terms of section 20(3) of the Natural Scientific Professions Act, 2003
(Act 27 of 2003)
in the following fields(s) of practice (Schedule 1 of the Act)

Soil Science (Professional Natural Scientist)
Agricultural Science (Professional Natural Scientist)

Effective **20 October 2010** Expires **31 March 2023**

Botha
Chairperson

Chief Executive Officer

To verify this certificate scan this code

HERITAGE IMPACT ASSESSMENT

In terms of Section 38(8) of the NHRA for the

Proposed development of the 100MW Harmony Moab Khotsong Solar PV Facility, Vierfontein, Free State Province

SAHRIS Ref:

Prepared by CTS Heritage

CTS HERITAGE

For

Savannah Environmental

July 2022

Updated September 2022

EXECUTIVE SUMMARY

1. Site Name:

100MW Harmony Moab Khotsong Solar PV Facility, Vierfontein, Free State Province

2. Location:

10km southeast of Orkney

3. Locality Plan:

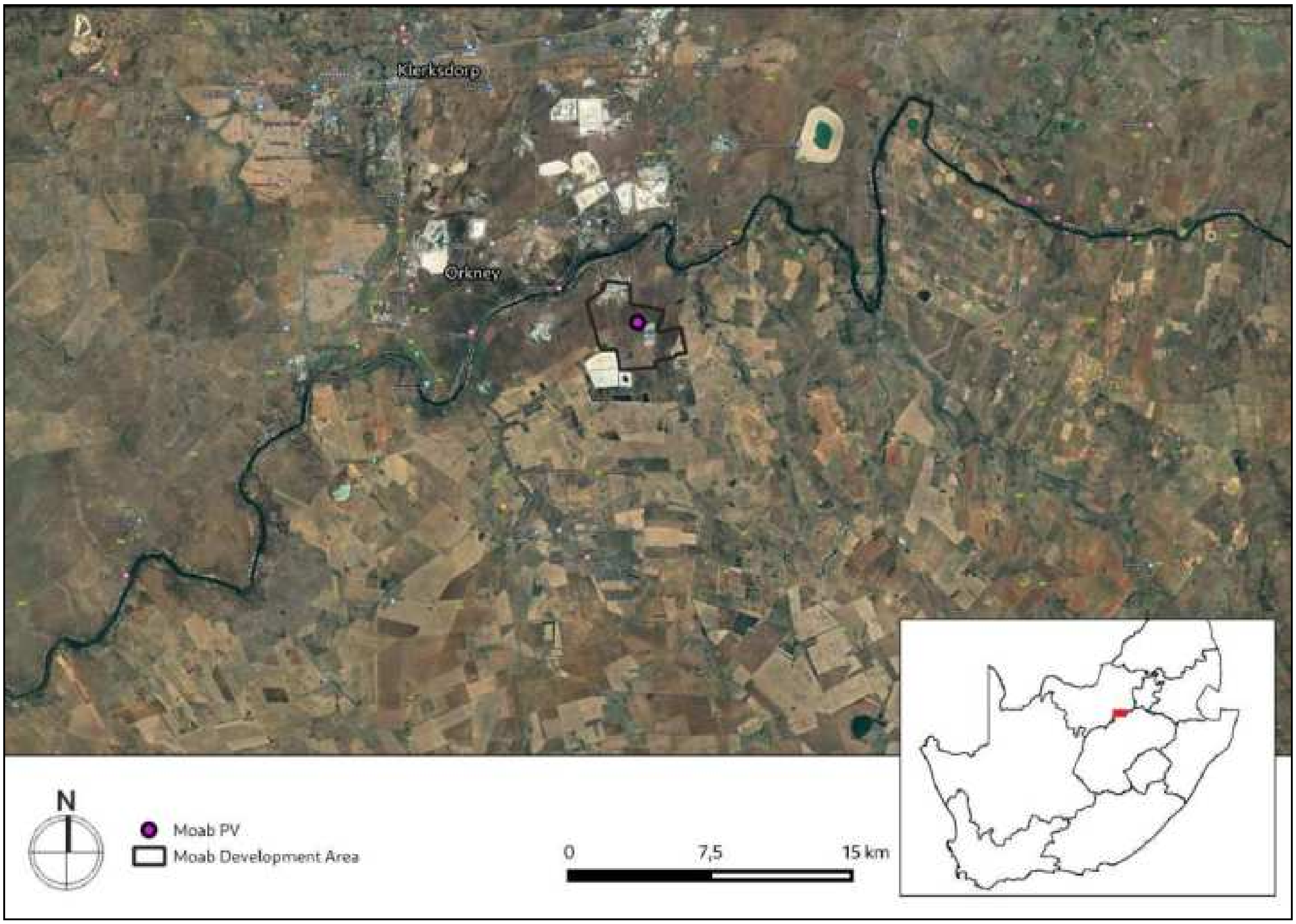

Figure 1: Location of the proposed study area

4. Description of Proposed Development:

The development of a renewable energy facility, overhead powerline and associated infrastructure is proposed by HARMONY MOAB KHOTSONG OPERATIONS PTY (LTD). The project entails the development of three (3) separate solar PV facilities with a combined contracted capacity of up to 100MW over 450 ha of land and will be known as Harmony Moab Khotsong Solar PV Facility, each facility will include a grid connection and other associated infrastructure.

The Solar PV facilities are based near Harmony Moab mining operations and fall within the Klerksdorp Renewable Energy Development Zone (REDZ) located ~10km North of the town of Vierfontein within the Moqhaka Local Municipality respectively, and within the Fezile Dabi District Municipality, Free State Province.

5. Heritage Resources Identified in and near the study area:

Site No.	Site Name	Description	Period	Co-ordinates		Grading	Mitigation
CM1	Moab 1	Isolated artefacts on sub-volcanic rock: Levallois core; Bladelet core and several flakes	MSA/LSA	-26.98790498	26.80750899	IIIC	30m Buffer
CM2	Moab 2	Chert outcrop with evidence of hominin exploitation	Stone Age	-26.98115604	26.77801601	NCW	NA
CM3	Moab 3	Isolated chert artefacts: several flakes	LSA	-26.97650903	26.78688196	NCW	NA

6. Anticipated Impacts on Heritage Resources:

The areas surveyed as part of this assessment have been transformed through agricultural interventions and/or mining activity. As such, it is not surprising that the results of the survey only identified one site of scientific cultural value - CM1 located outside of the area proposed for the Moab PV development and graded IIIC.

The identified site of archaeological significance has the potential to provide scientific insight into the past and as such, it is recommended that this area is not impacted by the proposed development. It is therefore recommended that no-go development buffers as per the recommendations below are implemented. Further, it is recommended that these sites are mapped on all relevant SDPs and that on-going conservation measures are put in place in the EMPrs for the developments.

Furthermore, no impacts to significant palaeontological heritage is anticipated on condition that the attached Chance Fossil Finds Process is implemented and no impacts to the cultural landscape are anticipated.

7. Recommendations:

There is no objection to the proposed development in terms of impacts to heritage resources on condition that:

- The 30m buffer area recommended around site CM1 is implemented
- The attached Chance Fossil Finds Procedure is implemented for the duration of construction activities

- Should any buried archaeological resources or human remains or burials be uncovered during the course of development activities, work must cease in the vicinity of these finds. The South African Heritage Resources Agency (SAHRA) must be contacted immediately in order to determine an appropriate way forward.

Details of Specialist who prepared the HIA

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 100 Heritage Impact Assessments throughout South Africa.

CTS HERITAGE

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APPENDICES

1. INTRODUCTION

1.1 Background Information on Project

Harmony Moab Khotsong Operations (Pty) Ltd 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 development of a solar photovoltaic (PV) facility with a generating capacity of up to 100MW is proposed north of the Harmony Gold Moab Khotsong operations, approximately ~10km north of the town of Vierfontein within the Moqhaka Local Municipality and within the Fezile Dabi District Municipality, Free State Province.

The PV facility is located on:

- the Farm Anglo 593;
- Farm Hoekplaats 598;
- Farm Mispah 274;
- Portion 1 of Farm Zaaiplaats 190;
- Remaining Extent of Farm Doornkom Wes 446;
- Portions 1, 3, 4, 5, of Farm Chrystalkop 69;
- and the Remaining Extent of the Farm Zuiping 394,

The properties are owned by the Mine. The solar PV development will be known as Harmony Moab Khotsong Solar PV Facility.

The preferred site for the projects is on properties which are owned by Harmony Gold and are available for the proposed projects and is therefore deemed technically feasible by the project developer for such development to take place.

A project site considered to be technically suitable for the development of the solar PV facility, with an extent of approximately 1400ha, was identified. A development area of ~900ha was demarcated within this project site and allows an adequate footprint (~450ha) for the installation of a solar PV facility with a contracted capacity of up to 100MW, while allowing for the avoidance of environmental site sensitivities.

The full extent of the project site is to be evaluated in the Basic Assessment process to identify sensitivities. Site-specific studies and assessments will delineate areas of potential sensitivity within the identified study area. Once constraining factors have been confirmed, the layout of the solar PV facility within the development area can be planned to avoid sensitive environmental areas and features.

The infrastructure associated with the 100MW solar PV facility will include:

- PV modules and mounting structures.
- Inverters and transformers a SCADA room, and maintenance room.
- Cabling between the project components, to be laid underground where practical.
- Access roads, internal roads and fencing around the development area.
- Temporary and permanent laydown areas.
- Grid connection infrastructure including an on-site facility substation and a switching substation to be connected to the existing:
- Vaalreefs Eleven Substation via a 3km overhead power line (located in the eastern corner of the site);
- Southvaal Plant Substation via an up to 1km overhead power line (located in the western corner of the site);
- and to the Southvaal Substation via a 2km overhead power line (located in the northern corner of the site).

The site is accessible via the R76 from Viljoenskroon which is south of the proposed 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 (Chamber of Mines of South Africa, 2017). The successful development of the renewable energy project will enable Harmony Gold to make a valuable and meaningful contribution towards growing the green economy within the Free State Province and South Africa. This will assist the Free State in creating green jobs and reducing Green House Gas emissions, while reducing the energy demand on the Eskom national grid.

1.2 Description of Property and Affected Environment

The potentially affected area related to the proposed PV facility is located across the Moab mining area and some privately owned agricultural camps in the east, approximately 12 km south-east of the town of Orkney. Although Orkney is located in the North-West province, the PV footprint is located across the southern bank of the Vaal River, on the northern border of the Free State province of South Africa.

Much of the footprint has been affected by sporadic surface disturbance and modern excavation likely associated with historical agricultural activities (and modern ploughed fields to the east of the Moab boundary included in the affected footprint) (CMB3), with mining prospection and the development of mining related infrastructure (CMB26). Where the natural vegetation is retained, it comprises grassland typical of the southern African Grassland Biome in the summer-rainfall region interspersed with acacia, and in some areas, such as the south-west, dense invasive forest comprising eucalyptus plantation and occasional black Wattle (CMB10). Chert bedrock outcrops in multiple locations (CMB4) in the north-west and in the south-east (some with clear prehistoric exploitation traces) (CM2). Where indigenous grassland is retained, evidence of smaller antelope (such as Duiker and Steenbok), abundant Vervet monkeys, indigenous fowl including francolin, spurfowl and guineafowl, as well as traces of burrowing rodents (molerats, hares and meerkats) were observed within the affected area.

The topography of the project area is generally flat. It declines, however, gradually in the south-east where a drainage channel is located associated with Middle and Later Stone Age materials. There is extensive disturbance in the form of recent and historical clearing associated with probable mining-related activities. Bioturbation in the form of rodent activity is evident in the upper ~0.4-1m of sandy topsoil, as well as evidence for past stock rotation farming in the southern portion (probably prior to the land being owned by the mining company), and modern stock farming and bean plantation in the most easterly portion (on what looks to be privately owned/leased land).

The sandy upper sediments look to be fluvially deposited across much of the area, with very few lithic inclusions (some marginally rounded), indicating low-energy deposition in the north-western portions probably related to the Vaal river system, and with primary nodules of chert (5-10cm in maximum diameter) deriving from the local bedrock.

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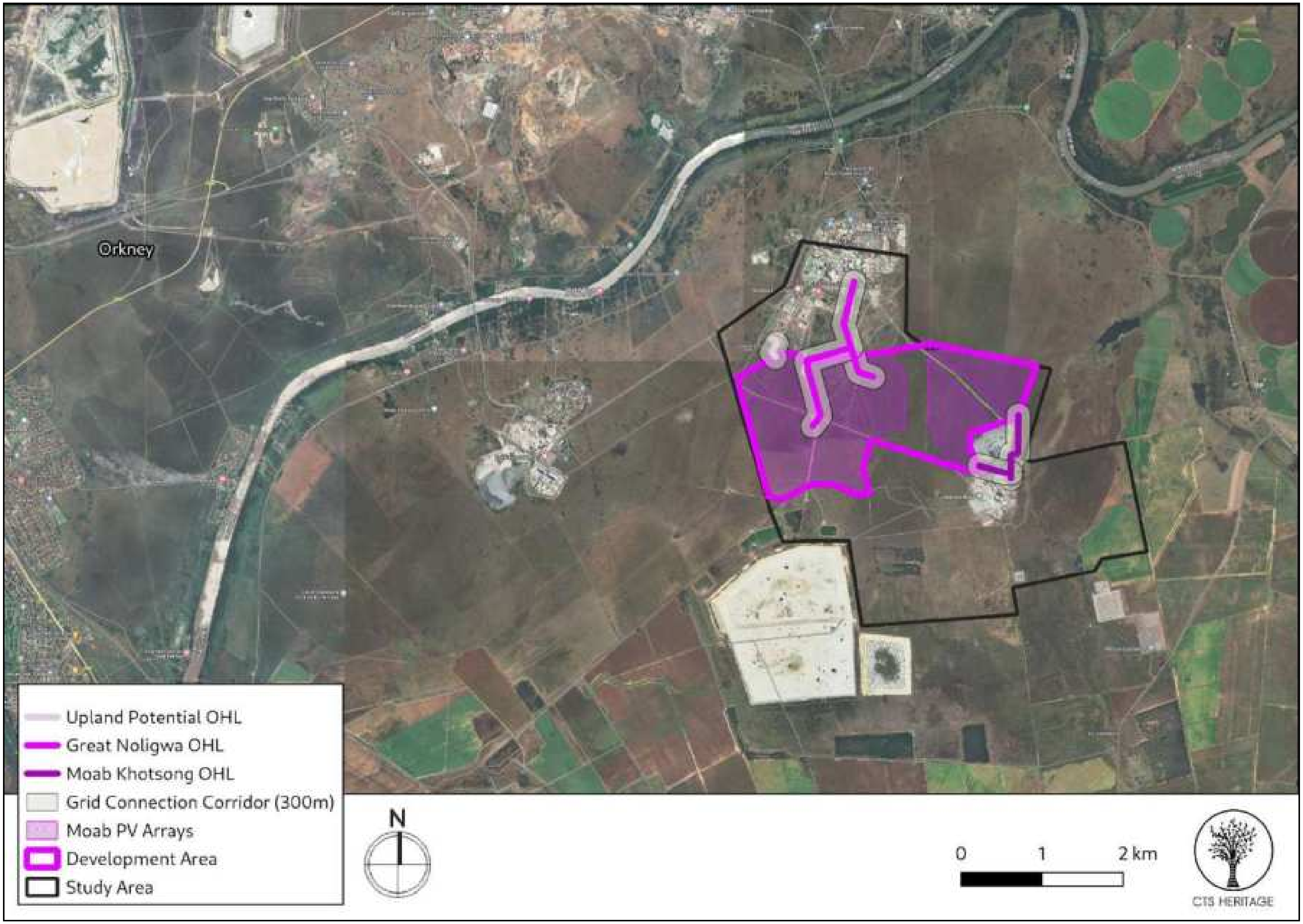
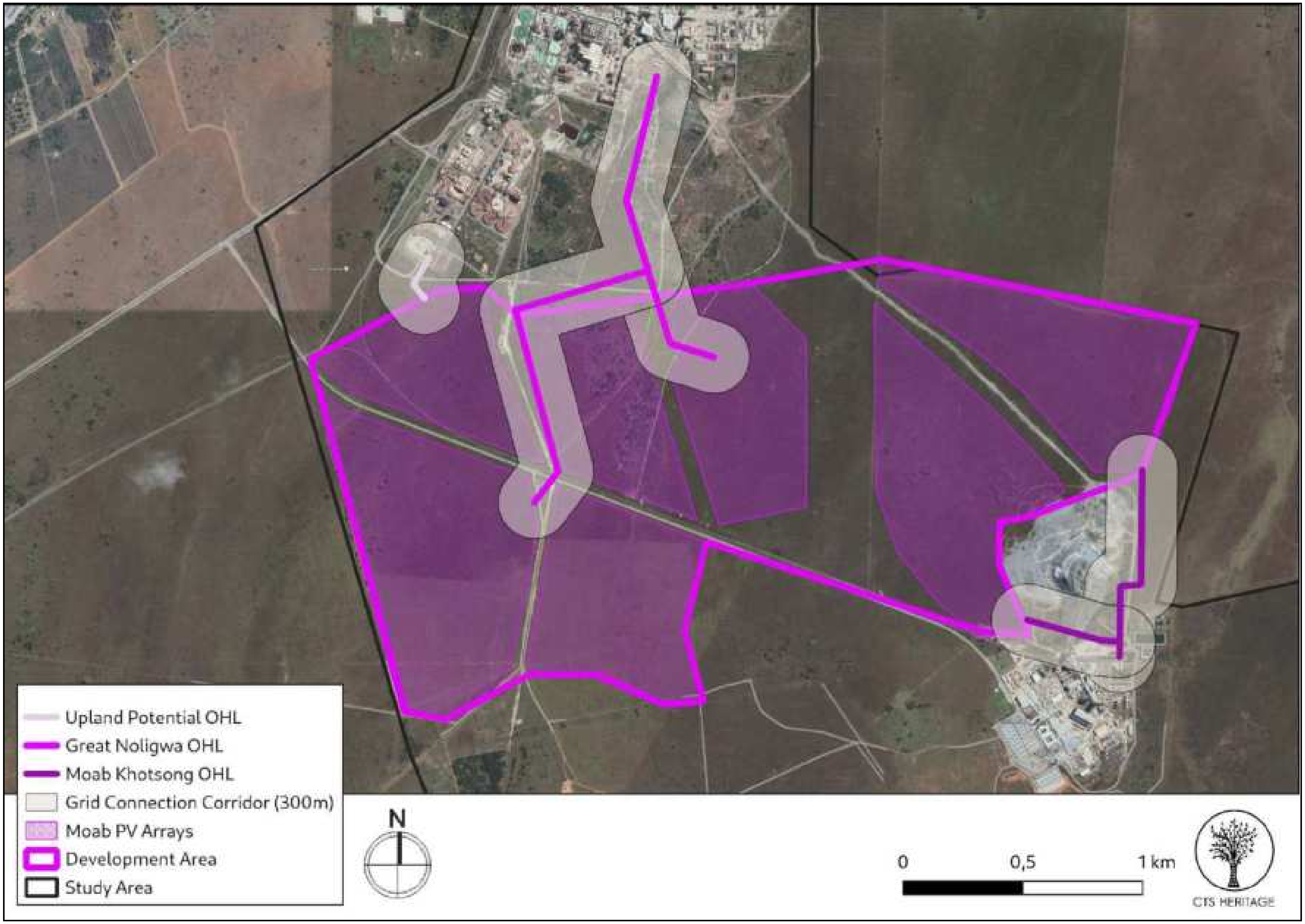


Map 1.1: The proposed development area



Map 1.2: The proposed development area

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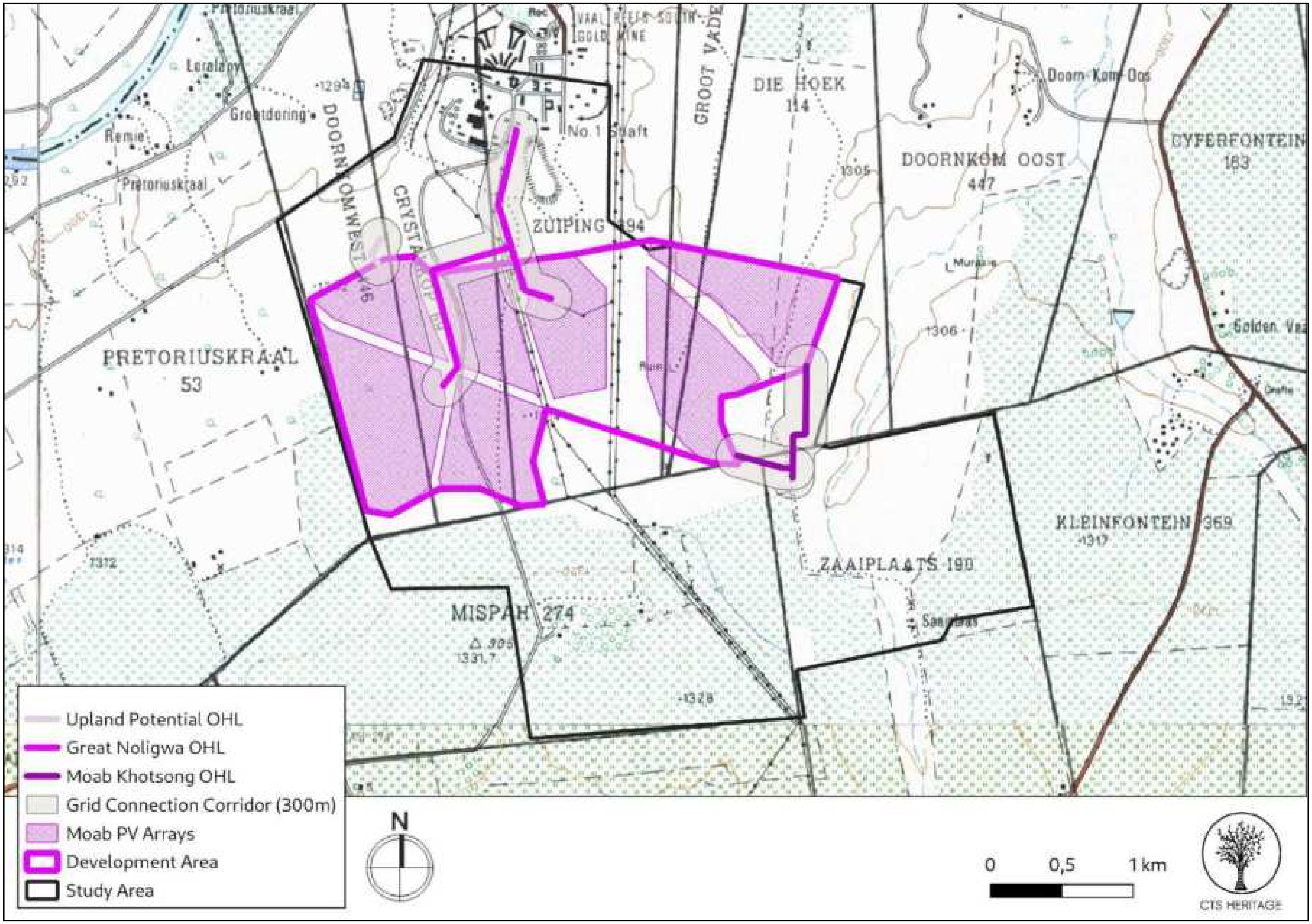


Map 1.3: Study Area reflected on the 1:50 000 Topo Map

Cedar Tower Services (Pty) Ltd t/a CTS Heritage
Bon Esperance, 238 Queens Road, Simons Town
Email info@ctsheritage.com **Web** http://www.ctsheritage.com

2. METHODOLOGY

2.1 Purpose of HIA

The purpose of this Heritage Impact Assessment (HIA) is to satisfy the requirements of section 38(8), and therefore section 38(3) of the National Heritage Resources Act (Act 25 of 1999).

2.2 Summary of steps followed

- A Desktop Study was conducted of relevant reports previously written (please see the reference list for the age and nature of the reports used) (Appendix 1)
- An archaeologist conducted an assessment of the broader study area in order to determine the archaeological resources likely to be disturbed by the proposed development. The archaeologist conducted her site visit on 8 and 9 June 2022 (Appendix 2)
- A Desktop Palaeontology Assessment was completed 6 July 2022, Appendix 3)
- The identified resources were assessed to evaluate their heritage significance and potential impacts to these resources were interrogated
- Alternatives and mitigation options were discussed with the Environmental Assessment Practitioner

2.3 Assumptions and uncertainties

- The *significance* of the sites and artefacts is determined by means of their historical, social, aesthetic, technological and scientific value in relation to their uniqueness, condition of preservation and research potential. It must be kept in mind that the various aspects are not mutually exclusive, and that the evaluation of any site is done with reference to any number of these.

- It should be noted that archaeological and palaeontological deposits often occur below ground level. Should artefacts or skeletal material be revealed at the site during construction, such activities should be halted, and it would be required that the heritage consultants are notified for an investigation and evaluation of the find(s) to take place.

However, despite this, sufficient time and expertise was allocated to provide an accurate assessment of the heritage sensitivity of the area.

2.4 Constraints & Limitations

Dense grasses and occasional shrubland cover portions of the project area. This coverage significantly inhibited the visibility of surface archaeology. However, this is not regarded as a substantial problem in relation to the Stone Age archaeological remains, which in most cases look to have generally limited scientific importance due to the disturbed and deflated contexts they occur in. Additionally, even in the places that had optimal visibility, evidence of archaeology was extremely sparse. It is clear that the Stone Age sensitivity and scientific potential of the project area has been comprehensively assessed.

The inability to assess some of the footprint area at ground surface level in some portions (due to modern vegetation cover), should be regarded as a constraint to the documentation of potential graves.

Previous vegetation clearing activities through prospection may have affected evidence of surface archaeology including the possible above-surface presence of material evidence of graves (i.e. the removal of surface stone structures).

Upper sediments are substantially disturbed in the eastern portion where crops are actively growing and cattle grazing is evident (in the area that appears to be private property).

Access was inhibited in areas actively mined; however, any archaeology occurring in these areas would likely be *ex situ* in any case, and of limited scientific importance.

The team is confident that, despite these challenges, the work completed has provided a sufficient assessment of the heritage sensitivity of the area proposed for development.

2.5 Savannah Impact Assessment Methodology

Direct, indirect and cumulative impacts of the issues identified through the Basic Assessment process were 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.
    - Permanent – assigned a score of 5.
- The consequences (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.
- 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:

$S = (E + D + M) \times P$

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).

3. HISTORY AND EVOLUTION OF THE SITE AND CONTEXT

3.1 Desktop Assessment

Background

The assessment area for the proposed PV Solar farms and grid connections is situated north and south of the R76 close to the town of Viljoenskroon in the Free State Province. It falls within the jurisdiction of the Moqhaka Local Municipality in the Fezile Dabi District Municipality and is located within the existing Harmony Mine.

Built Environment & Cultural Landscapes

The development area is located in peri-urban farms just outside the towns of Orkney (North West) and Viljoenskroon (Free State). The town of Orkney was established in 1940 at the junction of the various railway lines. It was name after the old gold mine opened by Thomas Leask, who came from the Orkney Islands, in 1880 (SESA 1973 in Van Schalkwyk 2021). Viljoenskroon is a maize and cattle farming town located in the Free State province of South Africa. It was named after the original farm owner J. J. Viljoen and his horse Kroon. The town was laid out in 1921 on the farm "Mahemskuil" and became a municipality in 1925. A number of large gold and diamond mines are also located inbetween the three solar PV sites, namely Taulekoa Mine next to Goedgenoeg 433, Kopanong Gold Mine next to Pretorius Kraal 53 and Great Noligwa Mine next to Groot Vaders Bosch 592. Ruins of or intact avenues of trees, historical farmsteads and farm labourer's cottages may potentially be found within the proposed development areas. The cultural landscape is characterised by a agriculture with abrupt transitions into extremely heavy industrial areas in and around the mining compounds. The installation of solar PV plants is therefore unlikely to have any impacts on the landscape character of the area.

Archaeology

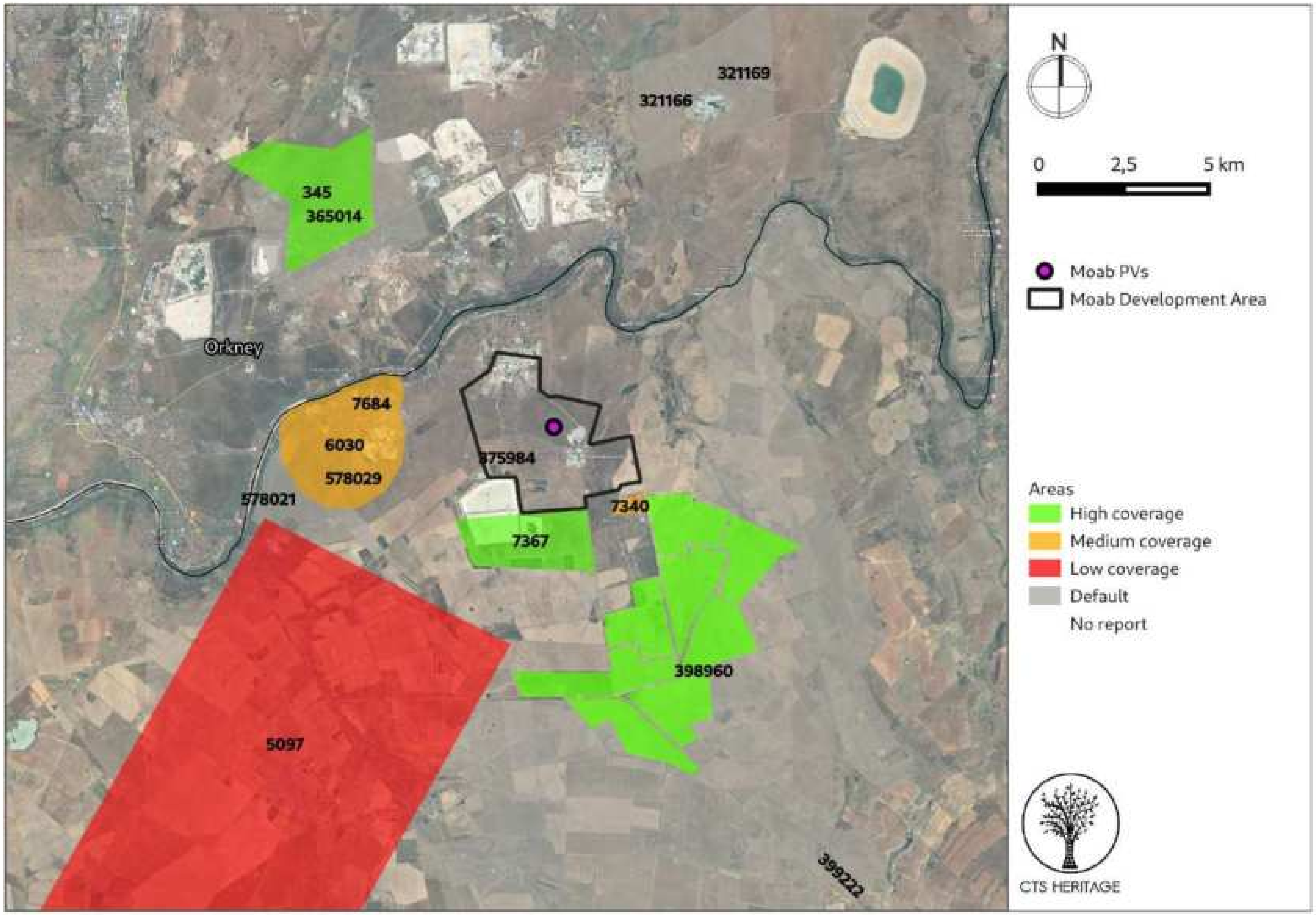
Archaeological sites spanning the Earlier, Middle and Later Stone Age have been found in the region despite the extensive agricultural transformation of the area. In Dreyer (2005) and Van der Walt's (2007) heritage impact assessments of the nearby Pretorius Kraal 53, various modern buildings were recorded that are located near the banks of the Vaal River that were deemed as not conservation worthy. Van der Walt identified some Middle to Later Stone Age artefacts scattered across the farm but did not map them. In Van Schalkwyk's (2021) impact assessment of the Siyanda Solar farm on Grootdraai 468 (which lies on the western border of Pretorius Kraal 53), visibility issues were a major problem,

"Due to the very dense vegetation cover that occur in the project area, natural as well as agricultural fields, it was impossible to obtain any ground visibility. The strategy was therefore to examine natural and man-made features that are usually associated with human habitation and activities such as clumps of trees and rock outcrops. The proposed power line corridor connecting the Solar Power Plant to the the existing Vaal Reef Substation was not surveyed as access to the relevant properties (Pretoriuskraal 53) was not possible. It is proposed that once the power line route has been confirmed within the 100m corridor a heritage walk-though needs to be undertaken."

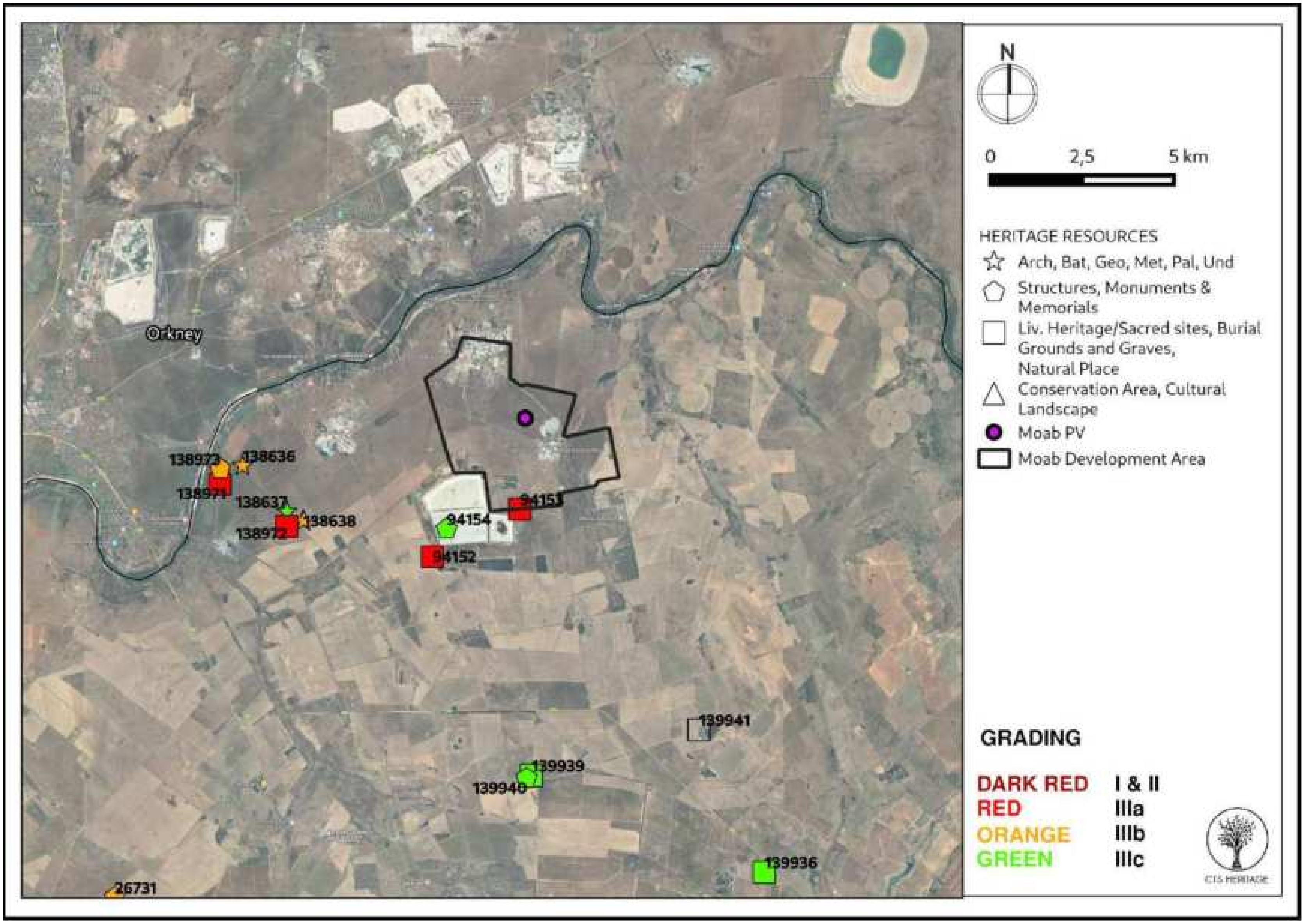
Two burial sites were recorded during this survey despite the lack of Stone Age sites with the help of a local informant who had been working on the property for a number of years.

In his assessment of an area immediately adjacent to the project area, Huffman (2005, SAHRIS ID 7367) identified no sites of archaeological interest. In their assessment of an area located immediately adjacent to the areas proposed for development, Henderson and Koortzen (2007, SAHRIS ID 7340) noted that while no sites were found in the area surveyed, a number of previously excavated inspection pits yielded archaeological material in the form of stone artefacts. Henderson and Koortzen (2007, SAHRIS ID 7340) note that "These artefacts had been brought up from an unknown depth (probably no more than a metre or two), and were mostly undiagnostic flakes with one blade-like flake which could be Middle Stone Age. Raw material included cryptocrystalline, chert and quartz."

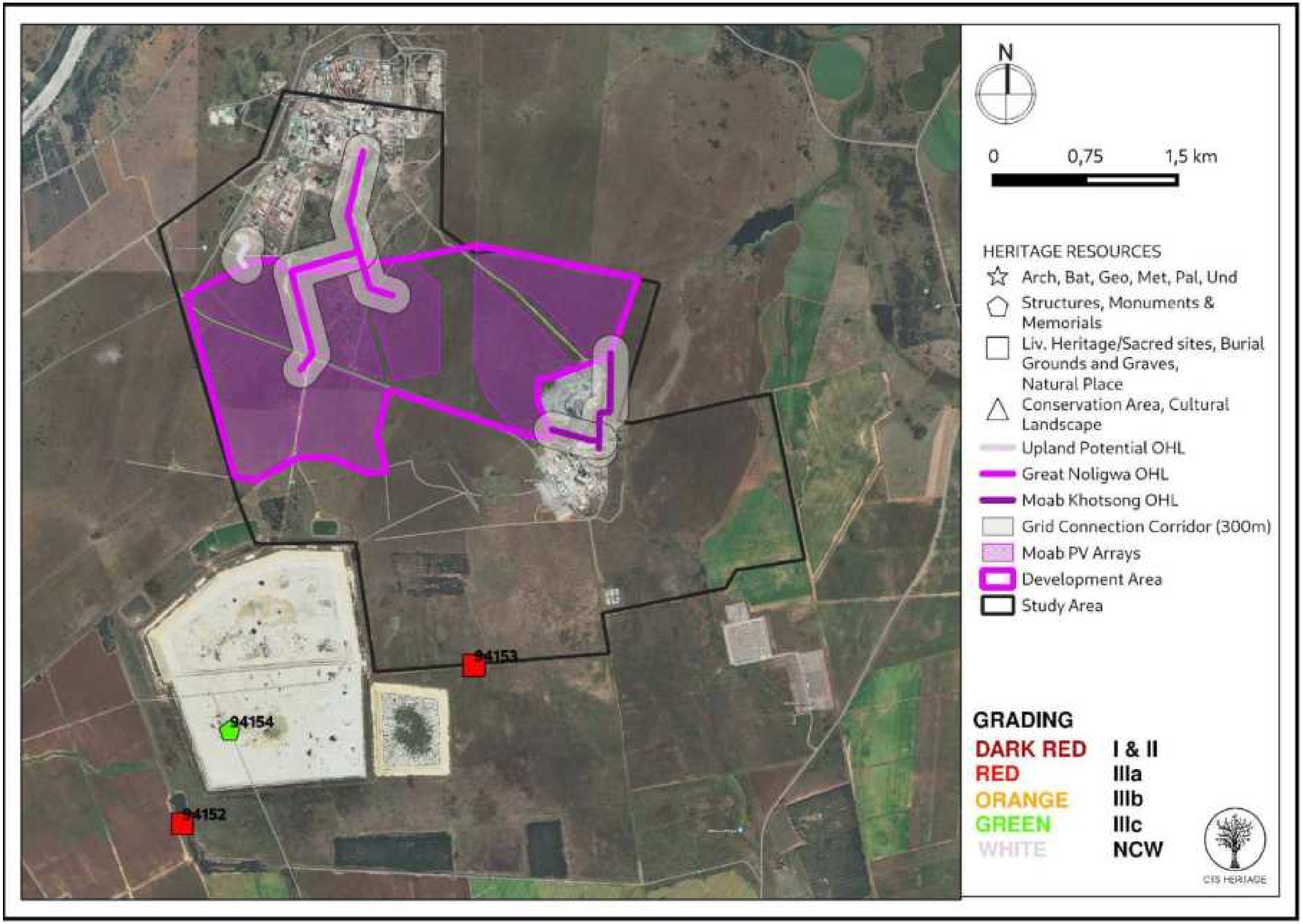
In an assessment completed by CTS Heritage for a proposed PV facility located nearby, a single site and very few isolated individual artefacts were documented. Cumulatively these findings indicate cultural evidence for MSA and LSA occupations of the area. It was noted that the majority of finds were identified in disturbed surface contexts, and could not be tied chrono-culturally to a particular prehistoric period, however one site (VK4) was relatively less affected by post-depositional processes, and may have been exposed relatively recently. Apart from this one site, the potential for finding a dateable *in-situ* archaeological horizon based on current surface observations appears to be low. The documented archaeology is therefore classified as scientifically LOW-SIGNIFICANCE. It is therefore highly likely that further burials may be located on the proposed solar PV areas as well as Stone Age material similar to the artefacts recorded but not mapped by Van der Walt. An archaeological field survey is therefore recommended.



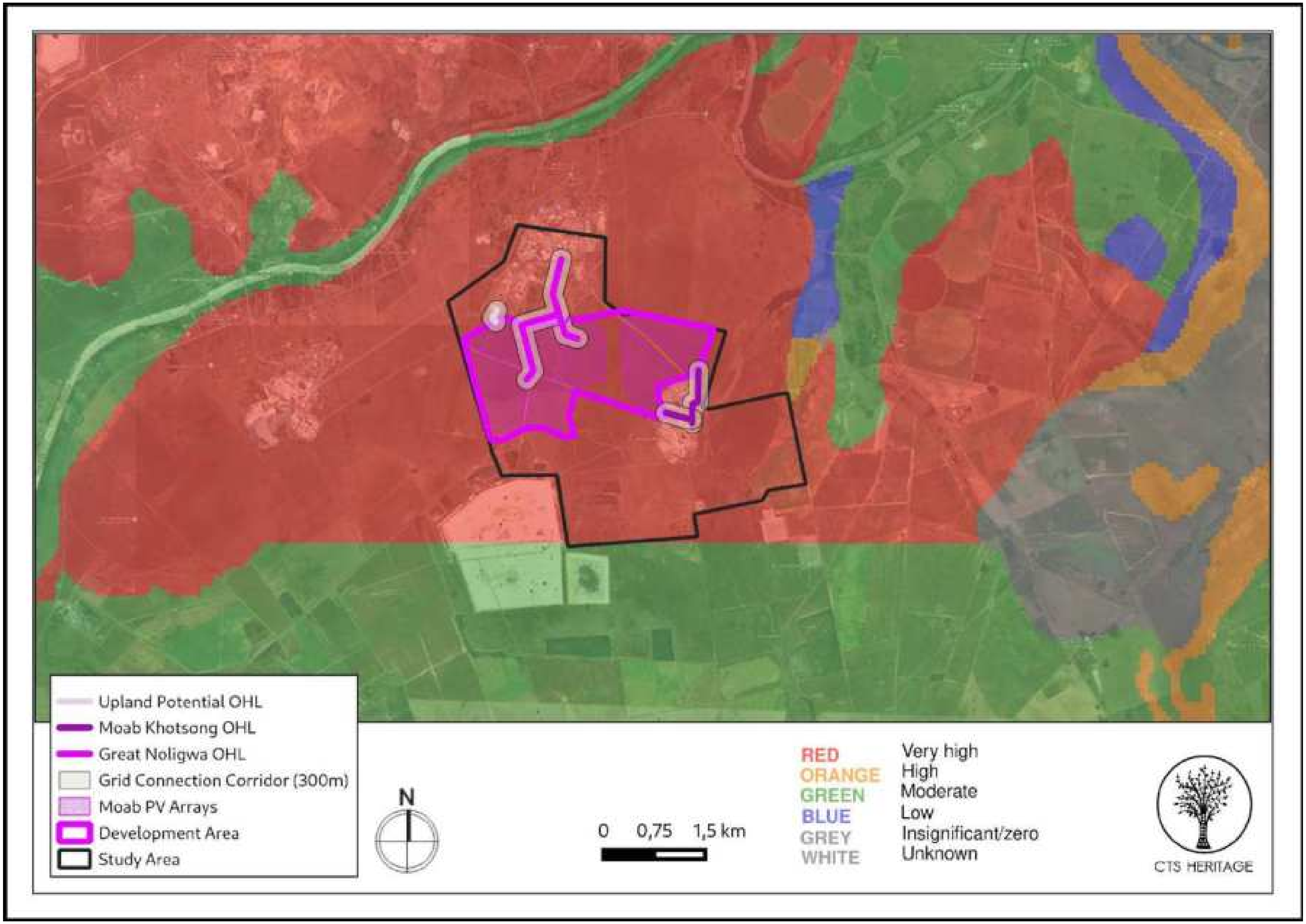
Map 2.1: Spatialisation of heritage assessments conducted in proximity to the broader study area



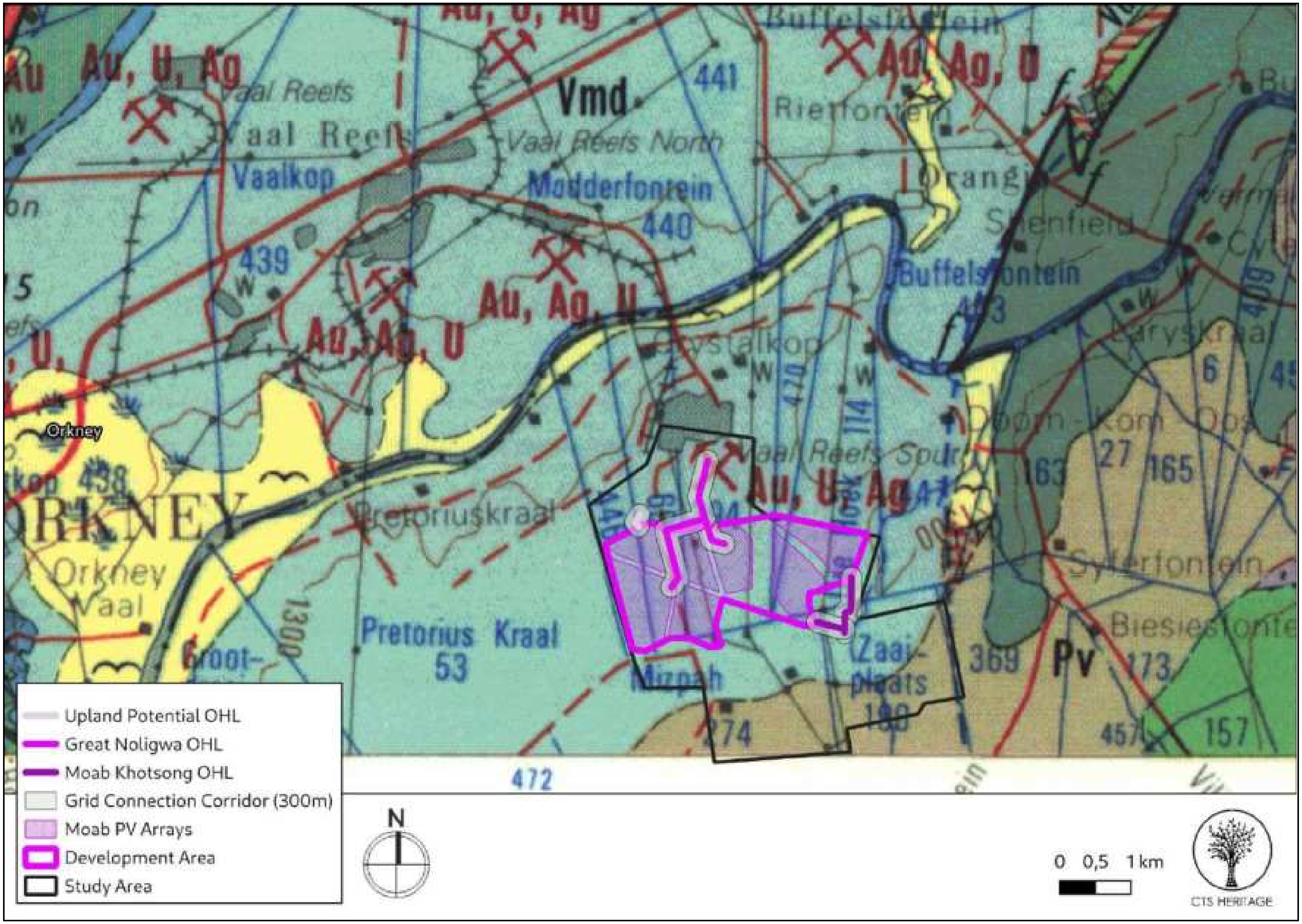
Map 2.2: Spatialisation of heritage resources known in proximity to the broader study area



Map 2.3: Spatialisation of heritage resources known in proximity to the broader study area



Map 3.1: Palaeontological sensitivity of the area surrounding the broader study area



Map 3.2: Geology Map. Extract from the CGS 2626 West Rand Geology Map indicating that the development area is underlain by sediments of the (Pv) Vryheid Formation and (Vmd) Malmani Subgroup.

3.2 Palaeontology

According to the SAHRIS Palaeosensitivity Map the development sites are underlain by sediments of Low to Very High fossil sensitivity (Figure 4a). The solar PV sites are underlain by sediments of the Malmani subgroup (Vmd) and the Vryheid Formation (Figure 4b). In his assessment of the Siyanda Solar Plant, Almond (2021) found "*several large float blocks on either side of farm track comprising pale grey to yellowish-weathering chert within mm-scale fine internal lamination, locally convolute or with zones of regular, stromatolite-like, upward-convex stacked laminae. These might be pseudostromatolites - i.e. abiogenic sedimentary structures formed by isopachous cement growth - rather than true microbially-bound stromatolites.*"

In a PIA completed by Bamford (2022) for an adjacent PV development, it was noted that "The proposed site lies on the moderately sensitive Quaternary sands and alluvium which might have trapped transported and fragmentary fossils if there are such features as palaeo-pan and palaeo-springs. The land has been cultivated or grazed for decades and no such feature is visible in the satellite imagery. Due to inconsistency in the geological maps it appears that (the development is located) on very highly sensitive rocks of the Vryheid Formation that are most likely covered by Quaternary sands and alluvium." Based on the geology of the area and the palaeontological record as we know it, it can be assumed that the formation and layout of the dolomites, sandstones, mudstones, shales and sands are typical for the country and might contain fossil plant, insect, invertebrate and vertebrate material. The sands and soils of the Quaternary period would not preserve fossils.

Based on the nature of the project, surface activities may impact upon the fossil heritage if preserved in the development footprint. The geological structures suggest that the rocks are the right age and type to contain fossils but the area is covered in deep cultivated soils. Since there is an extremely small chance that fossils from the Vryheid Formation may occur below ground and may be disturbed a Fossil Chance Find Protocol has been added to this report. Taking account of the defined criteria, the potential impact to fossil heritage resources is extremely low.

4. IDENTIFICATION OF HERITAGE RESOURCES

4.1 Summary of findings of Specialist Reports

4.1.1 Archaeology

The survey was conducted primarily on foot but also involved driving between key targeted areas, and sought to assess the presence and significance of archaeological occurrences within the project area. Overall field assessment documented a sparse number of isolated stone artefacts in secondary and surface contexts and one denser occupational context in a potentially dateable context, suggesting the area may have been traversed intermittently by Stone Age groups through periods in both the Middle Stone Age (MSA – ~300ka:~40ka), the Later Stone Age (LSA: ~40ka: ~2ka) in addition to individual bifacial tools potentially associated with the later ESA (~400--~200ka), although artefacts that could be clearly linked with chrono-cultural periods were scarce.

The presence of small nodules of artefact-quality chert rocks, homogenous quartzites as well as high-quality riverine Hornfels and Quartz in the project areas in addition to relatively abundant standing water, were likely the resources that attracted groups to the broader region, and resulted in them leaving behavioural traces in the form of stone artefacts and traces of lithic exploitation on primary sources of raw-material (the latter exclusively at Moab). Indeed the majority of the stone artefacts identified look to be the result of expedient 'testing' of rocks for quality, although several cores and tools associated with more extensive investment in production were identified. In this sense no evidence of substantial densities of finds or occupational debris were identified, and the stone artefacts present look to have been produced by mobile forager groups moving through the area.

Artefact quality raw-material in the form of primary local cherts is available within the footprint, with several outcrops associated with sparse archaeological evidence. Some ephemeral Stone Age exploitation evidence in the form of simple cortical flakes, flake removal traces on outcrops and cores were identified as well as some systematic Levallois and bladelet production in the eastern portion. No identified sites represent archaeological remains in dateable contexts that need to be avoided (see sensitivity ranking), and all are of low scientific significance.

Importantly, no graves were identified within the survey, and there would not be evidence of graves within the extensively disturbed areas of the footprint. In addition, there was no evidence for historical dwelling structures apart from the non-domestic dilapidated Vaal Reef Shooting Club. Relevantly though, the dense grass cover was a pertinent constraint to documenting potential graves in the areas that were not disturbed. Extensive grass cover made potential grave locations impossible to exhaustively assess across the project area (particularly in cases where above surface material indicators may have been removed through modern disturbance or through trampling related to historical stock farming activities.

4.1.2 Palaeontology

The site for development is on the Adelaide Subgroup with the margins on the Quaternary Kalahari Group sands. The Adelaide Subgroup can be divided into four vertebrate assemblage zones if there are fossils present but this has not been indicated in the geological map. Extrapolating from the recently updated biostratigraphy (Smith et al., 2020), the site is probably in the Balfour Formation and so is represented by the *Daptocephalus* Assemblage Zone

The *Daptocephalus* Assemblage Zone is recognised by the co-occurrence of the dicynodontoid *Daptocephalus leoniceps*, the therocephalian *Theriognathus microps*, and the cynodont *Procynosuchus delaharpeae* (Viglietti, 2020). This has been further divided into two subzones, the lower *Dicynodon -Theriognathus* Subzone (in co-occurrence with Daptocephalus), and the upper *Lystrosaurus maccaigi – Moschorhinus kitchingi* Subzone (ibid). Other taxa include fish, amphibians, parareptiles, eureptiles, biarmosuchians, anomodontians, gorgonopsians, therocephaleans, cynodonts and molluscs. The flora is more diverse than the older Assemblage Zones and comprises glossopterids, mosses, ferns, sphenophytes, lycopods, cordaitaleans and gymnosperm woods (Plumstead, 1969; Anderson and Anderson, 1985; Bamford, 2004).

Six formations are recognised in the Kalahari Group but they are not often indicated on the geological maps. A more recent review by Botha (2021) attempts to correlate the Quaternary sediments but they are difficult to date or to determine their source. In this part of the Free State the Hoopstad Aeolian sands are present. According to Harmse (1963, in Botha, 2021) this extensive red and grey sandy soil cover is associated with three generations of aeolian sand sheets. Moreover, these generations of aeolian sand form the soil substrate in the heart of the nation's maize cultivation region, yet their geological origin and age remains understudied (Botha, 2021, p. 825).

Quaternary sands and alluvium do not preserve fossils because they are transported and porous. For preservation of fossils, a low energy deposit with sedimentation of fine grained silts or muds that exclude decomposing organisms such as bacteria, fungi and invertebrates is required to maintain a highly reducing environment (Cowan, 1995). Only if there are traps such as palaeo-pans or palaeo-springs that provide traps for water and fine sediments, would plants or bones be preserved and fossilised. No such features are visible in the satellite imagery in the project footprint.






Figure 4.: Dense grasses and occasional shrubs cover portions of the project area, inhibiting the visibility of surface archaeology at Moab: CMB1; CMB3; CMB5; CMB8; CMB9; CMB10; CMB16; CMB22; CMB25; CMB27.

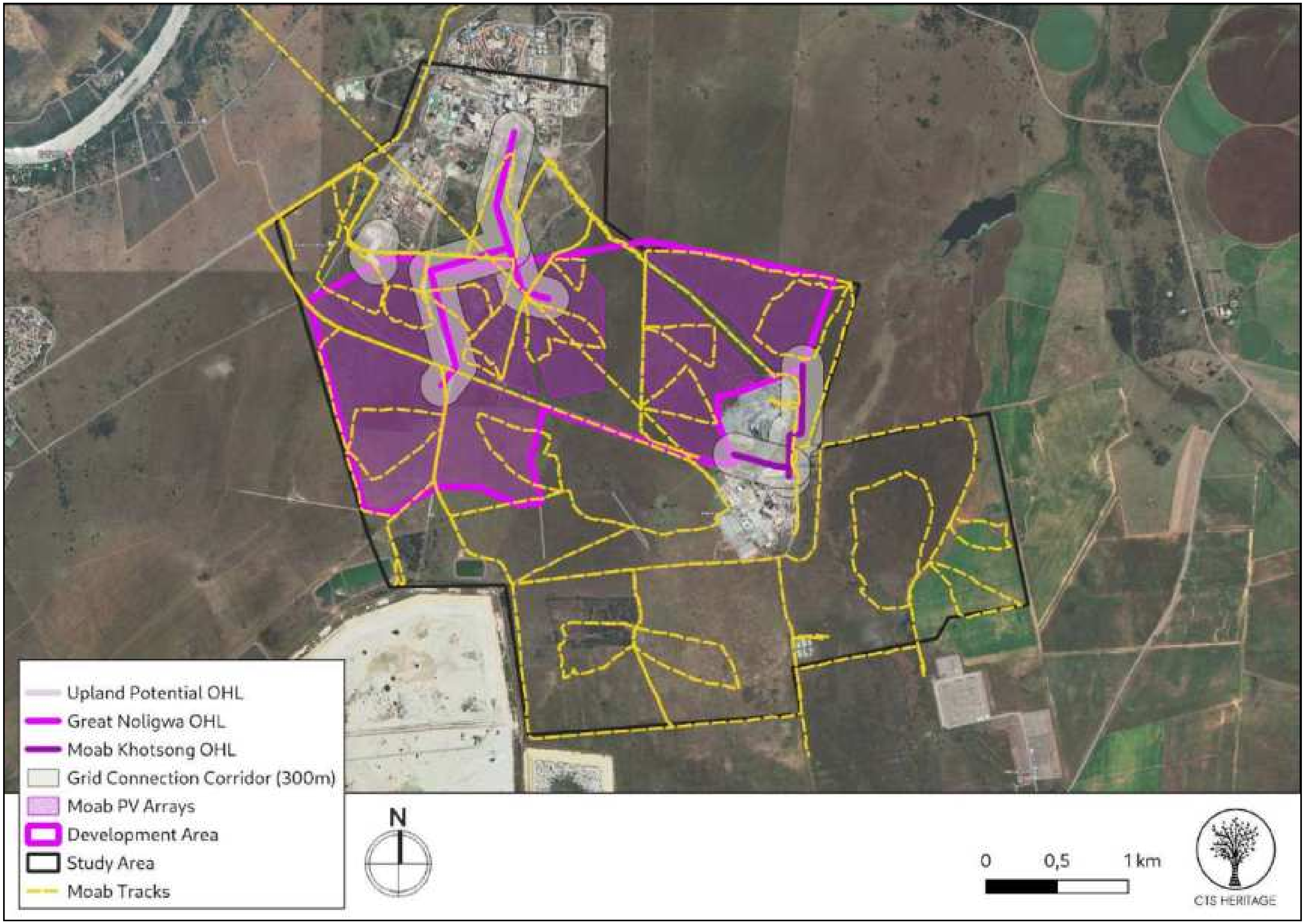


Figure 5.: Overall track paths of foot survey - Moab PV Facility

4.2 Heritage Resources identified

The survey at Moab documented several isolated finds, and a sparse stone artefact scatter in a secondary context. The site at CM1 has a concentration of artefacts that look to be eroding from an encompassing sedimentary context, although the sediments in the close vicinity have been affected by recent land use activities. If this site could be avoided with the guidance of a 30m buffer zone for development that would be optimal. At CM3 several isolated chert artefacts were present on a deflated land surface. The small size of the flakes in addition to the platform morphology and dorsal removal patterns on one specimen may be indicative of bladelet production, thus indicating a likely terminal Pleistocene or Holocene age for these artefacts. Primary sources of chert were documented at several locations within the footprint (e.g. CM2), and several negative flake removals indicating Stone Age exploitation were identified on these outcrops.

Table 2: Heritage resources identified from fieldwork 2022

Site No.	Site Name	Description	Period	Co-ordinates		Grading	Mitigation
CM1	Moab 1	Isolated artefacts on sub-volcanic rock: Levallois core; Bladelet core and several flakes	MSA/LSA	-26.98790498	26.80750899	IIIC	30m Buffer
CM2	Moab 2	Chert outcrop with evidence of hominin exploitation	Stone Age	-26.98115604	26.77801601	NCW	NA
CM3	Moab 3	Isolated chert artefacts: several flakes	LSA	-26.97650903	26.78688196	NCW	NA

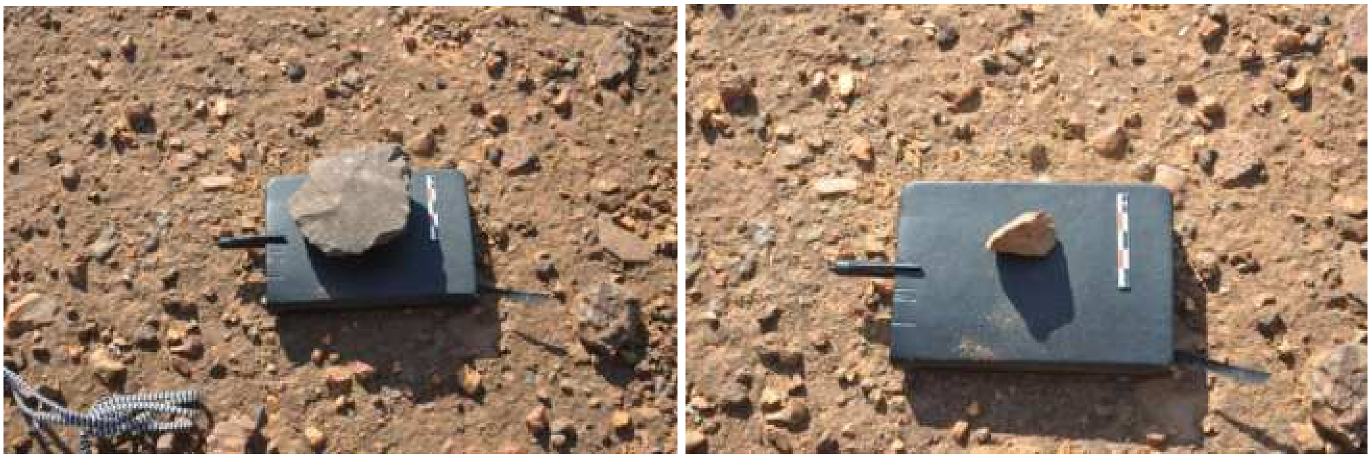


Figure 6.1: Deflated concentration of archaeological remains at Moab CM1: Levallois core and Bladelet core

Figure 6.2. Ex situ archaeological remains at Moab: CM2-Chert outcrop with evidence of hominin exploitation, CM3-flakes

4.3 Mapping and spatialisation of heritage resources

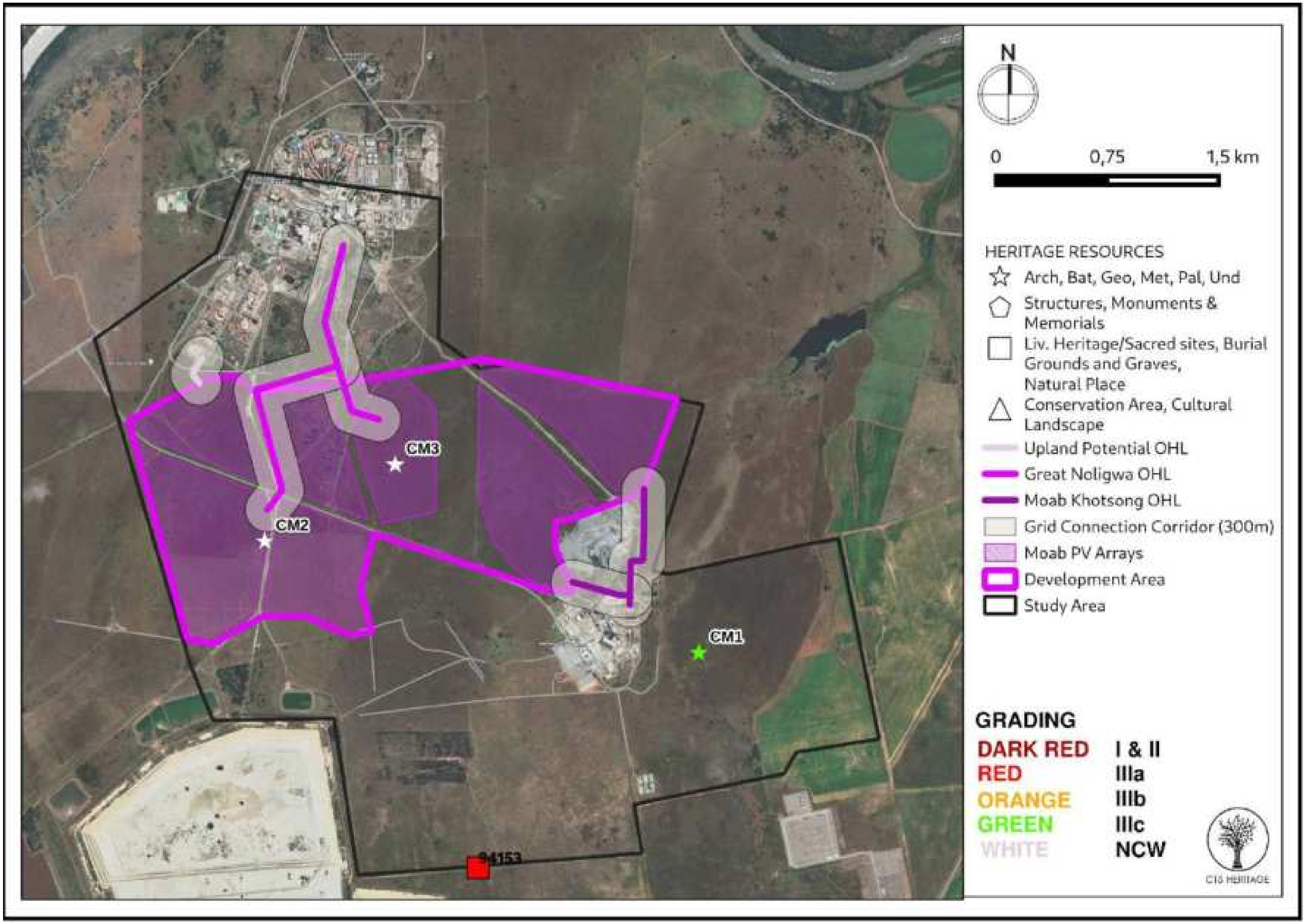


Figure 7.1: Map of significant heritage resources identified during the field assessment, relative to the proposed development

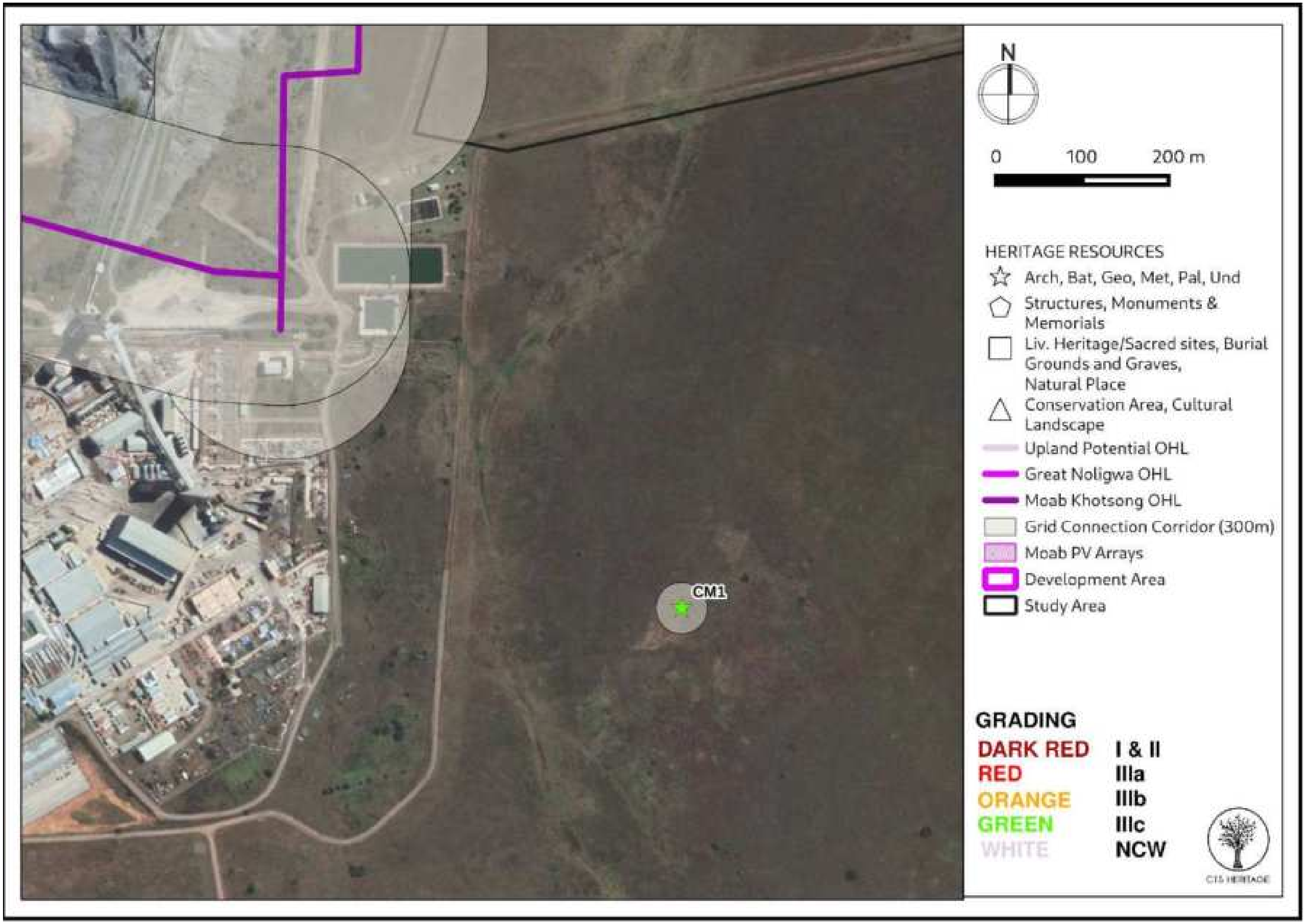


Figure 7.2: Map of significant sites relative to proposed development with recommended mitigation for CM1

5. ASSESSMENT OF THE IMPACT OF THE DEVELOPMENT

5.1 Assessment of impact to Heritage Resources

5.1.1 Archaeology

The potential for finding a dateable *in-situ* archaeological horizon based on current surface observations outlined above appears to be low. The documented archaeology at Moab is therefore classified as scientifically LOW SIGNIFICANCE.

Concerning the archaeology observed during the extensive survey of the potentially affected area at Moab, there are no objections to the authorization of the proposed development, provided that if any evidence of buried human remains are exposed during excavation, that development activities cease in the area of the identified remains.

Table 4.1: Impacts of the proposed development on archaeological resources

NATURE: It is possible that buried archaeological resources may be impacted by the proposed development in the preferred location				
		Without Mitigation		**With Mitigation**
MAGNITUDE	**M (6)**	One archaeological resource of significance was identified within the development area	**M (6)**	One archaeological resource of significance was identified within the development area
DURATION	**H (5)**	Where manifest, the impact will be permanent.	**H (5)**	Where manifest, the impact will be permanent.
EXTENT	**L (1)**	Limited to the development footprint	**L (1)**	Limited to the development footprint
PROBABILITY	**H (5)**	It is likely that significant will be impacted	**L (1)**	It is unlikely that significant resources will be impacted
SIGNIFICANCE	**L**	(6+5+1)x5 = 60	**L**	(6+5+1)x1 = 12
STATUS		Negative		Negative
REVERSIBILITY	**L**	Any impacts to heritage resources that do occur are irreversible	**L**	Any impacts to heritage resources that do occur are irreversible
IRREPLACEABLE LOSS OF RESOURCES?	**H**	Likely	**L**	Not Likely
CAN IMPACTS BE MITIGATED		Yes		
MITIGATION: • A no-impact buffer of 30m is implemented around Site CM1 as per Figure 7.2 • Should any previously unrecorded archaeological resources or possible burials be identified during the course of construction activities, work must cease in the immediate vicinity of the find, and SAHRA must be contacted regarding an appropriate way forward.				
RESIDUAL RISK: None				

5.1.2 Palaeontology

According to the Desktop Palaeontology Assessment, "Based on the geology of the area and the palaeontological record as we know it, it can be assumed that the formation and layout of the sandstones, shales and sands are typical for the country and might contain trapped fossils. The sands of the Quaternary period would not preserve fossils. The area has been disturbed from farming and mining so no fossils would be present on the surface. No vertebrates or plants have been recorded so the lithology and assemblage zone can only be extrapolated.."

"Based on the nature of the project, surface activities may impact upon the fossil heritage if preserved in the development footprint. The geological structures suggest that the rocks are the right age to contain fossils but are covered by soils. Furthermore, the material to be excavated are soils and this does not preserve fossils. Since there is a small chance that vertebrate fossils typical of the *Daptocephalus* Assemblage Zone or plant or bone fragments were trapped in pans that might occur below the soils and may be disturbed a Fossil Chance Find Protocol has been added to this report. Taking account of the defined criteria, the potential impact to fossil heritage resources is low."

"Based on experience and the lack of any previously recorded fossils from the area, it is extremely unlikely that any fossils would be preserved in the overlying sands and soils of the Quaternary. There is a very small chance that fossils may occur in pans or springs but no such feature is visible in the satellite imagery. Vertebrate fossils may occur but there is no outcrop. Nonetheless, a Fossil Chance Find Protocol should be added to the EMPr."

Table 4.2: Impacts of the proposed development to palaeontological resources

NATURE: It is possible that buried palaeontological resources may be impacted by the proposed development in the preferred location				
		Without Mitigation		**With Mitigation**
MAGNITUDE	**H (8)**	According to the SAHRIS Palaeosensitivity Map (Figure 3.1), the area proposed for development of the PV facilities is underlain by sediments that have very high palaeontological sensitivity.	**H (8)**	According to the SAHRIS Palaeosensitivity Map (Figure 3.1), the area proposed for development of the PV facilities is underlain by sediments that have very high palaeontological sensitivity.
DURATION	**H (5)**	Where manifest, the impact will be permanent.	**H (5)**	Where manifest, the impact will be permanent.
EXTENT	**L (1)**	Limited to the development footprint	**L (1)**	Limited to the development footprint
PROBABILITY	**L (1)**	It is unlikely that significant fossils will be impacted	**L (1)**	It is unlikely that significant fossils will be impacted
SIGNIFICANCE	**L**	(8+5+1)x1=14	**L**	(8+5+1)x1=14
STATUS		Negative		Negative
REVERSIBILITY	**L**	Any impacts to heritage resources that do occur are irreversible	**L**	Any impacts to heritage resources that do occur are irreversible
IRREPLACEABLE LOSS OF RESOURCES?	**L**	Unlikely	**L**	Not Likely
CAN IMPACTS BE MITIGATED		Yes		

MITIGATION:
● The attached Chance Fossil Finds Procedure must be implemented for the duration of construction activities ● Should any previously unrecorded palaeontological resources be identified during the course of construction activities, work must cease in the immediate vicinity of the find, and SAHRA must be contacted regarding an appropriate way forward.
RESIDUAL RISK: None

5.2 Sustainable Social and Economic Benefit

TBA

5.3 Proposed development alternatives

The alternatives assessed as part of this project have been mapped throughout the HIA. Based on the outcomes of this analysis, the preferred development alternative is also preferred from a heritage perspective as no impacts to significant heritage resources are anticipated.

There is also no preferred grid connection alternative from a heritage perspective.

5.4 Cumulative Impacts

This application is for the proposed development of a solar energy facility and associated grid connection to facilitate activities at the Harmony Moab Mine. The location of the proposed PV facility within an area with existing mining activities may lend itself to cumulative impacts. However, in terms of cumulative impacts to heritage resources, it is preferable that industrial-type infrastructure is clustered within an area in order to prevent the sprawl of industrial development across otherwise sensitive cultural landscapes.

As such, it is not anticipated that the proposed development will have a negative cumulative impact on significant heritage resources.

6. RESULTS OF PUBLIC CONSULTATION

The public consultation process will be undertaken by the EAP during the EIA. No heritage-related comments have been received to-date. SAHRA is required to comment on this HIA and make recommendations prior to the granting of the Environmental Authorisation.

7. CONCLUSION

The areas surveyed as part of this assessment have been transformed through agricultural interventions and/or mining activity. As such, it is not surprising that the results of the survey only identified one site of scientific cultural value - CM1 within the Alternative Area proposed for the Moab PV development graded IIIC.

The identified site of archaeological significance has the potential to provide scientific insight into the past and as such, it is recommended that this area is not impacted by the proposed development. It is therefore recommended that no-go development buffers as per the recommendations below are implemented. Further, it is recommended that these sites are mapped on all relevant SDPs and that on-going conservation measures are put in place in the EMPrs for the developments.

Furthermore, no impacts to significant palaeontological heritage is anticipated on condition that the attached Chance Fossil Finds Process is implemented and no impacts to the cultural landscape are anticipated.

8. RECOMMENDATIONS

There is no objection to the proposed development in terms of impacts to heritage resources on condition that:

- The 30m buffer area recommended around site CM1 is implemented
- The attached Chance Fossil Finds Procedure is implemented for the duration of construction activities
- Should any buried archaeological resources or human remains or burials be uncovered during the course of development activities, work must cease in the vicinity of these finds. The South African Heritage Resources Agency (SAHRA) must be contacted immediately in order to determine an appropriate way forward.

9. REFERENCES

Heritage Impact Assessments				
NID	Author(s)	Date	Type	Title
321166	Archaeological Specialist Reports	Jaco van der Walt	17/06/2015	Archaeological Scoping Report for the Proposed Buffels Solar 1 SEF, Klerksdorp, North West Province
321168	PIA Desktop	Barry Millsteed	21/06/2015	Palaeontological Heritage Impact Assessment Report on the Site of a Proposed Solar Power Production Facility known as the Buffels Solar 1 PV Energy Facility to be located approximately 20 km north East of Orkney, NW Province
321169	PIA Desktop	Barry Millsteed	21/06/2015	Palaeontological Heritage Impact Assessment Report on the Site of a Proposed Solar Power Production Facility known as the Buffels Solar 2 PV Energy Facility to be located approximately 20 km north East of Orkney, NW Province
321170	Archaeological Specialist Reports		17/06/2015	Archaeological Scoping Report for the Proposed Buffels Solar 2 SEF, Klerksdorp, North West Province
345	PIA Phase 1	Marion Bamford	18/05/2012	Palaeontological Impact Assessment for Kabi Vaalkop Solar PV Facility
365014	HIA Phase 1	Sidney Miller	02/03/2015	Cultural Heritage Impact Assessment for Shafts #1 to #7, Orkney, Northwest Province, South Africa, for CAPM Gold.
369846		Jaco van der Walt	31/08/2016	
5097	AIA Phase 1	Johnny Van Schalkwyk	07/03/2003	Mercury-Perseus 400 kV Transmission Line, Cultural Heritage Resources
6030	AIA Phase 1	Cobus Dreyer	20/06/2005	Archaeological and Historical Investigation of the Proposed Residential Developments on Subdivision 13 of the Farm Pretoriuskraal 53, Viljoenskroon, Free State
7340	AIA Phase 1	Zoe Henderson, C Koortzen	19/06/2007	Heritage Assessment Report Mercury Substation Expansion, Zaaiplaats 190/3, Fezile Dabi (DC20) District, Free State, South Africa
7367	AIA Phase 1	Thomas Huffman	01/03/2005	Archaeological Assessment of the Mispah Tailings Dam Extension
7684	AIA Phase 1	Jaco van der Walt	25/09/2007	Archaeological Impact Assessment. Township Development and Sub Division of AH18, Pretoriuskraal, Orkney, North West Province
7685	AIA Phase 1	Jaco van der Walt	25/09/2007	Archaeological Impact Assessment. Township Development on Sub Division of AH19, Pretoriuskraal, Orkney, North West Province

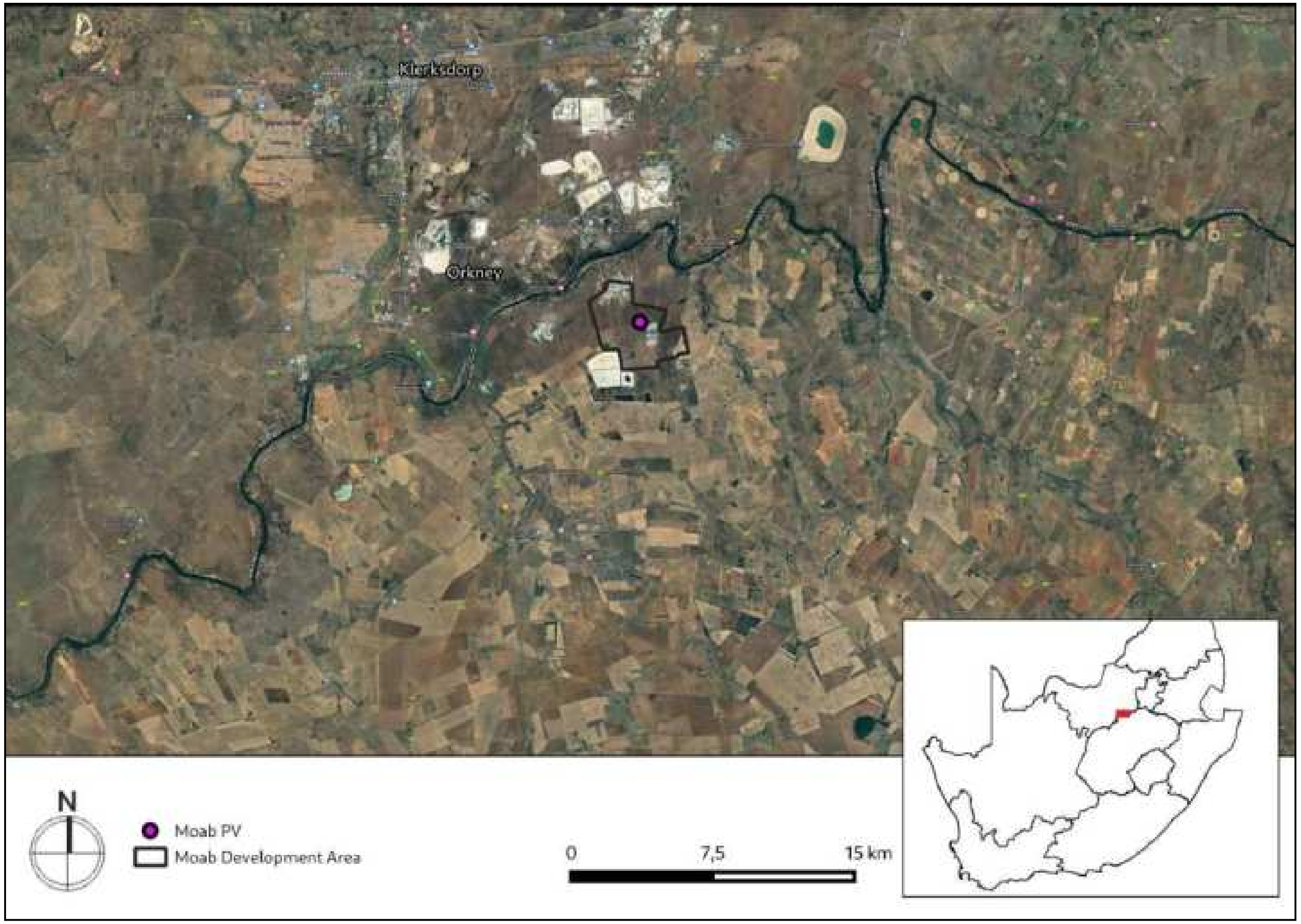
9124	Heritage Study	Francois P Coetzee	01/04/2012	Cultural Heritage Survey of the Proposed Kabi Vaalkop PV Facility near Orkney, Dr Kenneth Kaunda District, North West Province

APPENDICES

APPENDIX 1: Heritage Screening Assessment (2022)

CTS HERITAGE

HERITAGE SCREENER

CTS Reference Number:	**CTS22_101**	 **Figure 1a**. Satellite map indicating the location of the proposed development in the Free State
SAHRIS Reference:		
Client:	**Savannah Environmental (Pty) Ltd**	
Date:	**May 2022**	
Title:	**Proposed development of the Moab PV Facility**	
	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 a renewable energy facility, overhead powerline and associated infrastructure is proposed by HARMONY MOAB KHOTSONG OPERATIONS PTY (LTD). The project entails the development of three (3) separate solar PV facilities with a combined contracted capacity of up to 100MW over 280 ha of land and will be known as Harmony Moab Khotsong Solar PV Facility, each facility will include a grid connection and other associated infrastructure.

The Solar PV facilities are based near Harmony Moab mining operations and fall within the Klerksdorp Renewable Energy Development Zone (REDZ) located ~10km North of the town of Vierfontein within the Moqhaka Local Municipality respectively, and within the Fezile Dabi 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	26°59'7.19"S 26°48'9.56"E
Erf number / Farm number	

ANGLO 593	593
HOEKPLAATS 598	598
MISPAH 274	274
MOAB 279	279
ZAAIPLAATS 2/190	2/190
ZAAIPLAATS 1/190	1/190
DOORNKOM WES 446	RE/446

	CHRYSTALKOP 69 / 69 ZUIPING 394 / 4/394 ZUIPING 394 / 3/394 ZUIPING 394 / 5/394 ZUIPING 394 / RE/394 ZUIPING 394 / 1/394
Local Municipality	Moqhaka
District Municipality	Fezile Dabi, Free State Province
Province	Free State
Current Use	Agricultural
Current Zoning	Agricultural

CHRYSTALKOP 69	69
ZUIPING 394	4/394
ZUIPING 394	3/394
ZUIPING 394	5/394
ZUIPING 394	RE/394
ZUIPING 394	1/394

4. Nature of the Proposed Development

Total Area	280ha
Depth of excavation (m)	<2m
Height of development (m)	20m pylons for OHL

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)

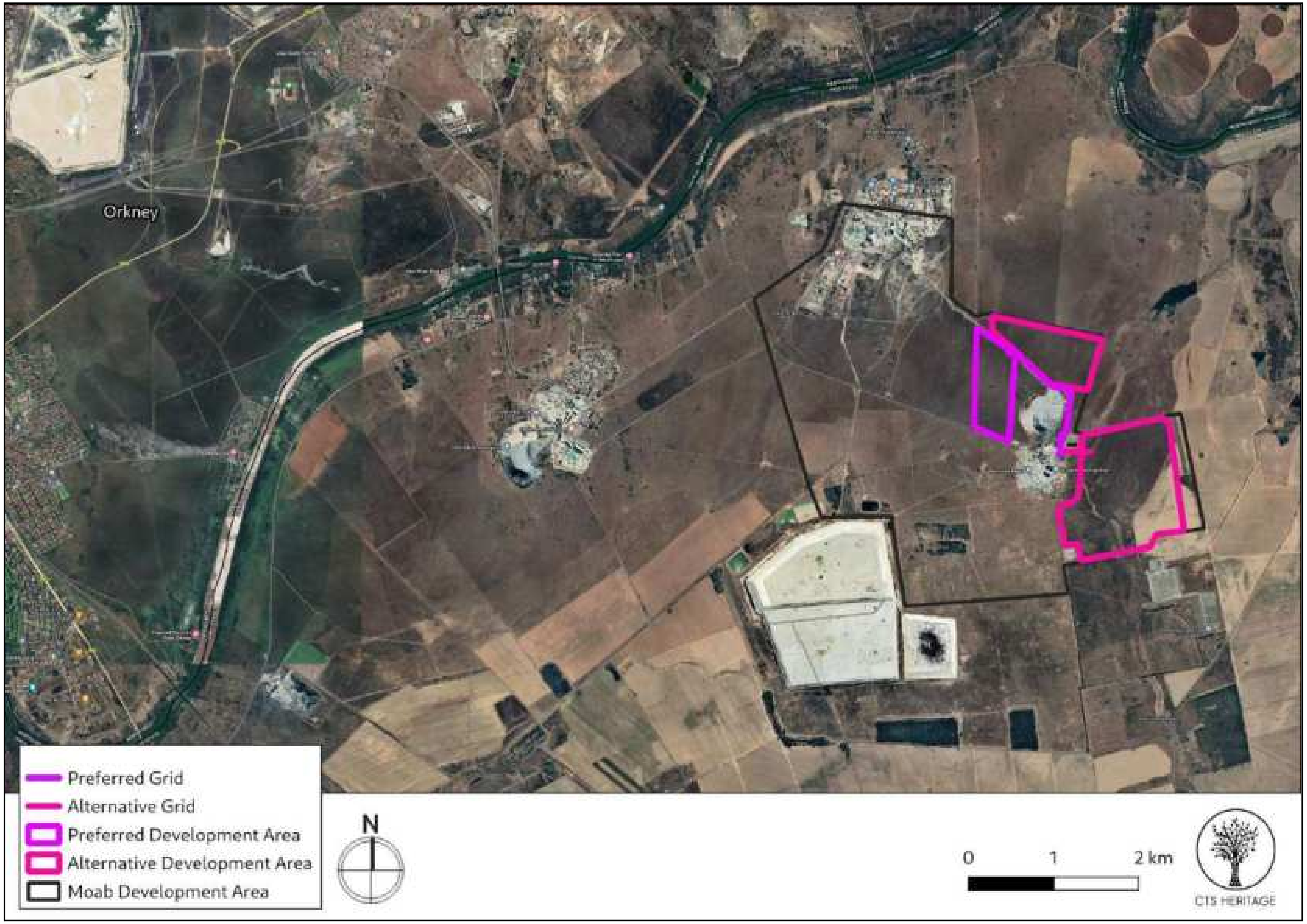


Figure 1b. Overview Map. Satellite image (2020) indicating the proposed development area

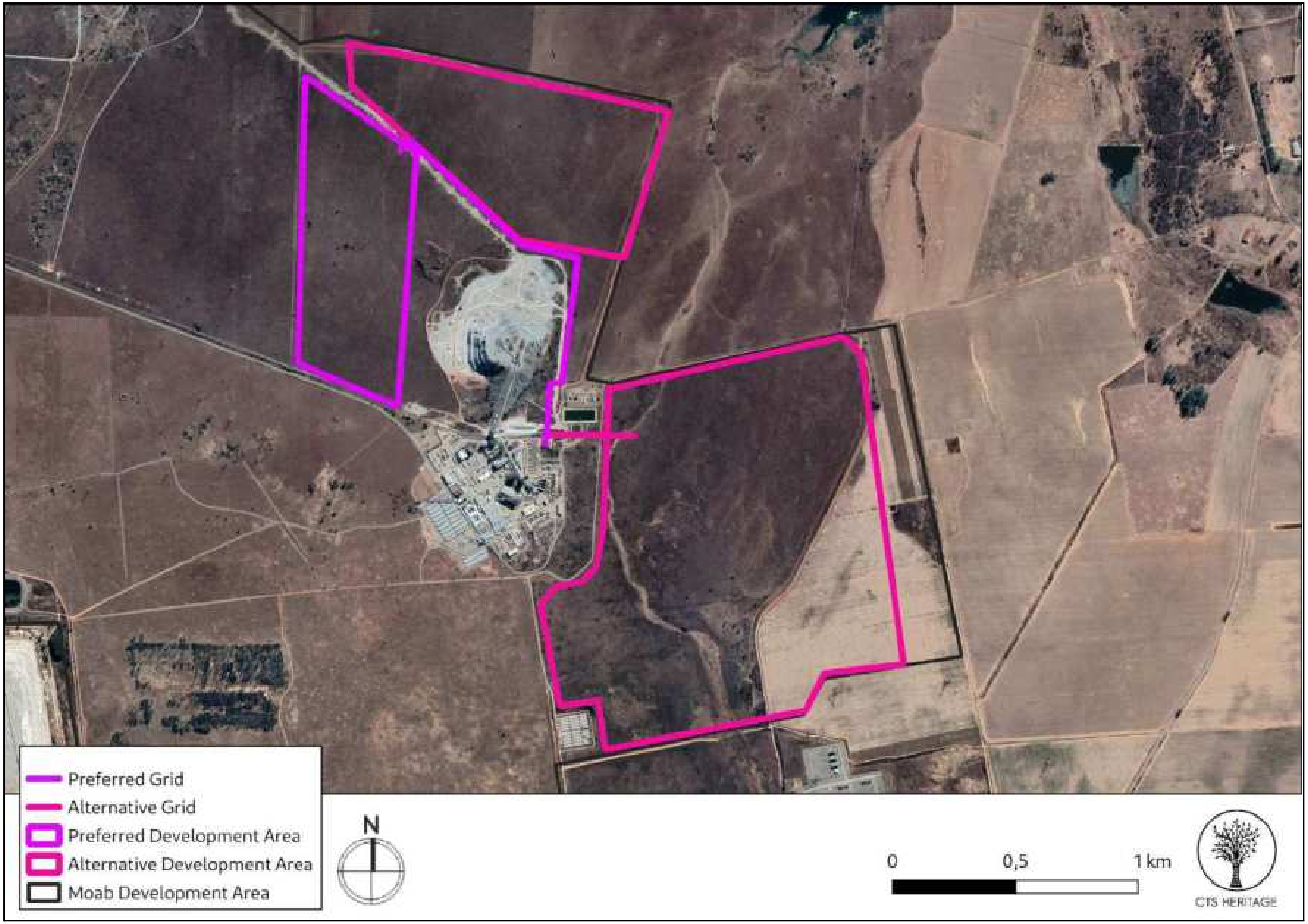


Figure 1c. Overview Map. Satellite image (2020) indicating the proposed development area

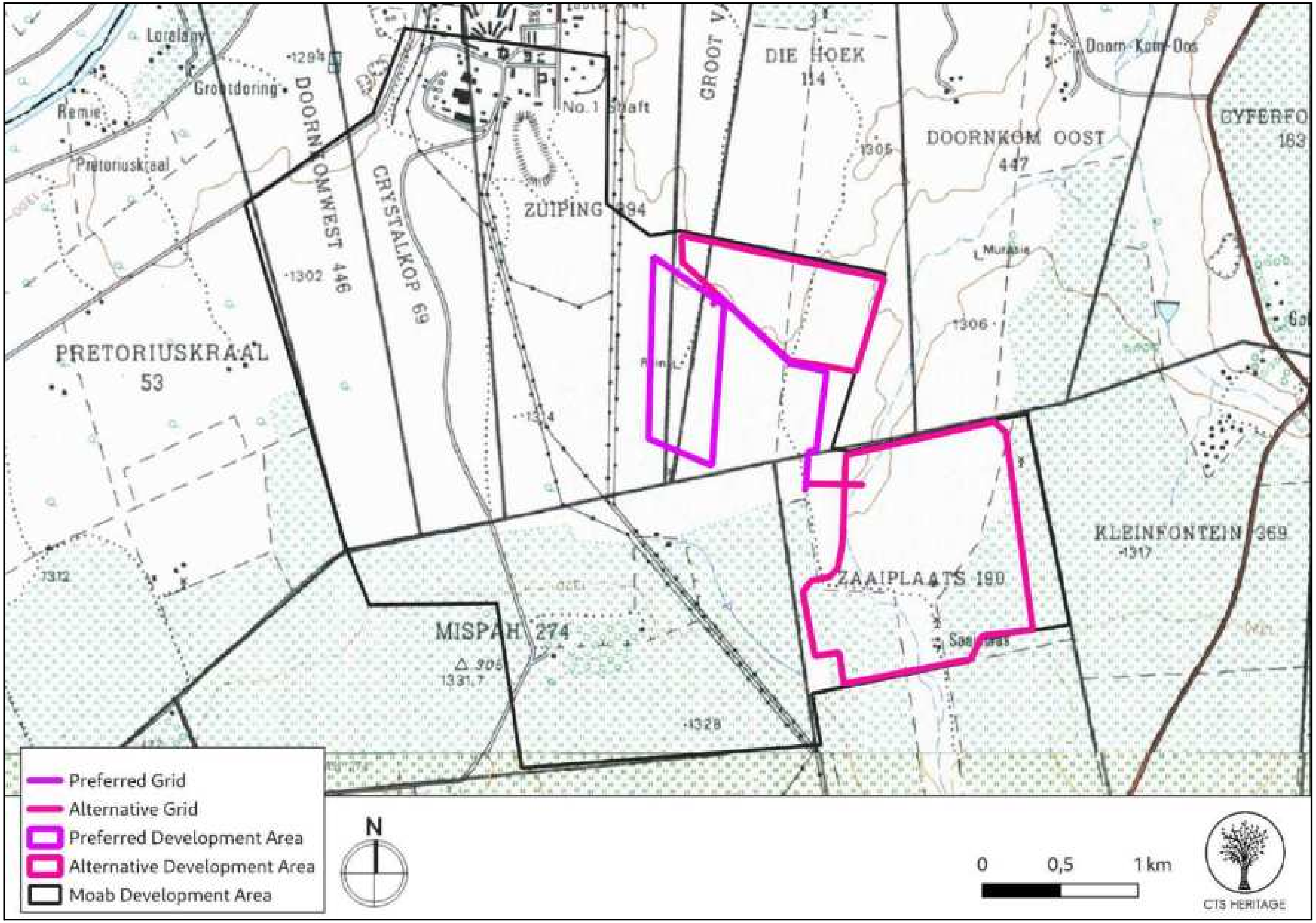


Figure 1d. Overview Map. Extract from 1:50 000 Topo

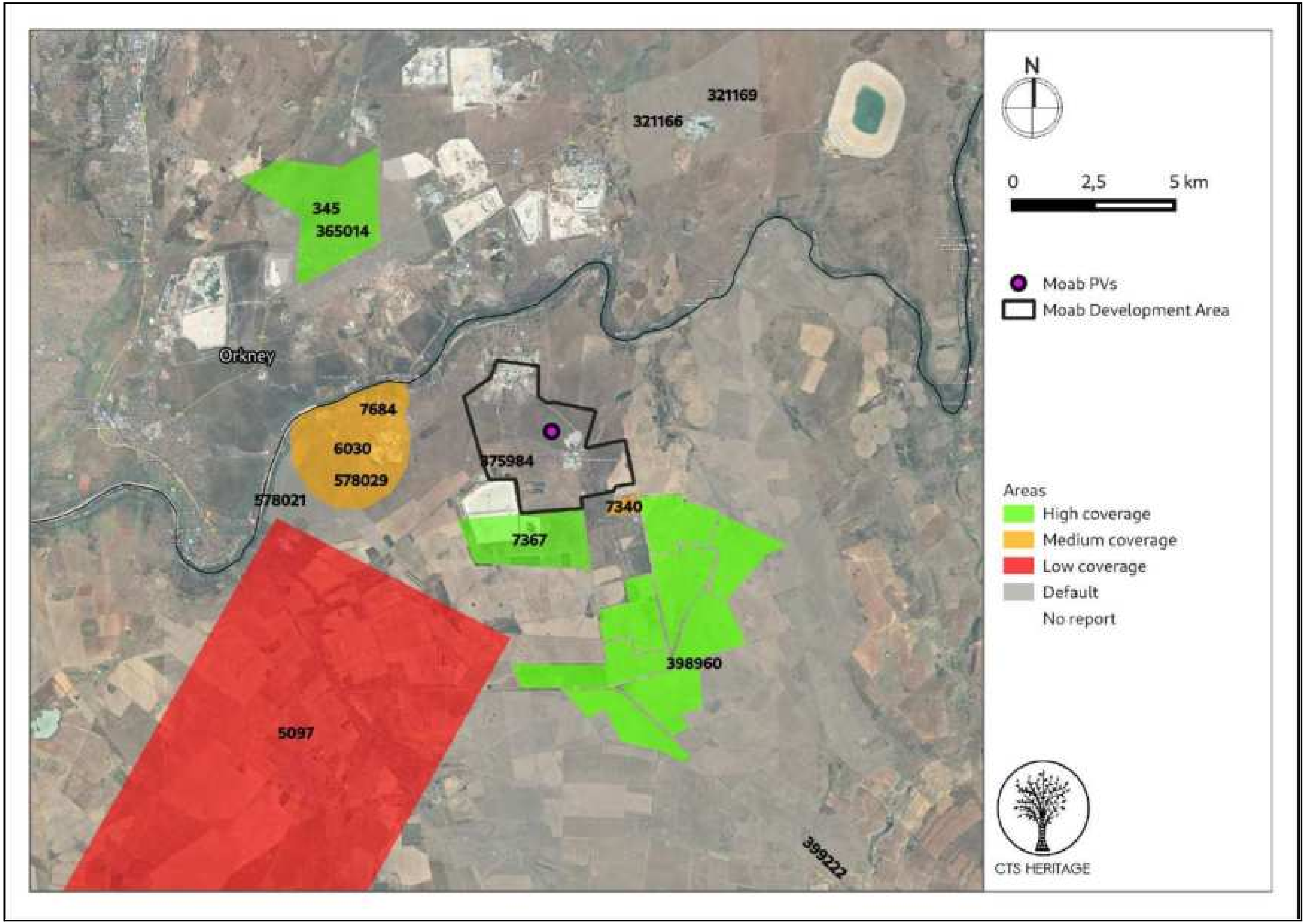


Figure 2. Previous HIAs Map. Previous Heritage Impact Assessments covering the proposed development area with SAHRIS NIDS indicated. Please see Appendix 2 for a full reference list.

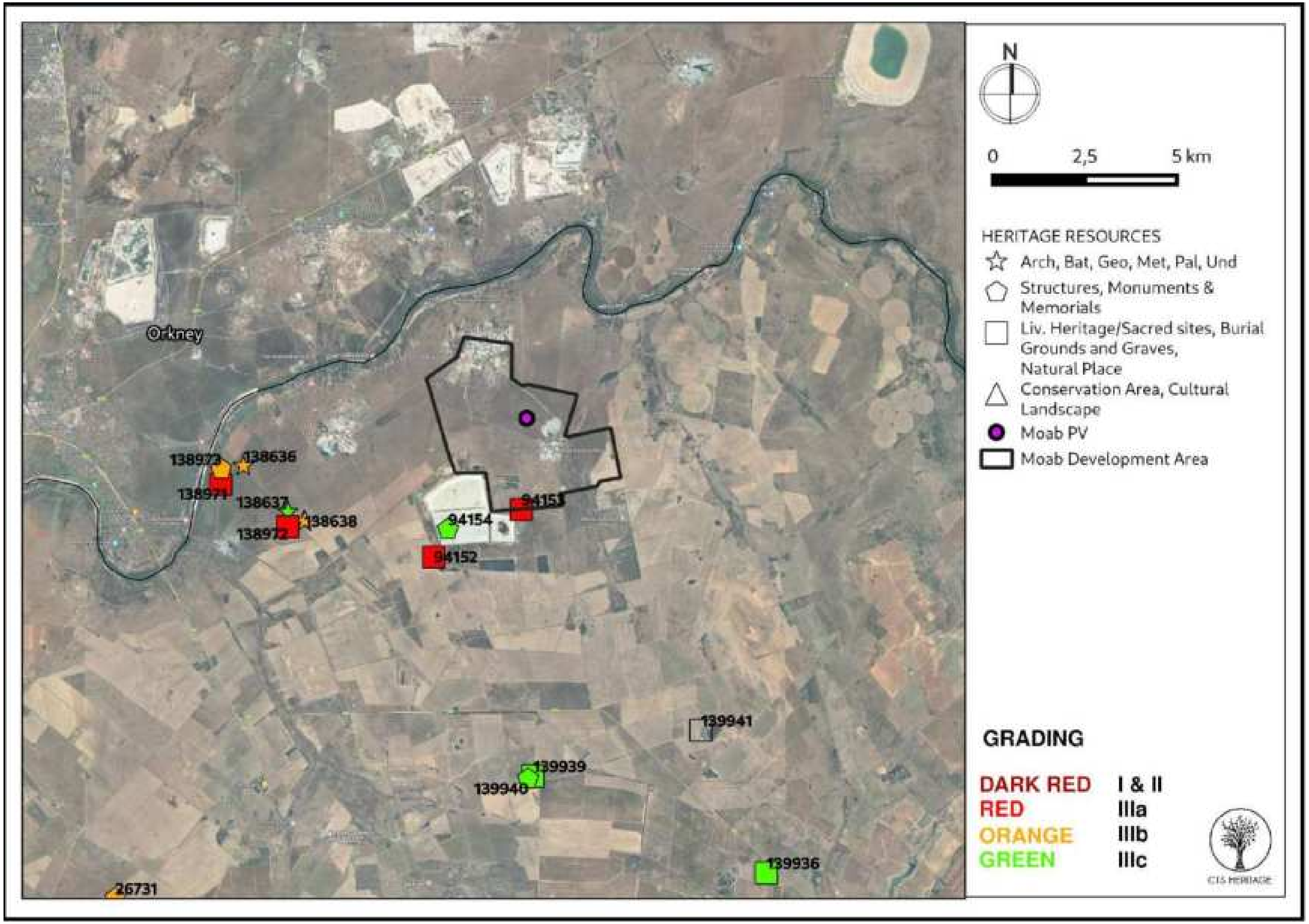


Figure 3. Heritage Resources Map. Heritage Resources previously identified within the study area, with SAHRIS Site IDs indicated in the insets below. Please See Appendix 4 for full description of heritage resource types.

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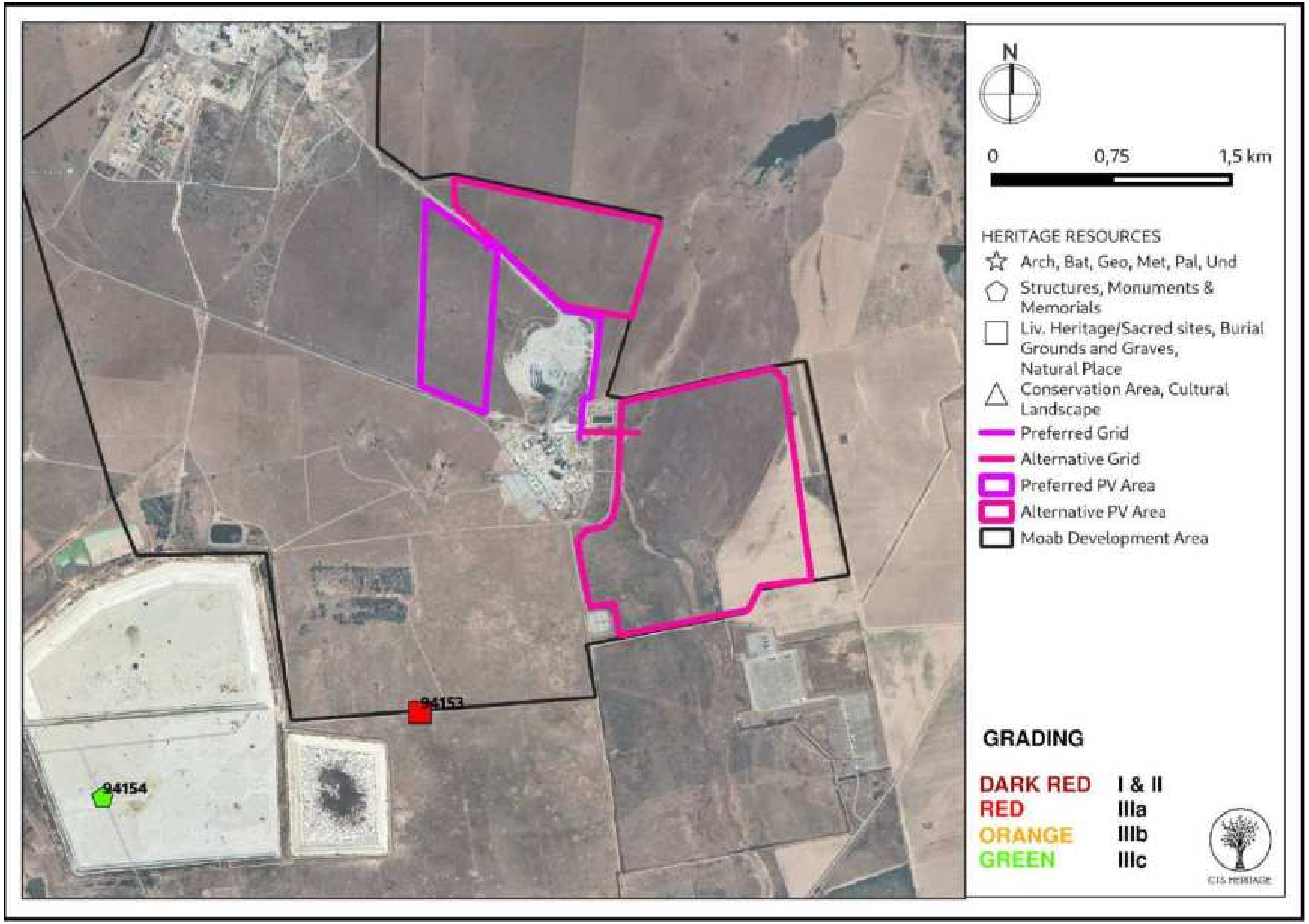

Figure 3a. Heritage Resources Map. Inset A

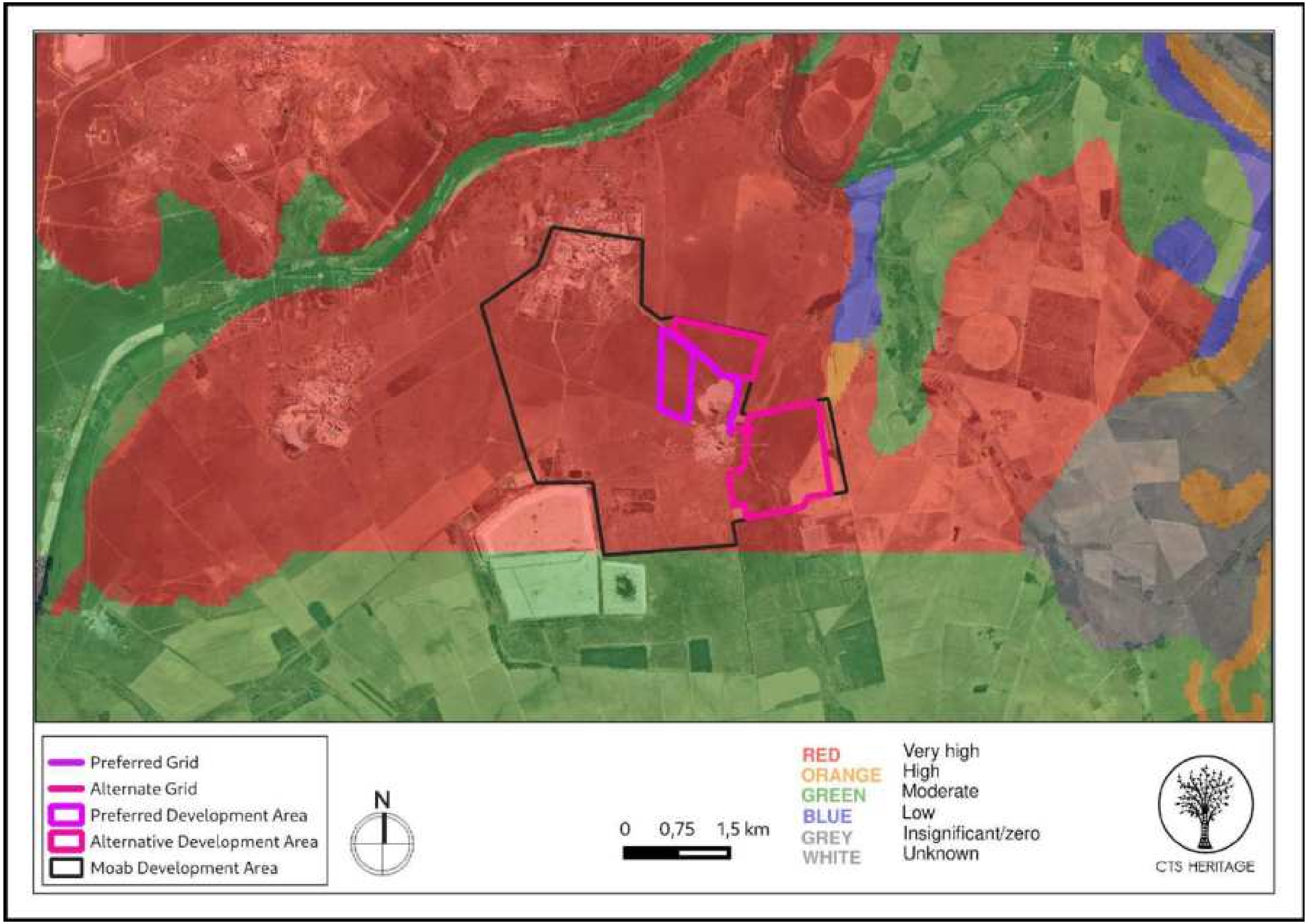

Figure 4a. Palaeosensitivity Map. Indicating fossil sensitivity underlying the study area. Please See Appendix 3 for a full guide to the legend.

CTS HERITAGE

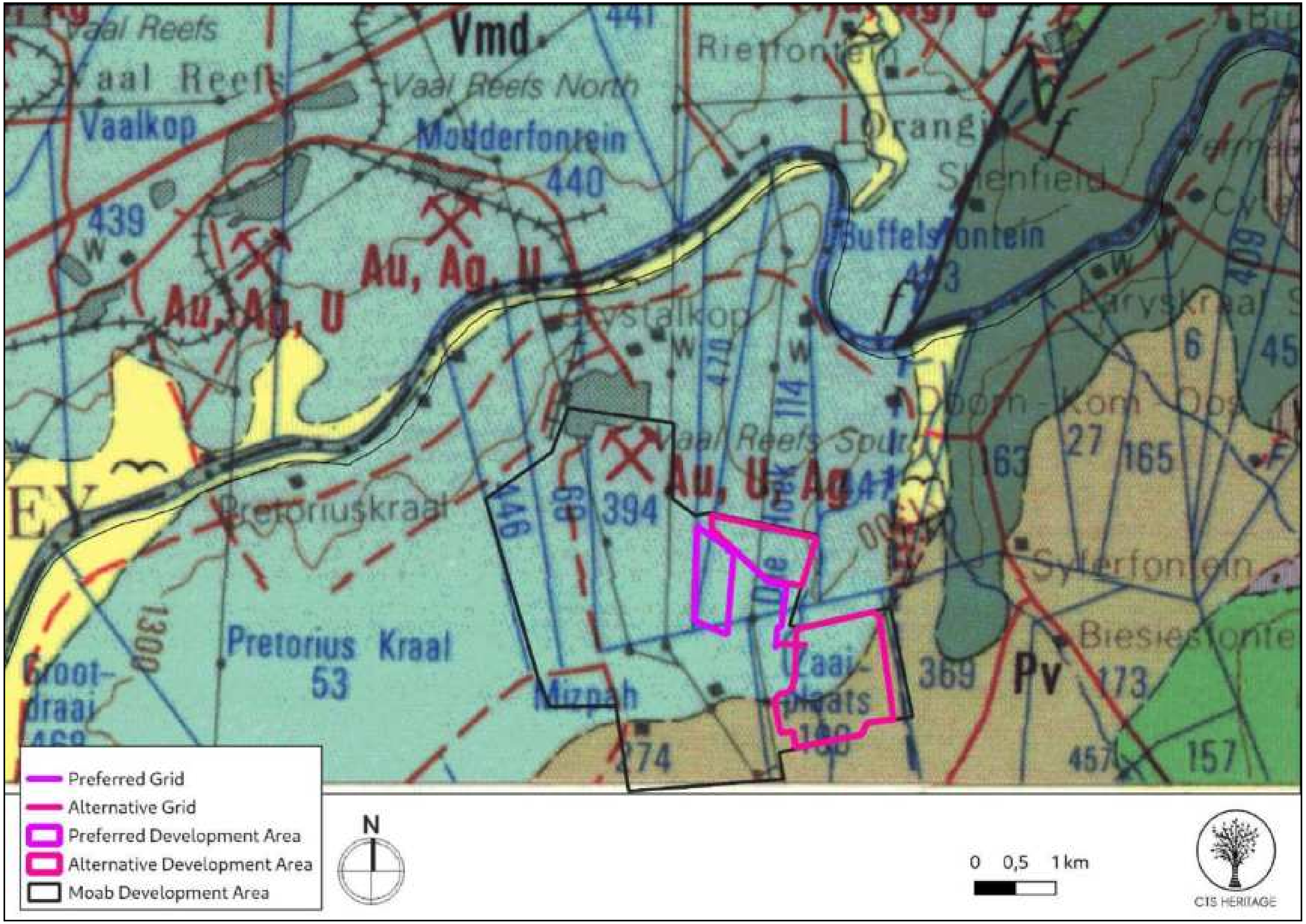

Figure 4b. Geology Map. Extract from the CGS 2626 West Rand Geology Map indicating that the development area is underlain by sediments of the (Pv) Vryheid Formation and (Vmd) Malmani Subgroup.

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8. Heritage Assessment

Background
The assessment area for the proposed PV Solar farms and grid connections is situated north and south of the R76 close to the town of Viljoenskroon in the Free State Province. It falls within the jurisdiction of the Moqhaka Local Municipality in the Fezile Dabi District Municipality and is located within the existing Harmony Mine.

Built Environment & Cultural Landscapes
The development areas are located in peri-urban farms just outside the towns of Orkney (North West) and Viljoenskroon (Free State). The town of Orkney was established in 1940 at the junction of the various railway lines. It was name after the old gold mine opened by Thomas Leask, who came from the Orkney Islands, in 1880 (SESA 1973 in Van Schalkwyk 2021). Viljoenskroon is a maize and cattle farming town located in the Free State province of South Africa. It was named after the original farm owner J. J. Viljoen and his horse Kroon. The town was laid out in 1921 on the farm "Mahemskuil" and became a municipality in 1925. A number of large gold and diamond mines are also located inbetween the three solar PV sites, namely Taulekoa Mine next to Goedgenoeg 433, Kopanong Gold Mine next to Pretorius Kraal 53 and Great Noligwa Mine next to Groot Vaders Bosch 592. Ruins of or intact avenues of trees, historical farmsteads and farm labourer's cottages may potentially be found within the proposed development areas. The cultural landscape is characterised by a agriculture with abrupt transitions into extremely heavy industrial areas in and around the mining compounds. The installation of solar PV plants is therefore unlikely to have any impacts on the landscape character of the area.

Archaeology
Archaeological sites spanning the Earlier, Middle and Later Stone Age have been found in the region despite the extensive agricultural transformation of the area. In Dreyer (2005) and Van der Walt's (2007) heritage impact assessments of the nearby Pretorius Kraal 53, various modern buildings were recorded that are located near the banks of the Vaal River that were deemed as not conservation worthy. Van der Walt identified some Middle to Later Stone Age artefacts scattered across the farm but did not map them. In Van Schalkwyk's (2021) impact assessment of the Siyanda Solar farm on Grootdraai 468 (which lies on the western border of Pretorius Kraal 53), visibility issues were a major problem,
"Due to the very dense vegetation cover that occur in the project area, natural as well as agricultural fields, it was impossible to obtain any ground visibility. The strategy was therefore to examine natural and man-made features that are usually associated with human habitation and activities such as clumps of trees and rock outcrops. The proposed power line corridor connecting the Solar Power Plant to the the existing Vaal Reef Substation was not surveyed as access to the relevant properties (Pretoriuskraal 53) was not possible. It is proposed that once the power line route has been confirmed within the 100m corridor a heritage walk-though needs to be undertaken." Two burial sites were recorded during this survey despite the lack of Stone Age sites with the help of a local informant who had been working on the property for a number of years.

In his assessment of an area immediately adjacent to the project area, Huffman (2005, SAHRIS ID 7367) identified no sites of archaeological interest. In their assessment of an area located immediately adjacent to the areas proposed for development, Henderson and Koortzen (2007, SAHRIS ID 7340) noted that while no sites were found in the area surveyed, a number of previously excavated inspection pits yielded archaeological material in the form of stone artefacts. Henderson and Koortzen (2007, SAHRIS ID 7340) note that "These artefacts had been brought up from an unknown depth (probably no more than a metre or two), and were mostly undiagnostic flakes with one blade-like flake which could be Middle Stone Age. Raw material included cryptocrystalline, chert and quartz."

In an assessment completed by CTS Heritage for a proposed PV facility located nearby, a single site and very few isolated individual artefacts were documented. Cumulatively these findings indicate cultural evidence for MSA and LSA occupations of the area. It was noted that the majority of finds were identified in disturbed surface contexts, and could not be tied chrono-culturally to a particular prehistoric period, however one site (VK4) was relatively less affected by post-depositional processes, and may have been exposed relatively recently. Apart from this one site, the potential for finding a dateable *in-situ* archaeological horizon based on current surface observations appears to be low. The documented archaeology is therefore classified as scientifically LOW-SIGNIFICANCE. It is therefore highly likely that further burials may be located on the proposed solar PV areas as well as Stone Age material similar to the artefacts recorded but not mapped by Van der Walt. An archaeological field survey is therefore recommended.

Palaeontology

According to the SAHRIS Palaeosensitivity Map the development sites are underlain by sediments of Low to Very High fossil sensitivity (Figure 4a). The solar PV sites are underlain by sediments of the Malmani subgroup (Vmd) and the Vryheid Formation (Figure 4b). In his assessment of the Siyanda Solar Plant, Almond (2021) found "*several large float blocks on either side of farm track comprising pale grey to yellowish-weathering chert within mm-scale fine internal lamination, locally convolute or with zones of regular, stromatolite-like, upward-convex stacked laminae. These might be pseudostromatolites - i.e. abiogenic sedimentary structures formed by isopachous cement growth - rather than true microbially-bound stromatolites.*"

In a PIA completed by Bamford (2022) for an adjacent PV development, it was noted that "The proposed site lies on the moderately sensitive Quaternary sands and alluvium which might have trapped transported and fragmentary fossils if there are such features as palaeo-pan and palaeo-springs. The land has been cultivated or grazed for decades and no such feature is visible in the satellite imagery. Due to inconsistency in the geological maps it appears that (the development is located) on very highly sensitive rocks of the Vryheid Formation that are most likely covered by Quaternary sands and alluvium." Based on the geology of the area and the palaeontological record as we know it, it can be assumed that the formation and layout of the dolomites, sandstones, mudstones, shales and sands are typical for the country and might contain fossil plant, insect, invertebrate and vertebrate material. The sands and soils of the Quaternary period would not preserve fossils.

Based on the nature of the project, surface activities may impact upon the fossil heritage if preserved in the development footprint. The geological structures suggest that the rocks are the right age and type to contain fossils but the area is covered in deep cultivated soils. Since there is an extremely small chance that fossils from the Vryheid Formation may occur below ground and may be disturbed a Fossil Chance Find Protocol has been added to this report. Taking account of the defined criteria, the potential impact to fossil heritage resources is extremely low.

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.

APPENDIX 1

List of heritage resources within the development area

Site ID	Site no	Full Site Name	Site Type	Grading
94152	Moab 01	Moab 271 / 01	Burial Grounds & Graves	Grade IIIa
94154	Moab 03	Moab 271 / 03	Building	Grade IIIc
94153	Moab 02	Moab 271 / 02	Burial Grounds & Graves	Grade IIIa
138636	GTI/468-001	GROOTDRAAI 468	Palaeontological	Grade IIIb
138637	GTI/468-002	GROOTDRAAI 468	Palaeontological	Grade IIIc
138638	GTI/468-003	GROOTDRAAI 468	Palaeontological	Grade IIIb
138639	GTI/468-004	GROOTDRAAI 468	Palaeontological	Grade IIIb
138971	GDI-001	Grootdraai 468	Burial Grounds & Graves	Grade IIIa
138972	GDI-002	Grootdraai 468	Burial Grounds & Graves	Grade IIIa
138973	GDI-003	Grootdraai 468	Structures	
138974	GDI-003	Grootdraai 468	Structures	Grade IIIb
139939	VNN-009	Viljoenskroon	Burial Grounds & Graves	Grade IIIc
139940	VNN-010	Viljoenskroon	Structures	Grade IIIc
139941	VNN-011	Viljoenskroon	Burial Grounds & Graves	

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APPENDIX 2

Reference List with relevant AIAs and PIAs

Heritage Impact Assessments				
Nid	**Report Type**	**Author/s**	**Date**	**Title**
321166	Archaeological Specialist Reports	Jaco van der Walt	17/06/2015	Archaeological Scoping Report for the Proposed Buffels Solar 1 SEF, Klerksdorp, North West Province
321168	PIA Desktop	Barry Millsteed	21/06/2015	Palaeontological Heritage Impact Assessment Report on the Site of a Proposed Solar Power Production Facility known as the Buffels Solar 1 PV Energy Facility to be located approximately 20 km north East of Orkney, NW Province
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365014	HIA Phase 1	Sidney Miller	02/03/2015	Cultural Heritage Impact Assessment for Shafts #1 to #7, Orkney, Northwest Province, South Africa, for CAPM Gold.
369846		Jaco van der Walt	31/08/2016	
5097	AIA Phase 1	Johnny Van Schalkwyk	07/03/2003	Mercury-Perseus 400 kV Transmission Line, Cultural Heritage Resources
6030	AIA Phase 1	Cobus Dreyer	20/06/2005	Archaeological and Historical Investigation of the Proposed Residential Developments on Subdivision 13 of the Farm Pretoriuskraal 53, Viljoenskroon, Free State
7340	AIA Phase 1	Zoe Henderson, C Koortzen	19/06/2007	Heritage Assessment Report Mercury Substation Expansion, Zaaiplaats 190/3, Fezile Dabi (DC20) District, Free State, South Africa

7367	AIA Phase 1	Thomas Huffman	01/03/2005	Archaeological Assessment of the Mispah Tailings Dam Extension
7684	AIA Phase 1	Jaco van der Walt	25/09/2007	Archaeological Impact Assessment. Township Development and Sub Division of AH18, Pretoriuskraal, Orkney, North West Province
7685	AIA Phase 1	Jaco van der Walt	25/09/2007	Archaeological Impact Assessment. Township Development on Sub Division of AH19, Pretoriuskraal, Orkney, North West Province
9124	Heritage Study	Francois P Coetzee	01/04/2012	Cultural Heritage Survey of the Proposed Kabi Vaalkop PV Facility near Orkney, Dr Kenneth Kaunda District, North West Province

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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.

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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.

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APPENDIX 2: Archaeological Assessment (2022)

ARCHAEOLOGICAL SPECIALIST STUDY

In terms of Section 38(8) of the NHRA for a

The development of various PV Facilities and their associated grid connections associated with Harmony Gold Mining activities throughout the Free State Province and in the North West Province

Prepared by

CTS HERITAGE

Jenna Lavin
Dr. D. Presnyakova

In Association with

Savannah Environmental

June 2022

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EXECUTIVE SUMMARY

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CONTENTS

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1. INTRODUCTION

1.1 Background Information on Project

TBA

1.2 Description of Property and Affected Environment

1.2.1 *Harmony*

The potentially affected footprint related to the proposed PV facility is located across the Harmony 1 mining area, approximately 2.5km south of the town of Welkom. The potentially affected area is largely flat. Yet an isolated elevated mound of disturbed quaternary sediments of fluvial origin is present on the landscape (CHM5). This elevated mound appears to have been exposed through past agricultural activities, and includes associated archaeological materials of Pleistocene age, as well as abundant unworked riverine raw-materials in certain localities.

Indeed, much of the northern and central portions of the affected area are significantly modified by recent and historical agricultural activities. In this regard, there are structural remnants of a farm (HM5) that would have encompassed substantial portions of the affected area when active, which is evident by the lateral spatial morphology of the now dense grasses and delineated fields associated with the agriculturally affected portions. Where retained and unaffected by agriculture, the natural vegetation comprises grassland and shrubland typical of the Free State Grassland Biome, interspersed with denser indigenous foliage along several drainage and paleo-drainage channels traversing the area. Predictably, local wildlife is more abundant in the areas that retain more extensive coverage of indigenous vegetation, with evidence of smaller antelope (such as Duiker and Steenbok), indigenous fowl including francolin, spurfowl and guineafowl , as well as some traces of burrowing rodents (molerats, hares and meerkats) evident in the project footprint.

The south-western portion of the potentially affected area has a higher frequency of active non-perennial drainages than the north-eastern portion. These drainages are associated with substantial fluvial deposits of riverine quartzite rocks (evident from the rock cortex), and other secondary deposits of sedimentary rocks that derive from the parent formations of the broader goldfields region. These cobbles would have been sources of raw-material for Stone Age occupants of the area. Other rock types incorporated in the cobble deposits include quartz and indurated shales (Hornfels), many of which are artefact manufacturing quality in terms of homogeneity and lithic fracture properties.

The historical use of the landscape for agricultural purposes, and relatively abundant remnants of recently abandoned structures in one area (HM5-HM8) raise the potential for graves and isolated burials. Importantly though, no graves were identified within this particular survey, and there would not be evidence of graves within the extensive ploughed areas of the footprint. However, the dense grass cover related to late summer heavy rainfall was a pertinent constraint to documenting potential graves in the areas that were not ploughed. Grass cover made potential grave locations impossible to exhaustively assess across the project area (particularly in cases where above surface material indicators may have been removed through crop related activities or through trampling related to stock farming).

1.2.2 *Central*

The potentially affected footprint related to the proposed PV facility and associated infrastructure is located across several previously ploughed agricultural camps, approximately 9.5km to the south-east of the town of Welkom. Overall the area is flat, and is heavily modified by modern land-use activities such as historical agriculture and prospecting. As a result of such disturbance, little of the original natural landscape - in terms of vegetation, geology and probably also archaeology - is visible today.

The northern portion (Central Plant PV Facility (Alternative 1)) of the affected area is characterised by ploughed agricultural camps. Agricultural activities have disturbed the upper ~0.5-1m of original quaternary sediments associated with this area. At several localities, exposures of agriculturally reworked quaternary surface deposits are visible (CCT63), which include sparsely distributed Pleistocene stone artefacts in some places. These artefacts have been rolled, as evidenced by rounding and frequencies of edge-damage on all specimens, and are in heavily disturbed depositional contexts. Structural remains of past agricultural activities are also evident in close proximity to the ploughed areas. Ephemeral remnants of one modern Kraal were visible, however, this Kraal is likely not older than 60 years, thus offering little in terms of scientific or heritage value (CCT14).

An active high energy non-perennial braiding river with associated minor drainages is located in the south-eastern portion, and there are extensively ploughed fields in the south-western portion of Alternative 1. Several associated drainage channels expose fluvial deposits that are likely Pleistocene in origin. However, the spatial extent and life-history of the drainages are affected by the extensive modern disturbance related to mining activity and prospection in the area (CCT1). Substantial fluvial deposits of riverine quartzite rocks, and other secondary deposits of sedimentary rocks that are characteristic of the parent formations of the broader goldfields region, are associated with these channels. A diversity of rocks is incorporated in the cobble deposits including quartz and indurated shales (Hornfels), many of which are artefact quality in terms of homogeneity and fracture characteristics. Sparse Pleistocene artefacts are associated with these cobble deposits, and mostly comprise products from early on in core reduction, with one weathered bifacial tool indicative of an earlier Late Pleistocene or Middle-Pleistocene occupation of the region. This bifacial tool may be indicative of a broad minimum age for the original fluvial deposition of the cobbles and artefacts in this area. That said, the artefacts themselves could have been fluvially transported over substantial distances. The artefacts identified were all *ex-situ*, meaning that they cannot be dated or geochronologically associated with an encompassing deposit, so are limited in scientific value. All artefacts occur as isolated finds rather than scatters of associated archaeological materials.

The potentially affected area also has sporadic invasive vegetation including eucalyptus, occasional black Wattle and several Pine trees. Where the indigenous vegetation is evident, it comprises grassland and semi-arid shrubland typical of the southern African Grassland Biome in the summer-rainfall region, although indigenous vegetation has been removed across >70% of the affected area. In terms of fauna, only evidence for burrowing rodents (predominantly hares) was observed. Bioturbation relating to burrowing rodents may well affect any potential sub-surface archaeology (though no sub-surface remains were documented apart from the reworked isolated Pleistocene artefacts).

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Apart from the isolated Stone Age remains mentioned, there was no evidence of Iron Age archaeology within the footprint. No graves were identified within the survey and visibility was reasonably good for stone structures, although much of the surface sediments were only visible in disturbed contexts. Relevantly, the dense grass cover was a pertinent constraint to documenting potential graves in the areas that were not disturbed. Agricultural and prospection activities may have removed surficial indicators of sub-surface archaeology such as burials, which needs to be considered in future development implicating excavation.

1.2.3 *Target*

The potentially affected area associated with the proposed PV facility is located in the Target mining area, approximately 12 km north-east of the town of Odendaalsrus in the goldfields region of the Lejweleputswa district of the Free State province of South Africa. The footprint for potential development is largely flat, and characterised - over substantial portions - by ploughed agricultural camps in the western most two-thirds. The upper sediments in the agriculturally affected regions (western portion) have thus been extensively disturbed through agricultural processes, and the original quaternary deposits have been reworked or removed to depths in excess of ~0.5m in several places, as a consequence of agriculture and/or mining related clearing (CTG1 - CTG6).

Local bedrock outcrops ephemerally at several points east of the affected area. This bedrock is comprised largely of shales and indurated siltstones (Ecca Group), whereas the upper sediments covering these host rocks, and the footprint itself, likely derive from the in-situ weathering of local parent formations. The upper sediments were fluvially deposited across much of the area (as evidenced by sub-angular edges and rounding of lithic inclusions), and potentially relate in depositional origin to summer flooding of the drainages to the south and west.

In the eastern portion of the affected property, where natural landscape is primarily retained (i.e. unaffected by modern activity), grassland and semi-arid shrubland is evident with shale and some evidence for sub-volcanic rock in the form of small secondary colluvial nodules (<5cm in maximum diameter) in several locations. No primary or secondary sources of artefact quality stone were documented on the affected property, and only two stone artefacts (on exotic fine-grained quartzite) were documented in the vicinity of the affected property. The isolated archaeological finds were documented in the eastern portion, in broad association with the original quaternary upper sediments. However these archaeological finds occurred in secondary contexts on a deflated land surface, so therefore have limited potential for modern scientific analyses (due to the *ex situ* spatial contexts of the finds and limited possibility of radiometric dating or directly associating them with dateable sediments).

The western portion of the affected property is interspersed with vehicle tracks where grass has been trampled and/or removed, probably to facilitate vehicle manoeuvrability between agricultural infrastructure and to facilitate movement associated with prospecting. Indigenous fowl including francolin and guineafowl were observed on the affected property, in addition to abundant traces of burrowing rodents (predominantly hares), which may well affect any potential sub-surface archaeology (though no sub-surface remains were documented).

Apart from the ephemeral Stone Age remains documented, evidence for archaeology was minimal. No graves were identified within the survey and visibility was reasonably good for stone structures, so the latter finding could be considered comprehensive. However, the substantial grass cover and soil formation across the eastern part of the footprint was a relevant constraint to documenting stone artefacts and other smaller potential surface remains such as pottery etc.

1.2.4 *Joel*

The potentially affected footprint related to the proposed PV facility is located across the Joel mining area, approximately 12 km north-east of the town of Odendaalsrus in the goldfields region of the Lejweleputswa district of the Free State province of South Africa. Relative to the 4 other affected areas discussed in the report, the Joel area is substantially less affected by modern activities and significant portions of the original landscape are retained that have thick shrubs and grasses, although portions of the property owned by the mine look currently to be leased out for cattle grazing, and one small central area has been affected by historical mining (evidenced by an abandoned shaft CJL13).

The footprint is located in the vicinity of the Free State Doring meandering river system. Portions of the affected property are located on the terraces of this drainage system, with evidence of banded chert nodules (4-11cm in maximum diameter – a high quality raw-material for artefact manufacture) (CJL2), and thick fluvially deposited sands (CJL11). Importantly, only marginal topsoil formation was evident in the area, which may be a further indicator of the erosional effects of a past active high-energy river system. Several remnants of dam structures were recorded, implicating the historical anthropogenic capture of naturally available water in the summer rainfall season (CJL3 and CHL6). Although the affected area is relatively flat, there are more resistant raised areas that are richer in archaeological materials relative to the deflated areas between(CJL11). There is also more evidence for soil formation in the raised portions, indicating that parts of the landscape have been differentially eroded by natural (flooding) and/or anthropogenic processes (agriculture) over time.

The natural vegetation comprises Savanna Grassland typical of the southern African summer-rainfall region interspersed with abundant acacia, and dense grasses among the shrubs, with small open patches of sand dispersed between the thicker vegetation (which were extensively examined, although archaeological visibility was poor) (CJL1, CJL2, CJL4, CJL10, CJL12, and JL1 and 2) . Chert artefacts were exposed in several patches indicating that the vegetation cover may be inhibiting visibility of more extensively distributed archaeological materials. There is abundant evidence of indigenous and invasive fauna including smaller to medium sized buck (Bushbuck, Duiker and Steenbok), Suids including various bushpig species (and modern traps set for their capture), abundant Vervet monkeys, indigenous and feral fowl including herds of Ostrich, francolin, spurfowl and guineafowl, as well as traces of burrowing rodents (molerats, hares and meerkats).

Importantly, no graves were identified within the survey, and there would not be evidence of graves within the areas of the footprint extensively affected by flooding. In addition, there was no evidence for historical dwelling structures that would make potential burials more likely. The dense grass and acacia cover, however, was a pertinent constraint to documenting potential graves in the areas that were not disturbed. Extensive grass cover made potential grave locations impossible to exhaustively assess across the project area although their presence seems unlikely given the paucity of archaeological evidence for historical domestic activities such as dwellings.

1.2.5 Moab

The potentially affected area related to the proposed PV facility is located across the Moab mining area and some privately owned agricultural camps in the east, approximately 12 km south-east of the town of Orkney. Although Orkney is located in the North-West province, the PV footprint is located across the southern bank of the Vaal River, on the northern border of the Free State province of South Africa.

Much of the footprint has been affected by sporadic surface disturbance and modern excavation likely associated with historical agricultural activities (and modern ploughed fields to the east of the Moab boundary included in the affected footprint) (CMB3), with mining prospection and the development of mining related infrastructure (CMB26). Where the natural vegetation is retained, it comprises grassland typical of the southern African Grassland Biome in the summer-rainfall region interspersed with acacia, and in some areas, such as the south-west, dense invasive forest comprising eucalyptus plantation and occasional black Wattle (CMB10). Chert bedrock outcrops in multiple locations (CMB4) in the north-west and in the south-east (some with clear prehistoric exploitation traces) (CM2). Where indigenous grassland is retained, evidence of smaller antelope (such as Duiker and Steenbok), abundant Vervet monkeys, indigenous fowl including francolin, spurfowl and guineafowl, as well as traces of burrowing rodents (molerats, hares and meerkats) were observed within the affected area.

The topography of the project area is generally flat. It declines, however, gradually in the south-east where a drainage channel is located associated with Middle and Later Stone Age materials. There is extensive disturbance in the form of recent and historical clearing associated with probable mining-related activities. Bioturbation in the form of rodent activity is evident in the upper ~0.4-1m of sandy topsoil, as well as evidence for past stock rotation farming in the southern portion (probably prior to the land being owned by the mining company), and modern stock farming and bean plantation in the most easterly portion (on what looks to be privately owned/leased land).

The sandy upper sediments look to be fluvially deposited across much of the area, with very few lithic inclusions (some marginally rounded), indicating low-energy deposition in the north-western portions probably related to the Vaal river system, and with primary nodules of chert (5-10cm in maximum diameter) deriving from the local bedrock. Artefact quality raw-material in the form of primary local cherts is available within the footprint, with several outcrops associated with sparse archaeological evidence. Some ephemeral Stone Age exploitation evidence in the form of simple cortical flakes, flake removal traces on outcrops and cores were identified as well as some systematic Levallois and bladelet production in the eastern portion. No identified sites represent archaeological remains in dateable contexts that need to be avoided (see sensitivity ranking), and all are of low scientific significance.

Importantly, no graves were identified within the survey, and there would not be evidence of graves within the extensively disturbed areas of the footprint. In addition, there was no evidence for historical dwelling structures apart from the non-domestic dilapidated Vaal Reef Shooting Club. Relevantly though, the dense grass cover was a pertinent constraint to documenting potential graves in the areas that were not disturbed. Extensive grass cover made potential grave locations impossible to exhaustively assess across the project area (particularly in cases where above surface

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material indicators may have been removed through modern disturbance or through trampling related to historical stock farming activities.

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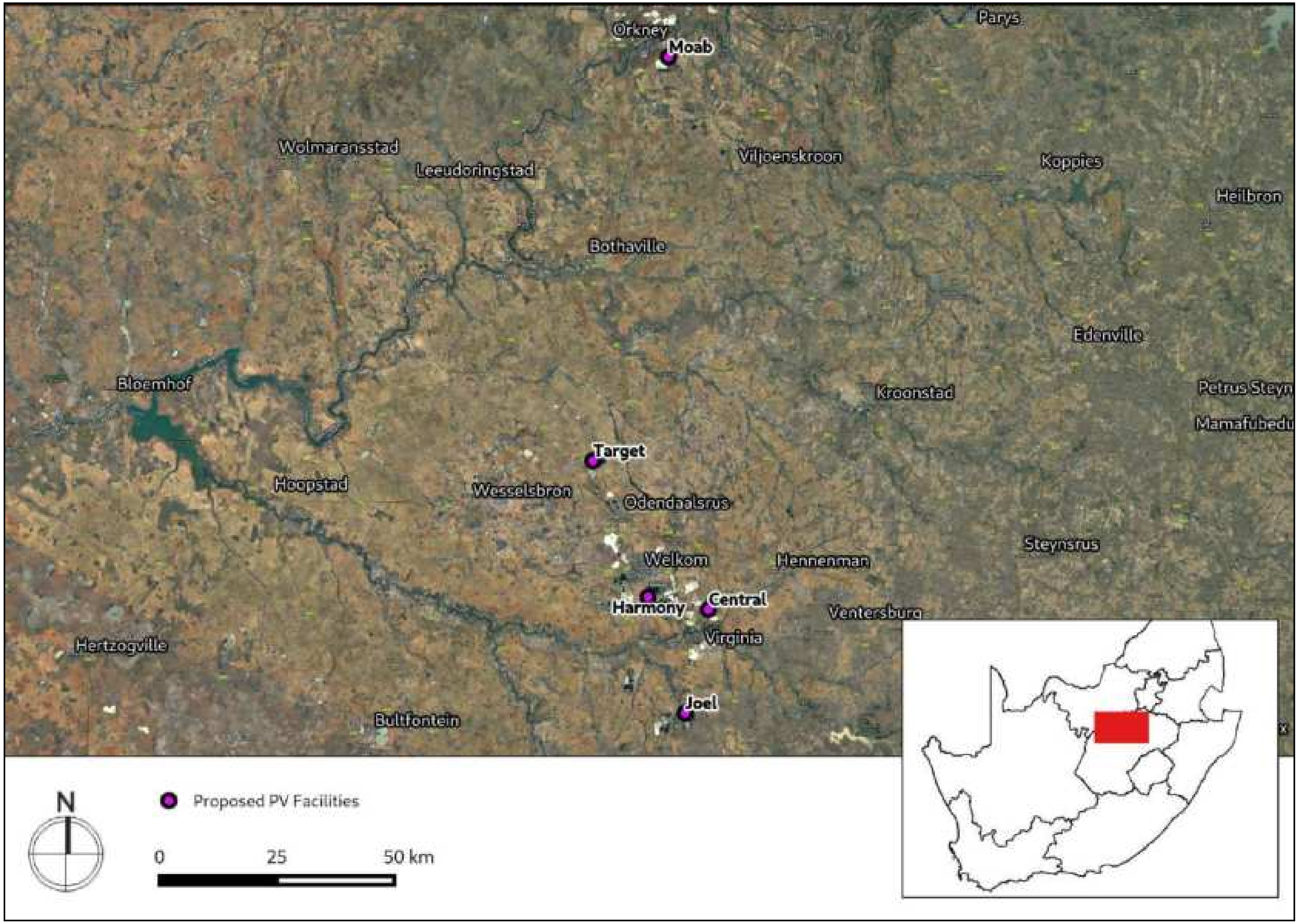

Figure 1.1: Close up satellite image indicating proposed location of study area

Figure 1.2: Study Area

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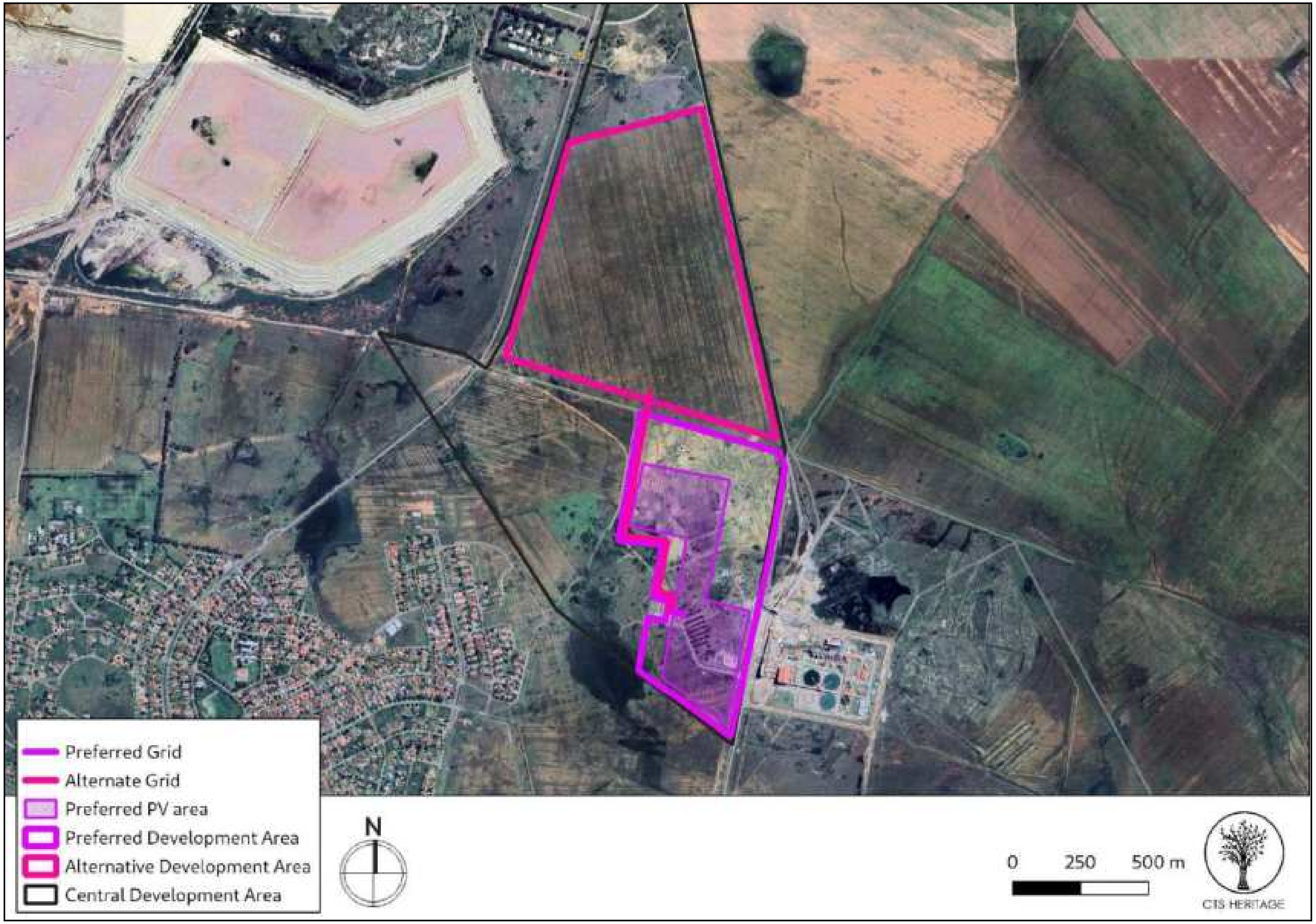

Figure 1.3: Study Area for Central PV

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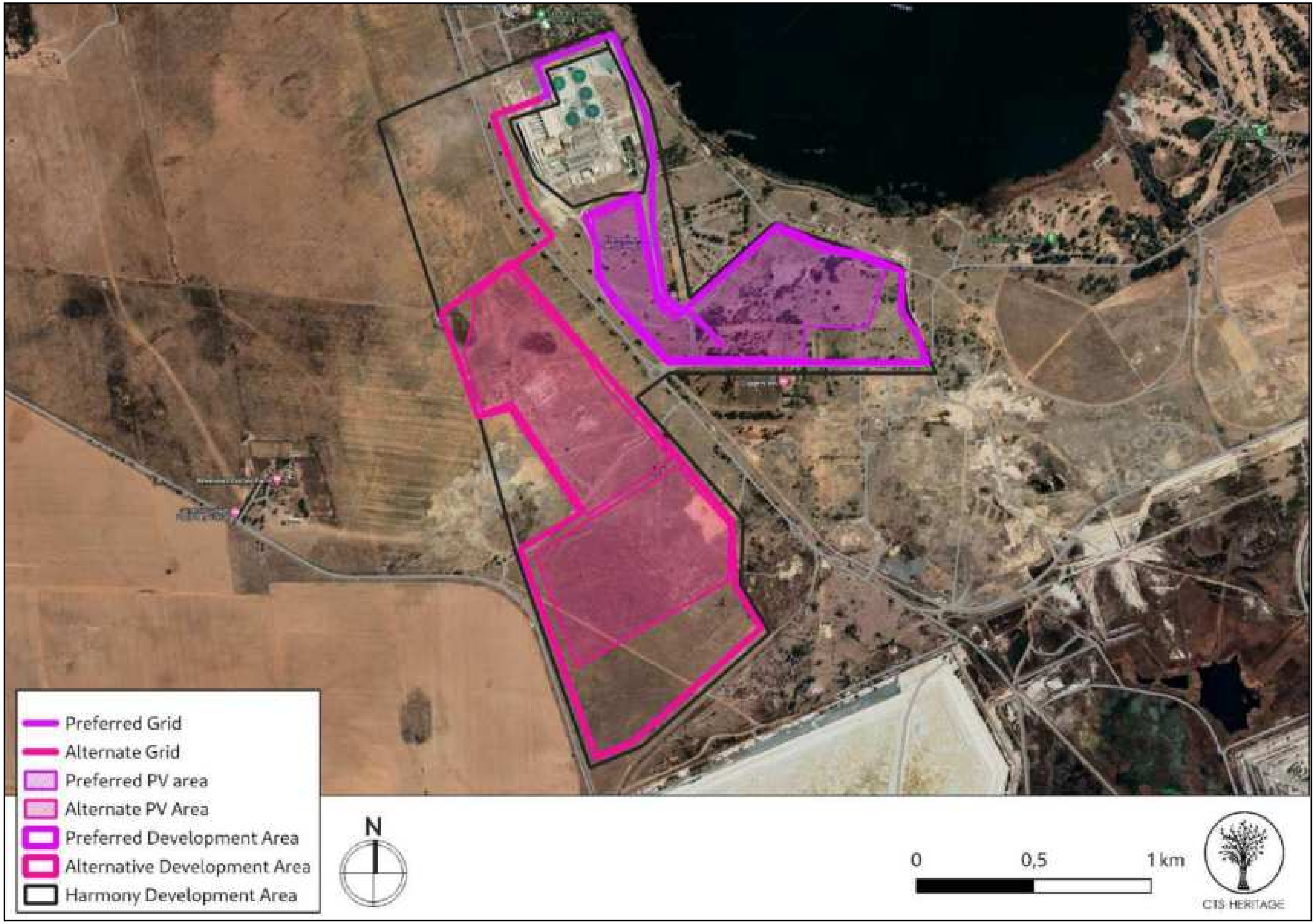

Figure 1.4: Study Area for Harmony PV

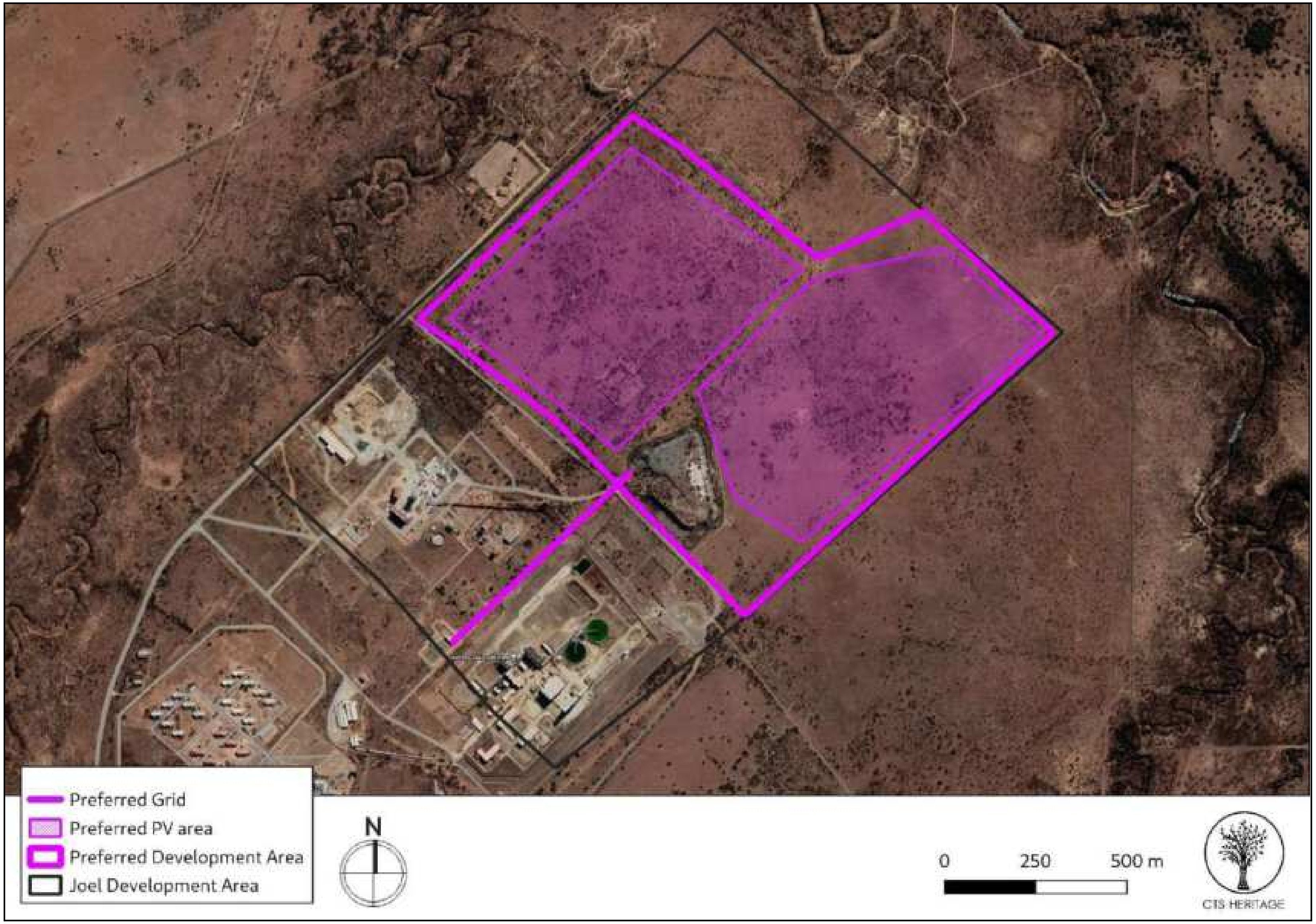

Figure 1.5: Study Area for Joel PV

Figure 1.6: Study Area for Target PV

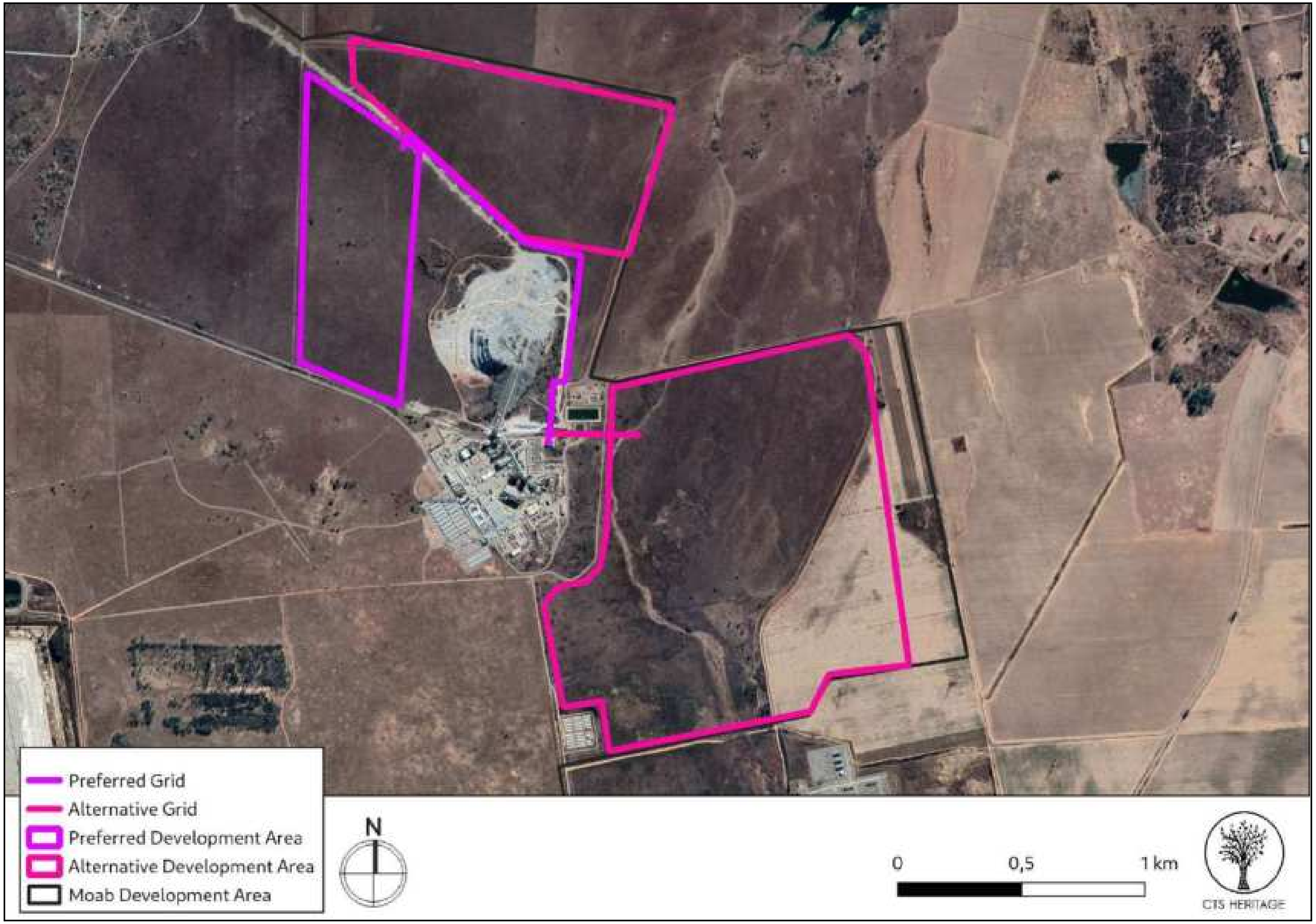

Figure 1.7: Study Area for Moab PV

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2. METHODOLOGY

2.1 Purpose of Archaeological Study

The purpose of this archaeological study is to satisfy the requirements of section 38(8), and therefore section 38(3) of the National Heritage Resources Act (Act 25 of 1999) in terms of impacts to archaeological resources.

2.2 Summary of steps followed

- An archaeologist conducted a survey of the sites and its environs from May to July 2022 to determine what archaeological resources are likely to be impacted by the proposed development.
- The study area was assessed on foot in transects, photographs of the context and finds were taken, and tracks were recorded using a GPS.
- The identified resources were assessed to evaluate their heritage significance in terms of the grading system outlined in section 3 of the NHRA (Act 25 of 1999).
- Alternatives and mitigation options were discussed with the Environmental Assessment Practitioner.

2.3 Constraints & Limitations

2.1 Harmony

(1) Dense grasses and occasional shrubs cover portions of the project area. This coverage significantly inhibited the visibility of surface archaeology. However, this is not regarded as a substantial problem in relation to the Stone Age archaeological remains, which in most cases look to have generally limited scientific importance due to the disturbed and deflated contexts they occur in. An exception is the context of the archaeology at JL2, which occurs in a potentially dateable context. Additionally, even in the places that had optimal visibility, evidence of archaeology was sparse. It is clear that the Stone Age sensitivity and scientific potential of the project area has been comprehensively assessed.

(2) The inability to assess some of the footprint area at ground surface level in some portions (due to modern vegetation cover), should be regarded as a constraint to the documentation of potential graves.

(3) Previous vegetation clearing activities through prospecting, and by farmers, may have affected evidence of surface archaeology including the possible above-surface presence of material evidence of graves (i.e. the removal of surface stone structures).

(4) Upper sediments are disturbed in the portions of the potentially affected area that have been historically farmed, inhibiting visibility.

(5) Access was not possible in areas that are being actively mined; however, any archaeology occurring in these areas would probably be *ex situ* in any case, and of limited scientific importance.

2.2 Central

(1) The area is heavily modified by modern land-use activities such as historical agriculture and prospecting. As a result of such disturbance, little of the original natural landscape - in terms of vegetation, geology and

probably also archaeology - is visible today. Previous vegetation clearing activities through prospecting, and by farmers historically, may have affected evidence of surface archaeology including the possible above-surface presence of material evidence of graves (i.e. the removal of surface stone structures).

(2) Dense grasses and occasional shrubland cover portions of the project area. This coverage significantly inhibited the visibility of surface archaeology. However, this is not regarded as a substantial problem in relation to the Stone Age archaeological remains, which in most cases look to have generally limited scientific importance due to the disturbed and deflated contexts they occur in. Additionally, even in the places that had optimal visibility, evidence of archaeology was sparse. It is clear that the Stone Age sensitivity and scientific potential of the project area has been comprehensively assessed.

(3) The inability to assess some of the footprint area at ground surface level in some portions (due to modern vegetation cover), should be regarded as a constraint to the documentation of potential graves.

(4) Access was inhibited in areas actively prospected or mined; however, any archaeology occurring in these areas would be *ex situ* in any case, and of limited scientific importance.

2.3 *Target*

(1) Ploughed agricultural camps encompass the western most two-thirds of the affected area. Consequently, the upper sediments are substantially disturbed where crops are actively growing and cattle grazing and resulting trampling is evident.

(2) Dense grasses and occasional shrubland cover portions of the project area. This coverage significantly inhibited the visibility of surface archaeology. However, this is not regarded as a substantial problem in relation to the Stone Age archaeological remains, which in most cases look to have generally limited scientific importance due to the disturbed and deflated contexts they occur in. Additionally, even in the places that had optimal visibility, evidence of archaeology was extremely sparse. It is clear that the Stone Age sensitivity and scientific potential of the project area has been comprehensively assessed.

(3) The inability to assess some of the footprint area at ground surface level in some portions (due to modern vegetation cover), should be regarded as a constraint to the documentation of potential graves.

(4) Previous vegetation clearing activities through prospection, and by farmers, may have affected evidence of surface archaeology including the possible above-surface presence of material evidence of graves (i.e. the removal of surface stone structures).

(5) Access was not possible in areas actively mined; however, any archaeology occurring in these areas would be *ex situ* in any case, and of limited scientific importance.

2.4 Joel

(1) Substantial acacia and other shrubs cover portions of the project area, which are interspersed with dense

grasses. This coverage significantly inhibited the visibility of surface archaeology. Given the presence of an archaeological site occurring in a dateable context, this vegetation coverage has to be considered a significant hindrance to assessing the Stone Age sensitivity of the project area.

(2) The inability to assess some of the footprint area at ground surface level in some portions (due to modern vegetation cover), should also be regarded as a constraint to the documentation of potential graves.

(3) High energy flooding may have affected evidence of surface archaeology including the possible above-surface presence of material evidence of graves (i.e. the removal of surface stone structures).

(4) Access was inhibited in areas that are actively mined; however, any archaeology occurring in these areas would be *ex situ* in any case, and of limited scientific importance.

2.5 Moab

(1) Dense grasses and occasional shrubland cover portions of the project area. This coverage significantly inhibited the visibility of surface archaeology. However, this is not regarded as a substantial problem in relation to the Stone Age archaeological remains, which in most cases look to have generally limited scientific importance due to the disturbed and deflated contexts they occur in. Additionally, even in the places that had optimal visibility, evidence of archaeology was extremely sparse. It is clear that the Stone Age sensitivity and scientific potential of the project area has been comprehensively assessed.

(2) The inability to assess some of the footprint area at ground surface level in some portions (due to modern vegetation cover), should be regarded as a constraint to the documentation of potential graves.

(3) Previous vegetation clearing activities through prospection may have affected evidence of surface archaeology including the possible above-surface presence of material evidence of graves (i.e. the removal of surface stone structures).

(4) Upper sediments are substantially disturbed in the eastern portion where crops are actively growing and cattle grazing is evident (in the area that appears to be private property).

(5) Access was inhibited in areas actively mined; however, any archaeology occurring in these areas would likely be *ex situ* in any case, and of limited scientific importance.

3. HISTORY AND EVOLUTION OF THE SITE AND CONTEXT

This application is for the proposed development of a number of PV Facilities located throughout the Free State associated with various Harmony Mines. Four of these facilities are located in proximity to one another around the Welkom area, and the fifth is located further north near Orkney.

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 the 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)".

Archaeology of the broader Welkom area

In his field assessment conducted within this broader area, Rossouw (2012) noted that "The Stone Age archaeological footprint in the region is largely represented by the occurrence of open-site, Middle Stone Age (MSA) and Later Stone Age (LSA) assemblages that are mainly located near river drainages. Interestingly, a large number of MSA artifacts were found 2m below the surface at the Allanridge railway siding in 1953. The material is stored at the National Museum in Bloemfontein. Unfortunately, the context of the assemblage is unknown. MSA as well as LSA artefacts, in association with mammal fossil remains, are also found in a series of erosional gullies along the Sand and Doring Rivers between Virginia and Theunisen. There are no records of rock engravings known from the area. The ruins of a large complex of Late Iron Age settlements (OXF 1, Maggs 1976) are found at Strydfontein between Hennenman and Ventersburg. However, it is noted that the affected area is situated outside the western periphery of the distribution of Late Iron Age settlements below the Vals River in the Free State (Maggs 1976)." In Rossouw's assessment, he found no evidence of *in situ* Stone Age or Iron Age archaeological material. He noted no indications of prehistoric structures or rock engravings, historical buildings or structures older than 60 years. Two small graveyards were also recorded during the survey.

In an assessment completed in this area, 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, 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.

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Archaeology of the broader Orkney area

Archaeological sites spanning the Earlier, Middle and Later Stone Age have been found in the region despite the extensive agricultural transformation of the area. In Dreyer (2005) and Van der Walt's (2007) heritage impact assessments of the nearby Pretorius Kraal 53, various modern buildings were recorded that are located near the banks of the Vaal River that were deemed as not conservation worthy. Van der Walt identified some Middle to Later Stone Age artefacts scattered across the farm but did not map them. In Van Schalkwyk's (2021) impact assessment of the Siyanda Solar farm on Grootdraai 468 (which lies on the western border of Pretorius Kraal 53), visibility issues were a major problem,

"Due to the very dense vegetation cover that occur in the project area, natural as well as agricultural fields, it was impossible to obtain any ground visibility. The strategy was therefore to examine natural and man-made features that are usually associated with human habitation and activities such as clumps of trees and rock outcrops. The proposed power line corridor connecting the Solar Power Plant to the the existing Vaal Reef Substation was not surveyed as access to the relevant properties (Pretoriuskraal 53) was not possible. It is proposed that once the power line route has been confirmed within the 100m corridor a heritage walk-though needs to be undertaken." Two burial sites were recorded during this survey despite the lack of Stone Age sites with the help of a local informant who had been working on the property for a number of years.

In his assessment of an area immediately adjacent to the Moab PV project area, Huffman (2005, SAHRIS ID 7367) identified no sites of archaeological interest. In their assessment of an area located immediately adjacent to the areas proposed for development, Henderson and Koortzen (2007, SAHRIS ID 7340) noted that while no sites were found in the area surveyed, a number of previously excavated inspection pits yielded archaeological material in the form of stone artefacts. Henderson and Koortzen (2007, SAHRIS ID 7340) note that "These artefacts had been brought up from an unknown depth (probably no more than a metre or two), and were mostly undiagnostic flakes with one blade-like flake which could be Middle Stone Age. Raw material included cryptocrystalline, chert and quartz."

In an assessment completed by CTS Heritage for a proposed PV facility located nearby, a single site and very few isolated individual artefacts were documented. Cumulatively these findings indicate cultural evidence for MSA and LSA occupations of the area. It was noted that the majority of finds were identified in disturbed surface contexts, and could not be tied chrono-culturally to a particular prehistoric period, however one site (VK4) was relatively less affected by post-depositional processes, and may have been exposed relatively recently. Apart from this one site, the potential for finding a dateable *in-situ* archaeological horizon based on current surface observations appears to be low. The documented archaeology is therefore classified as scientifically LOW-SIGNIFICANCE. It is therefore highly likely that further burials may be located on the proposed solar PV areas as well as Stone Age material similar to the artefacts recorded but not mapped by Van der Walt.

4. IDENTIFICATION OF HERITAGE RESOURCES

4.1 Field Assessment

The survey was conducted primarily on foot but also involved driving between key targeted areas, and sought to assess the presence and significance of archaeological occurrences within the project area. Across all 5 potentially affected areas, overall field assessment documented a sparse number of isolated stone artefacts in secondary and surface contexts and one denser occupational context in a potentially dateable context, suggesting the area may have been traversed intermittently by Stone Age groups through periods in both the Middle Stone Age (MSA – ~300ka:~40ka), the Later Stone Age (LSA: ~40ka: ~2ka) in addition to individual bifacial tools potentially associated with the later ESA (~400-~200ka), although artefacts that could be clearly linked with chrono-cultural periods were scarce. The presence of small nodules of artefact-quality chert rocks, homogenous quartzites as well as high-quality riverine Hornfels and Quartz in the project areas in addition to relatively abundant standing water, were likely the resources that attracted groups to the broader region, and resulted in them leaving behavioural traces in the form of stone artefacts and traces of lithic exploitation on primary sources of raw-material (the latter exclusively at Moab). Indeed the majority of the stone artefacts identified look to be the result of expedient 'testing' of rocks for quality, although several cores and tools associated with more extensive investment in production were identified. In this sense – apart from the single site at Joel (see below) - no evidence of substantial densities of finds or occupational debris were identified, and the stone artefacts present look to have been produced by mobile forager groups moving through the area.

4.1.1 Harmony

Field assessment at Harmony documented several stone artefact scatters in secondary contexts and one site (CHM4) in a close to primary context that optimally needs to be avoided. Cumulatively these finds suggest the area was occupied or traversed intermittently by Stone Age groups through periods in the Middle Stone Age (HM1-HM3), and perhaps the terminal ESA/early MSA (CHM4), as well as historical periods associated with more recent occupations of the region (HM5-8).

The sites of HM1, HM2 and HM3 have predominantly MSA artefacts that occur in ex-situ contexts, and the weathering of the edges suggests the artefacts have been exposed for substantial periods and have limited scientific value. HM4 is an MSA site associated with Pleistocene occupation of a paleo-drainage terrace. The artefacts at HM4 are eroding out of laminated – highly detailed – fluvial deposits that document both the depositional history of the meandering river system and the associated prehistoric occupation of the river terraces by MSA hominins. One bifacial tool was identified, which is certainly MSA, but may also document an older Middle-Pleistocene occupation of the terraces. Given the detailed depositional history of the river documented at HM4 and its association with anthropogenic activity, if this site could be avoided with the guidance of a 30m buffer zone for development that would be optimal.

The historical structures located at HM5-HM8 were documented, but are largely demolished and have limited scientific value. HM7 represents a historical walling structure associated with a drainage channel but has been affected by modern prospection to a degree that it no longer retains substantial heritage value.

4.1.2 Central

Field assessment at Central documented 4 Stone Age occurrences in secondary contexts (CT1-CT4). Cumulatively these

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finds suggest the area was occupied or traversed intermittently by Stone Age groups through periods in the Middle Stone Age, and perhaps the terminal ESA/early MSA.

CT1 was an isolated dolerite core that had been exposed in an intensively ploughed area. The bidirectional nature of removals suggest that the core is probably Middle Stone Age. CT2 was a quartz flake with a prepared platform, also occurring in an area affected substantially by modern agricultural activity. Such platform preparation (CT2) is typical of the products of MSA techniques of flake production. CT3 was a bifacial tool associated with a drainage channel within the footprint, although it was also isolated so has limited scientific value as a single find in an ex-situ, redeposited context. In addition, CT3 had substantial edge damage and weathering indicating that it may have been deposited by a river. As CT3 is a larger bifacial tool, it may be representative of terminal Acheulean technological activity within the area.

4.1.3 Target

No significant archaeology was documented within the footprint at Target. The only isolated finds were two small probably Later Stone age cores (TG1), however, these cores were documented in the area of the footprint that is not currently earmarked for development.

4.1.4 Joel

Field assessment at Joel documented several stone artefact scatters in secondary contexts and one site in a potentially dateable context that needs to be avoided. Cumulatively these finds suggest the area was occupied or traversed intermittently by Stone Age groups through periods in the Middle Stone Age (JL1, JL2, JL5), and the Later Stone Age (JL4, JL6), as well as potentially by groups in periods associated with herder and early historical occupations of the region. JL1 has a dolerite bi-directionally reduced core from initial nodule testing that is characteristic of the MSA. JL2 represents a site that accumulated because of the chert raw-material source nearby, so flakes are largely primary. JL2 also has a hammerstone with visible pitting associated with percussion activities – probably knapping. JL3 has heavily weathered quartzite artefacts including a single platform core (probably MSA given the degree of patination and probable Pleistocene age). JL4 has high-quality chert artefacts, which are also patinated, likely associated with bladelet production, thus indicative of a terminal Pleistocene or Holocene age. At JL6 there is a single platform bladelet core with evidence of crest production and unipolar bladelet production, certainly LSA, and probably indicative of Holocene technological activity.

The relatively more scientifically significant sites/finds are associated with J5, which has later MSA lithics (prepared core technologies), a diversity of raw-materials, as well as a unifacially retouched point potentially indicative of the post-Howiesons Poort period (~55ka-35ka). At JL5, artefacts are eroding out of quaternary sediments, and have been brought to the current land surface through rodent borrowing and other forms of bioturbation. As this site appears to be in a potentially close to primary context (at least an *in situ* context that is potentially dateable), it should be avoided with at least a ~50m buffer zone for development.

4.5 Moab

The survey at Moab documented several isolated finds, and a sparse stone artefact scatter in a secondary context.

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The site at CM1 has a concentration of artefacts that look to be eroding from an encompassing sedimentary context, although the sediments in the close vicinity have been affected by recent land use activities. If this site could be avoided with the guidance of a 30m buffer zone for development that would be optimal. At CM3 several isolated chert artefacts were present on a deflated land surface. The small size of the flakes in addition to the platform morphology and dorsal removal patterns on one specimen may be indicative of bladelet production, thus indicating a likely terminal Pleistocene or Holocene age for these artefacts. Primary sources of chert were documented at several locations within the footprint (e.g. CM2), and several negative flake removals indicating Stone Age exploitation were identified on these outcrops.

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Figure 4.1: Dense grasses and occasional shrubs covering portions of the project area. Such vegetation inhibits the visibility of surface archaeology at Harmony: CHM1, CHM4, CHM8, CHM9, CHM15.

Figure 4.2: Dense grasses cover portions of the project area inhibiting the visibility of surface archaeology at Central: CCT2; CCT8; CCT11; CT2.






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Figure 4.3: Dense grasses and occasional shrubs cover portions of the project area, inhibiting the visibility of surface archaeology at Moab: CMB1; CMB3; CMB5; CMB8; CMB9; CMB10; CMB16; CMB22; CMB25; CMB27.

Figure 4.4: . Dense grasses cover portions of the project area inhibiting the visibility of surface archaeology at Target: CTG9.

Figure 4.5:Acacia and other shrubs cover portions of the project area at Joel, which are interspersed with dense grasses: CJL1, CJL2, CJL10, CJL12.

Figure 4.6: Areas of Harmony affected by mining activities: CHM12

Figure 4.7: Photos show an isolated elevated mound of quaternary sediments of fluvial origin at Harmony (CHM5). Coarse sands followed by laminated well-sorted coarse-medium sand succeeded by silts displayed in the photo is typical for a perennial meandering river.

Figure 4.8: Active non-perennial drainages at Harmony (CHM4 and CHM13):

Figure 4.9: A depiction of raw material sources at Harmony: quartzite and shale (CHM3)..

Figure 4.10: Areas of Central affected by mining activities: CCT1.

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Figure 4.11: Agricultural activities at Central have disturbed the upper ~0.5-1m of original quaternary sediments: CCT6

Figure 4.12: An active high energy non-perennial braiding river (CCT11) with associated minor drainages is located in the south-eastern portion (CT3). Riverine quartzite rocks (CT3), and other secondary deposits of sedimentary rocks are associated with these fluvial channels. Many of these rocks are artefact quality in terms of homogeneity and fracture characteristics(CCT9).

Figure 4.13: Areas of Moab affected by mining activities: CMB26.

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Figure 4.14: Areas of Moab affected by agricultural activities, fields: CMB3 and CMB20, as well as topsoil removed: CMB22.

Figure 4.15: Artefact quality raw-material in the form of primary local cherts, available within the footprint (CMB4), with several outcrops associated with sparse archaeological evidence(CM1).

Figure 4.16: Areas of Target affected by mining activities

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Figure 4.17: Areas of Target affected by agricultural activities: CTG2, CTG4, CTG6

Figure 4.18:Areas of Joel affected by mining activities CJL13

Figure 4.19: The natural Savanna Grassland vegetation at Joel: CJL4.


Figure 4.20: small open patches of sand dispersed between the thicker vegetation: JL1 and JL2

Figure 4.21: Raised area of Joel that is richer in archaeological materials (site JL5) relative to the deflated areas surrounding (CJL11).

Figure 4.22: Raw material availability at Joel: banded chert (CJL2) and hornfels outcrop with associated artefact (JL2).

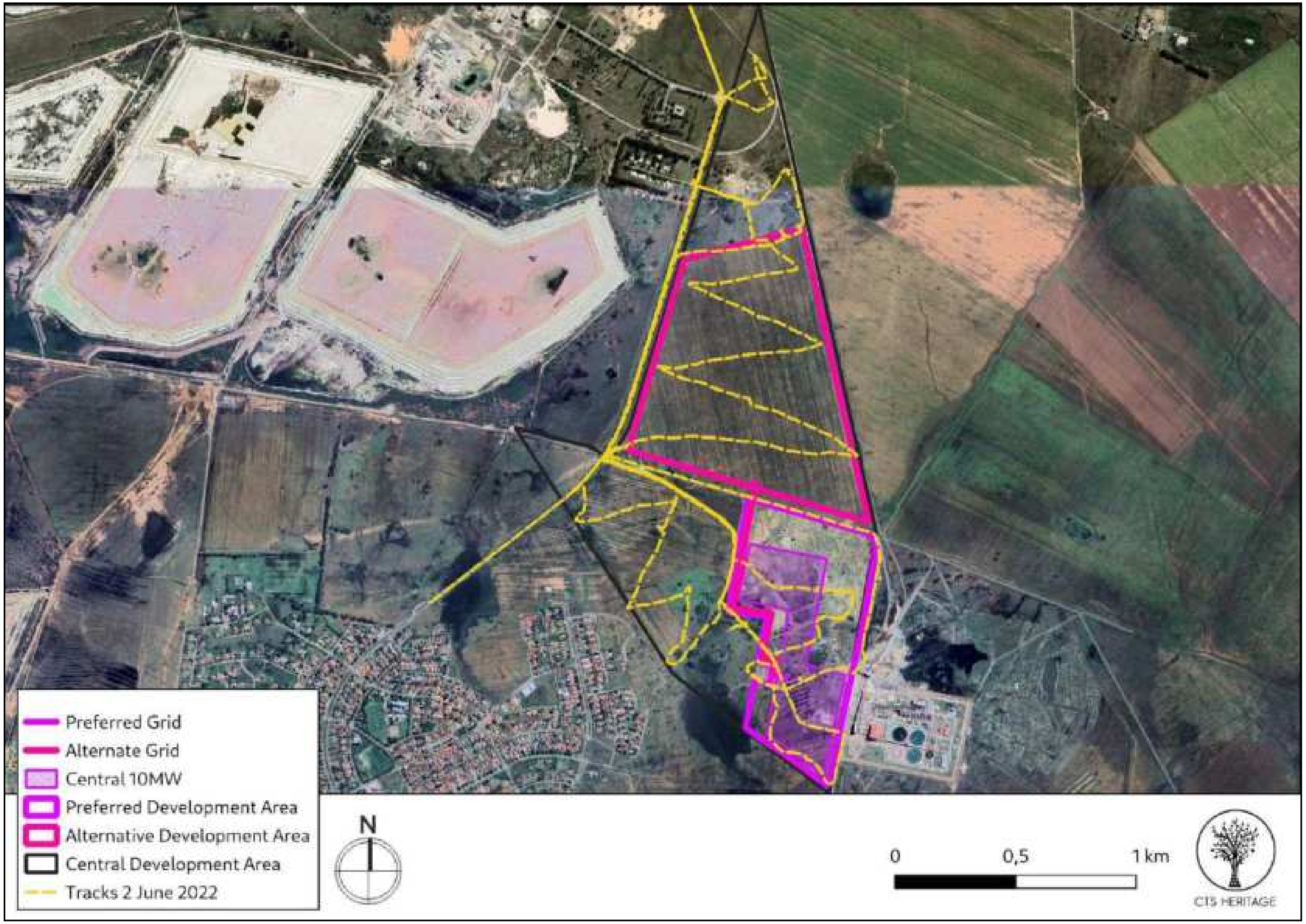

Figure 5.1: Overall track paths of foot survey - Central PV Facility

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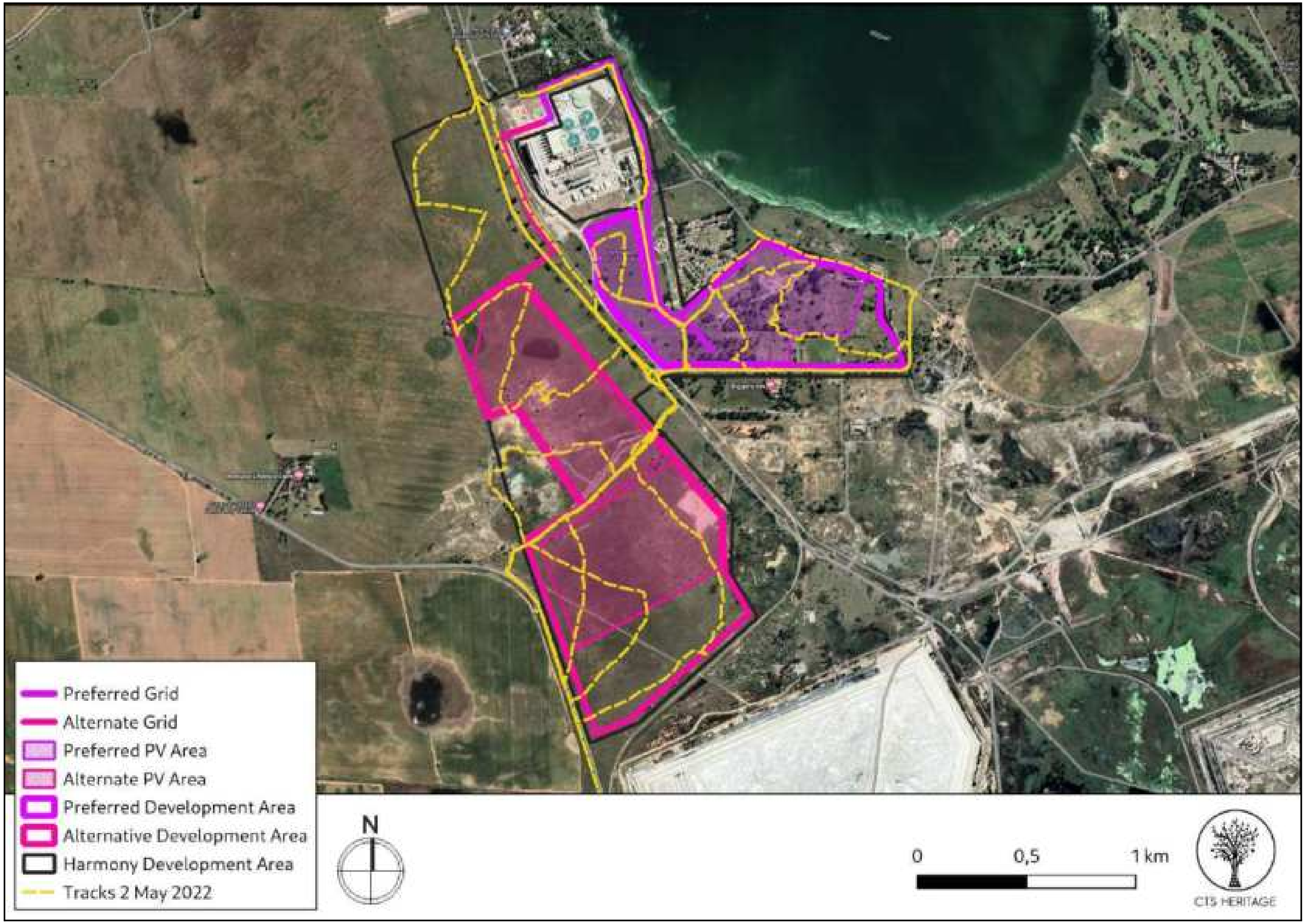

Figure 5.2: Overall track paths of foot survey - Harmony PV Facility

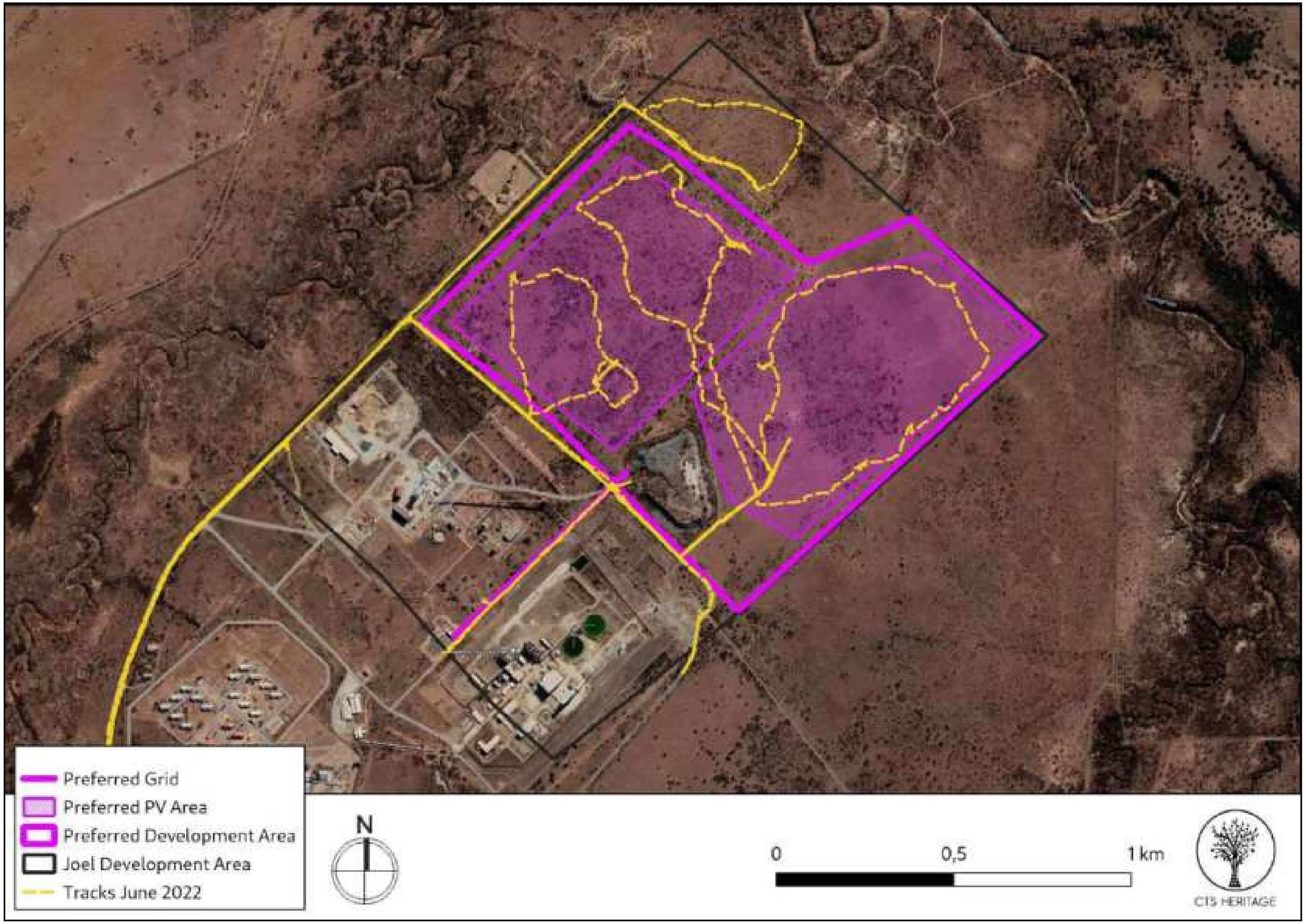

Figure 5.3: Overall track paths of foot survey - Joel PV Facility

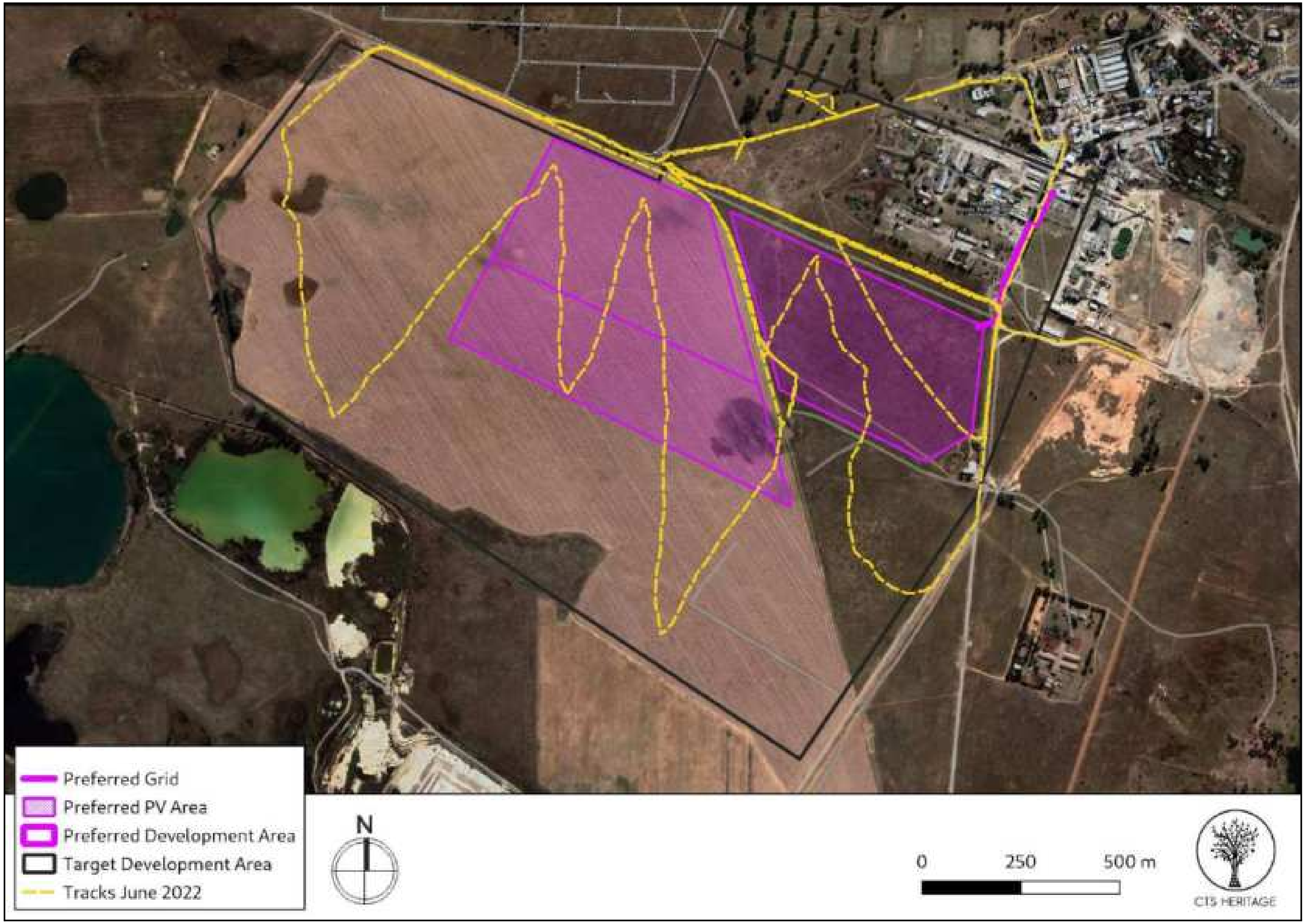

Figure 5.4: Overall track paths of foot survey - Target PV Facility

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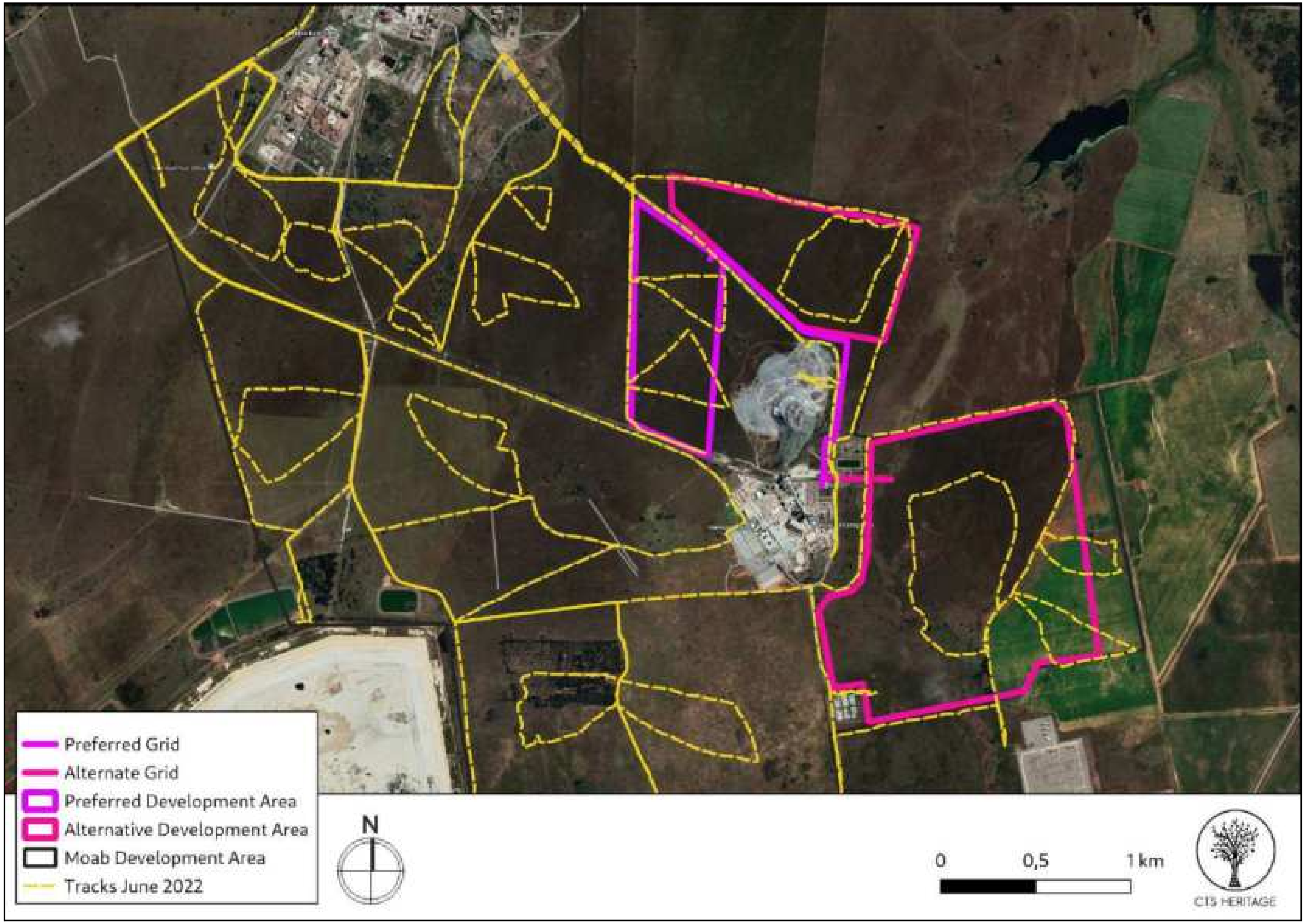

Figure 5.5: Overall track paths of foot survey - Moab PV Facility

4.2 Archaeological Resources identified

Table 2: Observations noted during the field assessments conducted

Site No.	Site Name	Description	Period	Co-ordinates		Grading	Mitigation
CT1	Central PV	Isolated dolerite artefact: core with primary removals	ESA-MSA	-28,0423649 959266	26,8796689 622104	NCW	NA
CT2	Central PV	Isolated quartz artefact: prepared platform flake, heavily rolled and weathered	ESA-MSA	-28,0541419 889777	26,8806460 406631	NCW	NA
CT3	Central PV	Isolated quartzite artefact: bifacial tool with alternating retouch on both faces	MSA	-28,0561190 284788	26,8845039 792358	NCW	NA
CT4	Central PV	Isolated quartzite artefact: core with primary removals	ESA-MSA	-28,0617710 296064	26,88364198 43137	NCW	NA
HM1	Harmony PV	Isolated quartzite artefact: large side scraper	MSA	-28,0374500 155448	26,75613303 66879	NCW	NA
HM2	Harmony PV	Isolated quartzite artefact: single platform core with platform preparation removals	MSA	-28,0343310 255557	26,75568401 8135	NCW	NA
HM3	Harmony PV	Isolated quartzite artefact: marginally reduced core with primary removals	MSA	-28,0334970 261901	26,74948199 65213	NCW	NA
HM4	**Harmony PV**	**Concentration of artefacts: bifacial tool; complete flake and flake fragments**	**ESA-MSA**	**-28,027887 0183974**	**26,7480419 855564**	**IIIC**	**AVOID completely**
HM5	Harmony PV	Building structure likely older than 60 years: remnants of the farm house	Historical	-28,0253369 919955	26,7440390 400588	NCW	NA
HM6	Harmony PV	Foundation structure of a building older than 60 years	Historical	-28,0260460 171848	26,76196298 56199	NCW	NA
HM7	Harmony PV	Stone structure older than 60 years: walling structure.	Historical	-28,0248629 953712	26,75855197 01242	NCW	NA
HM8	Harmony PV	Remains of building structure.	Unclear	-28,0253489 781171	26,7605979 926884	NCW	NA
JL1	Joel PV	Isolated dolerite artefact: bi-directional core, heavily reduced	MSA-LSA	-28,24715198 94897	26,8277529 627084	NCW	NA
JL2	**Joel PV**	**Concentration of artefacts: Anvil, flake fragment, chert outcrop with exploitation evidence**	**MSA-LSA**	**-28,247044 0305769**	**26,8308319 710195**	**IIIC**	**AVOID completely**
JL3		Isolated quartzite artefacts: poorly preserved core - heavily weathered and rolled, rolled flake	unknown	-28,2532779 872417	26,8349339 906126	NCW	NA
JL4	Joel PV	Isolated chert artefact: flake potentially associated with bladelet production	LSA	-28,2490820 06514	26,8273689 877241	NCW	NA
JL5	**Joel PV**	**Concentration of artefacts in a**	**MSA-LSA**	**-28,250538**	**26,8279530**	**IIIB**	**AVOID completely**

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		datable context: 1)single platform chert core; 2) chert flake; 3) chert core; 4) point; 5) silcrete retouched point on a blade; 6) miniature quartz flake; 6) dolerite big flake; 7) silcrete flake; 8) silcrete fragment		**026914**	**387371**		
JL6	Joel PV	Isolated chert artefacts: two chert cores	LSA	-28,2455849926918	26,8313020281493	NCW	NA
TG1	Target PV	Isolated artefacts: two miniature cores associated with microlithic flake production	LSA	-27,7608890365809	26,6334529872983	NCW	NA
CM1	**Moab PV**	**Isolated artefacts on sub-volcanic rock: Levallois core; Bladelet core and several flakes**	**MSA/LSA**	**-26,9879049807786**	**26,8075089901685**	**IIIC**	**AVOID completely**
CM2	Moab PV	Chert outcrop with evidence of hominin exploitation	Stone Age	-26,981156039983	26,778016006574	NCW	NA
CM3	Moab PV	Isolated chert artefacts: several flakes	LSA	-26,9765090290457	26,7868819646537	NCW	NA

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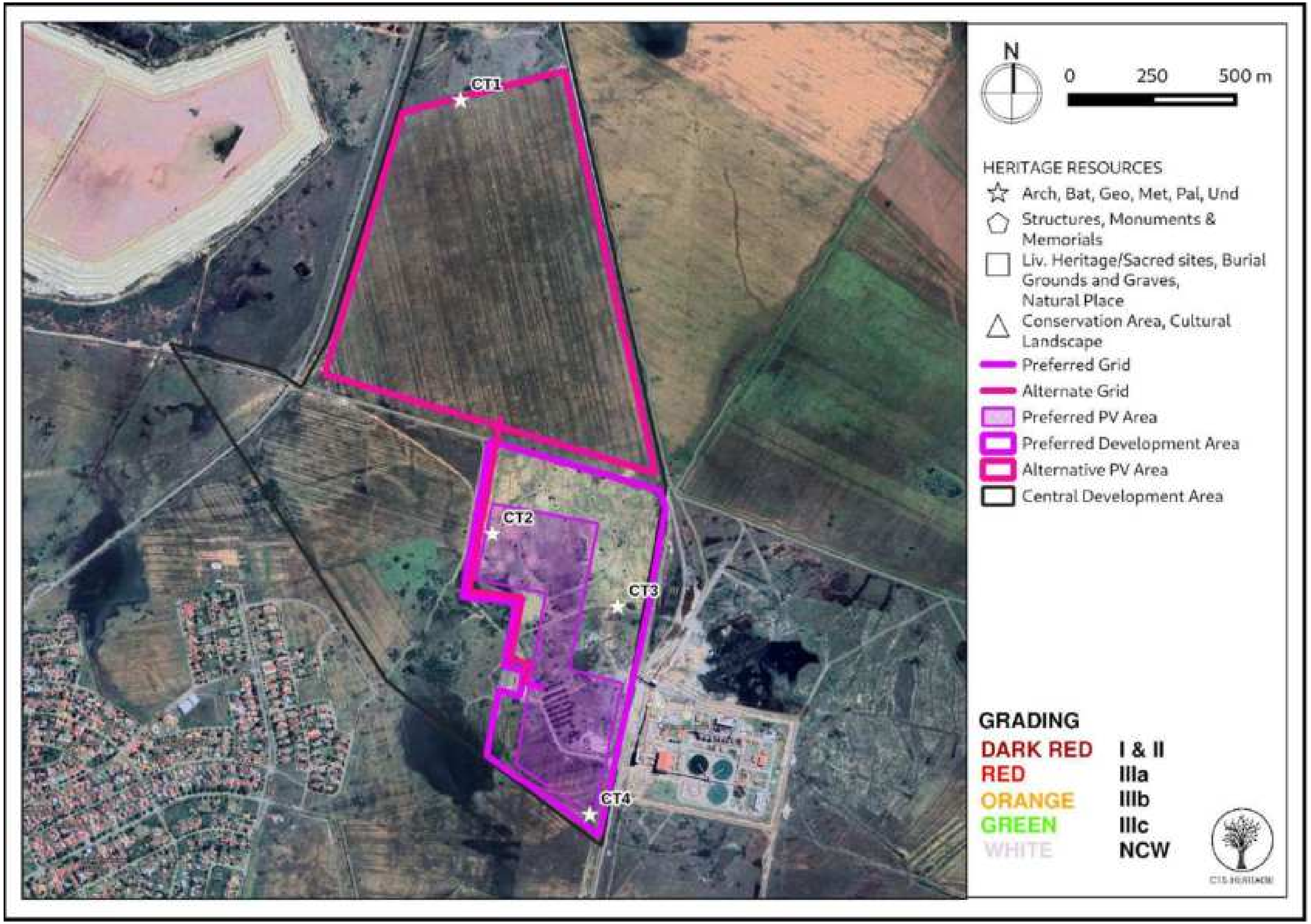

Figure 6.1: Map of field observations relative to the proposed development at the proposed Central PV Facility

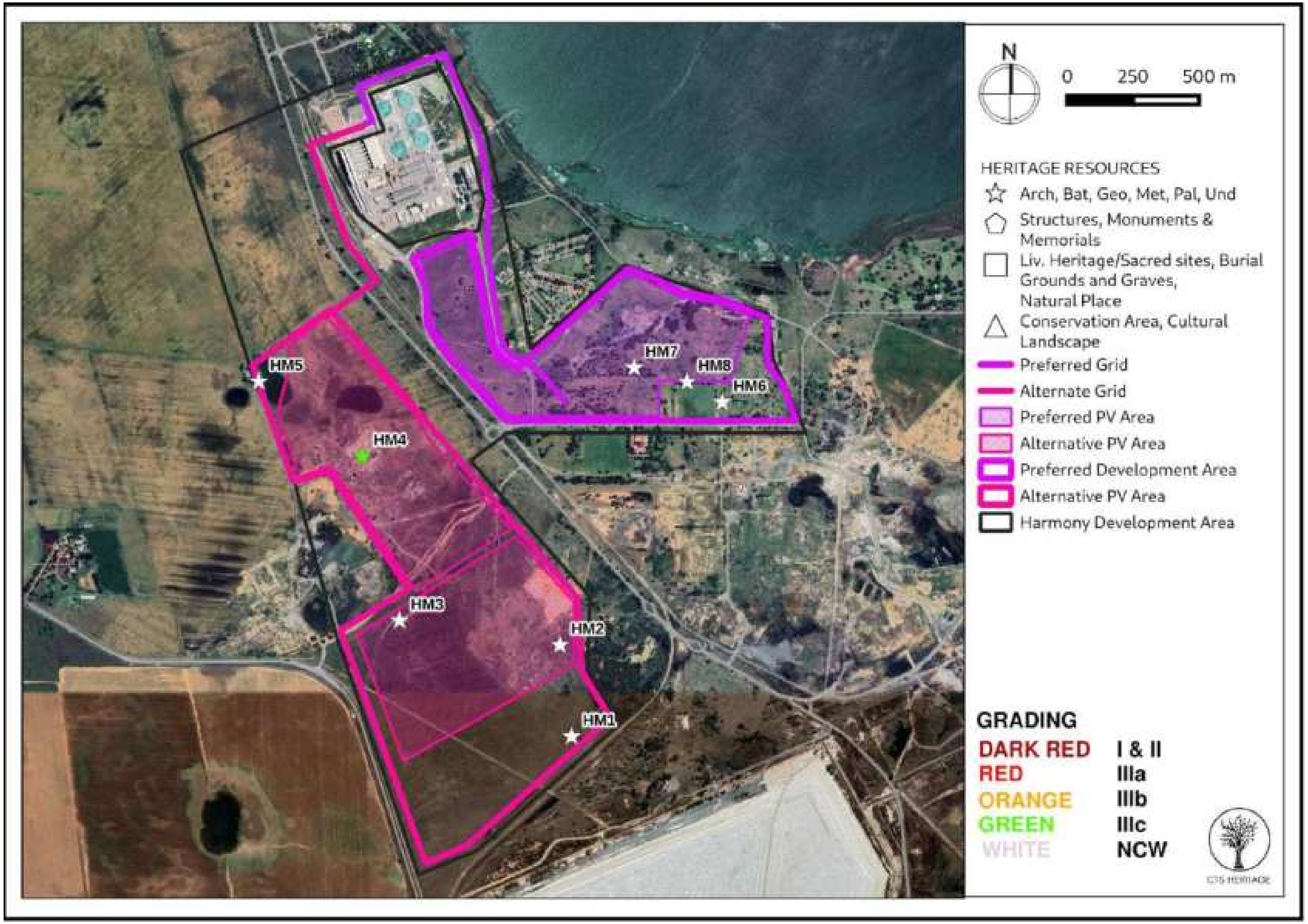

Figure 6.2: Map of field observations relative to the proposed development at the proposed Harmony PV Facility

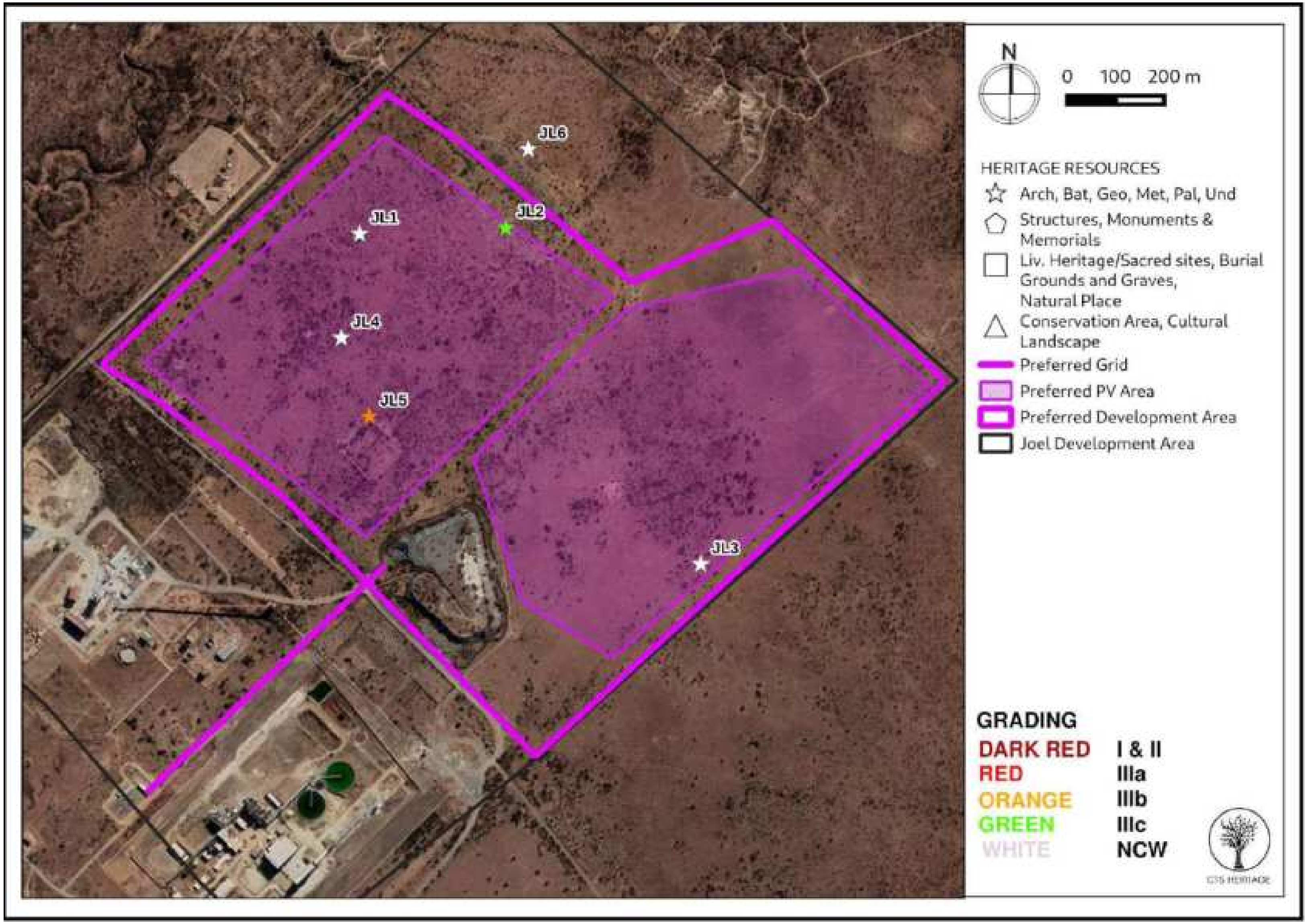

Figure 6.3: Map of field observations relative to the proposed development at the proposed Joel PV Facility

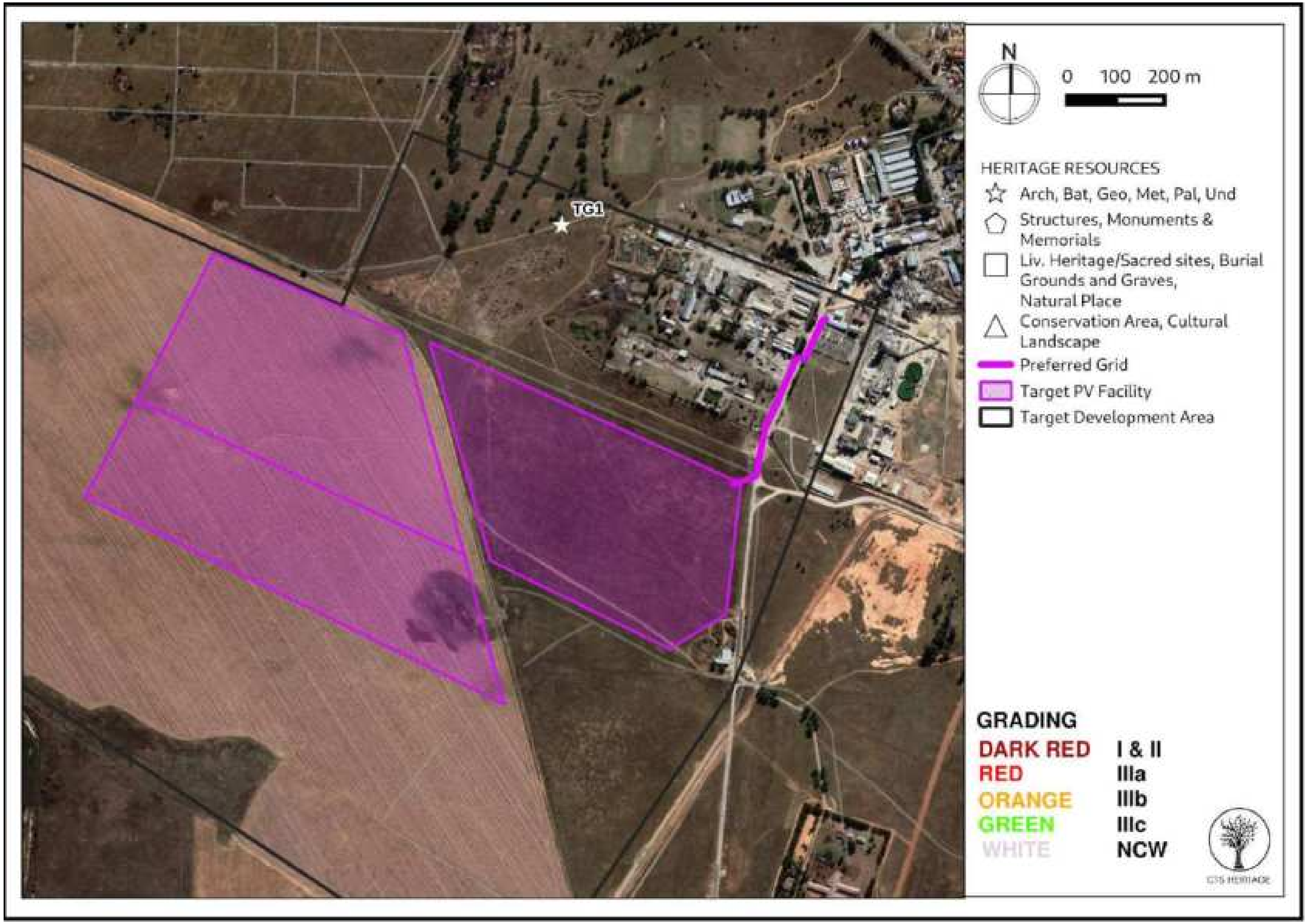

Figure 6.4: Map of field observations relative to the proposed development at the proposed Target PV Facility

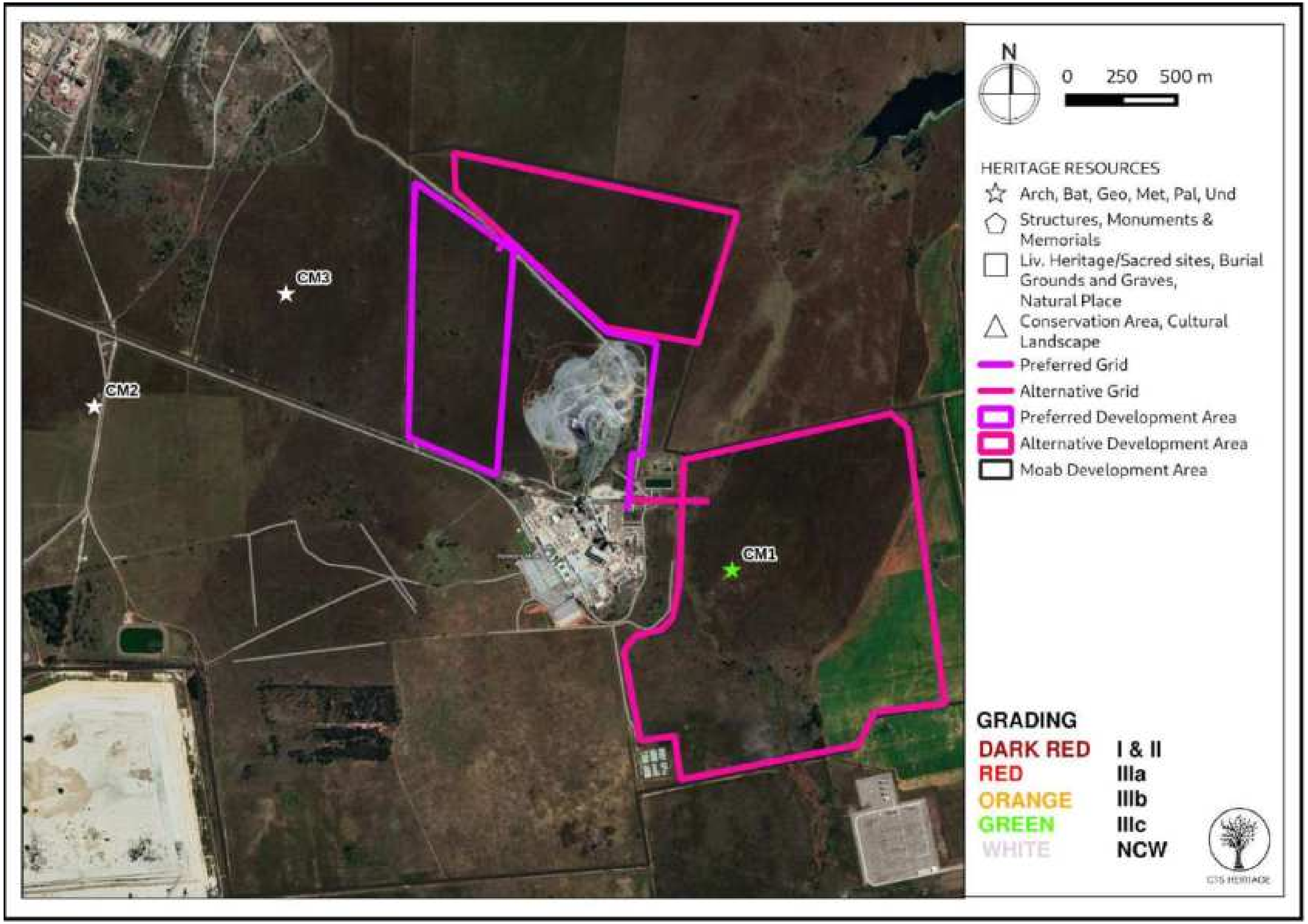

Figure 6.5: Map of field observations relative to the proposed development at the proposed Moab PV Facility

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4.3 Selected photographic record

(a full photographic record is available upon request)

Figure 7.1: Isolated stone artefacts from Harmony: HM1- large side scraper, HM2- single platform core with platform preparation removals, HM3-marginally reduced core with primary removals

Figure 7.2: Concentration of artefacts HM4 next to CHM4: bifacial tool; complete flake and flake fragments.

Figure 7.3: Demolished and dilapidated historical structures from Harmony: HM5, HM6, HM7, and HM8

Figure 7.4: Isolated stone artefacts from Central: CT 1-core with primary removals, CT2-prepared weather platform flake, CT3- bifacial tool with alternating retouch on both faces, CT4-core with primary removals.

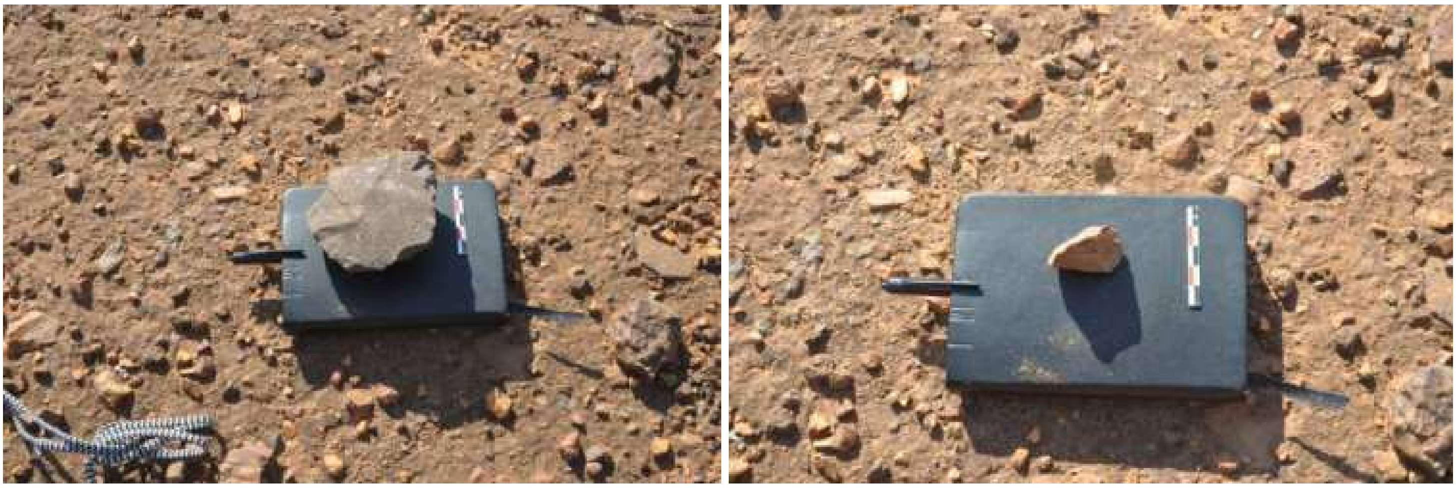

Figure 7.5: Deflated concentration of archaeological remains at Moab CM1: Levallois core and Bladelet core

Figure 7.7: Ex situ archaeological remains at Moab: CM2-Chert outcrop with evidence of hominin exploitation, CM3-flakes

Figure 7.8: Ex situ archaeological remains from Target: TG1: two miniature cores associated with microlithic flake production






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Figure 7.9: Ex-situ archaeological remains from Joel: JL1-bi-directional core, JL2-hammerstone-anvil, JL3-core and flake, JL4- flake potentially associated with bladelet production, JL6-two cores.

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Figure 7.10: Concentration of artefacts in a datable context: 1)single platform chert core; 2) chert flake; 3) chert core; 4) point; 5) silcrete retouched point on a blade; 6) miniature quartz flake; 6) dolorite big flake; 7) silcrete flake; 8) silcrete fragment

Figure 7.11: Burrows associated with artefacts at JL5.

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5. ASSESSMENT OF THE IMPACT OF THE DEVELOPMENT

5.1 Assessment of impact to Archaeological Resources

5.1.1 Harmony

All archaeological finds at Harmony were documented in what appear to be *ex-situ* surface contexts, yet the absence of evidence for trampling of artefacts at HM4 suggests that post-depositional effects may be minimal and that the artefacts may have eroded out of associated fluvial deposits. The river terrace deposits may be dateable with luminescence techniques, although the direct association of the archaeology with the fluvial stratigraphy would require further investigation to establish.

Based on the surface observations at Harmony, excavation associated with the development should be aware of the potential for sub-surface Stone Age materials if this excavation encroaches on the laminated river deposits. The documented archaeology at Harmony is classified as scientifically LOW SIGNIFICANCE, however the site at HM4 should be avoided if possible through the implementation of a 30m no-go buffer (Figure 7.1).

Concerning the Stone Age archaeology at Harmony, there are no objections to the authorization of the proposed development, provided that if any evidence of human remains are exposed during excavation, that development activities cease in the area of the identified remains.

5.1.2 Central

The potential for finding a dateable *in-situ* archaeological horizon at Central based on current surface observations outlined above appears to be low. The documented archaeology at Central is therefore classified as scientifically LOW SIGNIFICANCE.

Concerning the archaeology observed during the survey of the potentially affected area at Central, there are no objections to the authorization of the proposed development, provided that if any evidence of buried human remains are exposed during excavation, that development activities cease in the area of the identified remains.

No impacts to significant heritage resources are anticipated.

5.1.3 Target

The potential for finding a dateable *in-situ* archaeological horizon at Target based on current surface observations outlined above appears to be low. The documented archaeology at Target is therefore classified as scientifically LOW SIGNIFICANCE.

Concerning the archaeology observed during the survey of the potentially affected area at Target, there are no objections to the authorization of the proposed development, provided that if any evidence of buried human remains are exposed during excavation, that development activities cease in the area of the identified remains.

No impacts to significant heritage resources are anticipated.

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5.1.4 Joel

All archaeological finds at Joel were documented in what appear to be *ex-situ* surface contexts. However, the absence of evidence for trampling of artefacts, particularly at JL5, suggests that post-depositional effects on surface stone scatters may be marginal, and artefacts may have been exposed relatively recently. Further, the presence of artefacts that are currently eroding out of quaternary sediments at JL5 suggests that there may be sub-surface archaeological occurrences within the footprint. The potential for finding a preserved and dateable *in-situ* archaeological horizon based on surface observations and based on the availability of current dating techniques (luminescence would be the only set of applicable methods to this context), however, is low based on the absence of dateable organic materials and the bioturbated nature of sediments partially encompassing some of the artefacts (JL5). This site is graded IIIB for its potential to contribute to the body of scientific knowledge.

Based on the surface observations outlined above, the presence of sub-surface contextualised materials at Joel cannot be excluded as a possibility. Excavation associated with the development should therefore be aware of the potential for sub-surface Stone Age materials. As such, it is recommended that a no-development area of 50m is implemented around site JL5 (Figure 7.2).

JL2 represents a site that accumulated because of the chert raw-material source nearby, so flakes are largely primary. JL2 also has a hammerstone with visible pitting associated with percussion activities – probably knapping. This site has been graded IIIC and it is recommended that a no-development area of 30m is implemented around this site to ensure that it is conserved.

The documented archaeology at Joel is classified as scientifically LOW SIGNIFICANCE apart from the site at JL5 which is classified as MODERATE SIGNIFICANCE.

Concerning the Stone Age archaeology at Joel, there are no objections to the authorization of the proposed development, *provided that the monitoring recommendations outlined above are adhered to*, and provided that if any evidence of human remains are exposed during excavation, that development activities cease in the area of the identified remains.

5.1.5 Moab

The potential for finding a dateable *in-situ* archaeological horizon based on current surface observations outlined above appears to be low. The documented archaeology at Moab is therefore classified as scientifically LOW SIGNIFICANCE.

Concerning the archaeology observed during the extensive survey of the potentially affected area at Moab, there are no objections to the authorization of the proposed development, provided that if any evidence of buried human remains are exposed during excavation, that development activities cease in the area of the identified remains.

Figure 7.1: Map of significant sites relative to proposed development with recommended buffers around site HM4 (30m Buffer)

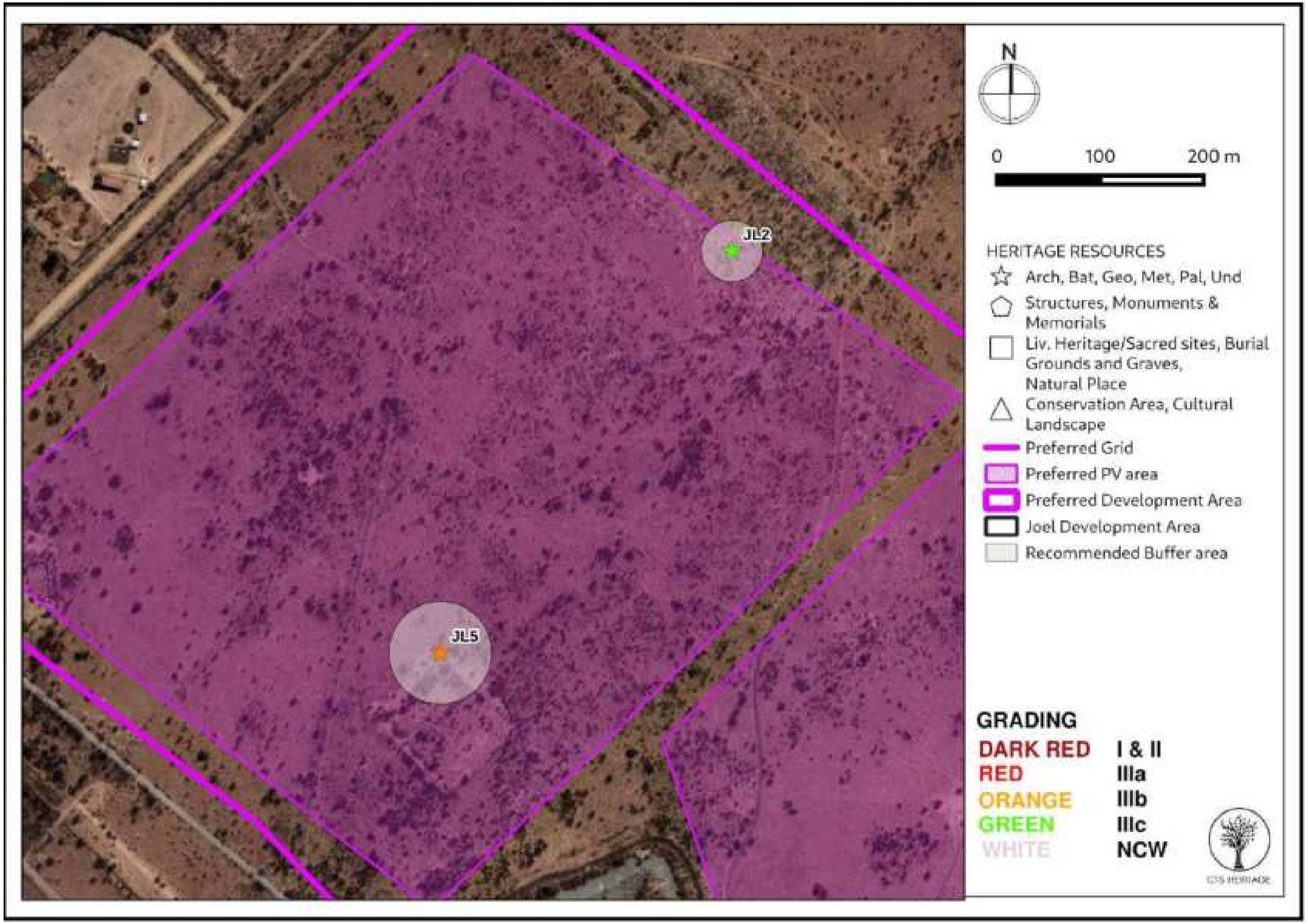

Figure 7.2: Map of significant sites relative to proposed development with recommended mitigation for JL2 (30m Buffer) and JL5 (50m Buffer)

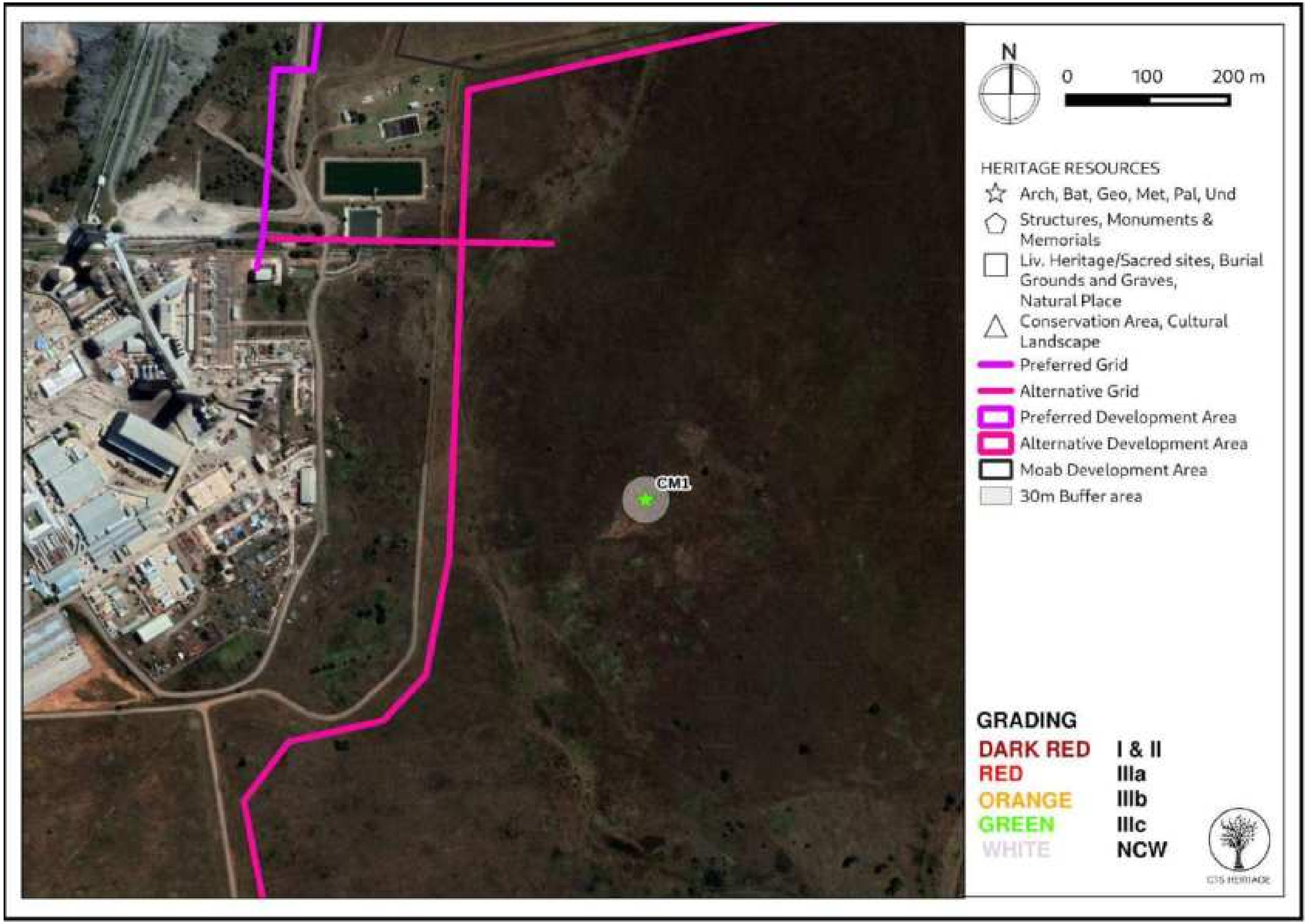

Figure 7.3: Map of significant sites relative to proposed development with recommended mitigation for CM1 (30m Buffer)

6. CONCLUSION AND RECOMMENDATIONS

All of the areas surveyed as part of this assessment have been transformed through agricultural interventions and/or mining activity. As such, it is not surprising that the results of the survey only identified four sites of scientific cultural value - HM4 within the Alternative Area proposed for the Harmony PV development graded IIIC, JL2, graded IIIC and JL5 graded IIIB within the area proposed for the Joel PV development and CM1, graded IIIC, within the Alternative Area proposed for the Moab PV development.

The identified sites of archaeological significance have the potential to provide scientific insight into the past and as such, it is recommended that these areas are not impacted by the proposed development. It is therefore recommended that no-go development buffers as per the recommendations below are implemented. Further, it is recommended that these sites are mapped on all relevant SDPs and that on-going conservation measures are put in place in the EMPrs for the developments.

Recommendations

There is no objection to the proposed development in terms of impacts to archaeological heritage on condition that:

- The 30m buffer area recommended around sites CM1, JL2 and HM4 is implemented
- The 50m buffer area recommended around site JL5 is implemented
- Should any buried archaeological resources or human remains or burials be uncovered during the course of development activities, work must cease in the vicinity of these finds. The South African Heritage Resources Agency (SAHRA) must be contacted immediately in order to determine an appropriate way forward.

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CTS HERITAGE

7. REFERENCES

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	22/07/2015	Palaeontological specialist assessment: desktop study for the proposed

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		Almond		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	Archaeologica l 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

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APPENDIX 3: Palaeontological Assessment (2022)

Palaeontological Impact Assessment for the proposed development of the Harmony Moab PV Facility, southeast of Orkney, Free State Province

CTS22_101

Desktop Study (Phase 1)

For

CTS Heritage

03 July 2022

Prof Marion Bamford
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Johannesburg, South Africa
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Expertise of Specialist

The Palaeontologist Consultant: Prof Marion Bamford
Qualifications: PhD (Wits Univ, 1990); FRSSAf, mASSAf
Experience: 33 years research and lecturing in Palaeontology
25 years PIA studies and over 300 projects completed

Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by CTS Heritage, Cape Town, South Africa. The views expressed in this report are entirely those of the author and no other interest was displayed during the decision making process for the Project.

Specialist: Prof Marion Bamford

Signature: MKBamford

Executive Summary

A Palaeontological Impact Assessment was requested for the proposed Moab PV facility for Harmony Mine, southeast of Orkney, near the town of Viljoenskroon, Free State.

To comply with the regulations of the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed development.

The proposed site lies on the potentially fossiliferous Malmani Subgroup that could have trace fossils such as stromatolites below the land surface. The southernmost part is on moderately fossiliferous sands and alluvium of the Quaternary that overlies the Vryheid Formation. The area has been greatly disturbed by farming and mining activities and no potential rocky outcrops of dolomite or of traps for Quaternary fossils (pans). Are visible from the satellite imagery. Nonetheless, a Fossil Chance Find Protocol should be added to the EMPr. Based on this information it is recommended that no further palaeontological impact assessment is required unless fossils are found by the contractor, environmental officer or other designated responsible person once excavations have commenced. Since the impact will be low, as far as the palaeontology is concerned, the project should be authorised.

Table of Contents

i. Background

Harmony Gold mines is proposing to develop photovoltaic farms (PVs) with grid connections on some of its properties in the Free State. This report is for the Moab PV Facility situated north and south of the R76 close to the town of Viljoenskroon in the Free State Province, southeast of Orkney. It falls within the jurisdiction of the Moqhaka Local Municipality in the Fezile Dabi District Municipality and is located within the existing Harmony Mine (Figures 1-2).

A Palaeontological Impact Assessment was requested for the Moab PV project. To comply with the regulations of the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed development and is reported herein.

Table 1: National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) and Environmental Impact Assessment (EIA) Regulations, 2014 (as amended) - Requirements for Specialist Reports (Appendix 6).

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	**Relevant section in report**
ai	Details of the specialist who prepared the report,	Appendix B
aii	The expertise of that person to compile a specialist report including a curriculum vitae	Appendix B
b	A declaration that the person is independent in a form as may be specified by the competent authority	Page 1
c	An indication of the scope of, and the purpose for which, the report was prepared	Section i.
ci	An indication of the quality and age of the base data used for the specialist report: SAHRIS palaeosensitivity map accessed – date of this report	Yes
cii	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 5
d	The date and season of the site investigation and the relevance of the season to the outcome of the assessment	N/A
e	A description of the methodology adopted in preparing the report or carrying out the specialised process	Section ii.
f	The specific identified sensitivity of the site related to the activity and its	Section 4

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	Relevant section in report
	associated structures and infrastructure	
g	An identification of any areas to be avoided, including buffers	N/A
h	A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	N/A
i	A description of any assumptions made and any uncertainties or gaps in knowledge;	Section vii.
j	A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Section vi.
k	Any mitigation measures for inclusion in the EMPr	Section 8, Appendix A
l	Any conditions for inclusion in the environmental authorisation	N/A
m	Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 8, Appendix A
ni	A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	Section 6
nii	If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	Sections 6, 8
o	A description of any consultation process that was undertaken during the course of carrying out the study	N/A
p	A summary and copies of any comments that were received during any consultation process	N/A
q	Any other information requested by the competent authority.	N/A
2	Where a government notice gazetted by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	N/A

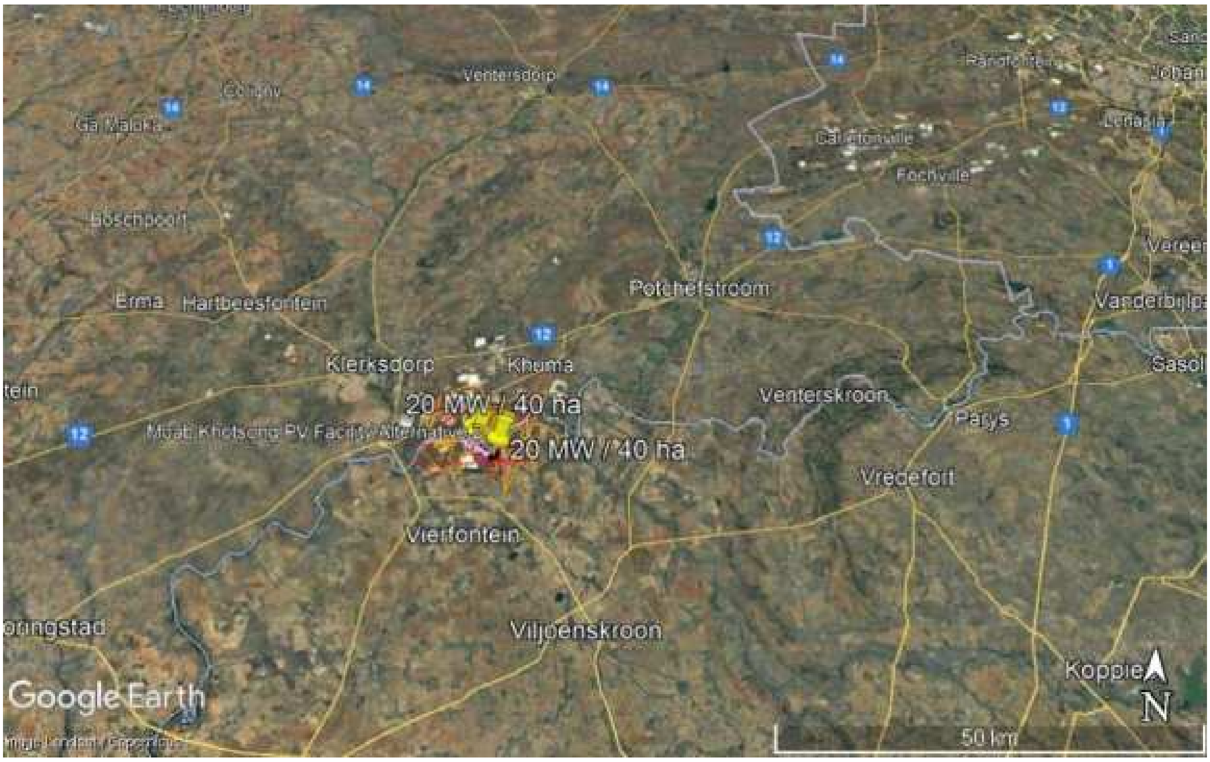

Figure 1: Google Earth map of the general area to show the relative land marks. The Moab PV facility is shown by the labels.

Figure 2: Google Earth Map of the proposed development of the Moab PV facility with the sections shown by the pink and yellow outlines.

ii. Methods and Terms of Reference

The Terms of Reference (ToR) for this study were to undertake a PIA and provide feasible management measures to comply with the requirements of SAHRA.

The methods employed to address the ToR included:

1. Consultation of geological maps, literature, palaeontological databases, published and unpublished records to determine the likelihood of fossils occurring in the affected areas. Sources included records housed at the Evolutionary Studies Institute at the University of the Witwatersrand and SAHRA databases;
2. Where necessary, site visits by a qualified palaeontologist to locate any fossils and assess their importance (*not applicable to this assessment*);
3. Where appropriate, collection of unique or rare fossils with the necessary permits for storage and curation at an appropriate facility (*not applicable to this assessment*); and
4. Determination of fossils' representivity or scientific importance to decide if the fossils can be destroyed or a representative sample collected (*not applicable to this assessment*).

iii. Geology and Palaeontology

iv. Project location and geological context

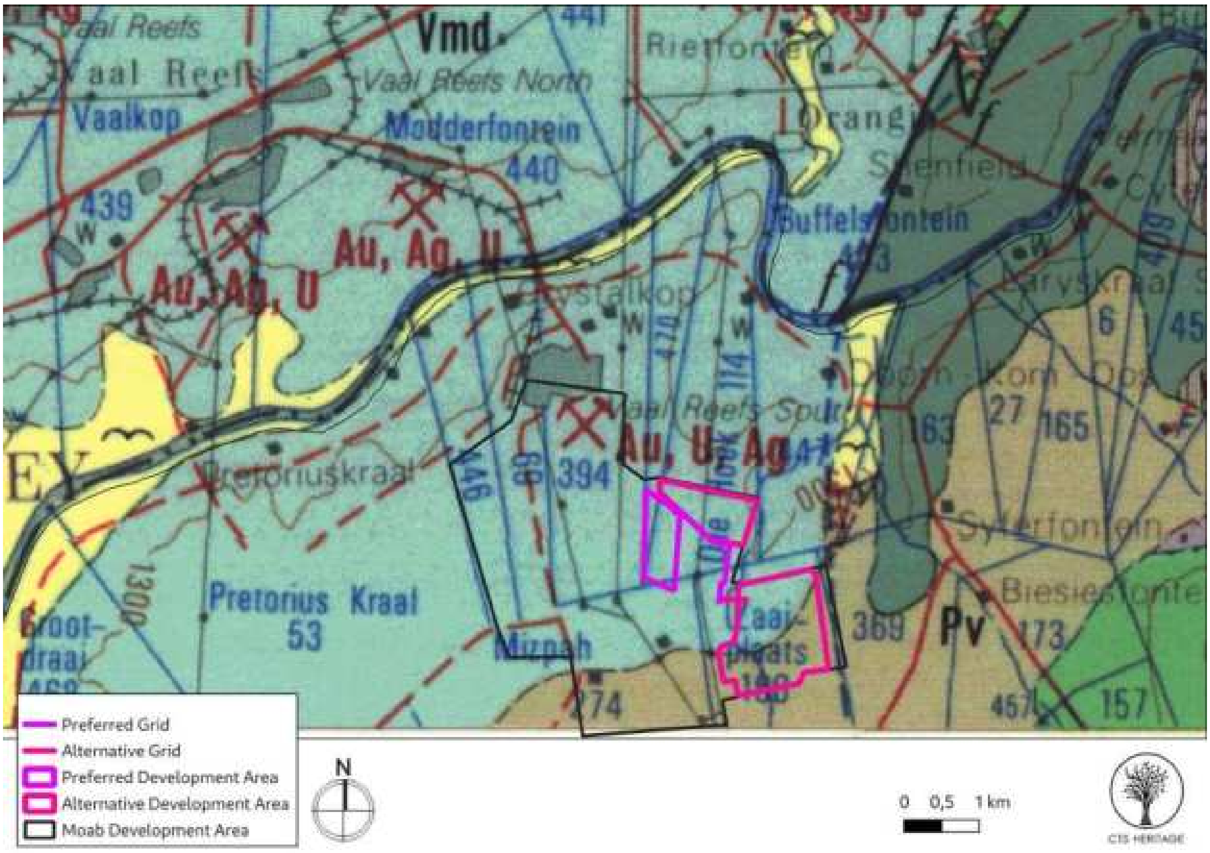

Figure 3: Geological map of the area around the proposed Moab PV facility. The location of the proposed project is indicated within the yellow rectangle. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2626 West Rand.

Table 2: Explanation of symbols for the geological map and approximate ages (Eriksson et al., 2006. Johnson et al., 2006; Partridge et al., 2006). SG = Supergroup; Fm = Formation; Ma = million years; grey shading = formations impacted by the project.

Symbol	Group/Formation	Lithology	Approximate Age
Q	Quaternary	Alluvium, sand, soil	Quaternary, ca 1.0 Ma to present
Pv	Vryheid Fm, Ecca Group, Karoo SG	Shales, siltstone, mudstone, sandstone, cola	Early Permian Ca 290-280 Ma
Vdi	Diabase	Diabase (intrusive volcanic rocks)	Post Transvaal SG
Vh	Hekpoort Fm, Pretoria Group, Transvaal SG	Mafic lavas	Palaeoproterozoic Ca 2224 Ma
Vmd	Malmani Subgroup, Chuniespoort Group, Transvaal SG	Dolomite, limestone, chert	Palaeoproterozoic Ca 2500 Ma

The project lies in the north-central part of the main Karoo Basin where it unconformably overlies the southern margin of the Transvaal Basin that preserves the Transvaal Supergroup. Much of the area is covered by young sands and alluvium of Quaternary age (Figure 3).

In the Transvaal Basin the Transvaal Supergroup is divided into two Groups, the lower Chuniespoort Group and the upper Pretoria Group (with ten formations; Eriksson et al., 2006). The Chuniespoort Group is divided into the basal **Malmani Subgroup** that comprises dolomites and limestones and is divided into five formations based on chert content, stromatolitic morphology, intercalated shales and erosion surfaces. The top of the Chuniespoort Group has the Penge Formation and the Duitschland Formation.

Making up the lower Pretoria Group are the Timeball Hill Formation and the Boshoek Formation. The Hekpoort, Dwaalheuwel, Strubenkop and Daspoort Formations form a sequence as the middle part of the Pretoria Group, Transvaal Supergroup, and represent rocks that are over 2060 million years old. The **Hekpoort Formation** is a massive lava deposit and is overlain by the Dwaalheuwel conglomerates, siltstone and sandstone (not present here). The Transvaal sequence has been interpreted as three major cycles of basin infill and tectonic activity with the first deep basin sediments forming the Chuniespoort Group, the second cycle deposited the lower Pretoria Group, and the sediments in this area are from the interim lowstand that preceded the third cycle. These sediments were deposited in shallow lacustrine, alluvial fan and braided stream environments (Eriksson et al., 2012).

The Karoo Supergroup rocks cover a very large proportion of South Africa and extend from the northeast (east of Pretoria) to the southwest and across to almost the KwaZulu Natal south coast. It is bounded along the southern margin by the Cape Fold Belt and along the northern margin by the much older Transvaal Supergroup rocks. Representing some 120 million years (300 – 183Ma), the Karoo Supergroup rocks have preserved a diversity of fossil plants, insects, vertebrates and invertebrates.

During the Carboniferous Period South Africa was part of the huge continental landmass known as Gondwanaland and it was positioned over the South Pole. As a result, there were several ice sheets that formed and melted, and covered most of South Africa (Visser, 1986, 1989; Isbell et al., 2012). Gradual melting of the ice as the continental mass moved northwards and the earth warmed, formed fine-grained sediments in the large inland sea (Johnson et al., 2006).

Overlying the Dwyka Group rocks are rocks of the Ecca Group that are Early Permian in age. There are eleven formations recognised in this group but they do not all extend throughout the Karoo Basin. In the west and central part are the following formations, from base upwards: **Vryheid** and Volksrust Formations. All of these sediments have varying proportions of sandstones, mudstones, shales and siltstones and represent shallow to deep water settings, deltas, rivers, streams and overbank depositional environments.

v. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 4. The site for development is mostly in the Malmani Subgroup dolomites and cherts and the southernmost part is on Quaternary sands that overlie the Vryheid Formation. The Malmani Subgroup is considered as very highly sensitive for palaeontology as the dolomites sometimes contain trace fossils, stromatolites. The Vryheid Formation is also very higly sensitive because it could have fossil plants of the Glossopteris flora.

Stromatolites are the trace fossils that were formed by colonies of green algae and blue-green algae (Cyanobacteria) that grew in warm, shallow marine settings. These algae were responsible for releasing oxygen via the photosynthetic process where atmospheric carbon dioxide and water, using energy from the sun, are converted into carbon chains and compounds that are the building blocks of all living organisms. The released carbon dioxide initially was taken up by the abundant reducing minerals to form oxides, e.g. iron oxide. Eventually free oxygen was released into the atmosphere and some was converted into ozone by the bombardment of cosmic rays. The ozone is critical for the filtering out of harmful ultraviolet rays.

Stromatolites are the layers upon layers of inorganic materials that were deposited during photosynthesis, namely calcium carbonate, magnesium carbonate, calcium sulphate and magnesium sulphate. These layers can be in the form of flat layers, domes or columns depending on the environment where they grew (Beukes, 1987). Some environments did not form stromatolites, just layers of limestone that later was converted to dolomite. The algae that formed the stromatolites are very rarely preserved, and they are microscopic so they can only be seen from thin sections studies under a petrographic microscope.

The Vryheid Formation is well known for the fossils of the *Glossopteris* flora that was widespread over Gondwanaland. The flora was dominated by *Glossopteris*, the leaves of glossopterid plants, as well as seeds, fructifications, roots and silicified wood. Other plants in this flora were lycopods, sphenophytes, ferns, cordaitaleans and early gymnosperms (Plumstead, 1969; Anderson and Anderson, 1985; Bamford, 2004). Coal seams were formed from buried peats of this flora that were later altered by heat and pressure. While no plants are discernible from coal itself, it is possible to find impressions of the plants in the shales and carbonaceous shales in lenses associated with the coals. In this part of the Free State the uppermost coal seam is between 25 and 50 m below the surface (Snyman, 1998; p 177).

Quaternary sands and alluvium do not preserve fossils because they are transported and porous. For preservation of fossils, a low energy deposit with sedimentation of fine grained silts or muds that exclude decomposing organisms such as bacteria, fungi and invertebrates is required to maintain a highly reducing environment (Cowan, 1995). Only if there are traps such as palaeo-pans or palaeo-springs that provide traps for water and fine sediments, would plants or bones be preserved and fossilised. No such features are visible in the satellite imagery in the project footprint.

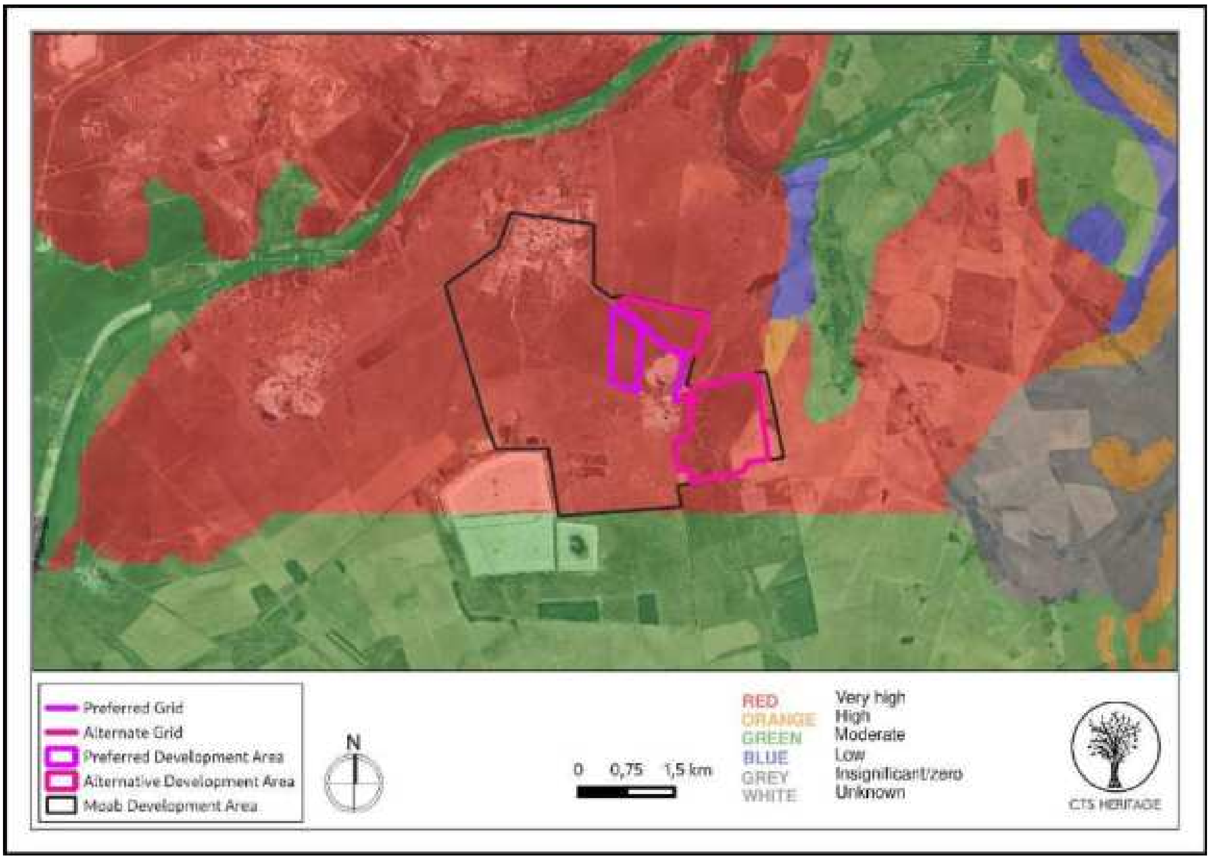

Figure 4: SAHRIS palaeosensitivity map for the site for the proposed Moab PV Facility shown within the lilac and pink outlines rectangle. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

From the SAHRIS map above the area is indicated as very highly sensitive (red) for the Malmani subgroup and moderately sensitive (green) for the Quaternary sands and alluvium that overlie the Vryheid Formation. Note the artificially horizontal contact line between the two strata that is based on the different interpretations of the adjacent geological maps. Both alternatives are on very highly sensitive rocks that are covered by soils and sands.

vi. Impact assessment

An assessment of the potential impacts to possible palaeontological resources considers the criteria encapsulated in Table 3:

Table 3a: Criteria for assessing impacts

PART A: DEFINITION AND CRITERIA		
Criteria for ranking of the SEVERITY/NATURE of environmental impacts	**H**	Substantial deterioration (death, illness or injury). Recommended level will often be violated. Vigorous community action.
	M	Moderate/ measurable deterioration (discomfort). Recommended level will occasionally be violated. Widespread complaints.
	L	Minor deterioration (nuisance or minor deterioration). Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	L+	Minor improvement. Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	M+	Moderate improvement. Will be within or better than the recommended level. No observed reaction.
	H+	Substantial improvement. Will be within or better than the recommended level. Favourable publicity.
Criteria for ranking the DURATION of impacts	**L**	Quickly reversible. Less than the project life. Short term
	M	Reversible over time. Life of the project. Medium term
	H	Permanent. Beyond closure. Long term.
Criteria for ranking the SPATIAL SCALE of impacts	**L**	Localised - Within the site boundary.
	M	Fairly widespread – Beyond the site boundary. Local
	H	Widespread – Far beyond site boundary. Regional/ national
PROBABILITY (of exposure to impacts)	**H**	Definite/ Continuous
	M	Possible/ frequent
	L	Unlikely/ seldom

Table 3b: Impact Assessment

PART B: Assessment		
SEVERITY/ NATURE	**H**	-
	M	-
	L	Quaternary sands and soils do not preserve fossils; so far there are no records from the Quaternary or from the Malmani Subgroup of plant or animal fossils, or stromatolites, respectively, in this region so it is very unlikely that fossils occur on the site. The impact would be negligible
	L+	-
	M+	-

PART B: Assessment		
	H +	-
DURATION	**L**	-
	M	-
	H	Where manifest, the impact will be permanent.
SPATIAL SCALE	**L**	Since the only possible fossils within the area would be trace fossils in the dolomites of the Malmani subgroup, the spatial scale will be localised within the site boundary.
	M	-
	H	-
PROBABILITY	**H**	**-**
	M	**-**
	L	It is very unlikely that any fossils would be found in the loose soils and sands that cover the area or in the dolomites that might occur below them. Nonetheless, a Fossil Chance Find Protocol should be added to the eventual EMPr.

Based on the nature of the project, surface activities may impact upon the fossil heritage if preserved in the development footprint. The geological structures suggest that the rocks are the right age to contain fossils but are covered by soils. Furthermore, the material to be excavated are soils and this does not preserve fossils. Since there is a small chance that trace fossils from the Malmani Subgroup or plant fossils in the Vryheid Formation that might occur below the soils and may be disturbed a Fossil Chance Find Protocol has been added to this report. Taking account of the defined criteria, the potential impact to fossil heritage resources is low.

vii. Assumptions and uncertainties

Based on the geology of the area and the palaeontological record as we know it, it can be assumed that the formation and layout of the dolomites, sandstones, shales and sands are typical for the country and might contain trace fossils or fossil plant, insect, invertebrate and vertebrate material. The sands of the Quaternary period would not preserve fossils. The area has been disturbed from farming and mining so no fossils would be present on the surface. It is unknown if the Malmani dolomite occurs below the surface or if it has stromatolites.

viii. Recommendation

Based on experience and the lack of any previously recorded fossils from the area, it is extremely unlikely that any fossils would be preserved in the overlying sands and soils of the Quaternary. There is a very small chance that fossils may occur in the adjacent shales of the early Permian Vryheid Formation, or trace fossils in the Malmani Subgroup, so a Fossil Chance Find Protocol should be added to the EMPr. If fossils are found by the environmental officer, or other responsible person once excavations for foundations and amenities have commenced then they should be rescued and a palaeontologist called to assess and collect a representative sample. Since the impact on the palaeontological heritage would be low, as far as the palaeontology is concerned, the project should be authorised. There is no preferred alternative as far as the palaeontology is concerned.

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x. Chance Find Protocol

Monitoring Programme for Palaeontology – to commence once the excavations / drilling activities begin.

1. The following procedure is only required if fossils are seen on the surface and when excavations commence.
2. When excavations begin the rocks and must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (stromatolites or plants) should be put aside in a suitably protected place. This way the project activities will not be interrupted.
3. Photographs of similar fossils must be provided to the developer to assist in recognizing the fossil plants, vertebrates, invertebrates or trace fossils in the shales and mudstones (for example see Figures 5-6). This information will be built into the EMP’s training and awareness plan and procedures.
4. Photographs of the putative fossils can be sent to the palaeontologist for a preliminary assessment.
5. If there is any possible fossil material found by the developer/environmental officer then the qualified palaeontologist sub-contracted for this project, should visit the site to inspect the selected material and check the dumps where feasible.
6. Trace fossils, fossil plants or vertebrates that are considered to be of good quality or scientific interest by the palaeontologist must be removed, catalogued and housed in a suitable institution where they can be made available for further study. Before the fossils are removed from the site a SAHRA permit must be obtained. Annual reports must be submitted to SAHRA as required by the relevant permits.
7. If no good fossil material is recovered then no site inspections by the palaeontologist will be necessary. A final report by the palaeontologist must be sent to SAHRA once the project has been completed and only if there are fossils.
8. If no fossils are found and the excavations have finished then no further monitoring is required.

xi. Appendix A – Examples of fossils from the Malmani Subgroup

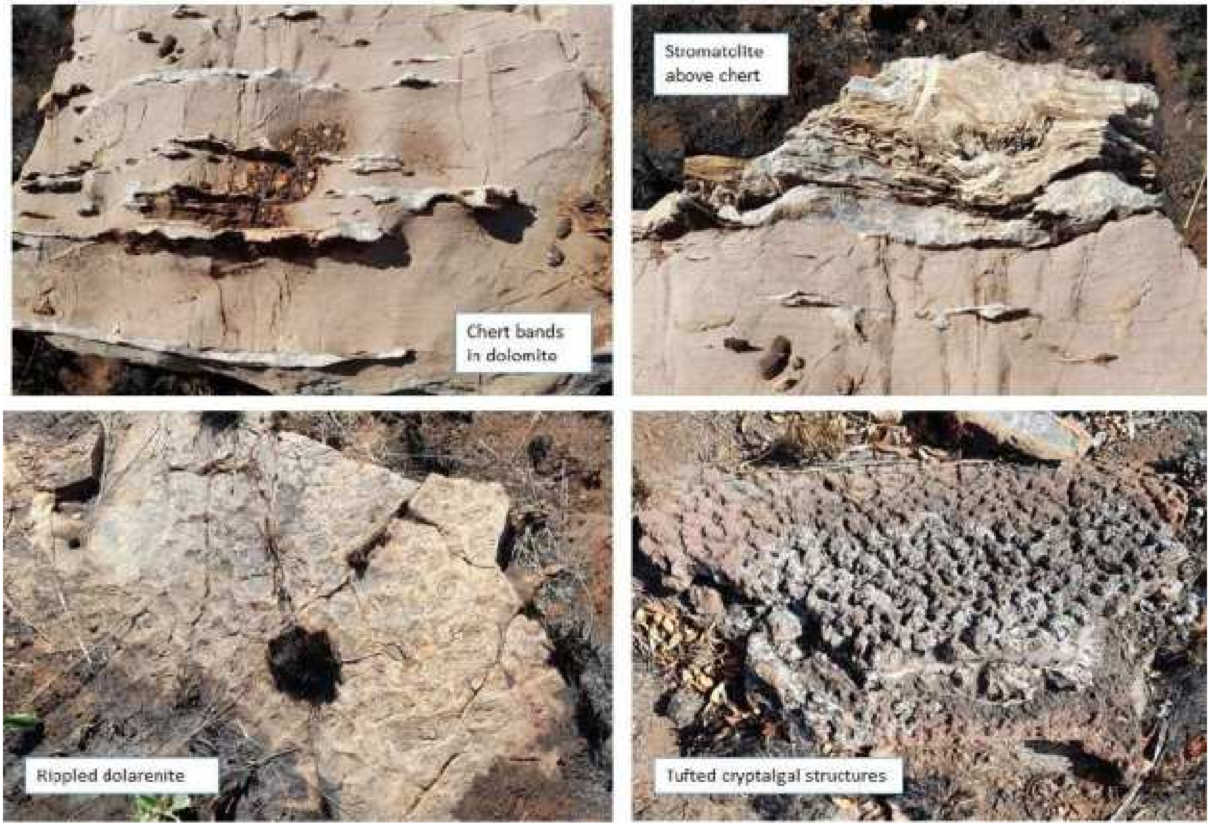

Figure 5: Photographs of different types of stromatolites that occur in the Malmani dolomite in some areas.

Figure 6: Photographs of fossil plants of the *Glossopteris* flora that could occur in the shales of the Vryheid Formation.

xii. Appendix B – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD

June 2022

I) Personal details

Surname : **Bamford**
First names : **Marion Kathleen**
Present employment : Professor; Director of the Evolutionary Studies Institute.
Member Management Committee of the NRF/DST Centre of Excellence Palaeosciences, University of the Witwatersrand, Johannesburg, South Africa
Telephone : +27 11 717 6690
Fax : +27 11 717 6694
Cell : 082 555 6937
E-mail : marion.bamford@wits.ac.za ; marionbamford12@gmail.com

ii) Academic qualifications
Tertiary Education: All at the University of the Witwatersrand:
1980-1982: BSc, majors in Botany and Microbiology. Graduated April 1983.
1983: BSc Honours, Botany and Palaeobotany. Graduated April 1984.
1984-1986: MSc in Palaeobotany. Graduated with Distinction, November 1986.
1986-1989: PhD in Palaeobotany. Graduated in June 1990.
NRF Rating: C-2 (1999-2004); B-3 (2005-2015); B-2 (2016-2020); B-1 (2021-2026)

iii) Professional qualifications
Wood Anatomy Training (overseas as nothing was available in South Africa):
1994 - Service d'Anatomie des Bois, Musée Royal de l'Afrique Centrale, Tervuren, Belgium, by Roger Dechamps
1997 - Université Pierre et Marie Curie, Paris, France, by Dr Jean-Claude Koeniguer
1997 - Université Claude Bernard, Lyon, France by Prof Georges Barale, Dr Jean-Pierre Gros, and Dr Marc Philippe

iv) Membership of professional bodies/associations
Palaeontological Society of Southern Africa
Royal Society of Southern Africa - Fellow: 2006 onwards
Academy of Sciences of South Africa - Member: Oct 2014 onwards
International Association of Wood Anatomists - First enrolled: January 1991
International Organization of Palaeobotany – 1993+
Botanical Society of South Africa
South African Committee on Stratigraphy – Biostratigraphy - 1997 - 2016
SASQUA (South African Society for Quaternary Research) – 1997+
PAGES - 2008 –onwards: South African representative
ROCEEH / WAVE – 2008+
INQUA – PALCOMM – 2011+onwards

vii) Supervision of Higher Degrees
All at Wits University

Degree	Graduated/ completed	Current
Honours	13	0
Masters	11	3
PhD	11	6
Postdoctoral fellows	15	1

viii) Undergraduate teaching
Geology II – Palaeobotany GEOL2008 – average 65 students per year
Biology III – Palaeobotany APES3029 – average 45 students per year
Honours – Evolution of Terrestrial Ecosystems; African Plio-Pleistocene Palaeoecology; Micropalaeontology – average 12-20 students per year.

ix) Editing and reviewing
Editor: Palaeontologia africana: 2003 to 2013; 2014 – Assistant editor
Guest Editor: Quaternary International: 2005 volume
Member of Board of Review: Review of Palaeobotany and Palynology: 2010 –
Associate Editor Open Science UK: 2021 -
Review of manuscripts for ISI-listed journals: 30 local and international journals
Reviewing of funding applications for NRF, PAST, NWO, SIDA, National Geographic, Leakey Foundation

x) Palaeontological Impact Assessments

Selected from the past five years only – list not complete:

- Mala Mala 2017 for Henwood
- Modimolle 2017 for Green Vision
- Klipoortjie and Finaalspan 2017 for Delta BEC
- Ledjadja borrow pits 2018 for Digby Wells
- Lungile poultry farm 2018 for CTS
- Olienhout Dam 2018 for JP Celliers
- Isondlo and Kwasobabili 2018 for GCS

- Kanakies Gypsum 2018 for Cabanga
- Nababeep Copper mine 2018
- Glencore-Mbali pipeline 2018 for Digby Wells
- Remhoogte PR 2019 for A&HAS
- Bospoort Agriculture 2019 for Kudzala
- Overlooked Quarry 2019 for Cabanga
- Richards Bay Powerline 2019 for NGT
- Eilandia dam 2019 for ACO
- Eastlands Residential 2019 for HCAC
- Fairview MR 2019 for Cabanga
- Graspan project 2019 for HCAC
- Lieliefontein N&D 2019 for EnviroPro
- Skeerpoort Farm Mast 2020 for HCAC
- Vulindlela Eco village 2020 for 1World
- KwaZamakhule Township 2020 for Kudzala
- Sunset Copper 2020 for Digby Wells
- McCarthy-Salene 2020 for Prescali
- VLNR Lodge 2020 for HCAC
- Madadeni mixed use 2020 for EnviroPro
- Frankfort-Windfield Eskom Powerline 2020 for 1World
- Beaufort West PV Facility 2021 for ACO Associates
- Copper Sunset MR 2021 for Digby Wells
- Sannaspos PV facility 2021 for CTS Heritage
- Smithfield-Rouxville-Zastron PL 2021 for TheroServe

xi) Research Output
Publications by M K Bamford up to January 2022 peer-reviewed journals or scholarly books: over 160 articles published; 5 submitted/in press; 10 book chapters.
Scopus h-index = 30; Google scholar h-index = 35; -i10-index = 92
Conferences: numerous presentations at local and international conferences.

APPENDIX 4: Chance Fossil Finds Procedure

CTS HERITAGE

CHANCE FINDS OF PALAEONTOLOGICAL MATERIAL

(Adopted from the HWC Chance Fossils Finds Procedure: June 2016)

Introduction

This document is aimed to inform workmen and foremen working on a construction and/or mining site. It describes the procedure to follow in instances of accidental discovery of palaeontological material (please see attached poster with descriptions of palaeontological material) during construction/mining activities. This protocol does not apply to resources already identified under an assessment undertaken under s. 38 of the National Heritage Resources Act (no 25 of 1999).

Fossils are rare and irreplaceable. Fossils tell us about the environmental conditions that existed in a specific geographical area millions of years ago. As heritage resources that inform us of the history of a place, fossils are public property that the State is required to manage and conserve on behalf of all the citizens of South Africa. Fossils are therefore protected by the National Heritage Resources Act and are the property of the State. Ideally, a qualified person should be responsible for the recovery of fossils noticed during construction/mining to ensure that all relevant contextual information is recorded.

Heritage Authorities often rely on workmen and foremen to report finds, and thereby contribute to our knowledge of South Africa's past and contribute to its conservation for future generations.

Training

Workmen and foremen need to be trained in the procedure to follow in instances of accidental discovery of fossil material, in a similar way to the Health and Safety protocol. A brief introduction to the process to follow in the event of possible accidental discovery of fossils should be conducted by the designated Environmental Control Officer (ECO) for the project, or the foreman or site agent in the absence of the ECO It is recommended that copies of the attached poster and procedure are printed out and displayed at the site office so that workmen may familiarise themselves with them and are thereby prepared in the event that accidental discovery of fossil material takes place.

Actions to be taken

One person in the staff must be identified and appointed as responsible for the implementation of the attached protocol in instances of accidental fossil discovery and must report to the ECO or site agent. If the ECO or site agent is not present on site, then the responsible person on site should follow the protocol correctly in order to not jeopardize the conservation and well-being of the fossil material.

Once a workman notices possible fossil material, he/she should report this to the ECO or site agent.Procedure to follow if it is likely that the material identified is a fossil:

- The ECO or site agent must ensure that all work ceases immediately in the vicinity of the area where the fossil or fossils have been found;
- The ECO or site agent must inform SAHRA of the find immediately. This information must include photographs of the findings and GPS co-ordinates;
- The ECO or site agent must compile a Preliminary Report and fill in the attached Fossil Discoveries: Preliminary Record Form within 24 hours without removing the fossil from its original position. The Preliminary Report records basic information about the find including:
    - The date
    - A description of the discovery
    - A description of the fossil and its context (e.g. position and depth of find)
    - Where and how the find has been stored
    - Photographs to accompany the preliminary report (the more the better):
        - A scale must be used
        - Photos of location from several angles
        - Photos of vertical section should be provided
        - Digital images of hole showing vertical section (side);
        - Digital images of fossil or fossils.

Upon receipt of this Preliminary Report, SAHRA will inform the ECO or site agent whether or not a rescue excavation or rescue collection by a palaeontologist is necessary.

- Exposed finds must be stabilised where they are unstable and the site capped, e.g. with a plastic sheet or sand bags. This protection should allow for the later excavation of the finds with due scientific care and diligence. SAHRA can advise on the most appropriate method for stabilisation.
- If the find cannot be stabilised, the fossil may be collect with extreme care by the ECO or the site agent and put aside and protected until SAHRA advises on further action. Finds collected in this way must be safely and securely stored in tissue paper and an appropriate box. Care must be taken to remove the all fossil material and any breakage of fossil material must be avoided at all costs.

No work may continue in the vicinity of the find until SAHRA has indicated, in writing, that it is appropriate to proceed.

CTS HERITAGE

FOSSIL DISCOVERIES: PRELIMINARY RECORDING FORM		
Name of project:		
Name of fossil location:		
Date of discovery:		
Description of situation in which the fossil was found:		
Description of context in which the fossil was found:		
Description and condition of fossil identified:		
GPS coordinates:	*Lat:*	*Long:*
If no co-ordinates available then please describe the location:		
Time of discovery:		
Depth of find in hole		
Photographs (tick as appropriate and indicate number of the photograph)	*Digital image of vertical section (side)*	
	Fossil from different angles	
	Wider context of the find	
Temporary storage (where it is located and how it is conserved)		
Person identifying the fossil Name:		
Contact:		
Recorder Name:		
Contact:		
Photographer Name:		
Contact:		

VISUAL IMPACT REPORT

Harmony Moab Khotsong PV Facility
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 Moab Khotsong PV Facility

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

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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 Harmony Moab Khotsong Solar PV Facility, The Solar PV facilities are based ~10km North of the town of Vierfontein, 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 site and study area

(PV) generation, aiding their transition to a more sustainable and environmentally friendly energy mix.

The development of a solar photovoltaic (PV) facility with a generating capacity of up to 100MW is proposed north of the Harmony Gold Moab operations, approximately ~10km north of the town of Vierfontein within the Moqhaka Local Municipality, Fezile Dabi District Municipality, Free State Province. The solar PV development will be known as Harmony Moab Khotsong Solar PV Facility.

The PV development area includes twelve (12) farm portions, all owned by the Mine. These include:

» Farm Anglo 593;
» Farm Hoekplaats 598;
» Farm Mispah 274;
» Remaining Extent of Farm Pretorius Kraal 53;
» Remaining Extent of Farm Doornkom Wes 446;
» Farm Chrystalkop 69; and
» Portions 1, 2, 3, 4, 5, and the Remaining Extent of the Farm Zuiping 394.

The generation is intended for own-use by the Mine, reducing the Mine's reliance on Eskom. The preferred site for the project is on properties which are owned by the Mine and are available for the proposed project and is therefore deemed technically feasible for such development to take place.

A project site considered to be technically suitable for the development of the solar PV facility, with an extent of approximately 1400ha, was identified. A development area of ~900ha was demarcated within this project site and allows an adequate footprint for the installation of a solar PV facility with a contracted capacity of up to 100MW, while allowing for the avoidance of environmental site sensitivities.

The full extent of the project site is to be evaluated in the Basic Assessment process to identify environmental sensitivities. Site-specific studies and assessments will be undertaken through the BA process in order to delineate areas of potential sensitivity within the identified study area and grid connection corridor/s. Once constraining factors have been determined, the layout of the solar PV facilities and the grid connection solution can be planned to minimise social and environmental impacts.

The infrastructure associated with the 100MW solar PV facility will include:

- PV modules and mounting structures
- Access roads, internal roads and fencing around the development area
- Temporary and permanent laydown areas
- Administrative building, control room, workshop, storage building, guard house, auxiliary buildings and structures, water supply infrastructure, weather station
- Peripheral boundary wall & fencing
- Inverters, transformers and up to 5 on-site facility substations and switching substations
- Cabling between the project components, to be laid underground where practical

- Grid connection infrastructure to be connected to the existing:
    - Vaalreefs Eleven Substation via a ~2km power line (located south-east of the facility);
    - Southvaal Plant Substation via a ~0.5km power line (located north-west of the facility); and
    - Southvaal Substation via a ~4km power line (located north of the facility).

The site is accessible via the R76 south of the project site.

As of 2019, the Industrial sector was the leading electricity consumer in South Africa, with up to 56% of the total consumption (Ratshomo 2019). Mining and quarrying accounted for 10% of the industrial consumption (Chamber of Mines of South Africa, 2017). The successful development of the renewable energy project will enable Harmony Gold to make a valuable and meaningful contribution towards growing the green economy within the Free State Province and South Africa. This will assist the Free State in creating green jobs and reducing Green House Gas emissions, while reducing the energy demand on the Eskom 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

[1] Adapted from Oberholzer (2005).

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 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 assessment has been based on the requirements of the Western Cape Guidelines.
- Whilst the majority of homesteads and housing areas were visited during the site visit in order to confirm their nature and likely visibility of the development, it was not possible to visit all homesteads and housing areas.
- 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.
- The assessment of cumulative impacts is partly based on information provided by the DFFE Website This source provides detail of all other renewable energy applications and has been used to indicate other possible solar energy sites within 30km of the application site.

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. A summary of each of the qualitative descriptions along with the equivalent quantitative rating scale is given in Annexure C.

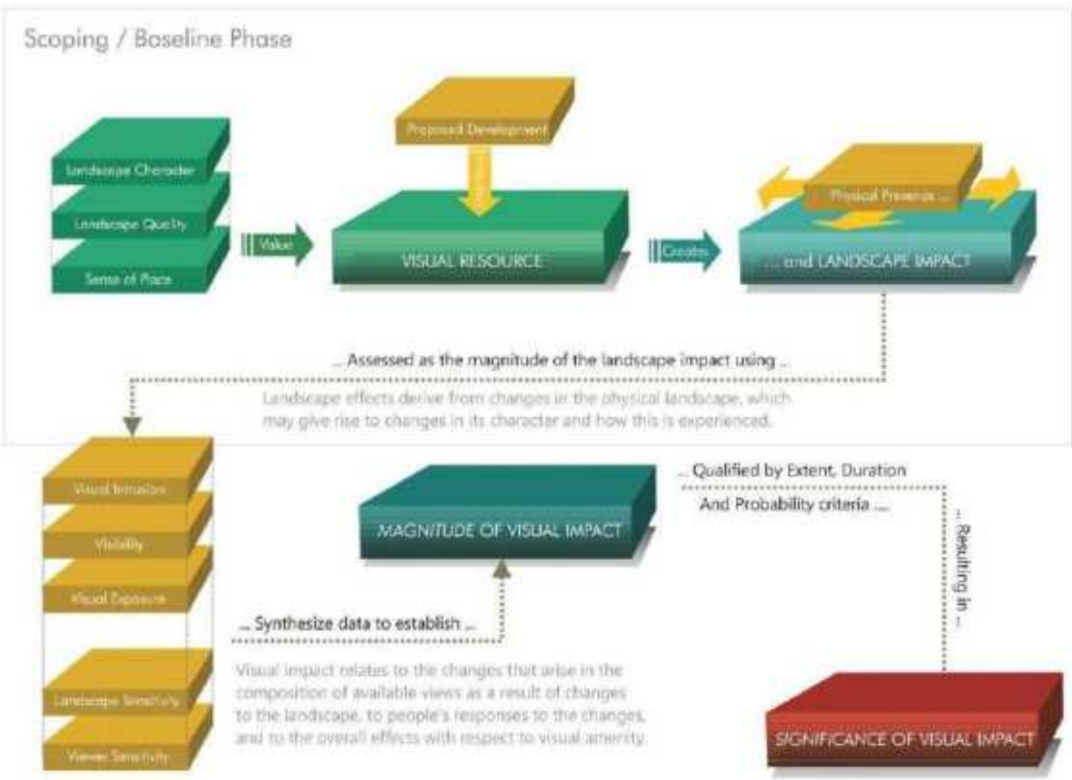

Figure 2: VIA Process

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

(PV) generation, aiding their transition to a more sustainable and environmentally friendly energy mix.

The development of a solar photovoltaic (PV) facility with a generating capacity of up to 100MW is proposed north of the Harmony Gold Moab operations, approximately ~10km north of the town of Vierfontein within the Moqhaka Local Municipality, Fezile Dabi District Municipality, Free State Province. The solar PV development will be known as Harmony Moab Khotsong Solar PV Facility.

The PV development area includes twelve (12) farm portions, all owned by the Mine. These include:

- Farm Anglo 593;
- Farm Hoekplaats 598;
- Farm Mispah 274;
- Remaining Extent of Farm Pretorius Kraal 53;
- Remaining Extent of Farm Doornkom Wes 446;
- Farm Chrystalkop 69; and
- Portions 1, 2, 3, 4, 5, and the Remaining Extent of the Farm Zuiping 394.

The generation is intended for own-use by the Mine, reducing the Mine's reliance on Eskom. The preferred site for the project is on properties which are owned by the Mine and are available for the proposed project and is therefore deemed technically feasible for such development to take place.

A project site considered to be technically suitable for the development of the solar PV facility, with an extent of approximately 1400ha, was identified. A development area of ~900ha was demarcated within this project site and allows an adequate footprint for the installation of a solar PV facility with a contracted capacity of up to 100MW, while allowing for the avoidance of environmental site sensitivities.

The full extent of the project site is to be evaluated in the Basic Assessment process to identify environmental sensitivities. Site-specific studies and assessments will be undertaken through the BA process in order to delineate areas of potential sensitivity within the identified study area and grid connection corridor/s. Once constraining factors have been determined, the layout of the solar PV facilities and the grid connection solution can be planned to minimise social and environmental impacts.

The infrastructure associated with the 100MW solar PV facility will include:

- PV modules and mounting structures
- Access roads, internal roads and fencing around the development area
- Temporary and permanent laydown areas

Central Solar PV Connection

- Administrative building, control room, workshop, storage building, guard house, auxiliary buildings and structures, water supply infrastructure, weather station
- Peripheral boundary wall & fencing
- Inverters, transformers and up to 5 on-site facility substations and switching substations
- Cabling between the project components, to be laid underground where practical
- Grid connection infrastructure to be connected to the existing:
    - Vaalreefs Eleven Substation via a ~2km power line (located south-east of the facility);
    - Southvaal Plant Substation via a ~0.5km power line (located north-west of the facility); and
    - Southvaal Substation via a ~4km power line (located north of the facility).

The site is accessible via the R76 south of the project site.

As of 2019, the Industrial sector was the leading electricity consumer in South Africa, with up to 56% of the total consumption (Ratshomo 2019). Mining and quarrying accounted for 10% of the industrial consumption (Chamber of Mines of South Africa, 2017). The successful development of the renewable energy project will enable Harmony Gold to make a valuable and meaningful contribution towards growing the green economy within the Free State Province and South Africa.

This will assist the Free State in creating green jobs and reducing Green House Gas emissions, while reducing the energy demand on the Eskom national grid.

Central Solar PV Connection

4.2. Project Phases and Activities

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

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 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;
- 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 25years. 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

The proposed 100MW Moab Khotsong Solar Energy Facility (SEF) is located on Farm Anglo 593, portion 593; Farm Hoekplaats 598, portion 598; Mispah 274, portion 274; Zaaiplaats 1/190, portion 1/190; Doornkom Wes 446, RE of portion 446; Chrystalkop 69, portion 69; and Zuiping 394, remaining extent of portion 394, portion 1/394, 3/394, 4/394 and 5/394 . The development is located near Harmony Moab mining operations approximately ~10km north of the town of Vierfontein within the Moqhaka Local Municipality, and within the Fezile Dabi District Municipality, Free State Province.

The proposed development is located in the Free State Province in the central interior of South-Africa. The town of Viljoenskroon is located approximately 32km southeast and Orkney is located approximately 6.5km northwest of the proposed development (it has to be noted that Viljoenskroon is a small mining town). The project entails the generation of up to 100MW electrical power through the operation of photovoltaic (PV) panels. The total development footprint of the project will approximately be 450 hectares (including supporting infrastructure on site).

The farms are located in a grain farming agricultural region, but on soils of limited depth that are unsuitable for crop production. There is almost no cultivation on the land type on which the site is located. Maize production occurs on different, suitable soils of a different land type to the south of the site. The development site is used only for grazing of cattle. Mining occurs in the surrounding area.

The climate is strongly seasonal and semibelow. arid, with an average rainfall volume of 565 mm/annum, falling between October and May. The summers are hot and wet, with summer temperatures ranging typically between 1430°C. The winters are cold and dry, wintertime temperatures ranging typically between with 1 to 19°C. An average of 34 frost days occur each winter. The soils are perpetually moisture stressed, with mean annual evaporation of 2,407 mm, resulting in 78% of days where the soils lose more mois ture than they receive from precipitation.

The main visual receptors in the area are industrial developments, the mining sector and to agricultural developments preferred route. The nearest towns in relation to the proposed development site are; Orkney, Klerksdorp, Stilfontein, Viljoenskroon and Potchefstroom. The site is located approximately 2.7km south of the Vaal River, which also serves as the provincial boarder separating the Free State and the North West Province. Most of the site is located within the Vaal River Mining Area, the site is accessible via the Vermaasdrift road originating from the R76 south of the project site, and via the Stokkiesdraai road originating from the R30 west of the project site.

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The Moqhaka Local Municipality incorporates Kroonstad, Renovaal, Steynsrus, Vierfontein and Viljoenskroon with a combined population of 160 532 people. The general tendency of migration from rural to urban areas is also occurring in the area, as is the case in the rest of the Free State Province. In comparison to the other municipalities within the Fezile Dabi District, it appears as if Moqhaka is significantly less urbanised. The main economic sectors in the municipality are agriculture, commercial transport, business services and mining.

The topography of the study area is described as slightly undulating plains with an even (flat) slopes. The proposed development site itself is located at an average elevation of 1 310m above sea level and has an even slope to the north. The preferred site is located at an above mean sea level (amsl) of approximately 1308m at the highest elevation and at an amsl of 1296m at the lowest elevation.

5.2. Land Use

The proposed development is located in close proximity to the Vaal River. Most of the site is located within the Vaal River Mining Area, a degraded grassland transformed by mining. The preferred site is located at an above mean sea

level (amsl) of approximately 1308m at the highest elevation and at an amsl of 1296m at the lowest elevation.
The observers in a 5km radius include:

» Eskom power line infrastructure.

» Vaal Reefs Eleven Substation.

» Harmony Moab Mine.

» Tailings dams.

» Water Processing Plant.

» Other mining operations.

» Various homesteads on farms and smallholdings

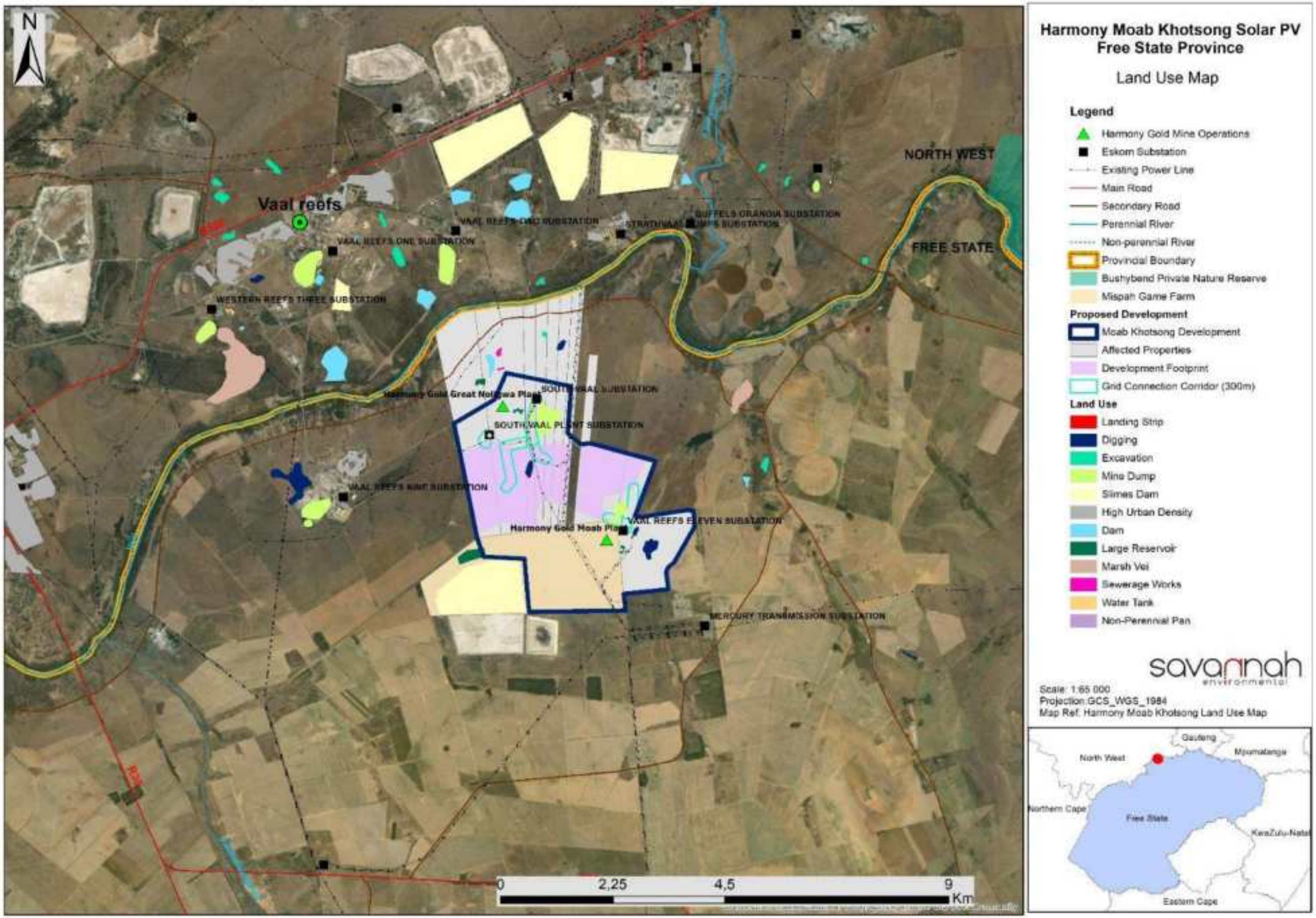
» R502 road

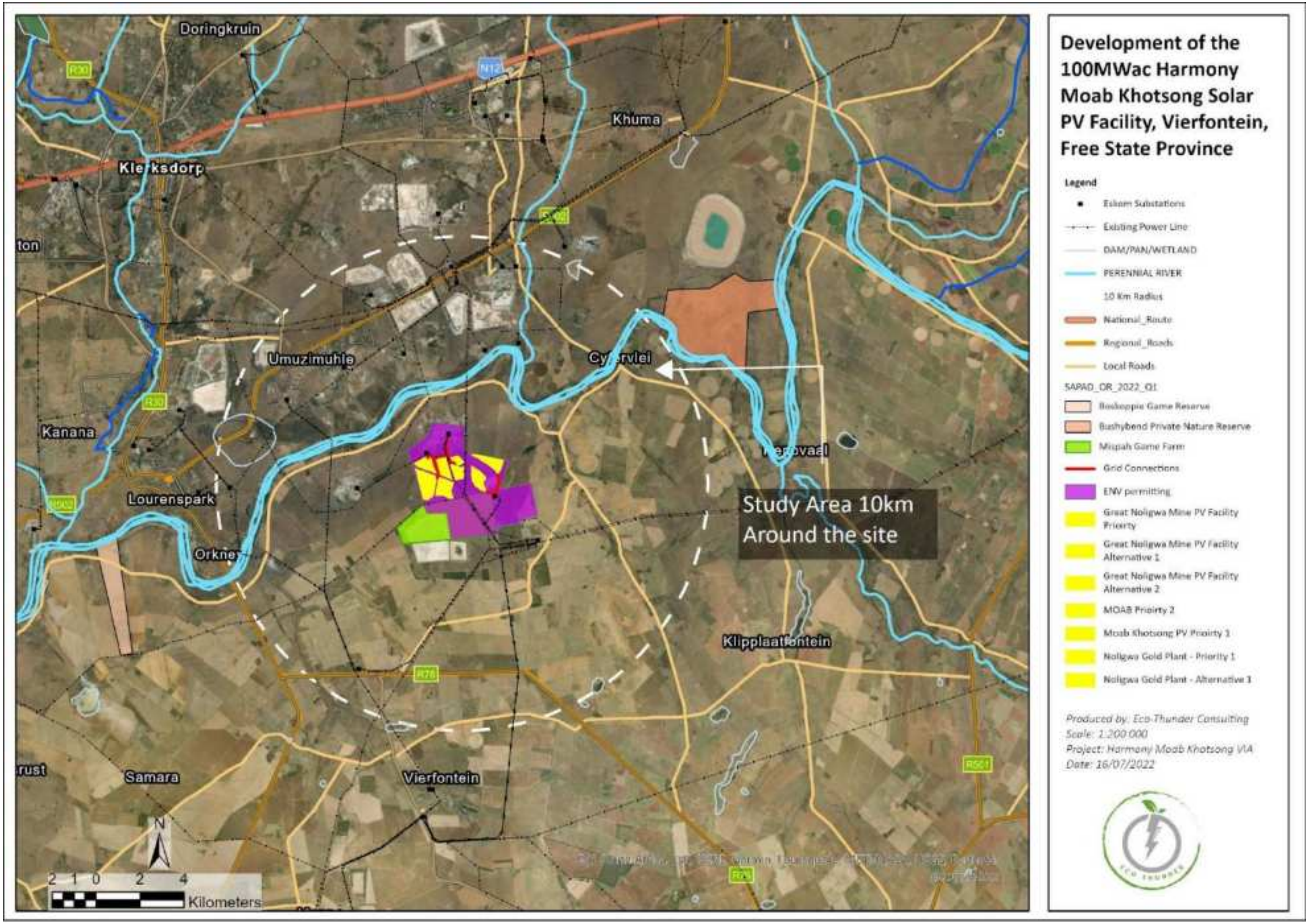
» Vermaasdrift road

» Stokkiesdraai road

» Vaal River.

» Wawielpark Holiday Resort.


Harmony Moab Khotsong Solar PV
Free State Province
Land Use Map
Legend
Harmony Gold Mine Operations
Eskom Substation
Existing Power Line
Main Road
Secondary Road
Perennial River
Non-perennial River
Provincial Boundary
Bushybend Private Nature Reserve
Mispah Game Farm
Proposed Development
Moab Khotsong Development
Affected Properties
Development Footprint
Grid Connection Corridor (300m)
Land Use
Landing Strip
Digging
Excavation
Mine Dump
Slimes Dam
High Urban Density
Dam
Large Reservoir
Marsh Vei
Sewerage Works
Water Tank
Non-Perennial Pan
savannah
environmental
Scale: 1:65 000
Projection: GCS_WGS_1984
Map Ref: Harmony Moab Khotsong Land Use Map
Gauteng
North West
Mpumalanga
Northern Cape
Free State
KwaZulu-Natal
Eastern Cape
N
Vaal reefs
NORTH WEST
FREE STATE
VAAL REEFS ONE SUBSTATION
WESTERN REEFS THREE SUBSTATION
VAAL REEFS NINE SUBSTATION
SOUTH VAAL PLANT SUBSTATION
Harmony Gold Moab Plant
VAAL REEFS ELEVEN SUBSTATION
MERCURY TRANSMISSION SUBSTATION
0
2,25
4,5
9
Km


Development of the 100MWac Harmony Moab Khotsong Solar PV Facility, Vierfontein, Free State Province
Legend
Eskom Substations
Existing Power Line
DAM/PAN/WETLAND
PERENNIAL RIVER
10 Km Radius
National_Route
Regional_Roads
Local Roads
SAPAD_OR_2022_Q1
Boskoppie Game Reserve
Bushybend Private Nature Reserve
Mispah Game Farm
Grid Connections
ENV permitting
Great Noligwa Mine PV Facility Priority
Great Noligwa Mine PV Facility Alternative 1
Great Noligwa Mine PV Facility Alternative 2
MOAB Priority 2
Moab Khotsong PV Priority 1
Noligwa Gold Plant - Priority 1
Noligwa Gold Plant - Alternative 1
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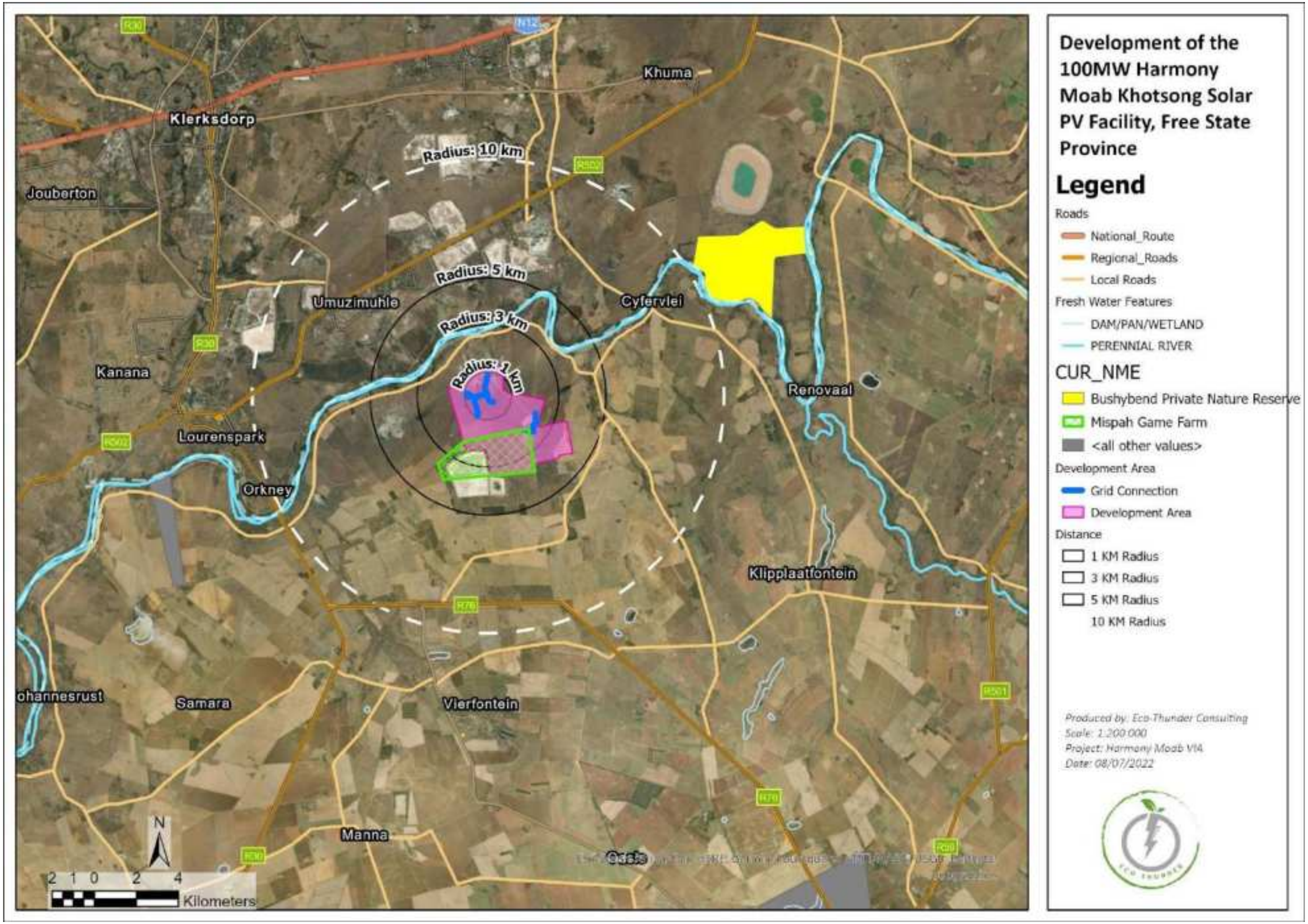
Scale: 1:200 000
Project: Harmony Moab Khotsong VIA
Date: 16/07/2022
Study Area 10km Around the site
Doringkruin
Khuma
Klerksdorp
Umuzimuhle
Kanana
Lourenspark
Orkney
Klipplaatfontein
Samara
Vierfontein
N12
R30
R502
R76
R501
2 1 0 2 4
Kilometers



Development of the 100MW Harmony Moab Khotsong Solar PV Facility, Free State Province
Legend
Roads
National_Route
Regional_Roads
Local Roads
Fresh Water Features
DAM/PAN/WETLAND
PERENNIAL RIVER
CUR_NME
Bushybend Private Nature Reserve
Mispah Game Farm
<all other values>
Development Area
Grid Connection
Development Area
Distance
1 KM Radius
3 KM Radius
5 KM Radius
10 KM Radius
Produced by: Eco-Thunder Consulting
Scale: 1:200 000
Project: Harmony Moab VIA
Date: 08/07/2022
Radius: 10 km
Radius: 5 km
Radius: 3 km
Radius: 1 km
Klerksdorp
Khuma
Jouberton
Umuzimuhle
Cyfervlei
Kanana
Renovaal
Lourenspark
Orkney
Klipplaatfontein
ohannesrust
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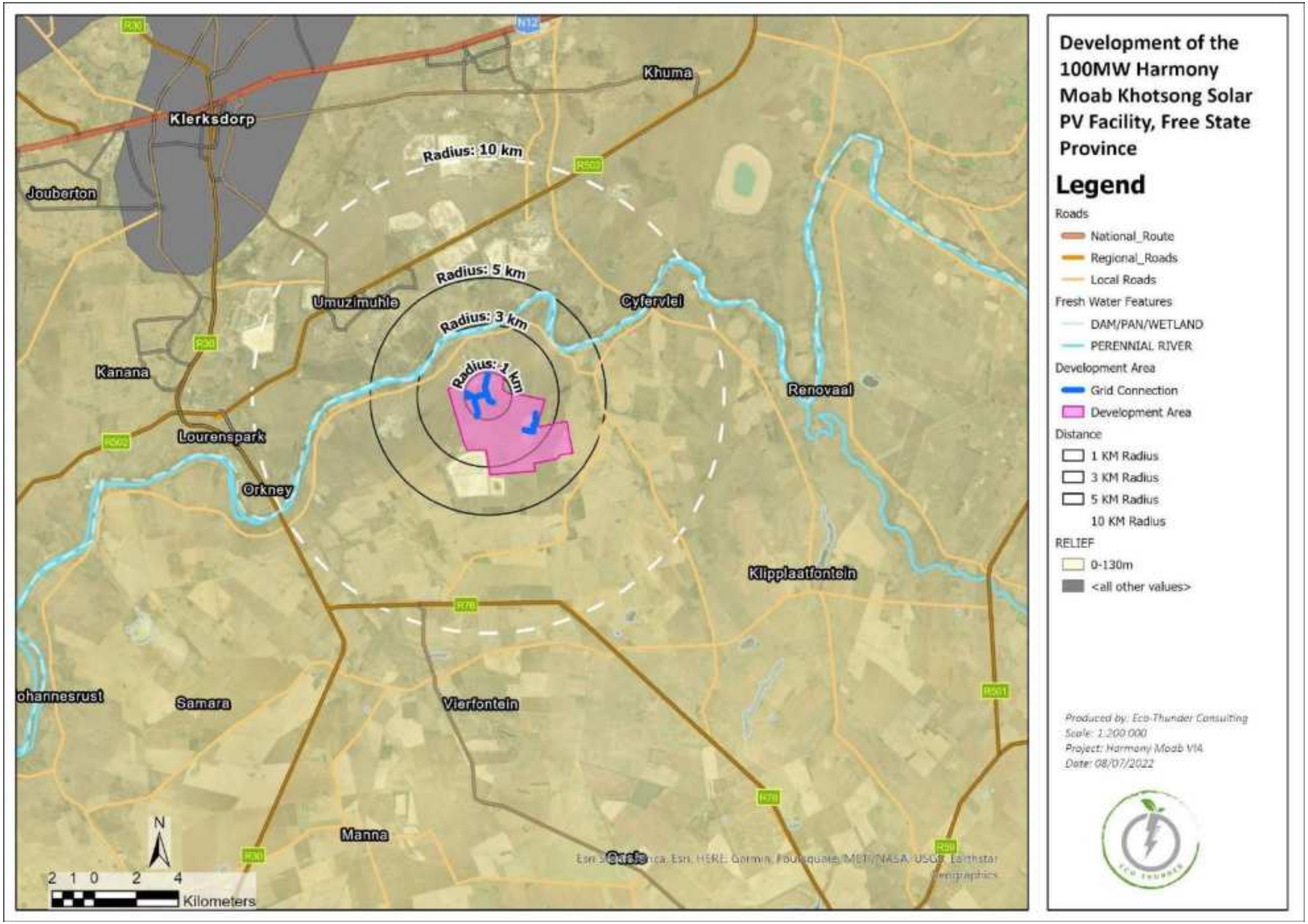
Development of the 100MW Harmony Moab Khotsong Solar PV Facility, Free State Province
Legend
Roads
National_Route
Regional_Roads
Local Roads
Fresh Water Features
DAM/PAN/WETLAND
PERENNIAL RIVER
Development Area
Grid Connection
Development Area
Distance
1 KM Radius
3 KM Radius
5 KM Radius
10 KM Radius
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0-130m
<all other values>
Produced by: Eco-Thunder Consulting
Scale: 1:200 000
Project: Harmony Moab VIA
Date: 08/07/2022
Radius: 10 km
Radius: 5 km
Radius: 3 km
Radius: 1 km
Klerksdorp
Khuma
Jouberton
Umuzimuhle
Cyfervlei
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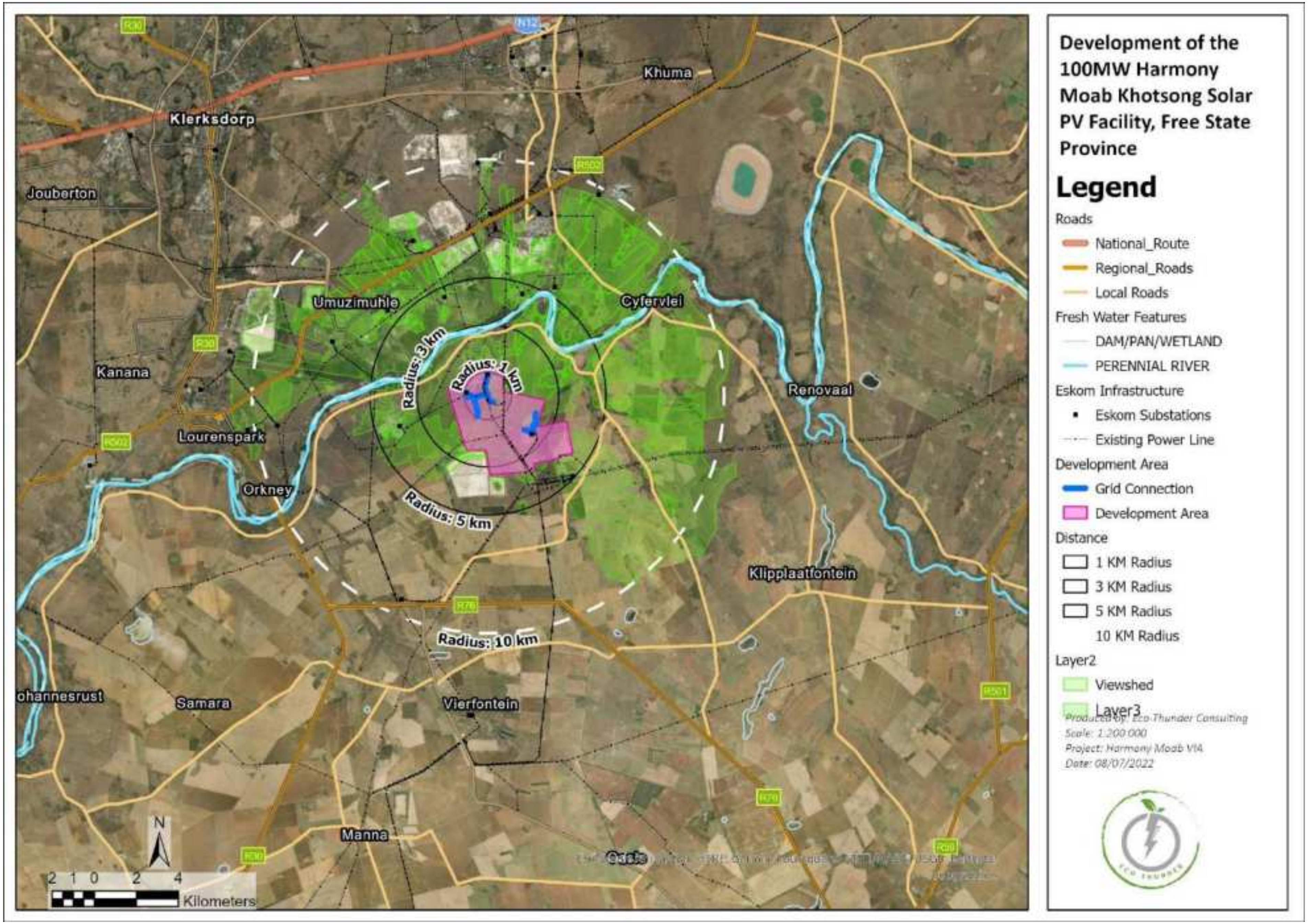

Development of the 100MW Harmony Moab Khotsong Solar PV Facility, Free State Province
Legend
Roads
National_Route
Regional_Roads
Local Roads
Fresh Water Features
DAM/PAN/WETLAND
PERENNIAL RIVER
Eskom Infrastructure
Eskom Substations
Existing Power Line
Development Area
Grid Connection
Development Area
Distance
1 KM Radius
3 KM Radius
5 KM Radius
10 KM Radius
Layer2
Viewshed
Layer3
Produced by: Eco-Thunder Consulting
Scale: 1:200 000
Project: Harmony Moab VIA
Date: 08/07/2022
Klerksdorp
Khuma
Jouberton
Umuzimuhle
Cyfervlei
Kanana
Renovaal
Lourenspark
Orkney
Klipplaatfontein
ohannesrust
Samara
Vierfontein
Manna
Radius: 1 km
Radius: 3 km
Radius: 5 km
Radius: 10 km
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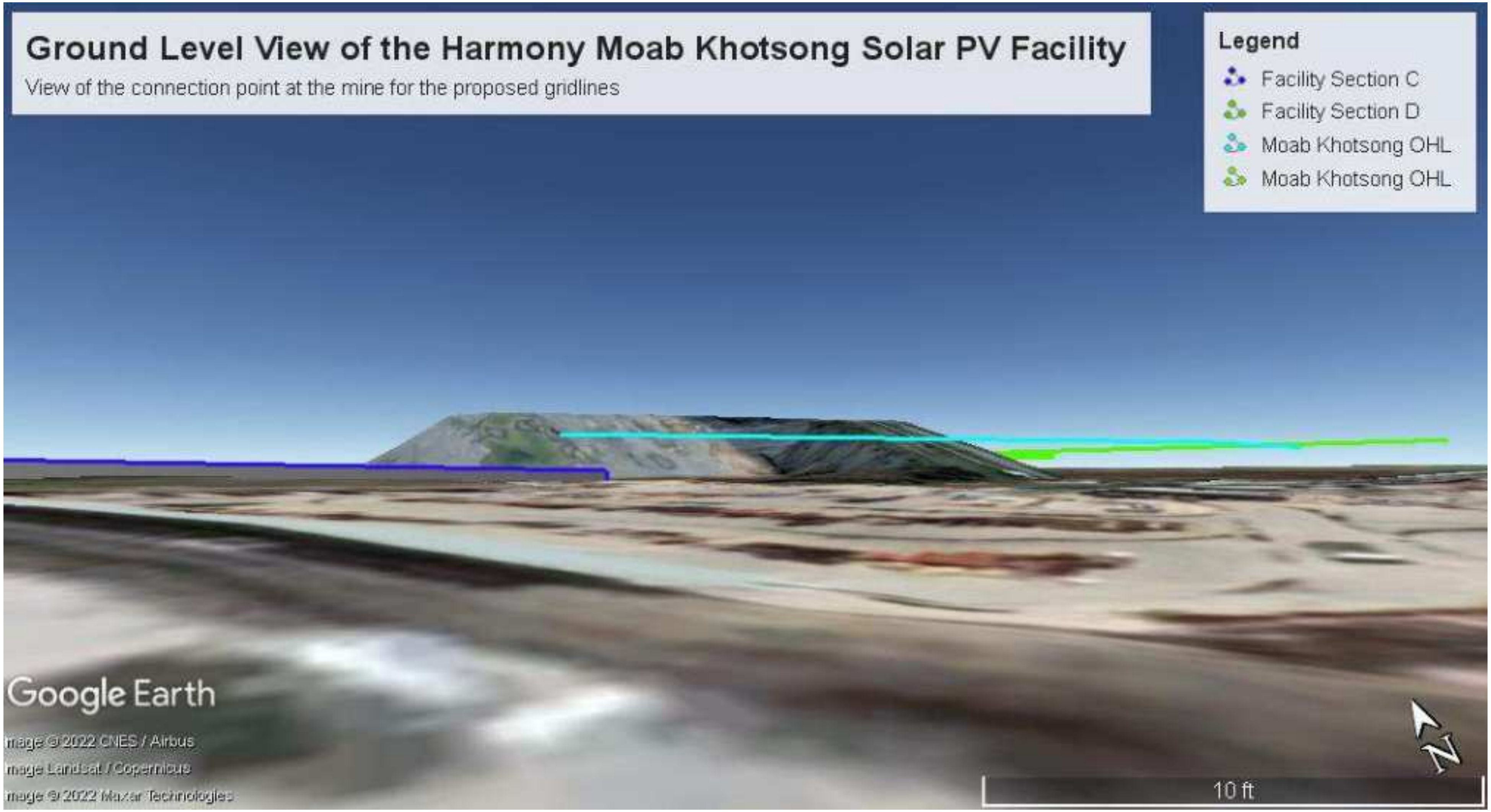
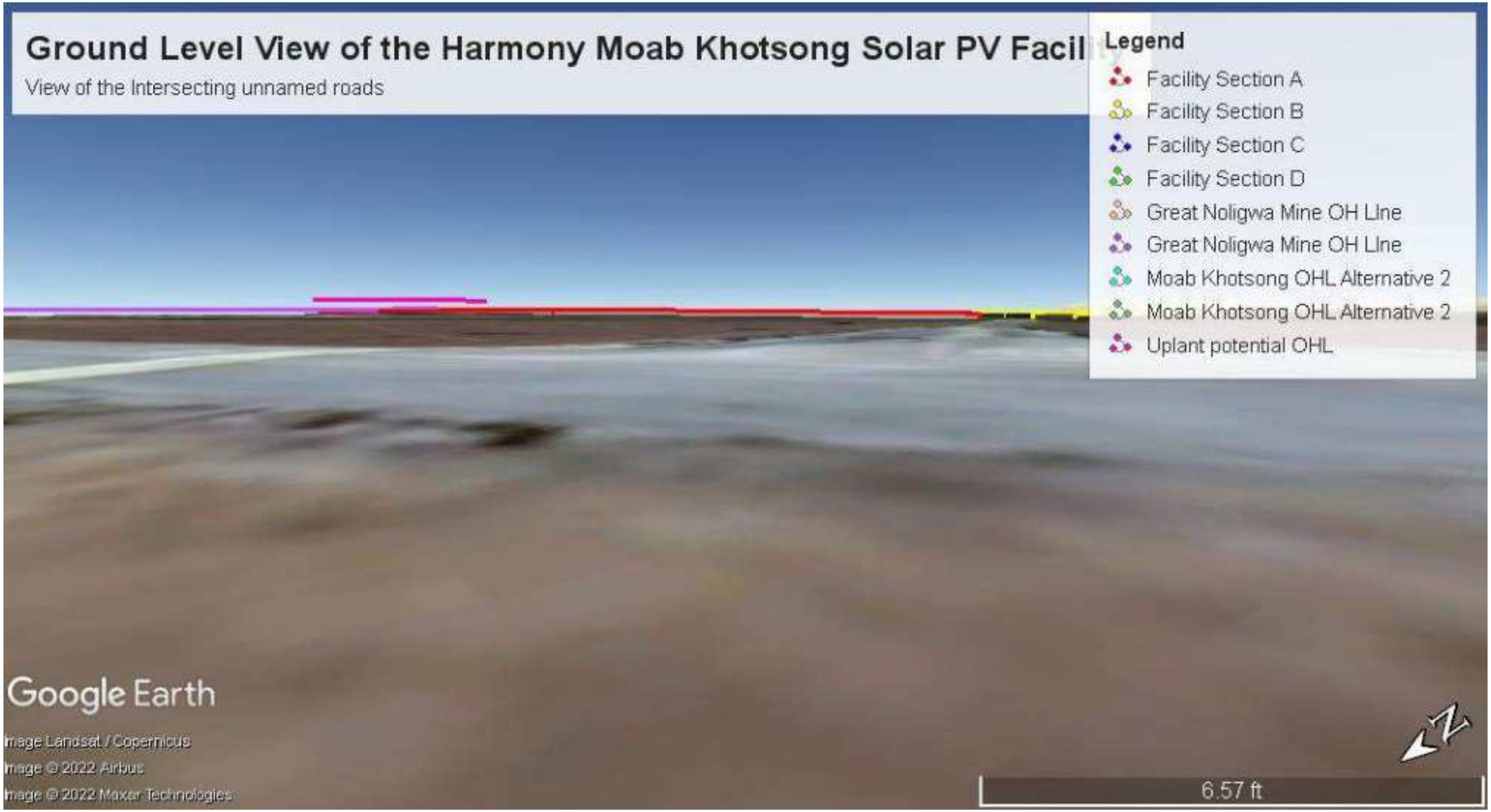
2 1 0 2 4
Kilometers


Ground Level View of the Harmony Moab Khotsong Solar PV Facility
View of the connection point at the mine for the proposed gridlines
Legend
Facility Section C
Facility Section D
Moab Khotsong OHL
Moab Khotsong OHL
Google Earth
10 ft


Ground Level View of the Harmony Moab Khotsong Solar PV Facility
View of the connection point at the mine for the proposed gridlines
Legend
Facility Section C
Facility Section D
Moab Khotsong OHL
Moab Khotsong OHL
Google Earth
Image © 2022 CNES / Airbus
Image Landsat / Copernicus
Image © 2022 Maxar Technologies
Image © 2022 Airbus
10 ft


Ground Level View of the Harmony Moab Khotsong Solar PV Facil
View of the Intersecting unnamed roads
Legend
Facility Section A
Facility Section B
Facility Section C
Facility Section D
Great Noligwa Mine OH LIne
Great Noligwa Mine OH LIne
Moab Khotsong OHL Alternative 2
Moab Khotsong OHL Alternative 2
Uplant potential OHL
Google Earth
Image Landsat / Copernicus
Image © 2022 Airbus
Image © 2022 Maxar Technologies
6.57 ft
N


View of the Harmony Moab Khotsong Solar PV Facility
Ground level view of the OHL
Legend
Great Noligwa Mine OH LIne
Great Noligwa Mine OH LIne
Moab Khotsong OHL Alternative 2
Moab Khotsong OHL Alternative 2
Uplant potential OHL
Google Earth
Image Landsat / Copernicus
Image © 2022 Maxar Technologies
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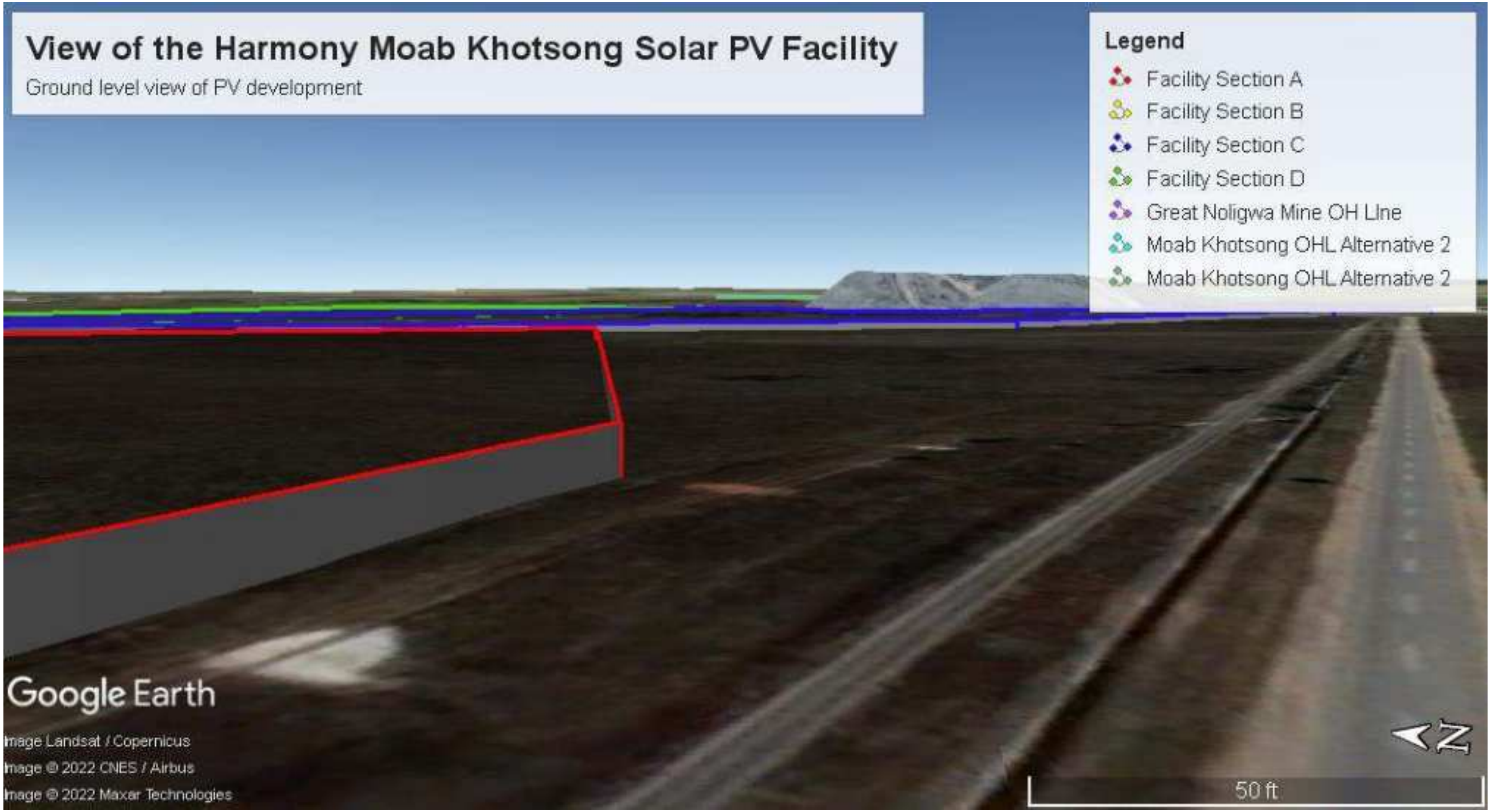
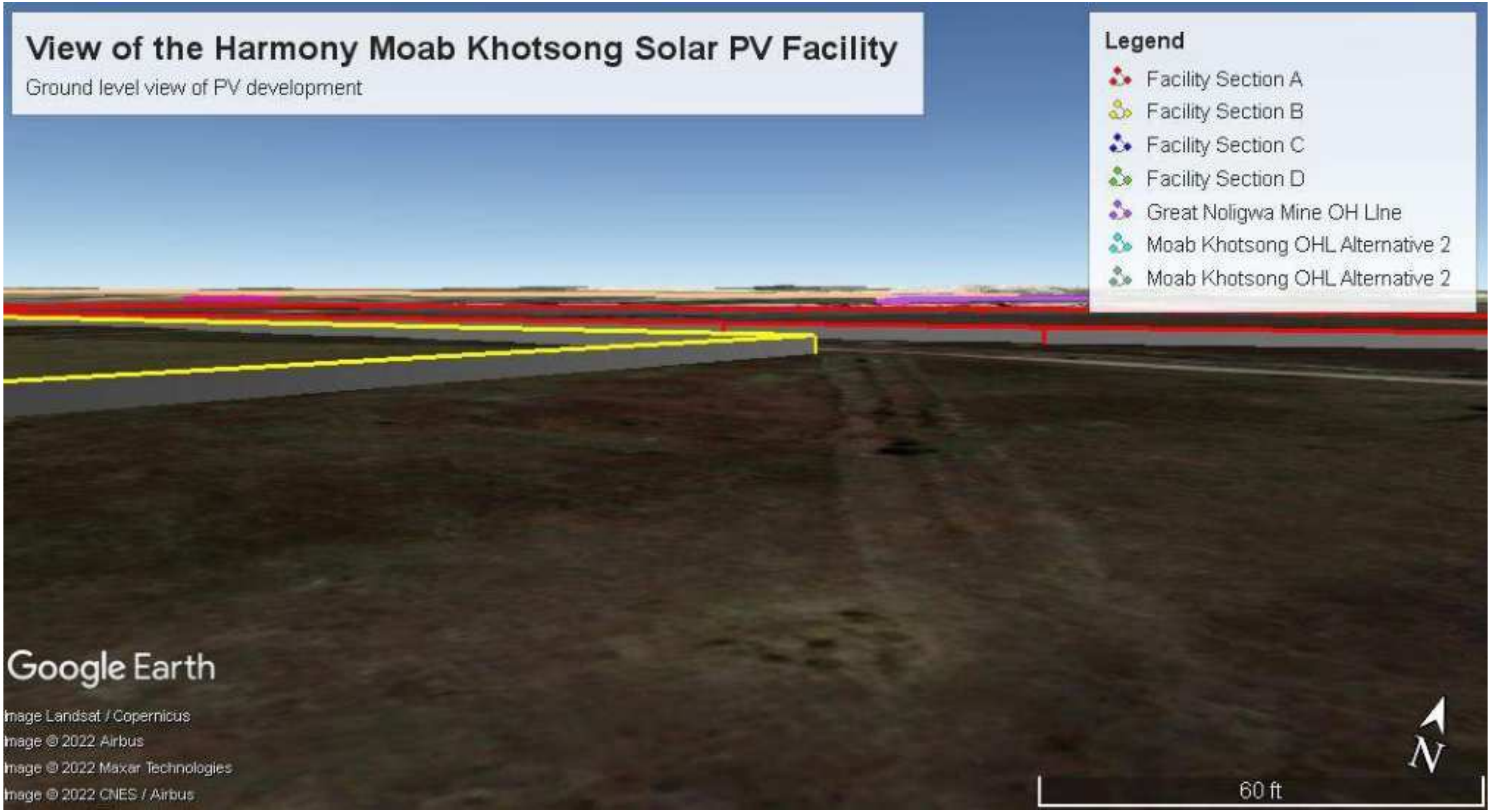

View of the Harmony Moab Khotsong Solar PV Facility
Ground level view of PV development
Legend
Facility Section A
Facility Section B
Facility Section C
Facility Section D
Great Noligwa Mine OH Line
Moab Khotsong OHL Alternative 2
Moab Khotsong OHL Alternative 2
Google Earth
Image Landsat / Copernicus
Image © 2022 CNES / Airbus
Image © 2022 Maxar Technologies
50 ft


View of the Harmony Moab Khotsong Solar PV Facility
Ground level view of PV development
Legend
Facility Section A
Facility Section B
Facility Section C
Facility Section D
Great Noligwa Mine OH Line
Moab Khotsong OHL Alternative 2
Moab Khotsong OHL Alternative 2
Google Earth
Image Landsat / Copernicus
Image © 2022 Airbus
Image © 2022 Maxar Technologies
Image © 2022 CNES / Airbus
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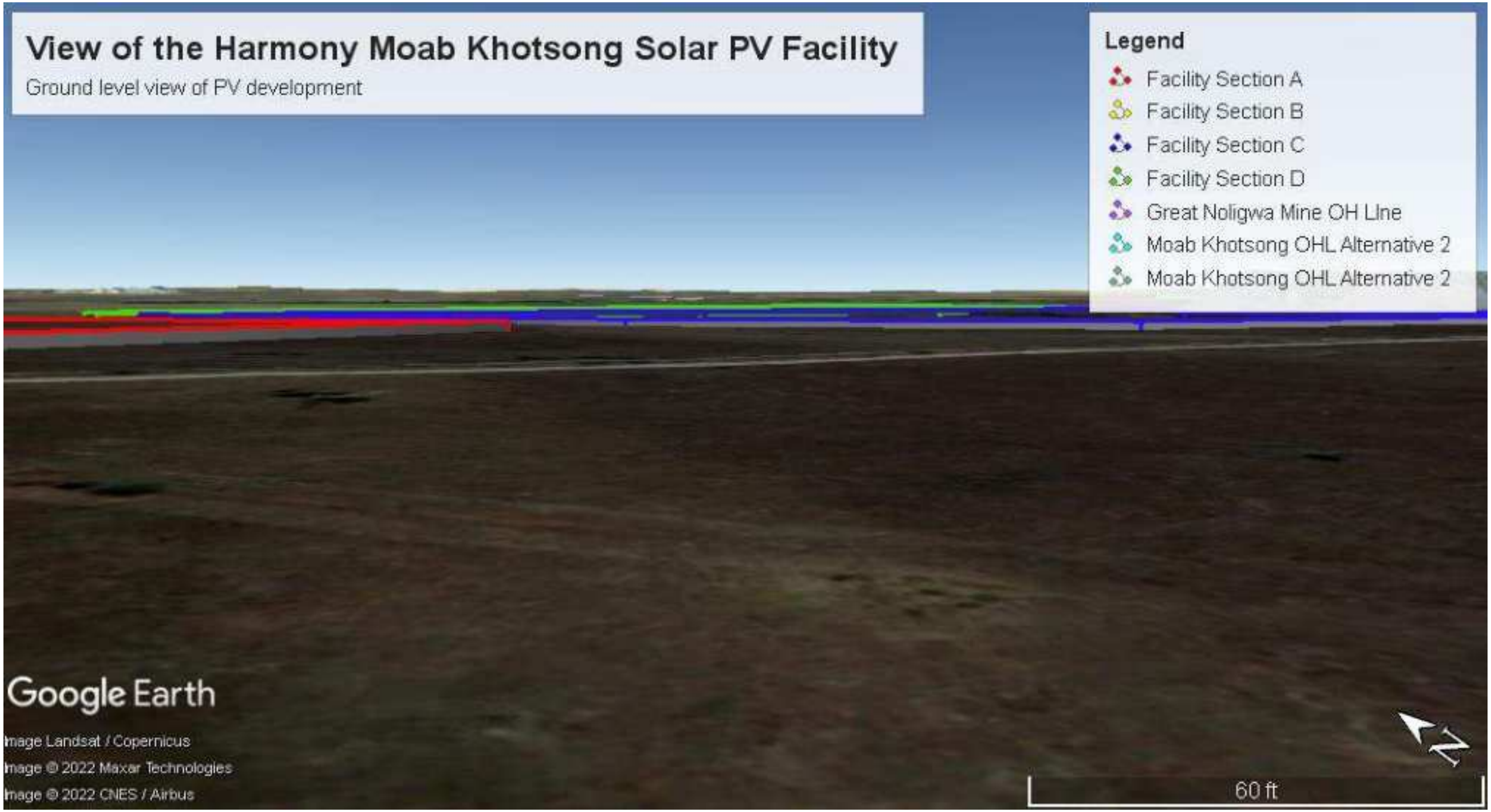
View of the Harmony Moab Khotsong Solar PV Facility
Ground level view of PV development
Legend
Facility Section A
Facility Section B
Facility Section C
Facility Section D
Great Noligwa Mine OH LIne
Moab Khotsong OHL Alternative 2
Moab Khotsong OHL Alternative 2
Google Earth
Image Landsat / Copernicus
Image © 2022 Maxar Technologies
Image © 2022 CNES / Airbus
60 ft

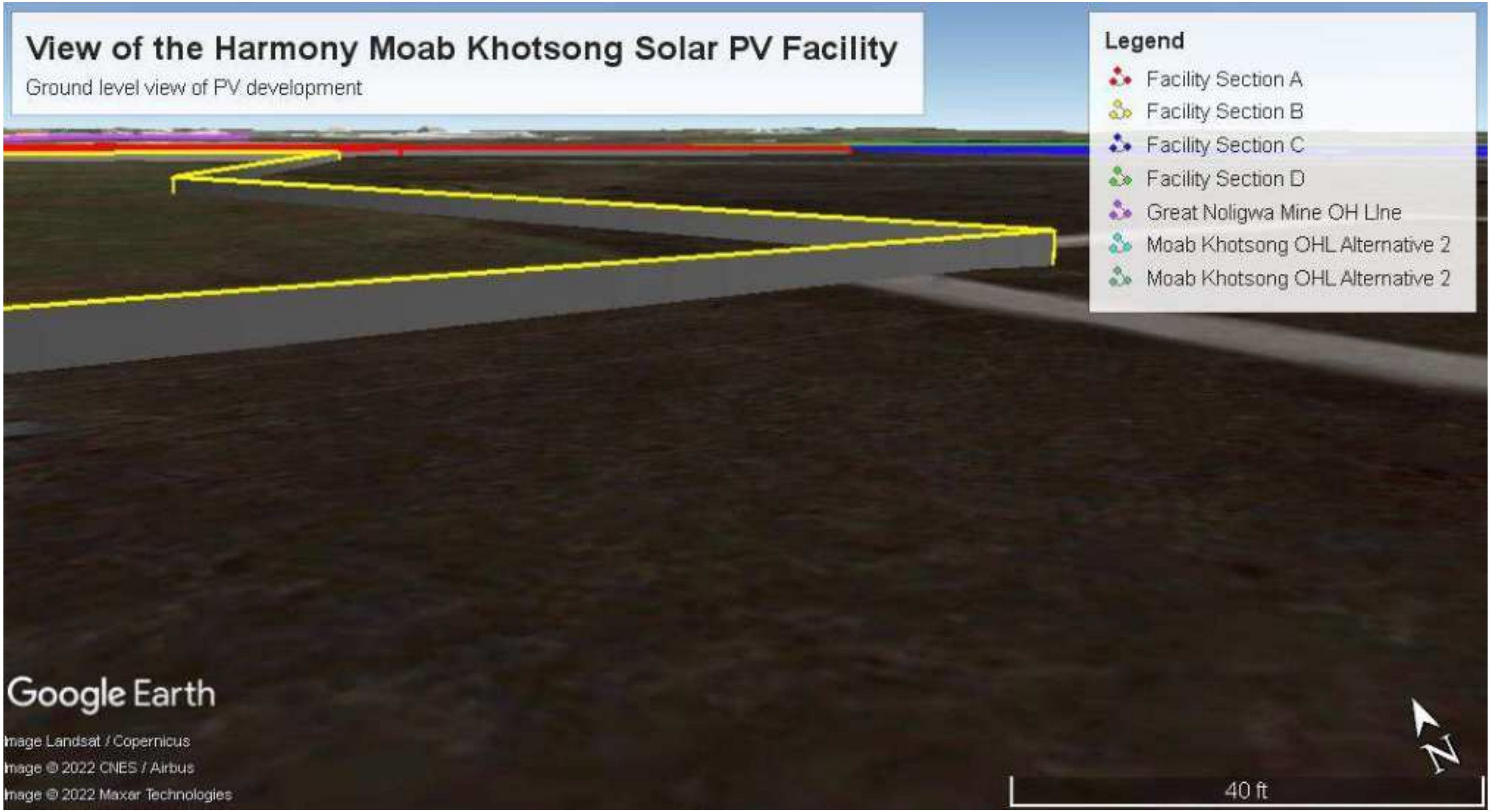
View of the Harmony Moab Khotsong Solar PV Facility
Ground level view of PV development
Legend
Facility Section A
Facility Section B
Facility Section C
Facility Section D
Great Noligwa Mine OH LIne
Moab Khotsong OHL Alternative 2
Moab Khotsong OHL Alternative 2
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Image Landsat / Copernicus
Image © 2022 CNES / Airbus
Image © 2022 Maxar Technologies
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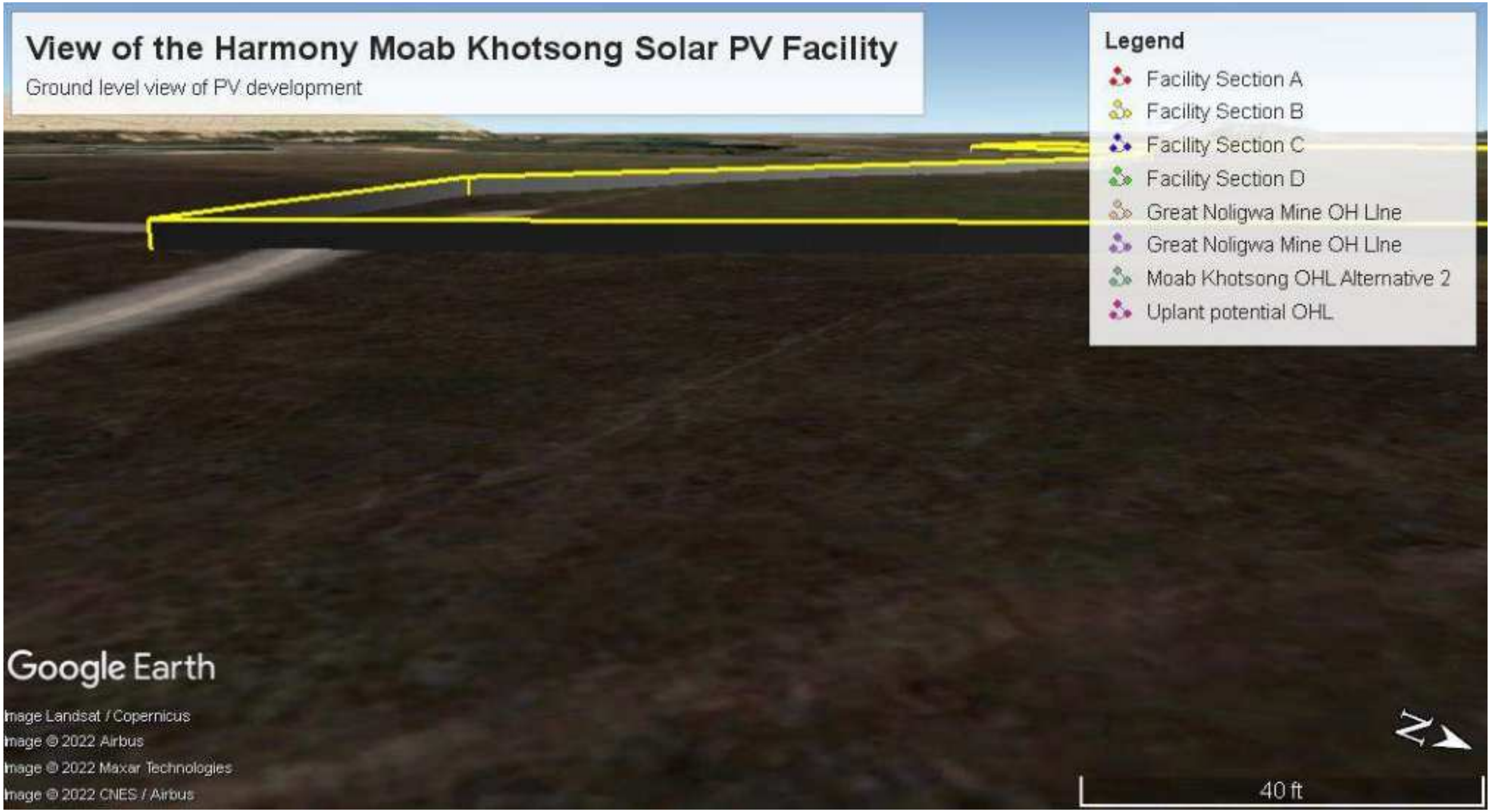
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Ground level view of PV development
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Facility Section B
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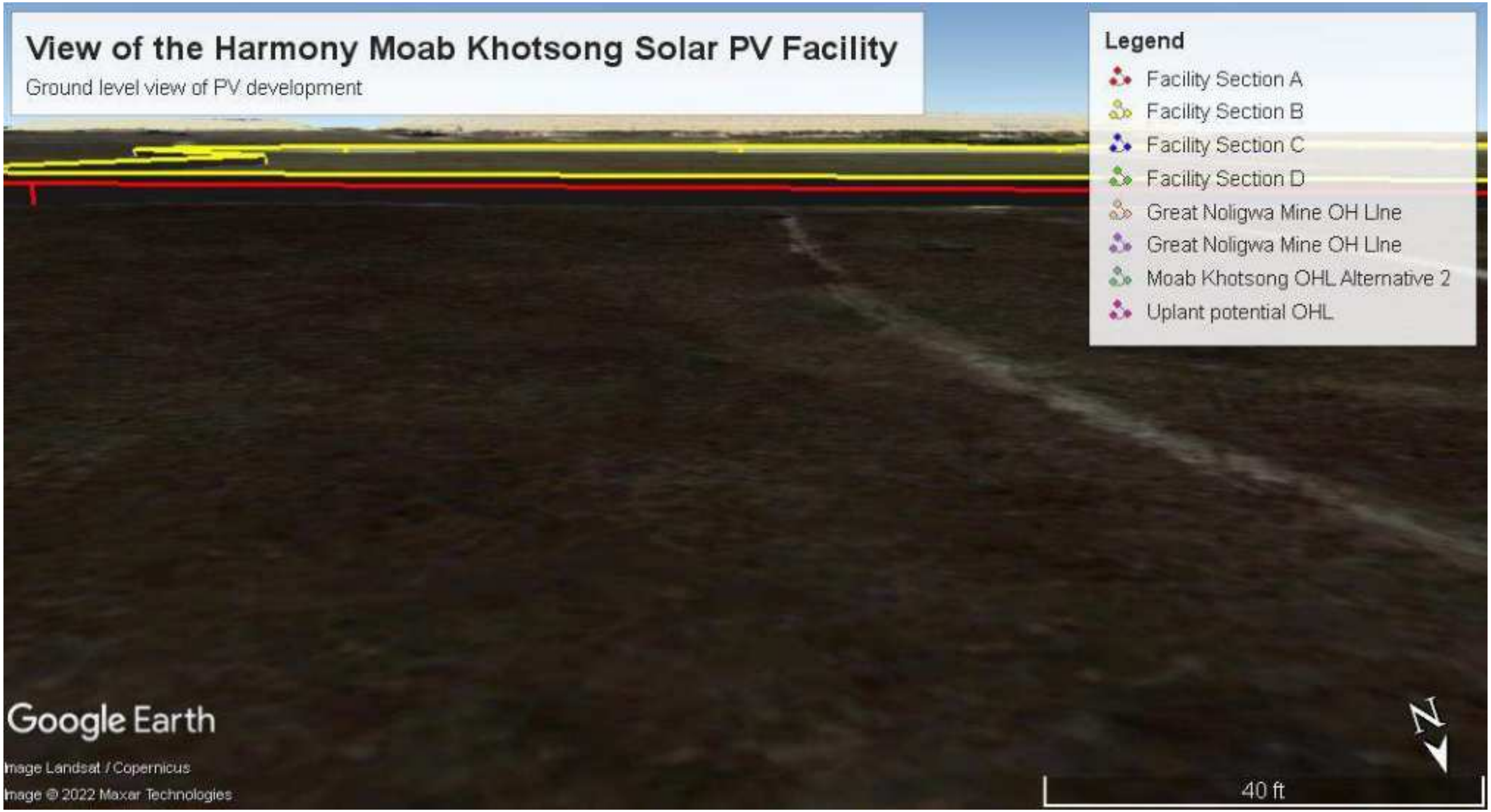
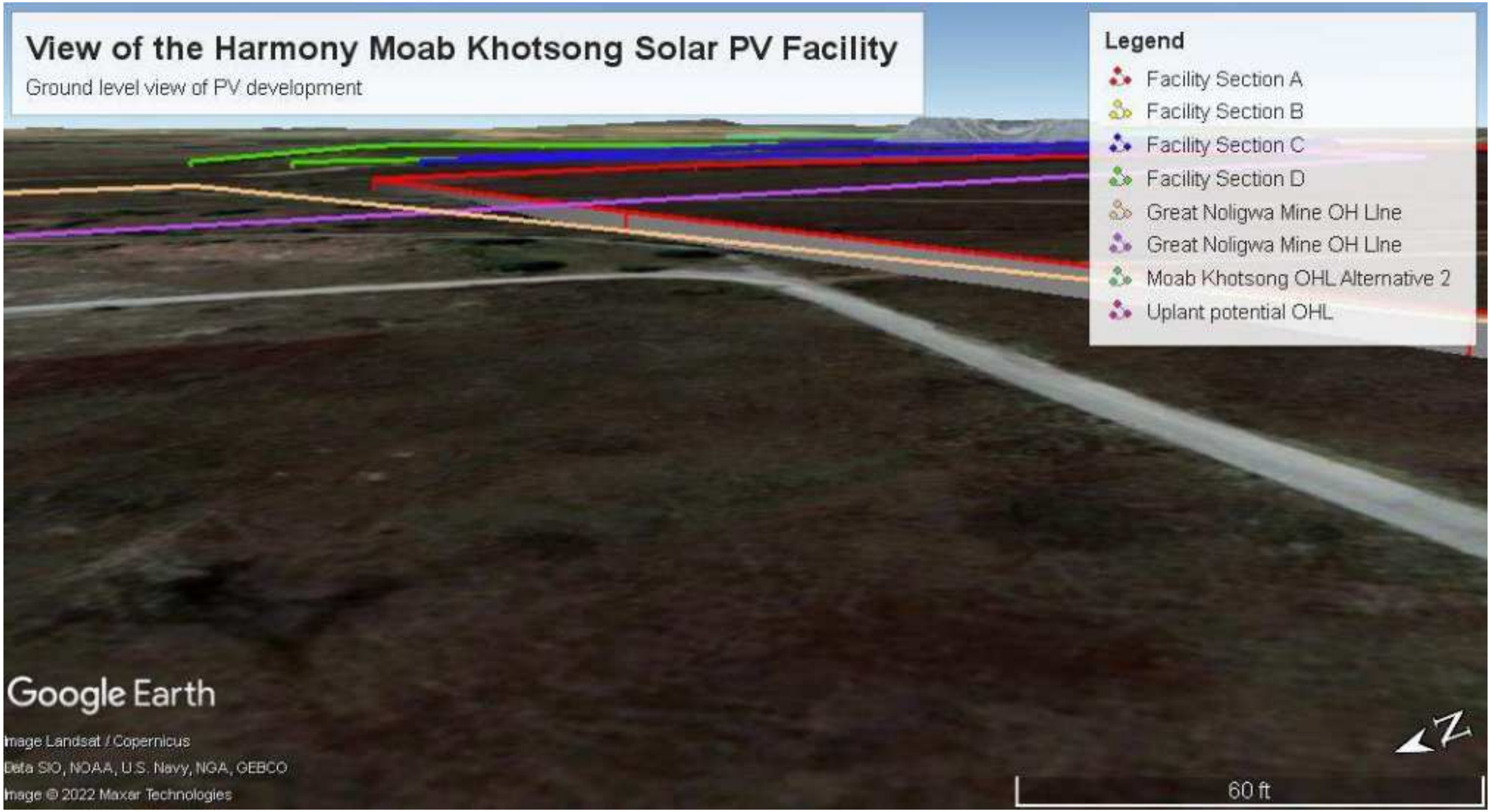
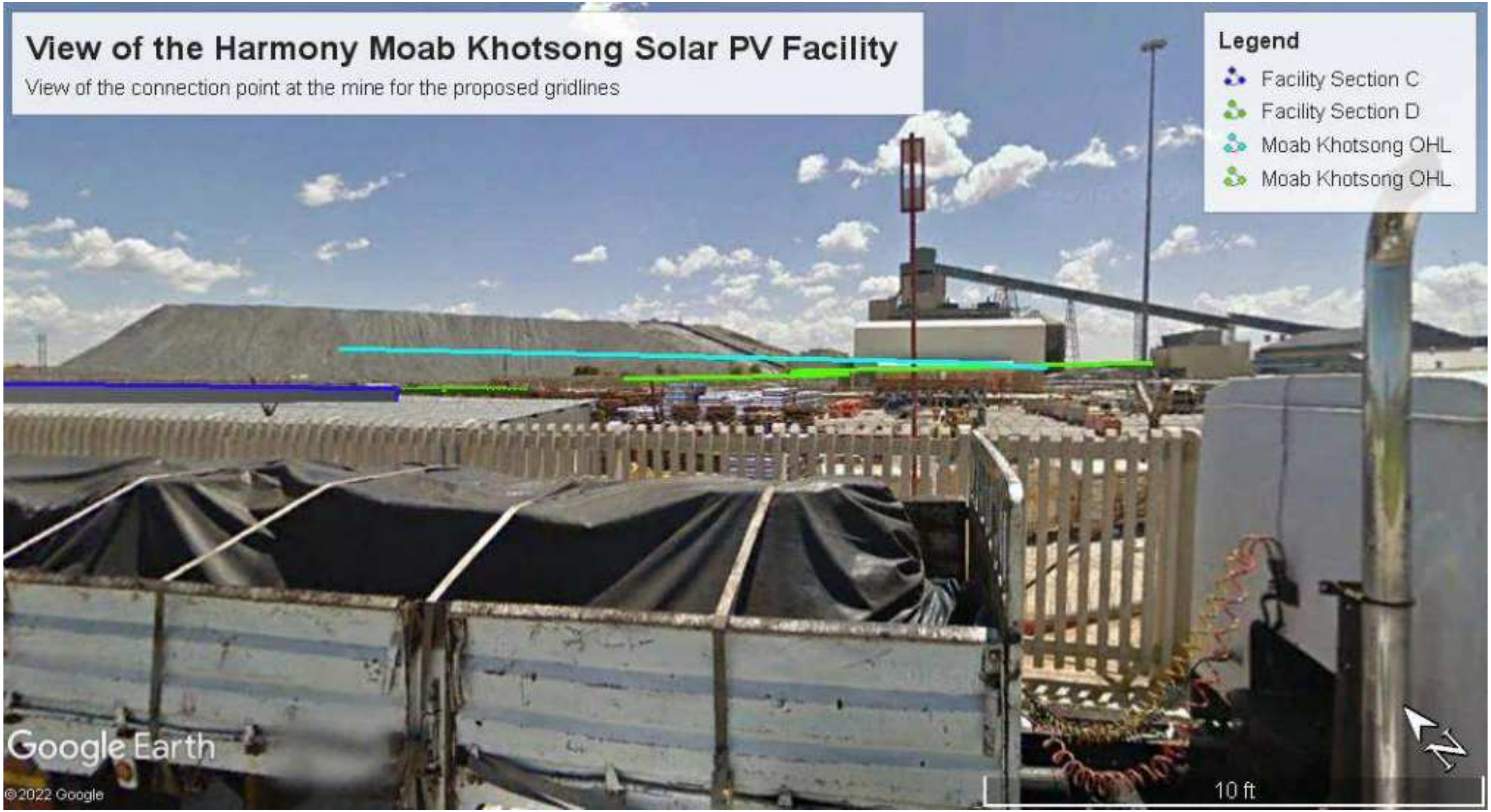
Uplant potential OHL
Google Earth
Image Landsat / Copernicus
Image © 2022 Airbus
Image © 2022 Maxar Technologies
Image © 2022 CNES / Airbus
40 ft

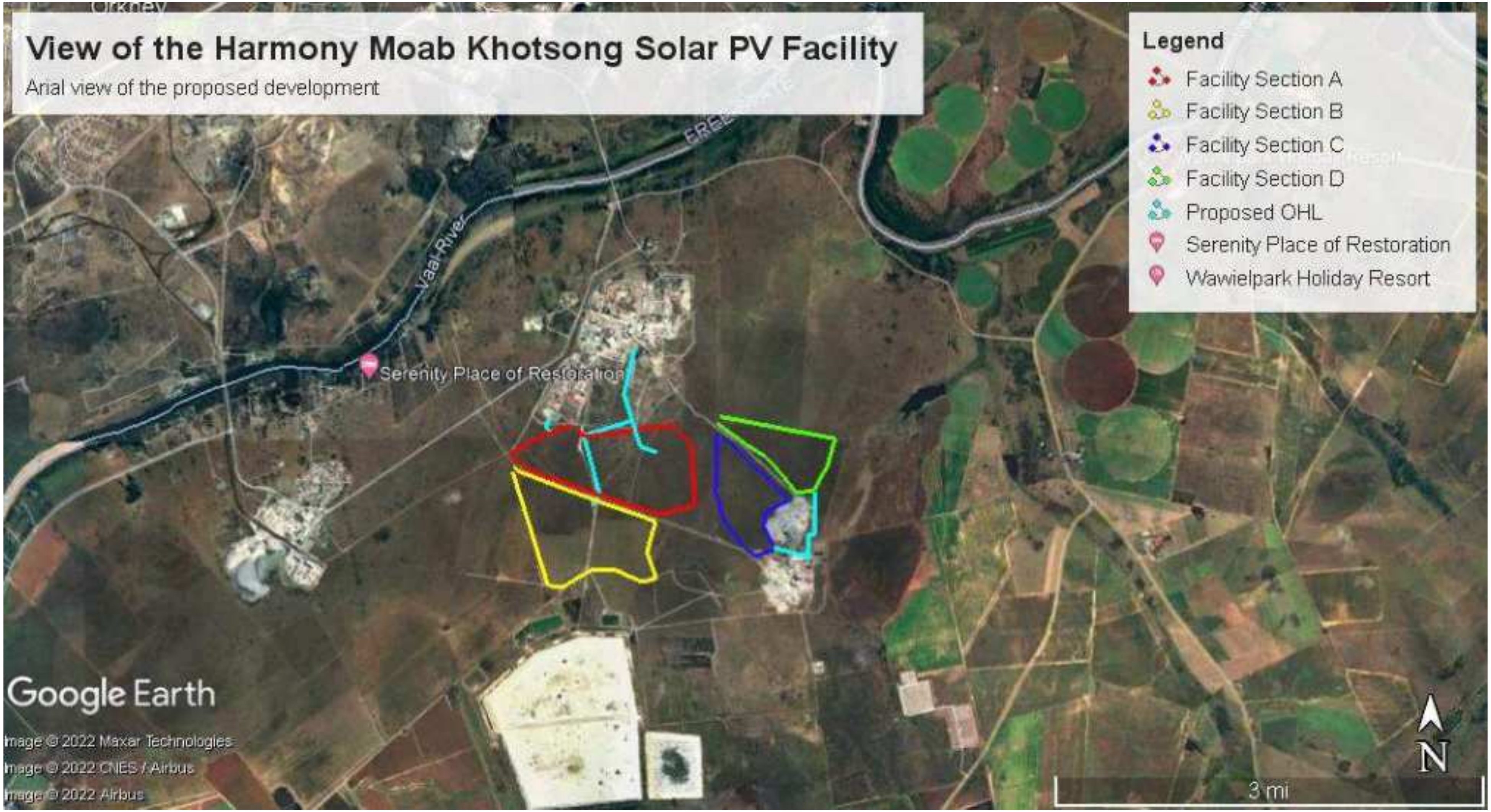

View of the Harmony Moab Khotsong Solar PV Facility
Ground level view of PV development
Legend
Facility Section A
Facility Section B
Facility Section C
Facility Section D
Great Noligwa Mine OH LIne
Great Noligwa Mine OH LIne
Moab Khotsong OHL Alternative 2
Uplant potential OHL
Google Earth
Image Landsat / Copernicus
Image © 2022 Maxar Technologies
40 ft
N


View of the Harmony Moab Khotsong Solar PV Facility
Ground level view of PV development
Legend
Facility Section A
Facility Section B
Facility Section C
Facility Section D
Great Noligwa Mine OH Line
Great Noligwa Mine OH Line
Moab Khotsong OHL Alternative 2
Uplant potential OHL
Google Earth
Image Landsat / Copernicus
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2022 Maxar Technologies
60 ft


View of the Harmony Moab Khotsong Solar PV Facility
View of the connection point at the mine for the proposed gridlines
Legend
Facility Section C
Facility Section D
Moab Khotsong OHL
Moab Khotsong OHL
Google Earth
©2022 Google
10 ft


View of the Harmony Moab Khotsong Solar PV Facility
View of surrounding area, the PV development is located west (In yellow)
Legend
Facility Section B
Google Earth
© 2022 Google
9.51 ft
N


View of the Harmony Moab Khotsong Solar PV Facility
View of surround area, the PV development is located to the north, and this view is south facing
Legend
Google Earth
© 2022 Google
10 ft
N


View of the Harmony Moab Khotsong Solar PV Facility
Arial view of the proposed development
Legend
Facility Section A
Facility Section B
Facility Section C
Facility Section D
Proposed OHL
Serenity Place of Restoration
Wawielpark Holiday Resort
Vaal River
Serenity Place of Restoration
Google Earth
Image © 2022 Maxar Technologies
Image © 2022 CNES / Airbus
Image © 2022 Airbus
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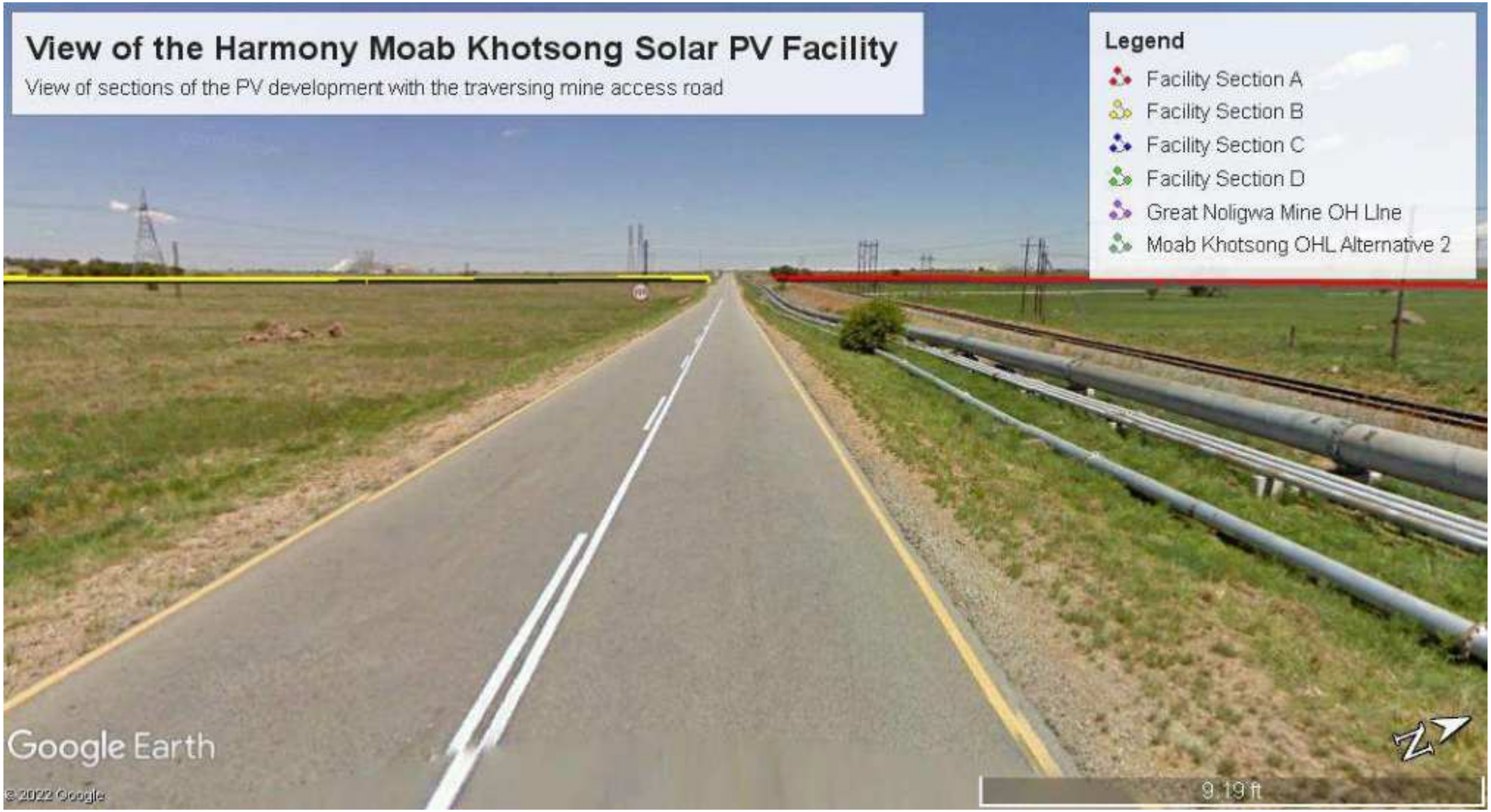
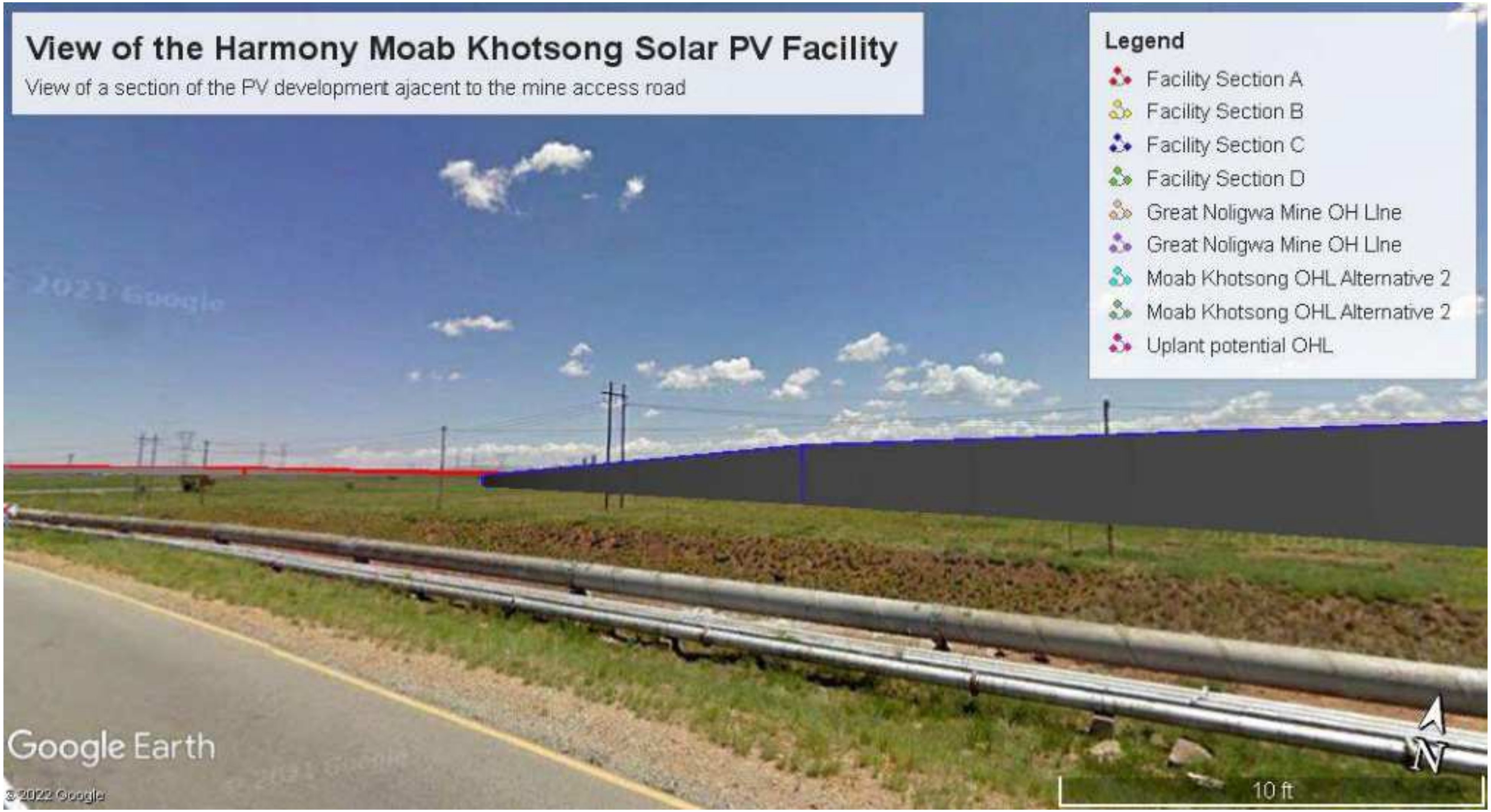
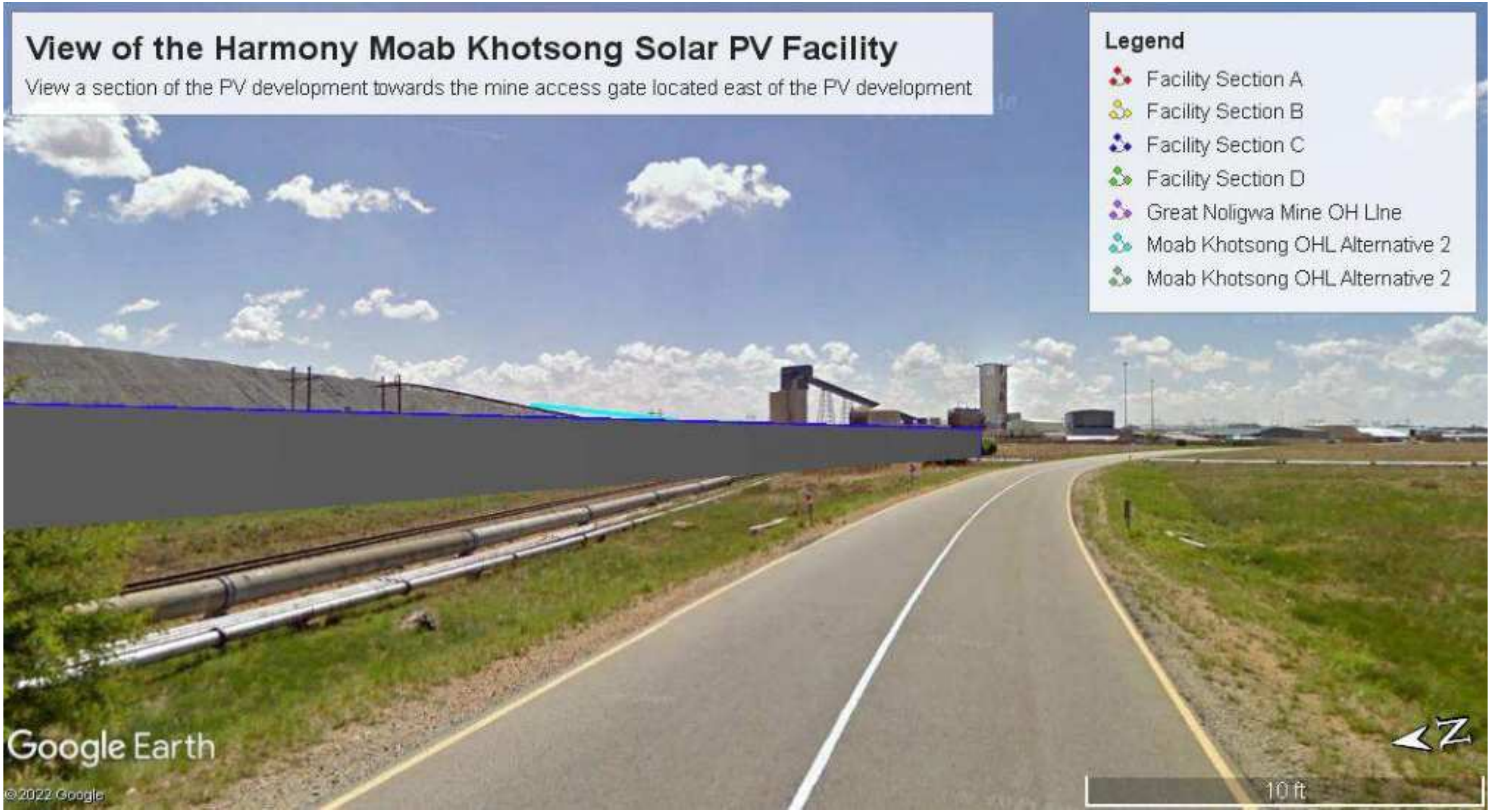
3 mi


View of the Harmony Moab Khotsong Solar PV Facility
View From the unnamed road located ajacent to mining pipeline infrastucture
Legend
Facility Section A
Facility Section B
Proposed OHL
Google Earth
© 2022 Google
10 ft


View of the Harmony Moab Khotsong Solar PV Facility
View of sections of the PV development with the traversing mine access road
Legend
Facility Section A
Facility Section B
Facility Section C
Facility Section D
Great Noligwa Mine OH Line
Moab Khotsong OHL Alternative 2
Google Earth
© 2022 Google
9.19 ft


View of the Harmony Moab Khotsong Solar PV Facility
View of a section of the PV development ajacent to the mine access road
Legend
Facility Section A
Facility Section B
Facility Section C
Facility Section D
Great Noligwa Mine OH LIne
Great Noligwa Mine OH LIne
Moab Khotsong OHL Alternative 2
Moab Khotsong OHL Alternative 2
Uplant potential OHL
Google Earth
© 2022 Google
10 ft
N


View of the Harmony Moab Khotsong Solar PV Facility
View a section of the PV development towards the mine access gate located east of the PV development
Legend
Facility Section A
Facility Section B
Facility Section C
Facility Section D
Great Noligwa Mine OH Line
Moab Khotsong OHL Alternative 2
Moab Khotsong OHL Alternative 2
Google Earth
©2022 Google
10 ft


View of the Harmony Moab Khotsong Solar PV Facility
View from Intersection of the Unknown Viljoenskroon Road
Legend
Potential OHL
Facility Section A
Facility Section B
Google Earth
© 2022 Google
10 ft


View of the Harmony Moab Khotsong Solar PV Facility
View from Unknown Viljoenskroon Road with the PV Facility located to the East of the road
Legend
Facility Section A
Facility Section B
Possible OHL
Google Earth
©2022 Google
10 ft


View of the Harmony Moab Khotsong Solar PV Facility
View from Unknown Viljoenskroon Road with the PV Facility located to the South of the road
Legend
Facility Section A
Facility Section B
Possible OHL
Google Earth
©2022 Google
10 ft

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 5), 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.

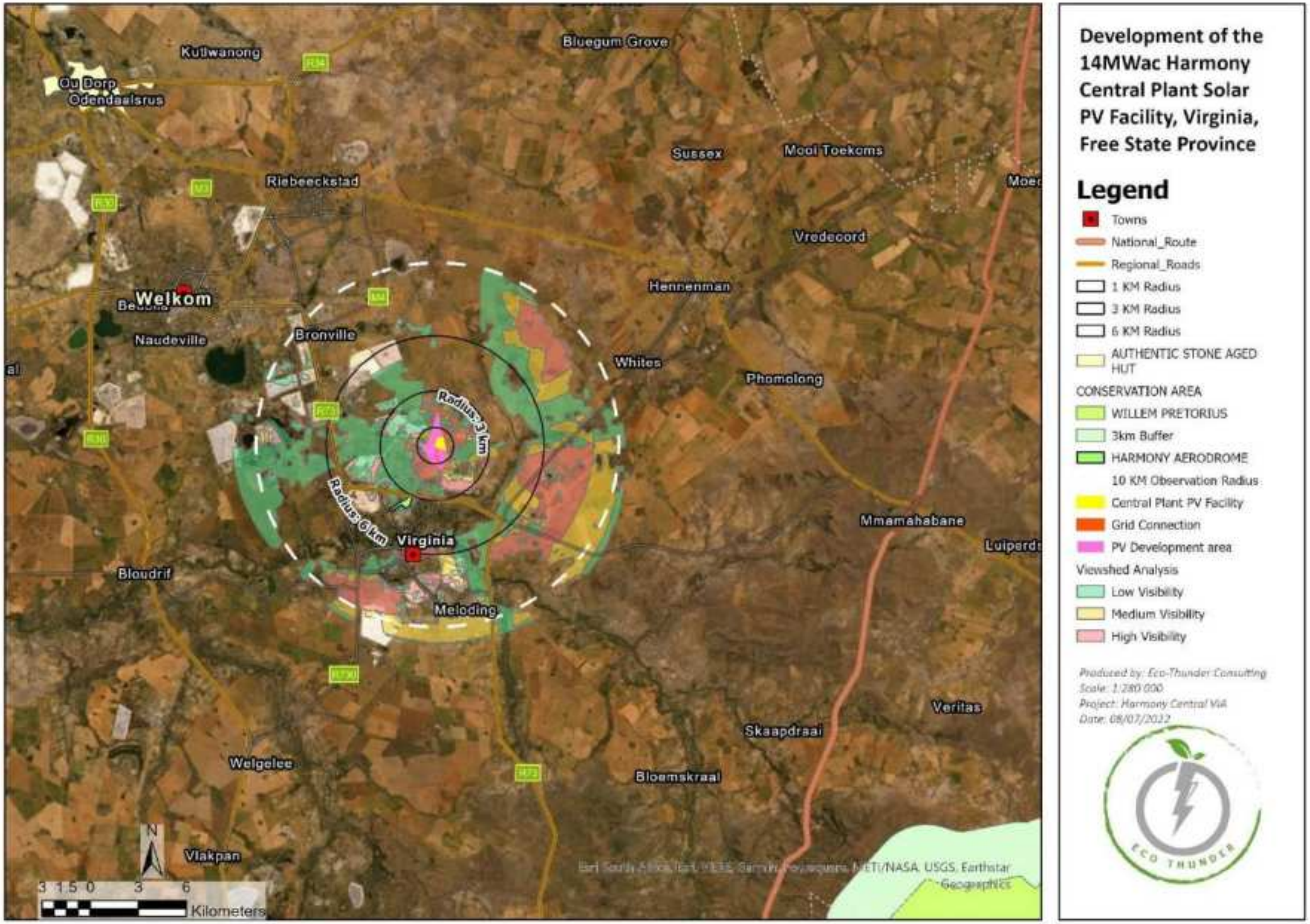


Figure 5: Viewshed analysis

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 2 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.

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

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[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.

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.

7.4.1. Construction Phase

Table 3: Construction of a PV Facility			
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.			
	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	Short (2)	Changes in the physical characteristics by changing the fabric and character of the landscape	**High (48)**
Extent	Very Short Distance (4)	Partial loss of features that contribute to the existing landscape by the introduction of new elements and structures	
Magnitude	Moderate (4)		
Probability	Highly probable (4)	If development is approved there is a high probability the landscape will be impacted	
Mitigation/Enhancement Measures			
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.			
Post Mitigation/Enhancement Measures			
Duration	Short (2)	Changes in the physical characteristics by changing the fabric and character of the landscape	**Low (30)**
Extent	Very Short Distance (4)	Partial loss of features that contribute to the existing landscape by the introduction of new elements and structures	

Magnitude	Low (4),		
Probability	Probable (3)	If development is approved there is a high probability the landscape will be impacted	
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.			
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 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)		
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	Local (4)	Development of the SEF will be visible for its entire lifespan	**Low (24)**
Extent	Long Term (4)	Only road users in the area will be subjected to the impact	
Magnitude	Low (4)		
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)		
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)		
Magnitude	Low (4)		
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 6: Glint and Glare
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.			
	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	Long term (4)	This will be a possible risk for the entire life cycle of the SEF	**Low (24)**
Extent	Very short distance (4)	This will only be a problem from short distances and at sustain times of day	
Magnitude	Low (4)		
Probability	Probable (4)	Reflection from sunlight, cars traveling on adjacent roads or night time elimination will trigger this risk	
Mitigation/Enhancement Measures			
Mitigation: N/A			
Post Mitigation/Enhancement Measures			
Duration	N/A		
Extent	N/A		
Magnitude	N/A		
Probability	N/A		
Cumulative Impacts: N/A			
Residual Risks: N/A			

Table 7: Visual Exposure			
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 R73, Boundary Road, and local roads generally servicing the farms, towns and mines throughout the study area. • The residential areas surrounding the Project sites.			
	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)		
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)		
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)		
Probability	Probable (3)	A significant probability for this to occur exists, which can be mitigated	
Mitigation/Enhancement Measures			
Mitigation:			
Post Mitigation/Enhancement Measures			
Duration	N/A		
Extent	N/A		
Magnitude	N/A		
Probability	N/A		
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)		
Probability	Improbable (2)	There is a small chance that this will impact visual receptors.	
Mitigation/Enhancement Measures			
Mitigation:			
Post Mitigation/Enhancement Measures			
Duration	N/A		
Extent	N/A		
Magnitude	N/A		
Probability	N/A		
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)		
Probability	Improbable (2)	There is a small chance that this will impact visual receptors.	
Mitigation/Enhancement Measures			
Mitigation:)			
Post Mitigation/Enhancement Measures			

Duration	N/A		
Extent	N/A		
Magnitude	N/A		
Probability	N/A		
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)).

Cumulative effect of the Project

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?	No, only 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 Moab Khotsong 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 of the proposed Project alone.

» The anticipated **visual** impact is not considered to be a fatal flaw from a visual perspective, considering the low incidence of visual receptors occurring within the region.

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 Moab Khotsong PV Facility 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 **modarate**) 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 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 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 into 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 Harmony Moab Khotsong 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 Harmony Moab Khotsong 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 Harmony Moab Khotsong 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 Moab Khotsong PV Facility 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

MOAB KHOTSONG
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 Moab Khotsong

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
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GDP	Gross Domestic Product
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I&AP	Interested and Affected Party

EXECUTIVE SUMMARY

DESCRIPTION OF PROPOSED PHOTOVOLTAIC FACILITY

Harmony Moab Khotsong Operations (Pty) Ltd 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 development of a solar photovoltaic (PV) facility with a generating capacity of up to 100MW is proposed north of the Harmony Gold Moab operations, approximately ~10km north of the town of Vierfontein within the Moqhaka Local Municipality, Fezile Dabi District Municipality, Free State Province. The solar PV development will be known as Harmony Moab Khotsong Solar PV Facility.

The PV development area includes twelve (12) farm portions, all owned by the Mine. These include:

- Farm Anglo 593;
- Farm Hoekplaats 598;
- Farm Mispah 274;
- Remaining Extent of Farm Pretorius Kraal 53;
- Remaining Extent of Farm Doornkom Wes 446;
- Farm Chrystalkop 69; and
- Portions 1, 2, 3, 4, 5, and the Remaining Extent of the Farm Zuiping 394.

The generation is intended for own-use by the Mine, reducing the Mine's reliance on Eskom. The preferred site for the project is on properties which are owned by the Mine and are available for the proposed project and is therefore deemed technically feasible for such development to take place.

A project site considered to be technically suitable for the development of the solar PV facility, with an extent of approximately 1400ha, was identified. A development area of ~900ha was demarcated within this project site and allows an adequate footprint for the installation of a solar PV facility with a contracted capacity of up to 100MW, while allowing for the avoidance of environmental site sensitivities.

The full extent of the project site is to be evaluated in the Basic Assessment process to identify environmental sensitivities. Site-specific studies and assessments will be undertaken through the BA process in order to delineate areas of potential sensitivity within the identified study area and grid connection corridor/s. Once constraining factors have been determined, the layout of the solar PV facilities and the grid connection solution can be planned to minimise social and environmental impacts.

The infrastructure associated with the 100MW solar PV facility will include:

- PV modules and mounting structures
- Access roads, internal roads and fencing around the development area
- Temporary and permanent laydown areas
- Administrative building, control room, workshop, storage building, guard house, auxiliary buildings and structures, water supply infrastructure, weather station
- Peripheral boundary wall & fencing
- Inverters, transformers and up to 5 on-site facility substations and switching substations
- Cabling between the project components, to be laid underground where practical
- Grid connection infrastructure to be connected to the existing:
  - Vaalreefs Eleven Substation via a ~2km power line (located south-east of the facility);
  - Southvaal Plant Substation via a ~0.5km power line (located north-west of the facility); and
  - Southvaal Substation via a ~4km power line (located north of the facility).

The site is accessible via the R76 south of the project site.

As of 2019, the Industrial sector was the leading electricity consumer in South Africa, with up to 56% of the total consumption (Ratshomo 2019). Mining and quarrying accounted for 10% of the industrial consumption (Chamber of Mines of South Africa, 2017). The successful development of the renewable energy project will enable Harmony Gold to make a valuable and meaningful contribution towards growing the green economy within the Free State Province and South Africa. This will assist the Free State in creating green jobs and reducing Green House Gas emissions, while reducing the energy demand on the Eskom national grid.

APPROACH TO THE STUDY

The development of renewable energy is strongly supported at a national, provincial, and local level. The development of and investment in renewable energy is supported by the National Development Plan (NDP), New Growth Path Framework and National Infrastructure Plan, which all refer to and support renewable energy. The Free State Province Renewable Energy Strategy also supports the development of renewable energy. The development of the proposed PV SEF is therefore supported by key policy and planning documents

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)
- Fezile Dabi District Municipality Integrated Development Plan 2022
- Matjabeng Local Municipality Integrated Development Plan 2022/2021

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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 Moab Khotsong 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 Moab Khotsong 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 Moab Khotsong 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:

- Identified 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 Moab Khotsong Operations (Pty) Ltd is looking to supplement its energy supply by implementing Photovoltaic (PV) generation, aiding their transition to a more sustainable and environmentally friendly energy mix.

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1.5. Project Location

The proposed 100MW Moab Khotsong Solar Energy Facility (SEF) is located on Farm Anglo 593, portion 593; Farm Hoekplaats 598, portion 598; Mispah 274, portion 274; Zaaiplaats 1/190, portion 1/190; Doornkom Wes 446, RE of portion 446; Chrystalkop 69, portion 69; and Zuiping 394, remaining extent of portion 394, portion 1/394, 3/394, 4/394 and 5/394 . The development is located near Harmony Moab mining operations approximately ~10km north of the town of Vierfontein within the Moqhaka Local Municipality, and within the Fezile Dabi District Municipality, Free State Province.

The proposed development is located in the Free State Province in the central interior of South-Africa. The town of Viljoenskroon is located approximately 32km southeast and Orkney is located approximately 6.5km northwest of the proposed development (it has to be noted that Viljoenskroon is a small mining town). The project entails the generation of up to 100MW electrical power through the operation of photovoltaic (PV) panels. The total development footprint of the project will approximately be 450 hectares (including supporting infrastructure on site).

The farms are located in a grain farming agricultural region, but on soils of limited depth that are unsuitable for crop production. There is almost no cultivation on the land type on which the site is located. Maize production occurs on different, suitable soils of a different land type to the south of the site. The development site is used only for grazing of cattle. Mining occurs in the surrounding area.

The climate is strongly seasonal and semibelow. arid, with an average rainfall volume of 565 mm/annum, falling between October and May. The summers are hot and wet, with summer temperatures ranging typically between 1430°C. The winters are cold and dry, wintertime temperatures ranging typically between with 1 to 19°C. An average of 34 frost days occur each winter. The soils are perpetually moisture stressed, with mean annual evaporation of 2,407 mm, resulting in 78% of days where the soils lose more mois ture than they receive from precipitation.

The proposed development is located in close proximity to the Vaal River. Most of the site is located within the Vaal River Mining Area, a degraded grassland transformed by mining. The preferred site is located at an above mean sea level (amsl) of approximately 1308m at the highest elevation and at an amsl of 1296m at the lowest elevation.
The observers in a 5km radius include:

- Eskom power line infrastructure.
- Vaal Reefs Eleven Substation.
- Harmony Moab Mine.
- Tailings dams.
- Water Processing Plant.
- Other mining operations.
- Various homesteads on farms and smallholdings
- R502 road
- Vermaasdrift road
- Stokkiesdraai road
- Vaal River.
- Wawielpark Holiday Resort.

The main visual receptors in the area are industrial developments, the mining sector and to agricultural developments.
preferred route. The nearest towns in relation to the proposed development site are Orkney, Klerksdorp, Stilfontein, Viljoenskroon and Potchefstroom. It is envisaged that most materials, water, plant, services and people will be procured within a 50 km radius of the proposed facility.

The Moqhaka Local Municipality incorporates Kroonstad, Renovaal, Steynsrus, Vierfontein and Viljoenskroon with a combined population of 160 532 people. The general tendency of migration from rural to urban areas is also occurring in the area, as is the case in the rest of the Free State Province. In comparison to the other municipalities within the Fezile Dabi District, it appears as if Moqhaka is significantly less urbanised. The main economic sectors in the municipality are agriculture, commercial transport, business services and mining.

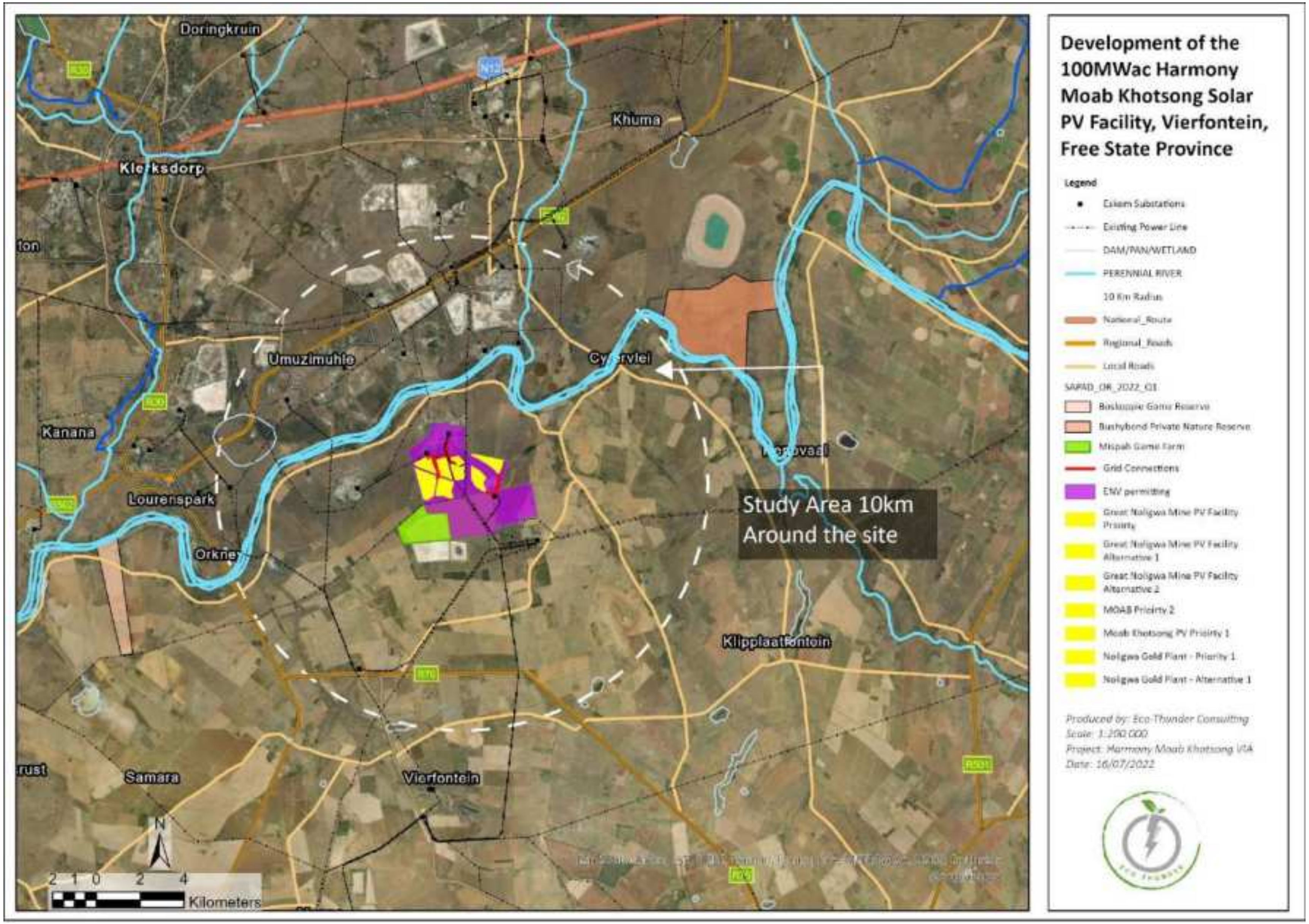

Figure 2: The proposed site and 10km radius of the Harmony Moab Khotsong PV Facility

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. Annexure A contains a list of the secondary information reviewed. Annexure B summarizes the assessment methodology used to assign significance ratings to the assessment

process.
- 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

"The consequences to human populations of any public or private actions (including policies, programs, plans, and/or projects) that alter the ways in which people live, work, play, relate to one another, organize to meet their needs, and generally live and cope as members of society." These effects are felt at various levels, including the individual, family or household, community, organization, or society. Some social impacts are physically felt by the body, whereas others are perceptual or emotional" (Vanclay, 2002).

When considering social impacts, keep in mind that social change is a natural and ongoing process (Burdge, 1995). However, it is also critical to recognize and comprehend the fact that policies, plans, programs, and/or projects implemented by government agencies and/or private institutions have the potential to influence and alter both the rate and direction of social change. Many social impacts are not "impacts" in and of themselves, but rather change processes that may result in social impacts (Vanclay, 2002). The influx of temporary construction workers, for example, has no social impact in and of itself. However, their presence can have a variety of social consequences, such as an increase in antisocial behavior. Vanclay's approach emphasizes the importance of understanding the processes that can have social consequences. As a result, social assessment specialists must think through the complex causal mechanisms that produce social impacts. The full range of impacts can be identified by following impact pathways, or causal chains, and specifically by considering interactions that are likely to occur (Vanclay, 2002).

An SIA should thus enable authorities, project proponents, individuals, communities, and organizations to understand and anticipate the potential social consequences of implementing a proposed policy, program, plan, or project. The SIA process should inform communities and individuals about the proposed project and its potential social consequences, while also 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, allowing them to anticipate and predict these impacts ahead of time, so that the assessment's findings and recommendations 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:
- Fezile Dabi District Municipality Integrated Development Plan (IDP) 2020/2021
- Moqhaka 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 17.8 GW to renewables by 2030. The 2013 version stipulates that 2.2 GW 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 20 GW 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 development of the agricultural 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 development of the agricultural 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 agricultural 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 development of the agricultural 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. Fezile Dabi District Municipality Integrated Development Plan (IDP) 2020/2021

The municipality will consider and structure its Performance Management System and Performance Management Plans at both organisational and departmental levels around the following 5 Key Performance Areas for local government as determined by the Municipal Performance Regulations for Municipal Managers and Manager Directly Accountable to the Municipal Manager, 2006:

- KPA1: Municipal Transformation and Institutional Development;
- KPA2: Financial Viability and Financial Management;
- KPA3: Basic Service Delivery and Infrastructure Investment;
- KPA4: Local Economic Development and
- KPA5: Good Governance and Community Participation

To this effect, this IDP is compatible with the IDPs of local municipalities within the district, the provincial and national development plans and planning requirements binding on the municipality in terms of legislation, and to this effect, and it takes que from the National Development Plan (NDP) and the Free State Growth and Development Strategy (FSGDS), and to the extent possible, aims to achieve the goals set out therein through an application of the following priorities:

- Uniting all the people of Fezile Dabi District Municipality around a common programme to achieve prosperity and equity.
- Promoting active citizenry to strengthen development, democracy and accountability within the municipality.
- Creating an enabling environment to bringing about faster local economic growth, higher investment and greater labour absorption.
- Focusing on key capabilities of local people and the municipality.
- Building a capable and developmental institution/municipality.
- Encouraging strong leadership throughout our community to work together to solve problems.

Through the provincial IDP assessments, we continue to grow in our understanding and that an Integrated Development Plan must simultaneously comply with relevant legislations and convey the following:

- Compliance and adherence to constitutional and policy mandate for developmental local government;
- Awareness by municipality of its role and place in the regional, provincial and national context and economy;
- Awareness by municipality of its own intrinsic characteristics and criteria for success;
- Comprehensive description of the area – the environment and its spatial characteristics including backlogs;
- A clear strategy, based on local developmental needs and that the IDP must not be a 'wish-list' but subjected to the realities of what can be delivered by the budget over the three to five year horizons;
- Insights into the trade-offs and commitments that are being made such as economic choices, integrated service delivery, etc.;
- The key deliverables for the next 5 years;
- Clear measurable budget and implementation plans aligned to the SDBIP;
- Performance Management Systems and mechanisms required for performance planning, monitoring and evaluation;
- Continuously measuring the capacity of municipality to deliver;
- Communication, participatory and decision-making mechanisms;
- The degree of intergovernmental action and alignment to government wide priorities;
- Reporting timeframes and the regulatory periods for reporting;
- Alignment with, and indication of, an aligned organogram; and
- Alignment between the SDBIP and the performance contracts of section 57 managers.

3.3.2. Moqhaka 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: Basic Service Delivery
- KPA 2: Good Governance and Public Participation
- KPA 3: Local Economic Development
- KPA 4: Municipal Transformation and Institutional Development
- KPA 5: Social and Community Development

The Moqhaka 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 Moab Khotsong Solar PV Facility will be located on Farm Anglo 593, portion 593; Farm Hoekplaats 598, portion 598; Mispah 274, portion 274; Zaaiplaats 1/190, portion 1/190; Doornkom Wes 446, RE of portion 446; Chrystalkop 69, portion 69; and Zuiping 394, remaining extent of portion 394, portion 1/394, 3/394, 4/394 and 5/394. The development is located near Harmony Moab mining operations approximately ~10km north of the town of Vierfontein within the Moqhaka Local Municipality, and within the Fezile Dabi District Municipality, Free State Province.

This chapter provides an overview of the socio-economic environment of the province, DM, and LM within which the Harmony Moab Khotsong Solar PV Facility is proposed and provides the socio-economic basis against which potential issues can be identified.

Free State Province is the landlocked core of the country. It is centrally placed, with good transport corridors to the north and the coast. It is the third biggest of South Africa's nine provinces in terms o f size, and primary agriculture is a key economic sector. Mining is also important but has been declining steadily since 2008. Although the Free State is the third largest province in South Africa, it has the second smallest population and the second lowest of 129 825km² and has a population of 2 834 714 t population density. It covers an area 5.1% of the national population. Languages spoken include Sesotho (64.4%), Afrikaans (11.9%) and Zulu (9.1%). The Free State Province contributes 5.4% to South Africa 's total gross domestic product (2006).

Agriculture is a key economic sector 8% of the country's produce comes from Free State. In 2010, agriculture provided 19.2% of all formal employment opportunities in the region. The economy is dominated by agricult ure, mining and manufacturing. Known as the 'breadbasket' of South Africa, about 90% of the province is under cultivation for crop production. It produces approximately 34% of the total maize production of South Africa, 37% of wheat, 53% of sorghum, 33% o f potatoes, 18% of red meat, 30% of groundnuts and 15% of wool. The province is the world's fifthlargest gold producer, with mining the major employer.

The Fezile Dabi District Municipality is a Category C municipality, formerly known as the Northern Fre e State District Municipality, situated in the north of the Free State. It is bordered by the North West, Gauteng and Mpumalanga Provinces to the north, Thabo Mofutsanyana District to the south, and Lejweleputswa District to the west. In 2011 the Municipa lity had a population of 488 036 with an unemployment rate of 33.9% and a youth unemployment rate of 44.4%. By 2016 only 48.3% of dwellings had piped water inside their dwellings and 7.7% of household still did not have electricity in their dwellings.

The Moqhaka Local Municipality is a Category B municipality situated within the southern part of the Fezile Dabi District in the Free State Province. It is the largest of four municipalities in the district, making up over a third of its geographical area and covering an area of 7 925m . The former Kroonstad, Steynsrus and Viljoenskroon Transitional Local Councils and sections of the Riemland, Kroonkop and Koepel Transitional Rural Councils are included in the municipality. The general tendency of migration fro 2 m rural to urban areas is also occurring in the area, as is the case in the rest of the Free State Province. In comparison to the other municipalities within the Fezile Dabi District, it appears as if Moqhaka is significantly less urbanised.

The population dwindled from 2011 at 160 532 to 154 732 in 2016. In 2011 the unemployment rate stood at 35.2% and the youth unemployment rate at 47.2%. In 2016 89.7% of households had flush toilets connected to sewerage and 96.3% of households had electricity for lighti ng in their dwellings. The main economic sectors in the municipality are a griculture, commercial transport, business services and mining. In the Moqhaka LM there are 55 594 economically active (employed or unemployed but looking for work) people, and of th ese 35,2% are unemployed. Of the 27 349 economically active youth (1534 years) in the area, 47,2% are unemployed. The creation of employment opportunities within the formal sector as a result of the development of therefore contribute to Thakadu SPP could wards growing employment within the formal sector in both the LM and DM, which could lead to greater levels of job security than may typically be associated with employment in the informal sector

As part of the identification of the Key social issues the Harmony Moab Khatsong and the Harmony Great Noligwa Social Labour Plans were evaluated and, where applicable incorporated into the findings of this report.

The Moab Khotsong Operations consist of the Greater Noligwa Mine, Moab Khotsong Mine, Noligwa Gold Plant, South Uranium Plant and Mispah 1 and 2 and Kopanang paydam tailings storage facilities (TSFs). The Operations are located at the boundary between the North-West and the Free State provinces. The northern portion of the mine lease area falls within the City of Matlosana Local Municipality and the jurisdiction of Southern District Municipality in the North West province. The southern portion of the operations falls within the Moqhaka Local Municipality, and under the Jurisdiction of District Municipality of Fezile Dabi in the Free State Province.

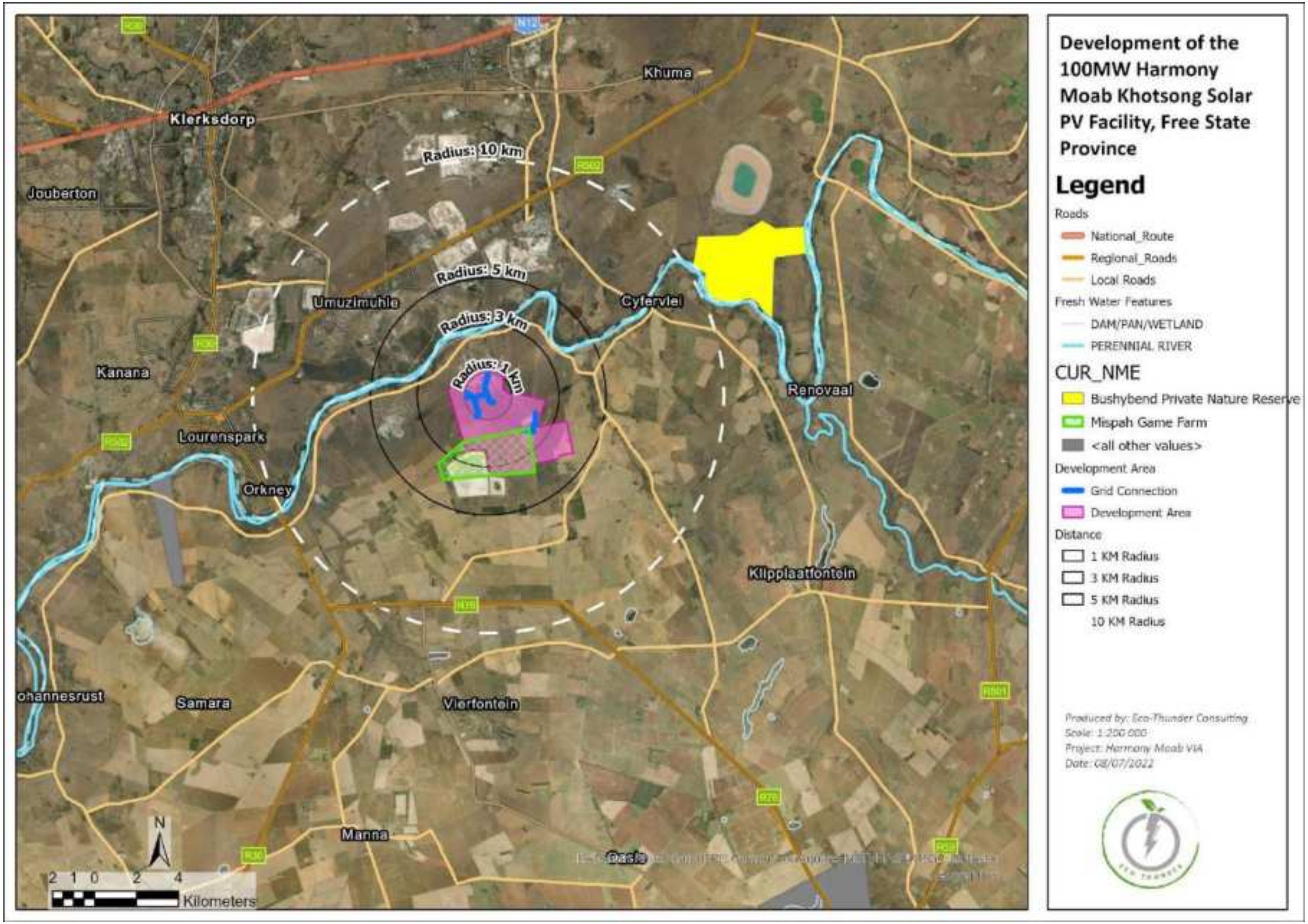

Figure 3A: Location of the site within the main study area, within the Free State Province

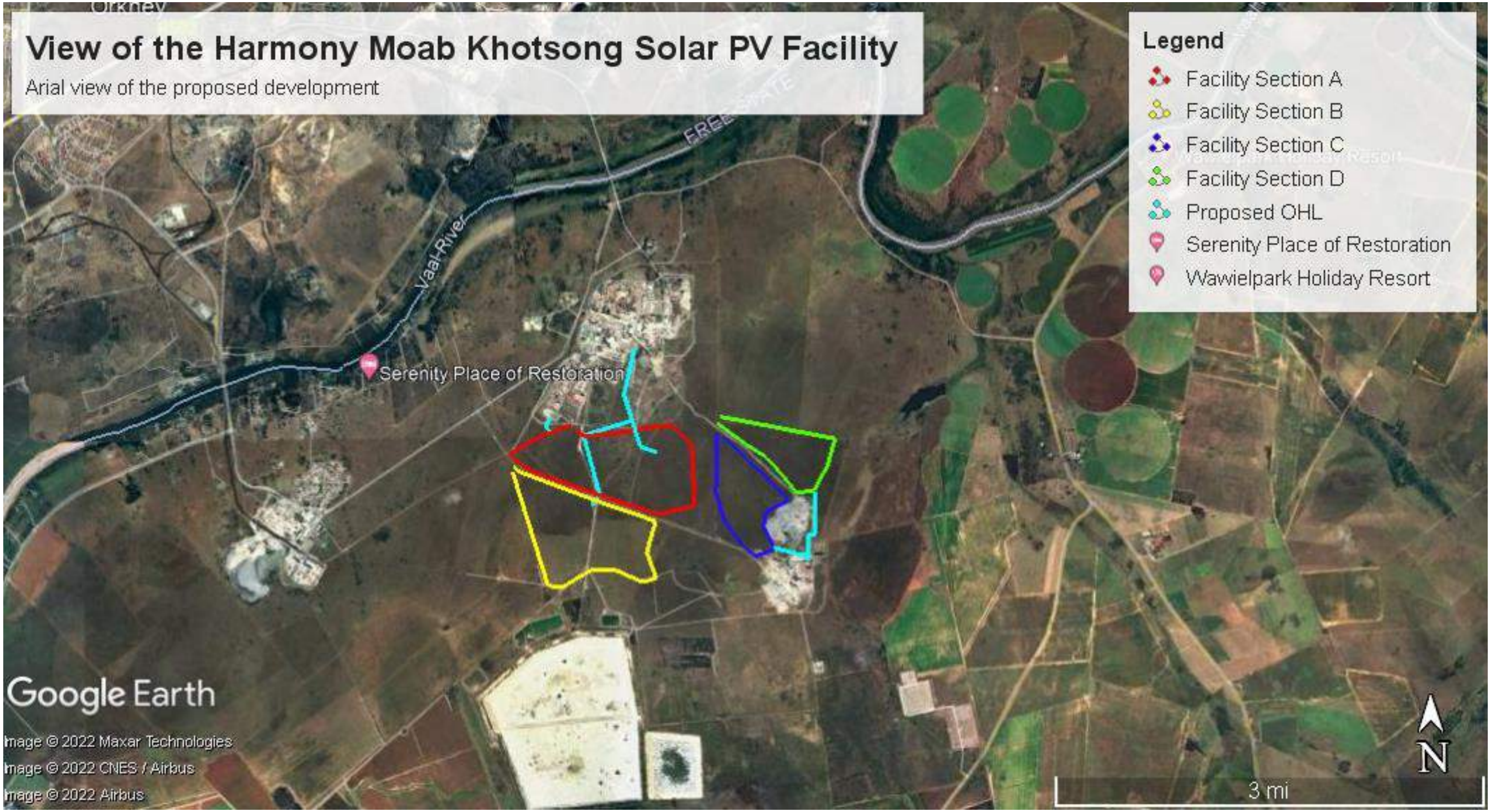

Figure 3B: Location of the site within the main study area, within the Free State Province

4.2. Administrative Context of Study Area

The Harmony Moab Khotsong Solar Energy Facility (SEF) is located within the Moqhaka Local Municipality (MLM), which is one of four local municipalities that make up the Fezile Dabi District Municipality (FDDM) in the Free State Province. The town of Sasolburg is the administrative seat for the FDDM and Kroonstad is the administrative seat for MLM.

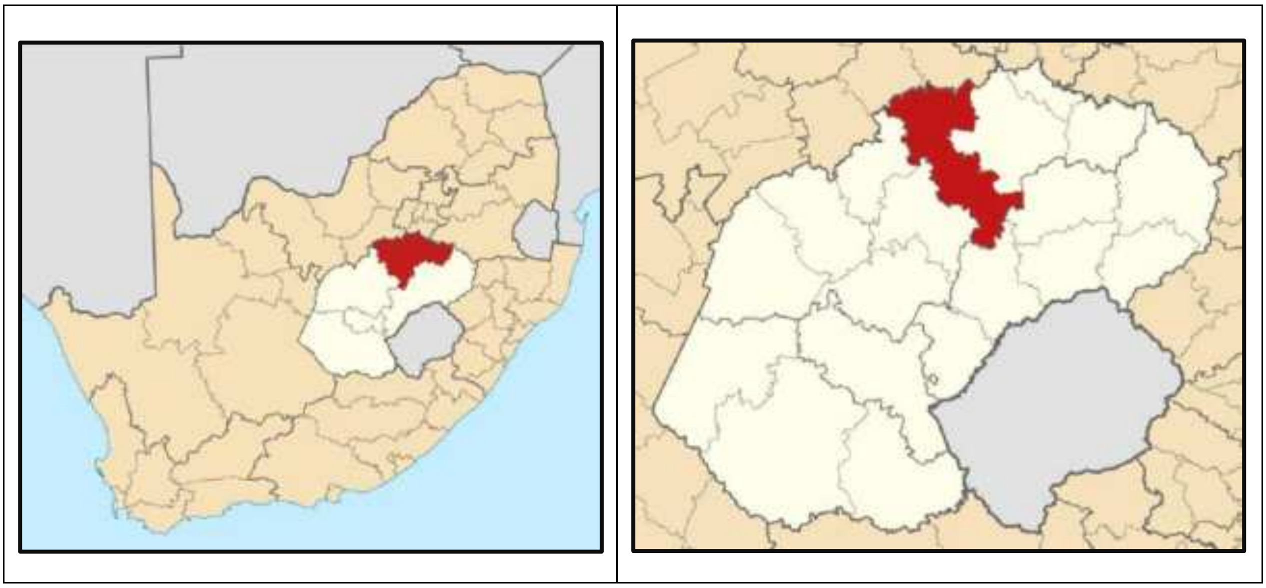

Figure 4: Location of Fezile Dabi District Municipality (left) and Moqhaka Local Municipality (right) within the Free State Province

Table 1: Spatial Context of the study area for the development of the Harmony Moab Khotsong Solar PV

Province	Free State Province
District Municipality	Fezile Dabi District Municipality
Local Municipality	Moqhaka Local Municipality
Ward number(s)	8
Nearest town(s)	~10km north of the town of Vierfontein
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 Vierfontein, Free State)

4.3. Provincial Socio-Economic Context

The proposed Solar Energy Facility 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, Lejweleputwa, Thabo Mofutsanyana and Xhariep (refer to Figure 5).

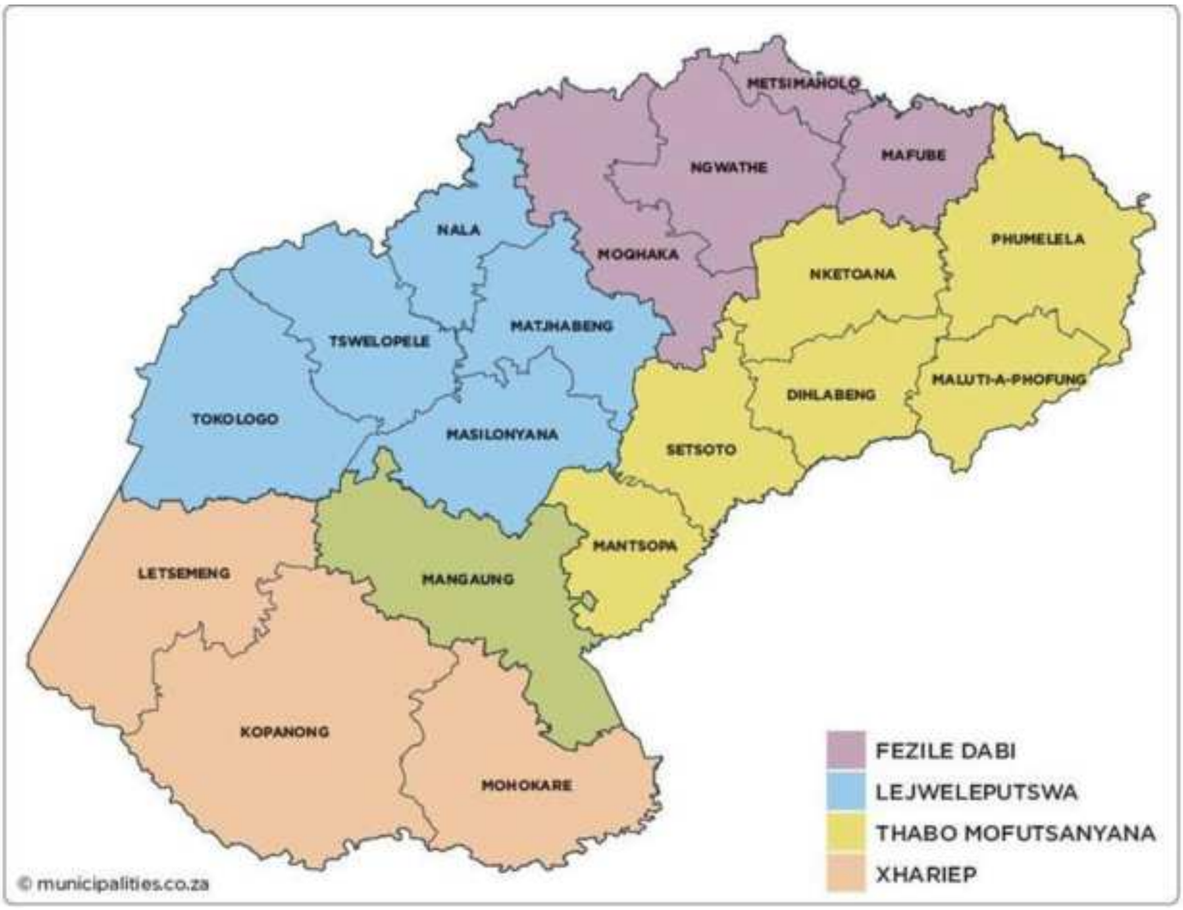

Figure 5: Map showing the districts of the Free State Province (Source: www.municipalities.co.za).

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% in 2011 to 5.1% 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% 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

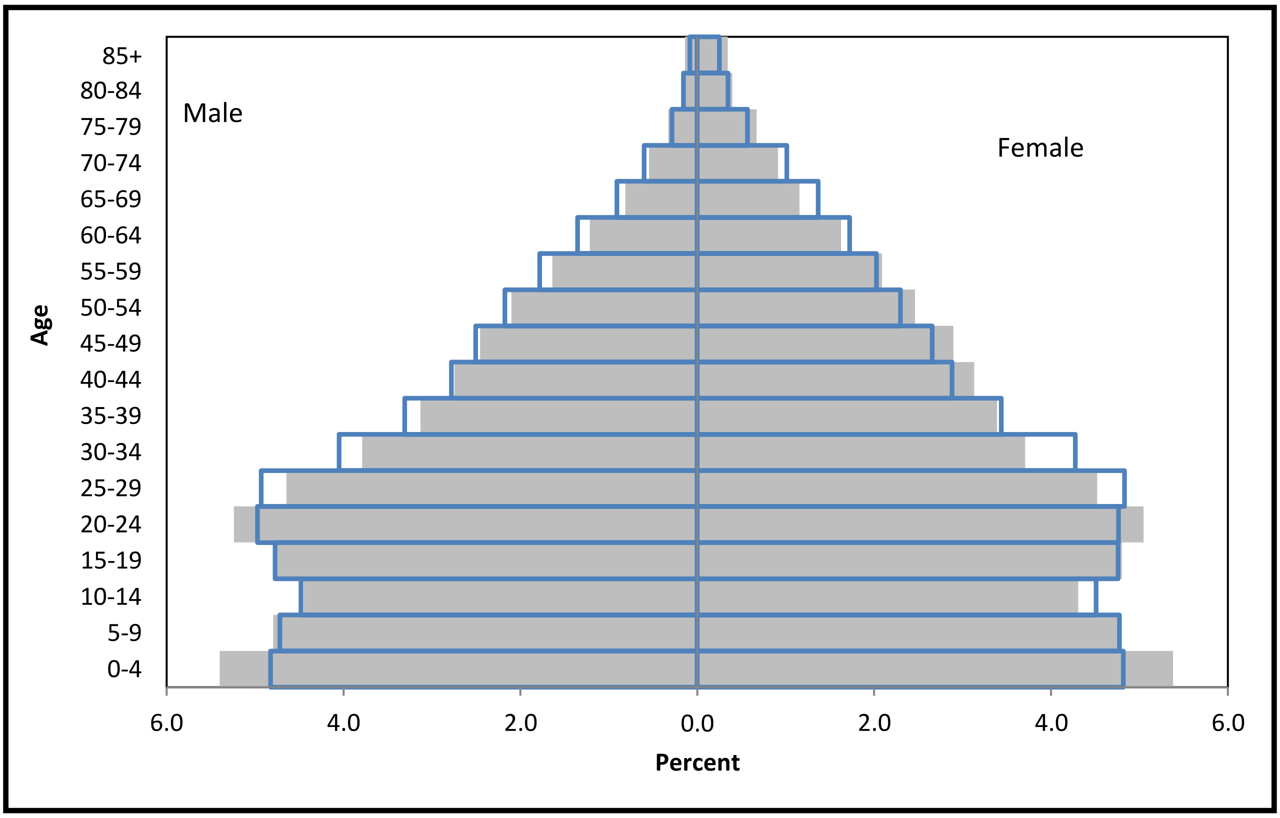

Figure 6: Population pyramid of the study area

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.

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.

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%

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.

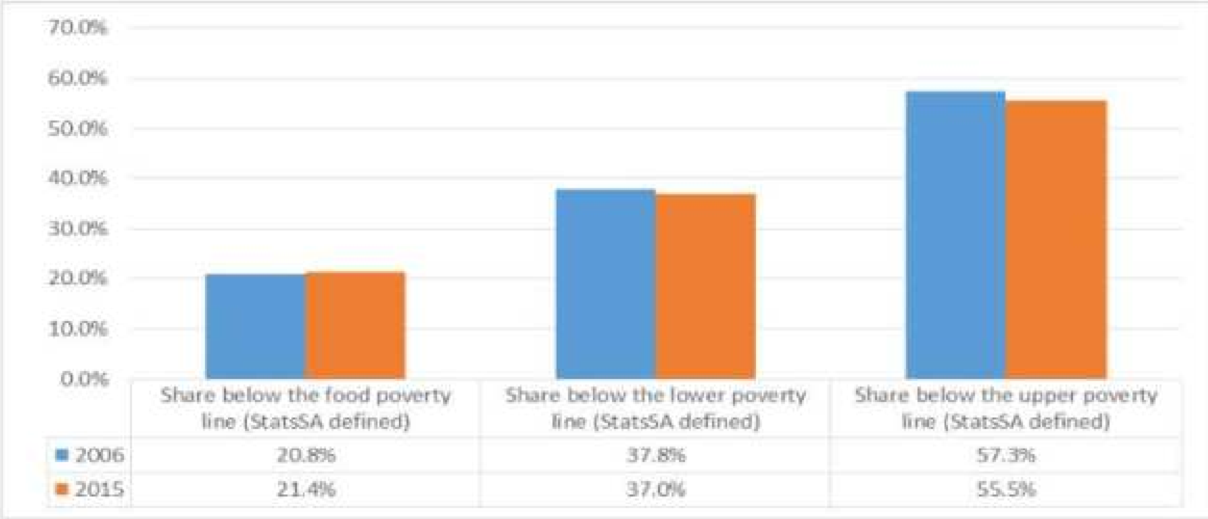

Figure 7: Poverty Within the District Municipality

4.4. Fezile Dabi District Municipality

Fezile Dabi District Municipality (FDDM) is situated at the northern part of the Free State Province and borders both Thabo Mofutsanyane and Lejweleputswa District Municipalities. FDDM also shares borders with 3 national provinces; Gauteng, Mpumalanga and the North West. The Vaal River and the Vaal dam form the northern boundary of FDDM and also serve as the boundary between the Free State and Gauteng Provinces. FDDM is the second smallest of the four District Municipalities, covering 16.4% of the provincial area and is made up of four Local Municipalities namely; Moqhaka, Metsimaholo, Ngwathe and Mafube (Figure 8). The district municipality has a total of 38 settlements, encompassing 4 farming settlements, 15 formal towns, 17 former urban townships and 2 urban informal settlements.

The main economic sectors in the area are trade, community services, manufacturing, households, and agriculture. The main attraction in the district is the Vredefort Dome, which is the third largest meteorite site in the world. The district consists of four local municipalities, namely Mafube, Metsimaholo, Moqhaka and Ngwathe

The community service sector mostly prevalent in Moqhaka Local Municipality, is the second highest GDP contributor in the district as well as in Ngwathe Local Municipality and is the second most prevalent sector in FDDM. Another active economic sector in district municipality include, agriculture, both livestock farming and horticulture.

Mining is also an economic contributor in FDDM as extensive areas have rich underground coal deposits and there are other smaller deposits for various other minerals. Most of the national headquarters of industries are based in FDDM. The district is serviced by a strategically important road network, both national and Provincial roads which include the N1, R59, N3 and N17. The road network is supported by a rail system. This makes the district accessible to all major urban centres in South Africa.

Figure 8: Local Municipalities of Fezile Dabi District Municipality Source: (Local Government Handbook, 2015)

4.4.1. Population

The Fezile Dabi District Municipality has a population of 527 788 in 2019 and accounts for a total population of (18.3%) of the total population in the Free State Province. When looking at the average annual growth rate, it is noted that Fezile Dabi ranked second (relative to its peers in terms of growth) with an average annual growth rate of 0.8% between 2009 and 2019. Based on the present age-gender structure and the present fertility, mortality and migration rates, Fezile Dabi's population is projected to grow at an average annual rate of 0.6% from 527 788 in 2019 to 545 000 in 2024.

The population projection of Fezile Dabi District Municipality shows an estimated average annual growth rate of 0.6% between 2019 and 2024. The average annual growth rate in the population over the forecasted period for Free State Province and South Africa is 0.5% and 1.3% respectively. The Free State Province is estimated to have average growth rate of 0.5% which is lower than the Fezile Dabi District Municipality. South Africa as a whole is estimated to have an average annual growth rate of 1.3% which is higher than that of Fezile Dabi's growth rate

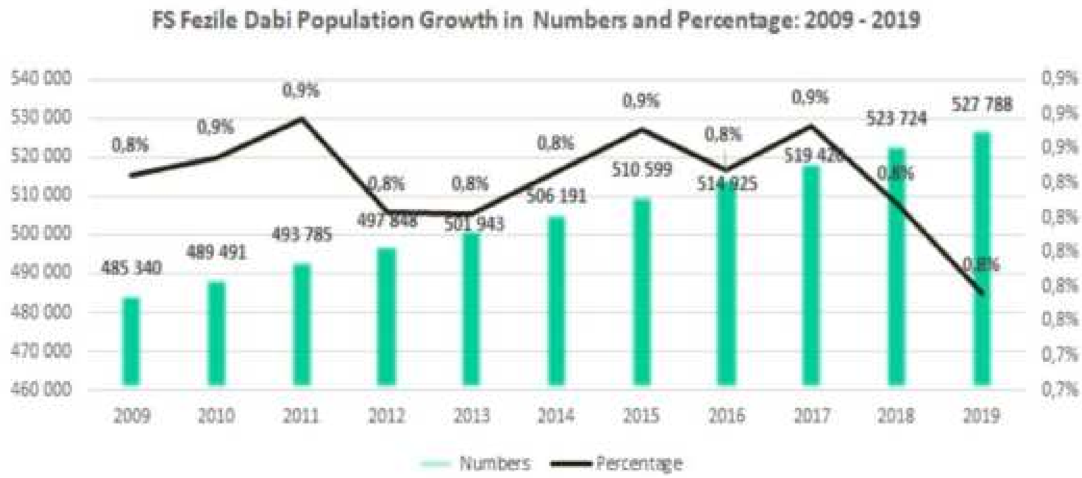

Figure 9: Predicted population growth 2009 -2019

4.4.2. Economy

In 2019, the manufacturing sector is the largest within Fezile Dabi District Municipality accounting for R 14 billion or 27.0% of the total GVA in the district municipality's economy. The sector that contributes the second most to the GVA of the Fezile Dabi District Municipality is the mining sector at 18.2%, followed by the community services sector with 13.1%. The sector that contributes the least to the economy of Fezile Dabi District Municipality is the construction sector with a contribution of R 1.14 billion or 2.20% of the total GVA.

The community sector, which includes the government services, is generally a large contributor towards GVA in smaller and more rural local municipalities. When looking at the regions within the district municipality, the Metsimaholo Local Municipality made the largest contribution to the community services sector at 40.09% of the district municipality. The Metsimaholo Local Municipality contributed R 34.6 billion or 66.47% to the GVA of the Fezile Dabi District Municipality, making it the largest contributor to the overall GVA of the Fezile Dabi District Municipality. This is due to the large petrochemical hub in Sasolburg and the related economic activities.

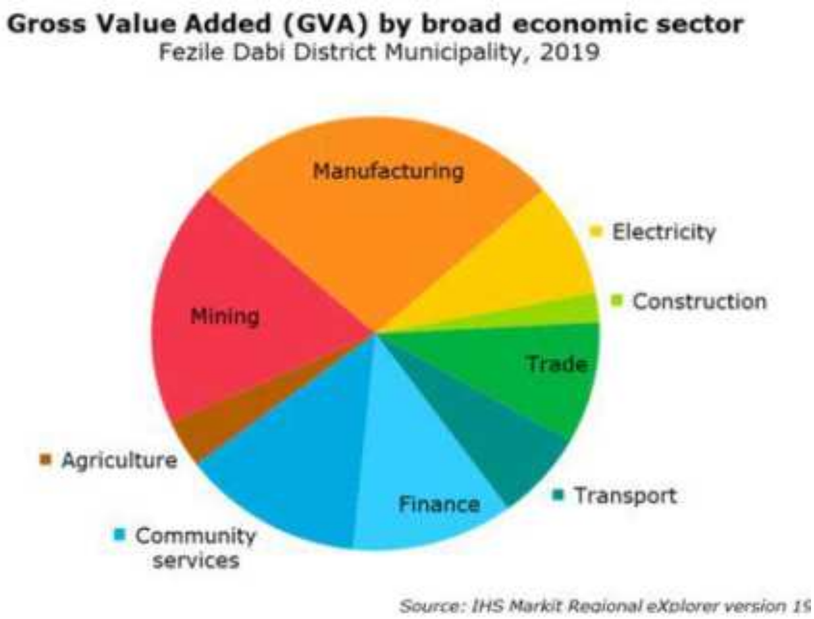

Figure 10: District municipality Economic Sector

Primary Sector

The primary sector consists of two broad economic sectors namely the mining and the agricultural sector. Both the agriculture and mining sectors are generally characterised by volatility in growth over the period. The Primary sector is expected to grow at an average annual rate of -5.04% between 2019 and 2024, with the Secondary sector growing at -0.80% on average annually. The Tertiary sector is expected to grow at an average annual rate of -0.33% for the same period.

<u>Agriculture</u>

Fezile Dabi district municipality has a strong agriculture base and is known as the grain/maize basket for South Africa. The district has a total of 327 592ha (15, 4% of all agricultural land in the province) of high potential agricultural land and 59% of agricultural land has low potential. The Integrated Development Plan (IDP, 2017/18) notes that land needs to be optimally used for agriculture and food production. Cattle and sheep farming provide opportunities for the processing of meat, wool and dairy products. Maize, sunflower seed, sorghum and wheat are cultivated in the district. There is a need for more agro-processing initiatives to boost agriculture in the district. A lack of funding for agricultural projects (Koppies Green House Vegetable production Project) has been identified (IDP, 2017/18). National Department of Agriculture has conceptualised Agri- Parks, & Ngwathe LM has been identified as one of the areas where Agri- Parks will be established (IDP, 2017/18).

<u>Mining</u>

Fezile Dabi district has location advantages in sectors such as agriculture, mining, manufacturing and electricity provision. In terms of mining, there are extensive areas with rich underground coal deposits. Large quantities are mined in the Sasolburg district by means of conventional and strip mining methods. The rare clay, Bentonite, is mined in the vicinity of Koppies. The re-exploitation of the Lacemyn diamond mine in the vicinity of Kroonstad is currently taking place and gold is mined at the Vaal Reefs Mine, part of the Witwatersrand gold reef, in the Viljoenskroon area (IDP, 2017/18).

4.4.3. Employment

In terms of the percentage of people living in poverty for each of the regions within the Fezile Dabi District Municipality, Mafube Local Municipality has the highest percentage of people living in poverty, using the upper poverty line definition, with a total of 67.5%. The lowest percentage of people living in poverty can be observed in the Metsimaholo Local Municipality with a total of 49.8% living in poverty, using the upper poverty line definition.

In 2019, the Gini coefficient in Fezile Dabi District Municipality was at 0.618, which reflects an increase in the number over the ten-year period from 2009 to 2019. The average annual income is R30 000 which is the same as the South Africa and Free State average. 62% of the households earn less than R40 000 per annum and 8% have no income.

The working age population in Fezile Dabi in 2019 was 343 000, increasing at an average annual rate of 0.69% since 2009. For the same period the working age population for Free State Province increased at 0.39% annually, while that of South Africa increased at 1.62% annually. The graph below combines all the facets of the labour force in the Fezile Dabi District Municipality into one compact view. The chart is divided into "place of residence" on the left, which is measured from the population side, and "place of work" on the right, which is measured from the business side.

Out of the economically active population, there are 72 600 (33%) unemployed people. Most of the formal employment lies in the Tertiary industry, with 54 600 jobs. Formal jobs make up 62.7% of all jobs in the Fezile Dabi District Municipality. The difference between the employment measured at the place of work, and the people employed living in the area can be explained by the net commuters that work outside of the district municipality.

4.4.4. Education

In 2019, the school pass rate in the Fezile Dabi District was 90.3%, the highest pass rate in the Free State province. According to the Community Survey, 2016, 94.8% or 109 806 of school-aged children between 5 and 17 years are in schools in the district which is about the same rate as in the Free State Province (95.96%) and in South Africa (94.9%). At a district wide level, 20.6% of the population have secondary education, whilst persons with tertiary education makes up only 1.3% of the district population.

4.5. Moqhaka Local Municipality

Moqhaka Local Municipality derives it name from the Afrikaans name ‘kroon’ which means crown a commonality in the names of the amalgamated municipalities in the area. Moqhaka is SeSotho for crown. It is not only kings who wear crowns, but winners are rewarded with them. Traditionally, the royal homestead is centrally situated. The new municipality is centrally situated in the province and the country as a whole

The municipality is situated within the southern part of the Fezile Dabi District in the Free State Province. At 7 925 km² it is the largest of four municipalities in the district, making up over a third of its geographical area. The former Kroonstad, Steynsrus and Viljoenskroon Transitional Local Councils and sections of the Riemland, Kroonkop and Koepel Transitional Rural Councils are included in the municipality. The seat of local government is Kroonstad.

The general tendency of migration from rural to urban areas is also occurring in the area, as is the case in the rest of the Free State Province. In comparison to the other municipalities within the Fezile Dabi District, it appears as if Moqhaka is significantly less urbanised. The Greater Kroonstad area is the centre of a large agricultural community that plays an important role in the economy of the district. Subsequently, industrial activities contribute significantly to the district’s economy. The Department of Correctional Services and the School of Engineers military bases are situated in the town. Kroonstad has recently become a distinguished holiday destination due to the ultra-modern and popular holiday resort of Kroonpark, adjacent to the Vaal River.

The urban area is situated adjacent to the N1 National Road, and located adjacent to one of the largest and most important four-way railway junctions in South Africa. The Viljoenskroon/Rammulotsi urban area is located within an area of extreme agricultural significance. The urban area plays a significant role in providing residential opportunities to the adjacent goldfields and mining activities in the North West province. The Provincial Roads P15/1 and P15/2 from Kroonstad to Klerksdorp in the North West province extend through the area from north to south. The Steynsrus/Matlwangtlwang urban area is situated approximately 45km east of Kroonstad and 92km west of Bethlehem. The major link road between Bethlehem and Kroonstad stretches adjacent to the urban area. Cities/Towns include Kroonstad, Renovaal, Steynsrus, Vierfontein, and Viljoenskroon, the mail economic activities are agriculture, commercial transport, business services and mining.

Viljoenskroon is located in an area of agricultural significance and mainly provides services in this regard to the surrounding rural areas. Viljoenskroon functions as a satellite town for residential purposes due to its strategic location in the proximity of the Vaal Reefs mines as well as the Orkney/Stilfontein mining areas in the North West Province. These towns have the opportunity for future growth based on industrial development, mining and tourism.

4.5.1. Population

The population of the municipality has decreased by 4.4% from 167 892 in 2001 to 160 532 persons in 2011. The community survey conducted during 2016 indicated that the population once again decreased with 3.61% to 154 732. Contrary to the aforementioned, the number of households increased by 10.0% from 41 514 in 2001 to 45 661 in 2011 and increased again with 17.39% to 53 601 according to the Community Survey results of 2016.

The population pyramid below shows a bulge from ages 15-19, 20-24 and 25-29 which is a reflection that Moqhaka Local Municipality consists of a young population that still needs to go to school and a pool of new entrants into the labour market. The pyramid also shows that males in those age groups are more than females, whereas from age 70 females are more than males which means that females outlive males. Households with access to piped (tap) water inside the dwelling and yard showed a positive movement and increased from 76.6% in 1996 to 94.2% in 2011, whilst piped water outside the yard decreased 6.8% over the same period.

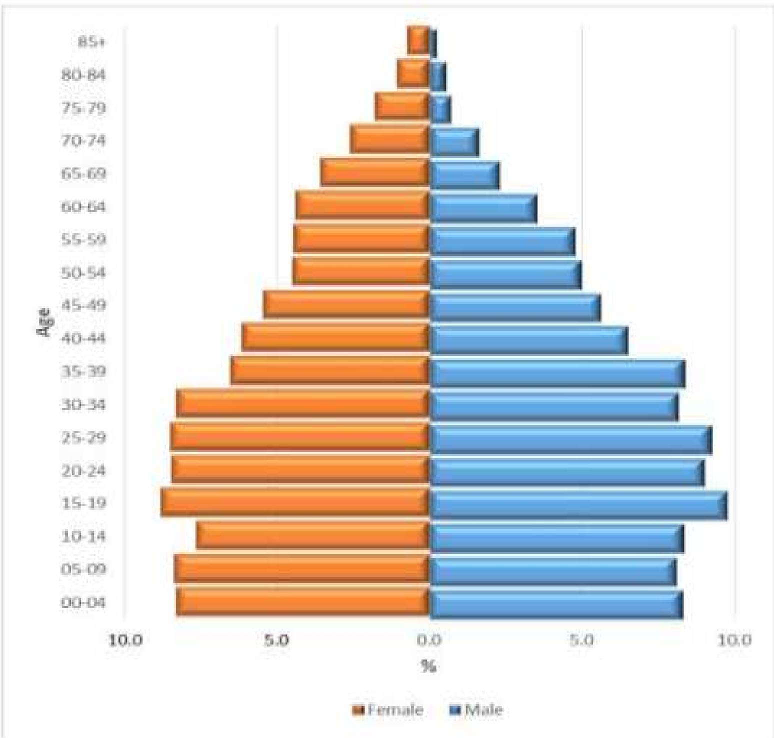

Figure 11: Population pyramid of Moqhaka Local Municipality

4.5.2. Economy

The Greater Kroonstad isthe centre of a large agriculture community that plays an important role in the economy of the district. Industrial activities subsequently contribute significantly to the district's economy. The Department of

Correctional Services and the School of Engineer's Military bases are situated in the town. Kroonstad has of late become a distinguished holiday destination due to the ultra-modern and popular holiday resort of Kroonpark, adjacent to the Vals River. The urban area is situated adjacent the N1 National Road and located adjacent one of the largest and most important four-way railway junctions in South Africa.

The municipality has a number of competitive advantages and key positives on which the economy can built. It has a solid economic infrastructure, the N1 road run just few minutes from the CBD. It has a solid railway line which plays a significant role in transporting agricultural products and other industrial good. The railway line linking the North West Province particularly Lichtenburg and Kwa Zulu Natal Province particularly the Durban Harbour passes through all the three towns of Moqhaka Local Municipality. It has airport that is designed for large aircraft such as Boeing 737s that can attract both international and national investors.

Main Economic Sectors include agriculture, manufacturing, trade, construction, electricity, transport and finance. The 2016 forecast of economic activity for each sector was as follows:

- Agriculture -2.0%
- Mining -1.4%
- Manufacturing -2.0%
- Electricity -0.6%

4.5.3. Employment

Moqhaka Local Municipality had an estimated population of 160 532 in 2011, with an estimated 45 661 household units and -0.45% growth rate. The population declined in 2016 community survey to 154 732 with unemployment rate of 35.2%. The youths are the hardest hit with 47.2 %. This decline exacerbates the range of challenges facing Moqhaka, including, but not limited to, unemployment and migration to name but a few. It has the necessary basic economic infrastructure like industrial areas of Kroonstad and Viljoenskroon, which plays an important role in agricultural industries.

The closure of two diamonds mine in the area, has negatively affected the economic standing of the municipality which is progressively shifting towards agriculture, tourism and transport. The largest areas of focus being black emerging farmers and the development businesses. There are prospects of coal and methane gas in the area.

4.5.4. Education

The level of education of 5-year-olds and higher within the study area is illustrated below. Table 7 compares the education levels of the residents from Grade 0 all the way to PHD level.
No schooling – 5092

Table 5: Overview of Education in the study area

Level of education	Gender		Total
	Male	Female	
No schooling	2323	2769	5092
Grade 0	1968	2038	4006
Grade 1/Sub A/Class 1	1755	1996	3751
Grade 2/Sub B/Class 2	1284	2057	3342
Grade 3/Standard 1/ABET 1	2642	2304	4947
Grade 4/Standard 2	3203	2663	5865
Grade 5/Standard 3/ABET 2	2665	2813	5478
Grade 6/Standard 4	3807	4123	7930
Grade 7/Standard 5/ABET 3	3269	3333	6602
Grade 8/Standard 6/Form 1	5743	5681	11424
Grade 9/Standard 7/Form 2/ABET 4/Occupational certificate NQF Level 1	5280	5422	10702
Grade 10/Standard 8/Form 3/Occupational certificate NQF Level 2	6902	7614	14515
Grade 11/Standard 9/Form 4/NCV Level 3/ Occupational certificate NQF Level 3	6428	7665	14093
Grade 12/Standard 10/Form 5/Matric/NCV Level 4/ Occupational certificate NQF Level 3	17398	15798	33197
NTC I/N1	20	-	20
NTCII/N2	71	86	157
NTCIII/N3	104	83	187
N4/NTC 4/Occupational certificate NQF Level 5	242	181	423
N5/NTC 5/Occupational certificate NQF Level 5	113	157	270
N6/NTC 6/Occupational certificate NQF Level 5	295	539	834
Certificate with less than Grade 12/Std 10	17	11	29
Diploma with less than Grade 12/Std 10	189	251	440
Higher/National/Advanced Certificate with Grade 12/Occupational certificate NQF	188	458	646
Diploma with Grade 12/Std 10/Occupational certificate NQF Level 6	972	1097	2070
Higher Diploma/Occupational certificate NQF Level 7	327	457	784
Post-Higher Diploma (Master's	202	135	338
Bachelor's degree/Occupational certificate NQF Level 7	303	368	670
Honours degree/Post-graduate diploma/Occupational certificate NQF Level 8	240	214	454
Master's/Professional Master's at NQF Level 9 degree	72	49	121
PHD (Doctoral degree/Professional doctoral degree at NQF Level 10)	140	106	246
Other	194	391	585

4.5.5. Income and poverty

The 2016 Community Survey have released a poverty headcount. The poverty measures used below are based on the South African Multidimensional Poverty Index (SAMPI). The SAMPI is an index that is constructed using eleven indicators across four dimensions, namely health, education, living standards and economic activity. There are two measures mentioned in the table, namely the "poverty headcount" and the "intensity of poverty". The poverty headcount shows the proportion of households that are considered “multidimensional poor" in the defined area. The intensity of poverty is the average proportion of indicators in which multidimensional poor households are deprived. This information will be utilised to gauge the demand for and extent of LED necessary in the region.

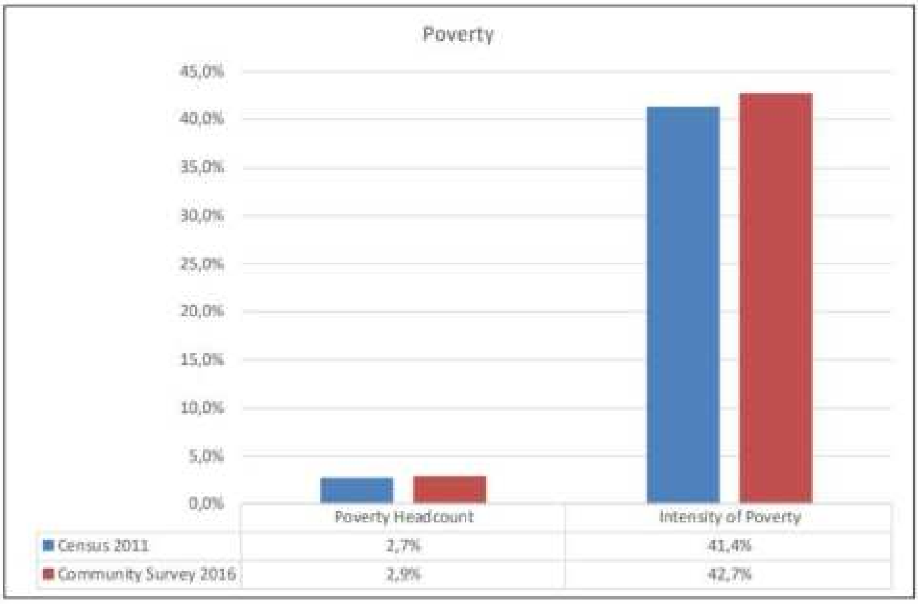

Figure 12: Poverty Index in Moqhaka municipality

5. ASSESSMENT OF KEY SOCIAL ISSUES AND IMPACT

5.1. Introduction

Section 5 highlights 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 thorough 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 Moab Khotsong 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, operational and decomissioning phases of the Harmony Moab Khotsong 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, as well as local and site-specific issues. Local and site-specific issues are further divided into construction and operational related issues.

A Social Impact Assessment (SIA) has been prepared to provide a description of the environment that may be impacted by the activity as well as the manner in which the environment may be impacted. This section also includes a description and assessment of the potential social issues associated with the proposed facility, as well as the identification of enhancement and mitigation measures aimed at maximizing opportunities and avoiding or mitigating negative impacts.

The Harmony Moab Khotsong and Harmony Great Noligwa Social Labour Plans were evaluated and, where applicable, incorporated into the findings of this report as part of the identification of the key social issues.

A Social and Labour Plan (SLP) is a document that outlines a mining company's commitments to its employees and impacted communities, as well as how and when these goals will be met. As a pre-requisite for the granting of a mining right, every company is required by law - in this case, Regulation 42 of the Minerals and Petroleum Resources Development Act (MPRDA) - to design and submit an SLP to the Department of Mineral Resources and Energy (DMRE). During the life of a mining right, SLPs are typically required to be revised and resubmitted every five years.

The main question which needs to be addressed is:

“How will the proposed development impact on the socio-economic environment?”

The development of the Moab Solar Facility and its associated infrastructure may have an impact on some vulnerable communities within the project area. Traditionally, the majority of social impacts are associated with the construction phase of a PV solar development. Many of the social consequences are unavoidable and will occur to some extent, but they can be managed through careful planning and implementation of appropriate mitigation measures. Several potential positive and negative social impacts for the project have been identified; however, an assessment of the potential social impacts revealed that there are no perceived negative impacts that are significant enough to be classified as "fatal flaws." Based on the social impact 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 are not limited to the construction of solar PV projects (these relate to an influx of non-local workforce and jobseekers, intrusion and disturbance impacts (i.e., noise and dust, road wear and tear), and safety and security risks), and could be mitigated by implementing the mitigation measures proposed. As a result, the significance of such impacts on local communities can be reduced
- The site is within the existing mining development area and thus within the mine's social and economic processes and structures; things like socio-economic development and local economic development plans will take the development of the PV facilities into account
- The development will introduce employment opportunities during the construction phase (temporary employment) and a limited number of permanent employment opportunities during operation phase
- The proposed project could help the local economy by fostering entrepreneurial growth and opportunities, particularly if local businesses are involved in the provision of general materials, goods, and services during the construction and operational phases. This positive impact is likely to be exacerbated by the cumulative impact associated with the development of several other solar facilities in the surrounding area, as well as by the project's location within an area characterized by high levels of solar irradiation and thus well suited to the development of commercial solar energy facilities
- The proposed development also represents an investment in infrastructure for the generation of non-polluting, renewable energy, which represents a positive social benefit for society when compared to energy generated by the combustion of polluting fossil fuels
- It is also important to take into account the cumulative social impacts of other proposed solar PV projects in the area when considering Moab Solar
- It should be noted that the project's perceived benefits, which include RE generation and local economic and social development, outweigh the project's perceived negative impacts

The proposed mitigation measures should be implemented to limit the negative impacts and enhance the positive impacts associated with the project.

The proposed project and associated infrastructure are unlikely to have long-term negative social consequences. From a social standpoint, it is concluded that the project could be developed subject to the implementation of recommended mitigation measures and project management actions.

5.3. Social Impacts Associated with the Construction Phase

The majority of the social impacts associated with the project are expected to occur during the development's construction phase and are typical of the types of social impacts typically associated with construction activities. These effects will be temporary and short-term (12 months), but they may have long-term consequences on the surrounding social environment if not properly planned and managed. As a result, the detailed design phase must be carried out in such a way that it does not result in long-term social impacts due to improper placement of project components or associated infrastructure, or mismanagement of 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
- Skills Development
- Growth of the local communities

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
- Impact of heavy vehicles, including damage to roads, safety, noise and dust

Construction Phase

Nature: Employment opportunities and skills development			
Impact description: Harmony Gold currently have social labour plans in place which meet the requirements of employment in terms of local employment and skills development act. As per their current SLP the Moab Khotsong mining operations will provide employment for 6 636 employees in mining, construction, management or other related activities. According to the SLP, the Moab Khotsong Human Resources Development (HRD) Strategy supports the company's business strategy and objectives, as well as the South African legislative and regulatory framework that seeks to address the country's general skills shortage while also ensuring equitable workplace representation. Part of these strategies include: • Adult Basic Education Training • Portable Skills Training Plans • Trainee Programmes and Learnerships for Employees • Management Development Programmes • Talent Pool Development • Community Human Resource Development Programme • Learnerships for the Community The mine intends to develop the Moab Khotsong Solar PV facility using the same principles outlined in the SLP, albeit on a smaller scale than the development of a 100MW solar PV facility.			
	Rating	**Motivation**	**Significance**
Prior to Enhancement			
Duration	Short-term (1)	The construction period will last less than one year	**Low Positive (30)**
Extent	Local – Regional (5)	The impact will occur at a local, regional and national level	
Magnitude	Low (4)	The creation of employment opportunities will assist to an extent in alleviating unemployment levels within the area	
Probability	Probable (3)	Construction of the project will result in the creation of a number of direct and indirect employment opportunities, which will assist in addressing unemployment levels within the area and aid in skills development of communities in the area	
Enhancement measures: To enhance the local employment, skills development and business opportunities associated with the construction phase, the following measures should be implemented: • It is recommended that the development be incorporated into the mine's SLP, and that the current skills development processes and policies at the mine or associated infrastructure be incorporated into the development and operation of the Solar energy facility • The SLP strategies (Adult Basic Education Training, Management Development Programs, Community Human Resource Development Programs, and so on) are specifically targeted at the mining and renewable energy development sectors			

- Be committed to involving and benefiting the communities surrounding mines, contributing to their development and growth; thus, it is recommended that special attention be paid to the needs of people living near mines in the Free State Province
- It is recommended to conduct structured and proactive engagement sessions within the municipal district, to expose local small, micro and medium enterprises which will benefit from the proposed development
- According to MPRDA REGULATION 46 (b) (v), "the contents of a Social and Labour Plan must include a human resources development programme that must include employment equity statistics that must be completed in the form of "Form S" contained in Annexure II and the mines plan to achieve 10% women participation in mining and 40% historically disadvantaged South Africans (HDSA) participation in management within 5 years from the grantie's grant."
- Training and skills development programmes should be initiated prior to the commencement of the construction phase

Post Enhancement

Duration	Short-term (1)	The construction period will last for less than one year	**Medium Positive (55)**
Extent	Regional (4)	The impact will occur at a local, regional and national level	
Magnitude	Moderate (6)	The creation of employment opportunities will assist to an extent in alleviating unemployment levels within the area	
Probability	Definite (5)	Construction of the project will result in the creation of a number of direct and indirect employment opportunities, which will assist in addressing unemployment levels within the area and aid in the skills development of communities in the area	

Residual Risks:

- Initiatives to eliminate unfair discrimination in employment
- Recruit and select suitably qualified individuals from the designated groups
- Employees from designated groups who have been identified in the talent pool should be advanced and accelerated through targeted training and development programs
- Assist individuals in obtaining an initial vocational education and pre-qualification, as well as additional education and training that refreshes knowledge, skills, work and life competencies that are critical for overall development
- Provide portable skills training to employees who express an interest in obtaining such training, with a special emphasis on employees who have been incapacitated or retrenched, in order for them to remain economically active, employable, or self-sustaining in their communities
- Growth of talent is facilitated, thereby providing opportunities for all employees to contribute to their full potential

Nature:

Contributions to the local economy

Impact description: According to Harmony Gold Mine Moab Khotsong Operations, they are committed to the long-term socioeconomic development and well-being of the communities in which they operate by contributing to community development that will last long after mining operations have ended.

Harmony's corporate social responsibility (CSR) policy for their South African operations acknowledges the country's need for socio-economic development. This policy includes initiatives for local economic development (LED) that are

	Rating	Motivation	Significance
carried out in accordance with the Mining Charter, MPRDA regulations, and codes of good practice for the minerals and mining industry.			
Prior to Enhancement			
Duration	Long-term (4)	Will continue for the duration of the project due to legal obligation to pay taxes	**Medium Positive (36)**
Extent	Local – Regional (4)	Will include mostly local and some regional impacts	
Magnitude	Low (4)	Will derive from increased cash flow from wages, local procurement, economic growth, taxes and LED and HRD initiatives	
Probability	Probable (3)	Will depend on; proportion of local spending by employees, capacity of local enterprises to supply; effectiveness of LED and HRD initiatives, contributions to local government	

Enhancement measures:

It has to be noted that there currently are measures in place that speaks to economic development in terms of the mining operations:

- The Harmony tender policy was amended to give preference to BEE entity suppliers
- BEE entities can win tenders even when their price is higher than that of non-BEE entity suppliers
- Certain commodities are set aside and may only be purchased from BEE-entity suppliers and certain commodities may only be acquired from 100% black owned suppliers through the Harmony business development centres
- BEE-entities get a second chance to revise their tender price, should they not win a tender
- Preference is given to suppliers that are local to the operation where the service will be consumed

The following measures must also be considered when constructing the solar PV facility

- Establishing liaison and communication structures with the district and local government structures
- Liaises with the local governmental structures and municipal authorities in the labour- sending communities to ensure that group development initiatives are integrated into the economic and development plans of those areas
- The continuous review of the economic development of the project during the implementation process will ensure that the project does not become static but is revised in terms of changing needs and also to ensure sustainability
- It is recommended that a local procurement policy be adopted by the developer to maximise the benefit to the local economy, where feasible
- Create job opportunities, boost local economies by supporting business activities, and contribute to government tax revenues through the development of the Solar Facility
- Prior to the start of the construction contractor procurement, the Developer of the Solar Facility should create a database of local companies, specifically Historically Disadvantaged (HD) companies, that qualify as potential service providers (e.g., construction companies, catering companies, waste collection companies, security companies, etc.). These businesses should be informed about the tender process and invited to bid on project-related work, if applicable
- Engage with local authorities and business organisations to investigate the feasibility of obtaining construction materials, goods, and products from local suppliers, where possible

Post Enhancement			
Duration	Long-term (4)	As for pre-enhancement	**Medium Positive (60)**

Extent	Local – Regional (4)	SMME capacity building will limit procurement from outside the local municipality	
Magnitude	Low (4)	Mitigation will likely increase intensity of multiplier effects as it will concentrate impact to local area, sustainability of initiatives will also be increased if aligned with other those of other institutions	
Probability	Definite (5)	Increased local employment and procurement as well as skilled SMME's skill enhance likelihood of benefits to local economy	
Residual Risks: • Improved local service sector, growth in local business • Community development and stimulation of the local economy • Growth in the local markets			

Nature: Safety and security			
Impact description: Temporary increase in safety and security concerns associated with the influx of people during the construction phase. The Solar PV Development will be in accordance with Moab Khotsong's occupational safety and health policies and related management frameworks, which are in accordance with South Africa's Mine Health and Safety Act. A collaborative approach is taken, involving all stakeholders and ensuring that the necessary infrastructure and systems, including relevant planning, communication, and training, are in place.			
	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	Short-term (2)	Will be limited to the construction phase which is less than one year	**Low Negative (27)**
Extent	Local – Regional (3)	Safety concerns will affect nearby communities	
Magnitude	Low (4)	Could place the lives of neighbouring community members at risk	
Probability	Probable (3)	Traffic would need to be considered in the area	
Mitigation: • Stopping significant unwanted events by focusing on critical control management • Safety awareness and training as well as positive behaviour reinforcement • Improving system monitoring and analysis to improve risk management • Encourage employees to stop working when a workplace is considered unsafe and/or to prevent unsafe actions • Focus on critical control management (as per International Council on Mining and Metals guidelines) • Education, Training and Development Services must be implemented • Access in and out of the construction area should be strictly controlled by a security company • The contractor must provide adequate firefighting equipment on site and provide firefighting training to selected construction staff • Have clear rules and regulations for access to the proposed site to control loitering			

• A comprehensive employee induction programme would cover land access protocols, fire management and road safety must be prepared • 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			
Post Mitigation			
Duration	Short-term (2)	As for pre-mitigation	**Low Negative (16)**
Extent	Local (2)	Safety measures will likely restrict impacts on nearby communities	
Magnitude	Low (4)	Appropriate mitigation will reduce the risk of this project	
Probability	Improbable (2)	As for pre-mitigation	
Residual Risks: • None anticipated			

Nature: Disruption of daily living and movement patterns			
Impact description: Temporary increase in traffic disruptions and movement patterns during the construction phase, Transport of equipment, material and staff to site will lead to congestion.			
	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	Short-term (2)	Will be limited to the construction phase which is less than one year	**Medium Negative (40)**
Extent	Local (2)	Will affect road users from nearby communities	
Magnitude	Moderate (6)	Will affect the quality of life of neighbouring communities	
Probability	Highly probable (4)	Traffic would need to be considered in the area	
Mitigation: • Implement standard dust control measures on gravel roads, including periodic spraying (frequency will depend on many factors including weather conditions, soil composition and traffic intensity and must thus be adapted on an on-going basis) of construction areas and access roads, and ensure that these are continuously monitored to ensure effective implementation • Stagger component delivery to site • Reduce the construction period • Make use of mobile batch plants and quarries in close proximity to the site • All vehicles must be road worthy, and drivers must be qualified, obey traffic rules, follow speed limits and be made aware of the potential road safety issues • Heavy vehicles should be inspected regularly to ensure their road worthiness • Provision of adequate and strategically placed traffic warning signs, which must be maintained throughout the construction phase, as well as control measures along the R30 and Stokkiesdraai roads to warn road users of construction activities taking place throughout the construction phase. Warning signs must be always visible, especially at night. • Implement penalties for reckless driving to enforce compliance to traffic rules • Avoid heavy vehicle activity during “peak” hours (when children are taken to school, or people are driving to work)			

• Ensure that all fencing along access roads is maintained in the present condition or repaired if disturbed due to construction activities • The Contractor must ensure that damage/wear and tear caused by construction related traffic to the access roads is repaired before the completion of the construction phase • Method of communication must be implemented whereby procedures to lodge complaints are set out for the local community to express any complaints or grievances with the construction process			
Post Mitigation			
Duration	Short-term (2)	As for pre-mitigation	**Low Negative (16)**
Extent	Local (2)	Safety measures will likely restrict impacts on road users	
Magnitude	Low (4)	Appropriate mitigation will reduce the risk of this project	
Probability	Improbable (2)	As for pre-mitigation	
Residual Risks: • None anticipated			

Nature: Increased pressure on local services/resources			
Impact description: Added pressure on economic and social infrastructure during construction as a result of in-migration of people.			
	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	Short-term (2)	Influx related pressure on services will start during construction and continue during the operational phase	**Medium Negative (30)**
Extent	Local (2)	May affect resource management on local district municipal level	
Magnitude	Moderate (6)	Intensify existing service delivery and resource problems and backlogs, especially sewerage and road networks	
Probability	Probable (3)	Population influx will affect the ability of the local municipality to meet increased demand	
Mitigation: • It is necessary to appoint a Community Liaison Officer. A method of communication should be implemented, with procedures for filing complaints outlined, so that the local community can express any complaints or grievances about the construction process • Current procurement channels set up by the mine should be utilized to reduce any complications which may arise from the development			
Post Mitigation			
Duration	Short-term (2)	As for pre-mitigation	**Low Negative (16)**
Extent	Local (2)	Safety measures will likely restrict impacts on road users	

Magnitude	Low (4)	Appropriate mitigation will reduce the risk of this project	
Probability	Improbable (2)	As for pre-mitigation	

Residual Risks:

- Possibility of outside workers remaining in the area after construction is completed and subsequent pressures on local infrastructure

Nature:

Nuisance impacts (noise& dust)

Impact description: Construction activities will result in the generation of noise and dust over a period of months. However, the development is located directly adjacent to mining sites. The noise and dust impact is therefore insignificant in comparison to the noise and dust generated by the mine and will only be temporary in nature.

	Rating	Motivation	Significance
Prior to Mitigation			
Duration	Short-term (2)	Nuisance impacts will only be limited to the construction phase	**Medium Negative (44)**
Extent	Local (1)	This will remain within the project extent from construction activities	
Magnitude	High (8)	Dust impacts and noise nuisance from construction activities	
Probability	Highly Probable (4)	Movement of heavy construction vehicles during the construction phase has a potential to create noise, damage to roads and dust	

Mitigation:

- The development of the Solar PV facility will be on owned and operated by the Moab Khotsong mine, the employees of the mine are subjected to:
  - Annual audiometric testing at occupational health hubs during medical examinations
  - Awareness drives to ensure employees are aware of the benefits of wearing personalized hearing protection
  - Monitoring programs to measure actual compliance in the workplace
  - Compliance monitoring is undertaken during routine occupational hygiene inspections and ad hoc audits are also conducted
- It is furthermore predicted that the current dust levels generated by the mining activities in the area far exceed that which will be generated by the construction of the PV facility. The Moab Khotsong mine currently has standardized dust control measures in place which will allow the monitoring of the dust generation by the PV facility, these include:
  - leading practices as advocated by the Mining Industry Occupational Safety and Health (MOSH)
  - Multi-stage dust filtration systems
  - Training and awareness programmes address dust control in stopes and all development ends are equipped with water blasts to settle dust directly after a blast

The following ''Generic'' Noise and Dust suppression must be implemented where not covered by current mining processes:

- During construction, care should be taken to ensure that noise from construction vehicles and plant equipment does not intrude on the residential areas nearby. Plant equipment such as generators, compressors, concrete mixers, and vehicles should be kept in good working order and, where possible, equipped with effective exhaust mufflers
- The movement of construction vehicles on the site should be confined to agreed access road/s

- Heavy vehicle movement during the construction phase should be timed (where possible) to avoid times of the week, such as weekends, when the volume of traffic on the access roads may be higher
- Dust suppression measures should be implemented, such as wetting on a regular basis and ensuring that vehicles used to transport sand and building materials are fitted with tarpaulins or covers

Post Mitigation

Duration	Short-term (2)	As per pre-mitigation	**Low Negative (18)**
Extent	Local (1)	Mitigation measures will assist with increasing the impact	
Magnitude	Moderate (6)	Appropriate mitigation will reduce the risk of this project	
Probability	Improbable (2)	As per pre-mitigation	

Residual Risks:

- Noise and Dust generation will remain an issue irrespective of the Solar PV development

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 of establishing a legal entity (such as a community trust) to represent the allocated beneficiary community
- 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

Nature:

Job creation during operation

Impact description: Harmony Gold currently have social labour plans in place which meet the requirements of employment in terms of local employment and skills development, act. As per their current SLP the Moab Khotsong mining operations will provide employment for 6 636 employees in mining, construction, management, or other related activities.

According to the SLP, the Moab Khotsong Human Resources Development (HRD) Strategy supports the company's business strategy and objectives, as well as the South African legislative and regulatory framework that seeks to address the country's general skills shortage while also ensuring equitable workplace representation.

Part of these strategies include:

- Adult Basic Education Training
- Portable Skills Training plans
- Trainee Programmes and Learnerships for Employees
- Management Development Programmes
- Talent Pool Development
- Community Human Resource Development Programme
- Learnerships for the Community

The mine intends to incorporate the development of the Moab Khotsong Solar PV facility under the same principles as outlined in the SLP, albeit on a smaller scale in comparison to the development of a 100MW solar PV facility.

	Rating	Motivation	Significance
Prior to Enhancement			
Duration	Long term (4)	Project will be operational up to 30 years	**Medium Positive (33)**
Extent	Regional (3)	Any new positions are likely to be filled by persons living in the local municipal area	
Magnitude	Low (4)	It is anticipated that ~10 jobs will be generated during the operation phase. A number of highly skilled personnel may need to be recruited from outside the local municipal area	
Probability	Probable (3)	Employment opportunities will be created during the operation phase	

Enhancement measures:

To enhance the local employment, skills development and business opportunities associated with the construction phase, the following measures should be implemented:

- It is recommended that the development be incorporated into the mine's SLP, and that the current skills development processes and policies at the mine or associated infrastructure be incorporated into the development and operation of the Solar energy facility
- The SLP strategies (Adult Basic Education Training, Management Development Programs, Community Human Resource Development Programs, and so on) are specifically targeted at the mining and renewable energy development sectors
- Be commitment to involving and benefing the communities neighbouring the mines, contributing to their development and growth, therefore it is recommended that particular attention be given to the needs of the people living near the mine in the Free State Province
- It is recommended to conduct structured and proactive engagement sessions within the municipal district, to expose local small, micro and medium enterprises which will benefit from the proposed development
- According to REGULATION 46 (b) (v) of the MPRDA, "the contents of a Social and Labour Plan must include a human resources development programme which must include employment equity statistics which must be completed in the form of "Form S" contained in Annexure II and the mines plan to achieve the 10% women participation in mining and 40% historically disadvantaged South Africans (HDSA) participation in management within 5 years from the grantie's grant." It is recommended that the development of a solar facility be undertaken with the same equity goals in mind, with women and previously disadvantaged individuals given special consideration during the requirement process
- Training and skills development programmes should be initiated prior to the commencement of the construction phase

Post Enhancement			
Duration	Long-term (4)	As per pre-enhancement	**Medium Positive (44)**
Extent	Local - regional (3)	As per pre-enhancement	
Magnitude	Low (4)	Mitigation will maximise local job creation	
Probability	High Probable (4)	Mitigation will maximise probability that any local recruitment targets are achieved and local benefits optimised	

Residual Risks:

- Improved pool of skills and experience in the local area
- Recruit and select suitably qualified individuals from the designated groups
- Advance employees from designated groups who have been identified in the talent pool and to fast track them through focused training and development programmes

- Assist individual to acquire an initial vocational education and pre-qualification, in addition to further education and training, and which refreshes knowledge, skills, work and life competencies that are crucial for overall development
- Provide portable skills training to employees who show an interest in obtaining such training and with a special emphasis on employees who are incapacitated or retrenched to remain economically active, employable, or self-sustaining within their communities

Nature: Development of clean, renewable energy infrastructure			
Impact description: Development of clean, renewable energy infrastructure The primary goal of the proposed project is to improve energy security in South Africa by generating additional energy. The proposed Solar PV Facility 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			
	Rating	**Motivation**	**Significance**
Prior to Enhancement			
Duration	Long term (4)	Adding a renewable energy sector to the Fezile Dabi District economy may contribute to the diversification of the local economy and provide greater economic stability	**Medium Positive (48)**
Extent	Local – Regional - National (4)	The generation of renewable energy will contribute to South Africa's electricity market. The mine will be the private off-taker of the power generated by the facility the proposed development will indirectly relieve the national grid	
Magnitude	Low (4)	The proposed facility will only generate up to 100MW	
Probability	Highly Probable (4)	Facility will help contribute to the total carbon emissions associated with non-renewable energy generation	
Enhancement measures: **None anticipated**			
Post Enhancement			
Duration	Long term (4)	As per pre-enhancement	**Medium Positive (48)**
Extent	National (4)	As per pre-enhancement	
Magnitude	Low (4)	As per pre-enhancement	
Probability	Highly Probable (4)	As per pre-enhancement	
Residual Risks: • Reduce carbon emissions through the use of renewable energy and contribute to reducing global warming • 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			

Nature:

Visual impacts and impacts on sense of place			
Impact description: Visual impacts and sense of place impacts associated with the operation phase of the project Due to the number of mines in the area, the scenic quality of the region is low, further construction and operation of the Solar PV Facility in the area is likely to have a negative impact.			
	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	Long term (4)	Impact on sense of place relates to the change in the landscape character and visual impact of the proposed solar energy facility	**Low Negative (18)**
Extent	Local (1)	Dependent on the demographics of the population that resides in the area and their perceptions	
Magnitude	Low (4)	There are industrial/mining operations and formal residential areas located in proximity to the site	
Probability	Improbable (2)	There are no tourist attractions located adjacent to the property and therefore the anticipated impact on the area's visual quality and sense of place is low	
Mitigation: • None anticipated			
Post Mitigation			
Duration	N.A. – Mitigation not possible		**N.A. – Mitigation not possible.**
Extent	N.A. – Mitigation not possible		
Magnitude	N.A. – Mitigation not possible		
Probability	N.A. – Mitigation not possible		
Residual Risks: • None anticipated if the visual impact will be removed after decommissioning, provided the solar energy facility infrastructure is removed and the site is rehabilitated to its original (current) status			

5.5. Social Issues Associated with the Decommissioning Phase

The social impact of decommissioning the Moab Khotsong PV project is likely to be significant. While the 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 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.

5.6. Social Issues Associated with the No-Development Option

The "no-go" alternative is the option of not constructing the Harmony Moab Khotsong Solar PV. The implementation of the proposed project is expected to result in several positive and negative social impacts. Most 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 positive social impacts associated with the construction and operation of the project include the following:

- Potential direct and indirect employment opportunities
- Skills development and training
- Development of Renewable energy facilities
- 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.

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 rules require both dynamic and static consideration of cumulative impacts. Driving along a tourist road must be perceived as a dynamic sequence of sights and visual impacts, not as the cumulative impact of multiple developments on one area. If each subsequent length of road is dominated by views of renewable energy installations, there may 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. This will be confirmed during the assessment phase.

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

This energy plant has cumulative impacts; especially, the installation of several Solar energy facilities in the Local Municipality will offer socio-economic prospects for the area, resulting in a positive social benefit. Job creation, skill development, and downstream business opportunities are good cumulative effects. Local, regional, and national economies could profit from job creation and service procurement if many renewable energy installations are established. This value will be considerably increased if a critical mass is reached that allows local enterprises to develop the capabilities to support building and maintenance activities and to manufacture renewable energy facility components in South Africa. The cumulative impact at the municipal level could be good, encouraging O&M companies to focus on education and training.

Nature: An increase in employment opportunities, skills development, and business opportunities with the establishment of a solar energy facility.		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	Local -regional (3)	Local-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.

Nature:
Negative impacts and change to the local economy with an in-migration of labourers, businesses, and jobseekers to the area.

	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	Local (1)	Local-regional (3)
Duration	Long-term (4)	Long-term (4)
Magnitude	Minor (2)	Low (4)
Probability	Very improbable (1)	Improbable (2)
Significance	**Low (7)**	**Low (22)**
Status (positive or negative)	Negative	Negative
Reversibility	Yes	
Irreplaceable loss of resources?	No	
Can impacts be mitigated?	Yes	

Confidence in findings: High.

Mitigation:

- Develop a recruitment policy/process (to be implemented by contractors), which will ensure the sourcing of labour locally, where available
- Work together with government agencies to ensure that service provision is in line with the development needs of the local area
- Form joint ventures with community organisations, through Trusts, which can provide local communities with benefits, such as employment opportunities and services
- Develop and implement a recruitment protocol in consultation with the municipality and local community leaders. Ensure that the procedures for applications for employment are clearly communicated

6. CONCLUSIONS AND IMPACT STATEMENT

6.1. Conclusions and Recommendations

The project represents an important development opportunity for the communities surrounding Harmony Moab Khotsong 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 development of the Solar Pv Facility will ensure that (if in line with the Moab Khotsong Mining Operation) skills development and employment equity strategies are aimed at achieving a demographically representative workforce. It is recommended that the Moab Khotsong Solar PV Facility is guided by the provisions of the Skills Development and Employment Equity Acts in terms of both planning and reporting, including with respect to "Core and Critical skills" whilst intensive attempts are made to improve all core and critical skills occupations which is still lagging due to the skills challenges faced by the industry in this respect.

As per the mines Social labout plan, the Human Resources Development interventions aims to address the abovementioned challenges through a variety of initiatives such as:

(i) Management Trainee Programmes
(ii) Bursary Schemes
(iii) Trainee Programmes
(iv) Learnerships

The Developer should be committed to the sustainable socio-economic development and well-being of the communities in which they operate and from which they draw their employees. Both Solar PV Facilities and mining operations have a limited lifespan, therefore strategic objective should focus on contributing to community development that is sustainable long after such operations have ceased.

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 6 and 7 for the potential impacts identified.

Table 6: 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 7: 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

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 includes primary interviews with key stakeholders and interested and affected parties, interviews are semi-structed. Essentially the approach is to provide information on the proposed development to the stakeholders (including maps and diagrams showing location and what is planned etc) and discuss the key activities that will take place, during the construction and operational phases.

The proposed Moab Khotsong 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.

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/

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 should also 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 phase commences; » Employ as many semi and unskilled labour from the local areaor 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 withthe 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 Moab Khotsong 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 security procedures are to be implemented	EPC Contractor	Construction phase
Open fires on the site for heating, smoking or cooking 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 access protocols, 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 Moab Khotsong 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 Moab Khotsong 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 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		The Proponent & EPC contractor	Pre-construction & construction phase
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 MOAB KHOTSONG SOLAR PV FACILITY, VIERFONTEIN, FREE STATE PROVINCE

Avifauna Baseline and Impact Assessment Report

July 2022

Compiled by:
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Prepared for:
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EXECUTIVE SUMMARY

Pachnoda Consulting cc was requested by Savannah Environmental (Pty) Ltd on behalf of Harmony Moab Khotsong Operations Pty (Ltd) to compile an avifauna impact assessment report for three separate solar facilities (referred to as the "Moab Khotsong PV facility") with a combined contracted capacity of up to 100MW located on a site approximately 10km north of the town of Vierfontein 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 (May 2022 and July 2022).

Eight avifaunal habitat types were identified on the study site and surroundings, consisting of four untransformed types (ranging from open grassland with bush clump mosaics, depressions, Imperata cylindrica seep zones to a valley-bottom see/stream) and four transformed units (ranging from agricultural land, *Eucalyptus* plantations, rehabilitated grassland and pastures to pollution control dams). The study site was also surrounded by slimes dams and an impoundment to the east (c. 700m from the site), which provided additional habitat for waterbird and shorebird taxa (especially the latter). Approximately 222 bird species are expected to occur in the wider study area, of which 109 species were observed in the study area (during two independent surveys). The expected richness included five threatened or near threatened species, 18 southern African endemics and 17 near-endemic species. However, the occurrence of threatened and near threatened bird species was predicted to be low, although the natural broad-scale habitat units provided foraging habitat for the occasional occurrence of the vulnerable Lanner Falcon (*Falco biarmicus*) and the regionally near threatened Abdim's Stork (*Ciconia abdimii*). In addition, the valley-bottom seep/stream on the eastern part of the study site provides suitable foraging habitat for the regionally endangered African Marsh Harrier (*Circus ranivorus*), although this species was not observed during the respective surveys. Although the African Marsh Harrier was recorded on the study site during the survey period, it was recommended that all potential habitat be conserved (as a precautionary principle) which included the seep zone/stream on the eastern part of the study site. Sixteen southern African endemics and 11 near-endemic species were confirmed on the study site.

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 (mainly large-bodied waterfowl such as the South African Shelduck *Tadorna cana* and Egyptian Goose *Alopochen aegyptiacus*) colliding with the PV infrastructure remained eminent due to the presence of wetland-associated features and pollution control dams 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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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 Moab Khotsong Operations Pty (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 Moab Khotsong Operations Pty (Ltd) to compile an avifauna impact assessment report for three separate solar facilities (all three herewith referred to as the "Moab Khotsong PV facility") with a combined contracted capacity of up to 100MW located on a site approximately 10km north of the town of Vierfontein in the Free State Province (Figure 1). The study site is situated within the Moqhaka Local Municipality respectively, and within the Fezile Dabi District Municipality. The Solar PV facilities are based near Harmony Moab mining operations and fall within the Klerksdorp Renewable Energy Development Zone (REDZ).

The solar facilities will be located on a 280ha development area, which will include the PV facilities and grid connection infrastructure (Figure 2). The infrastructure associated PV facilities 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 facilities will be located on the following farm portions:

Farm Name	Portion Number
ANGLO 593	593
HOEKPLAATS 598	598
MISPAH 274	274
MOAB 279	279
ZAAIPLAATS 2/190	2/190
ZAAIPLAATS 1/190	1/190
DOORNKOM WES 446	RE/446
CHRYSTALKOP 69	69
ZUIPING 394	4/394
ZUIPING 394	3/394
ZUIPING 394	5/394
ZUIPING 394	RE/394
ZUIPING 394	1/394

The facilities will tie-in to the Vaalreefs 11, Southvaal Plant and Southvaal (6.6/132 kV) substations respectively. Connection line A and C will have a connection capacity of up to 132kV, and Connection line B a connection capacity of up to 132kV. The lines connecting the PV facility to the respective substations 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).

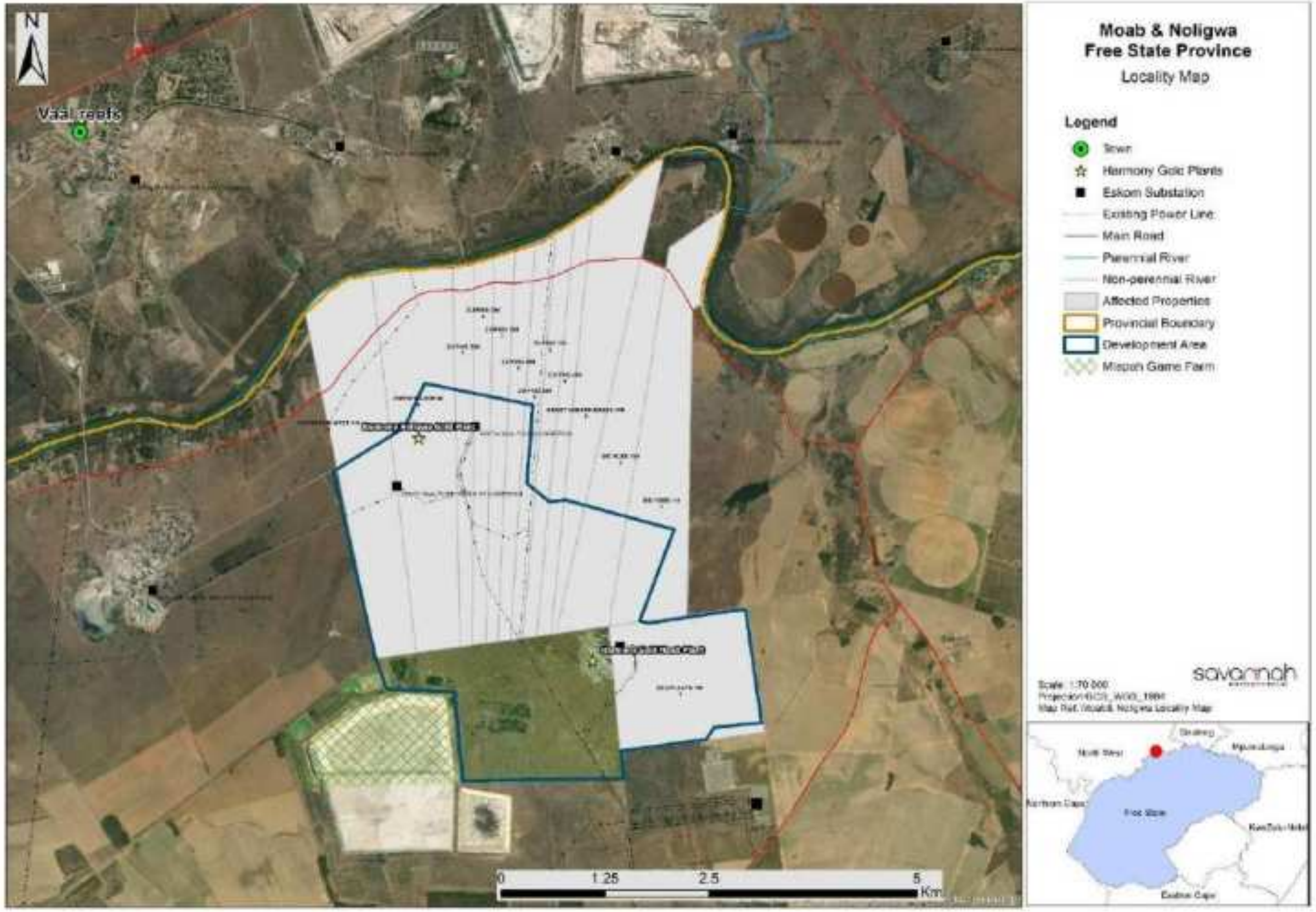


Figure 1: An image illustrating the geographic position of proposed Harmony Moab Khotsong Solar PV facility.

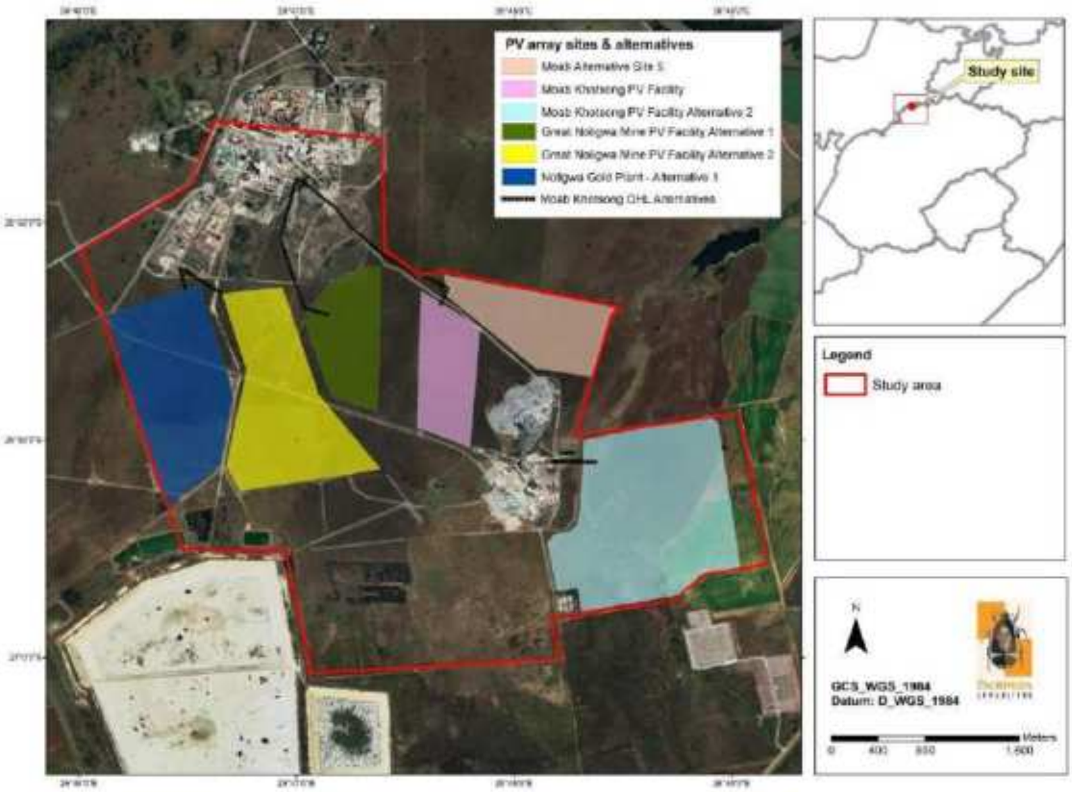


Figure 2: A satellite image illustrating the geographic position of the proposed Harmony Moab Khotsong Solar PV facility and associated infrastructure.

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 (23 - 27 May, 2022 and 04 - 08 July 2022); and
- personal observations from similar habitat types in proximity to the study area.

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 cells (QDCs) 2626DD (Stilfontein) and 2726BB (Viljoenskroon) (Figure 3). 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 2655_2645 (although all eight pentad grids surrounding grid 2730_2255 were also scrutinised) (Figure 4).
- 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).

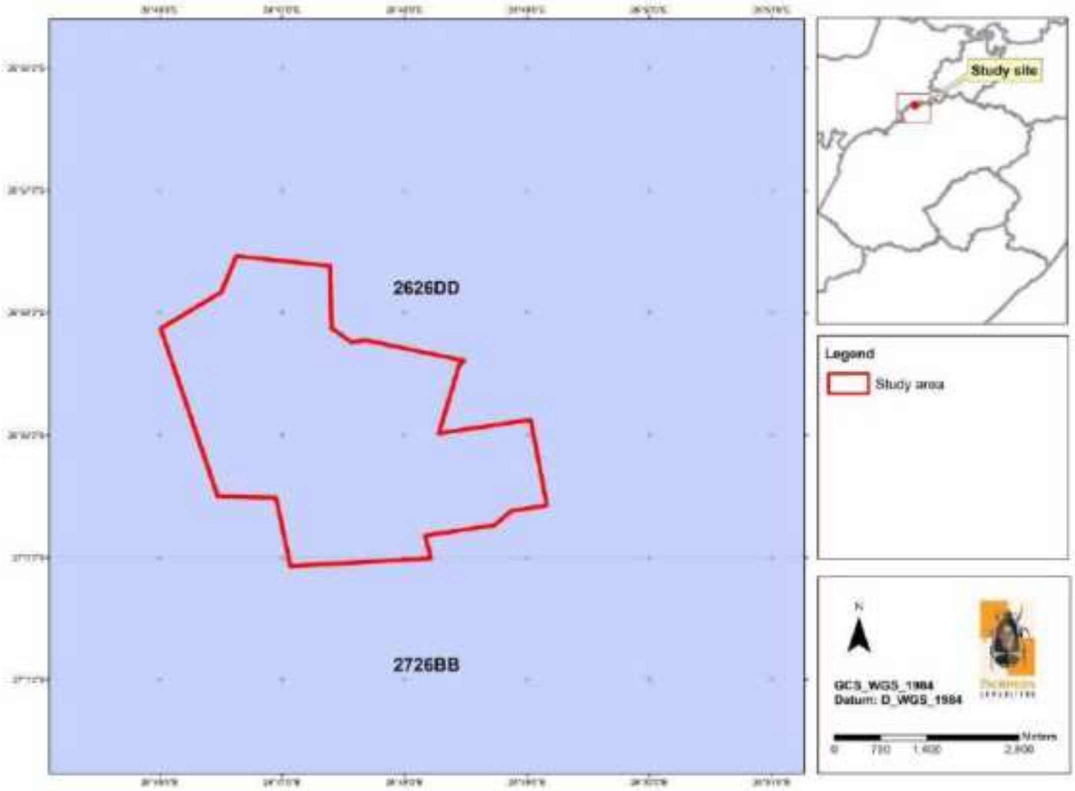


Figure 3: A map illustrating the quarter-degree grid cells that were investigated for this project.

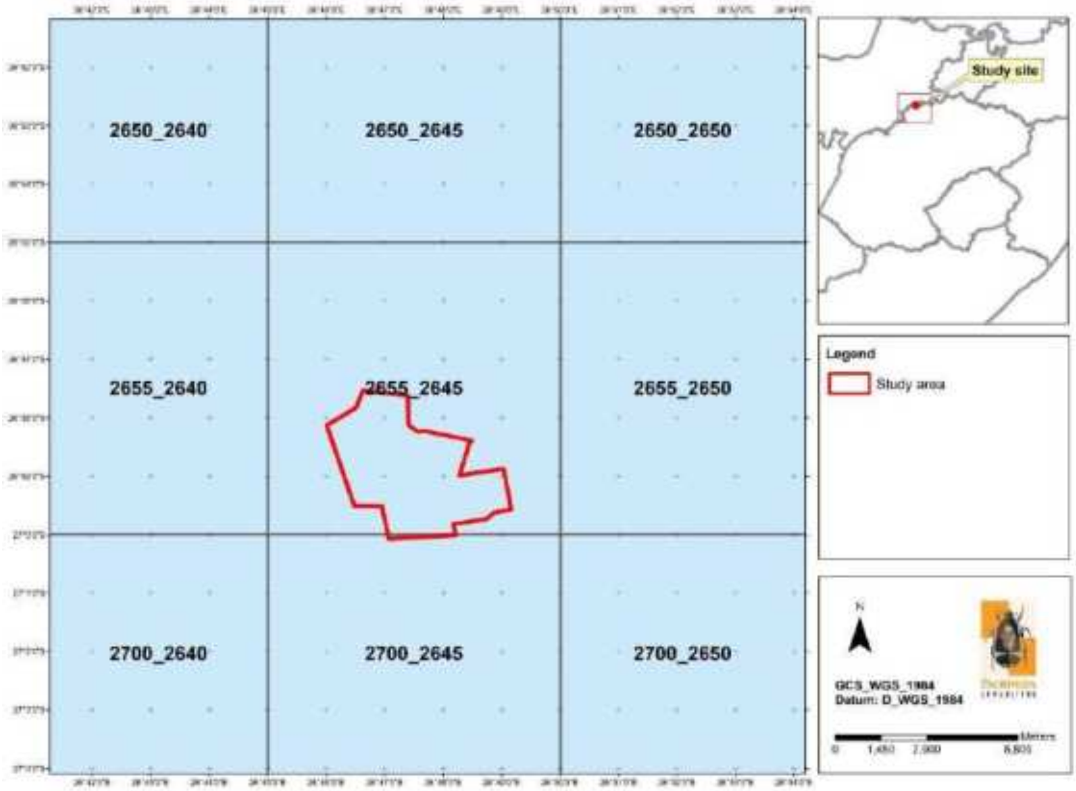


Figure 4: A map illustrating the pentad grids that were investigated for this project.

2.2 Field Methods

The avifauna of the study site was surveyed during two independent site visits (May 2022 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 30 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 5. 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.

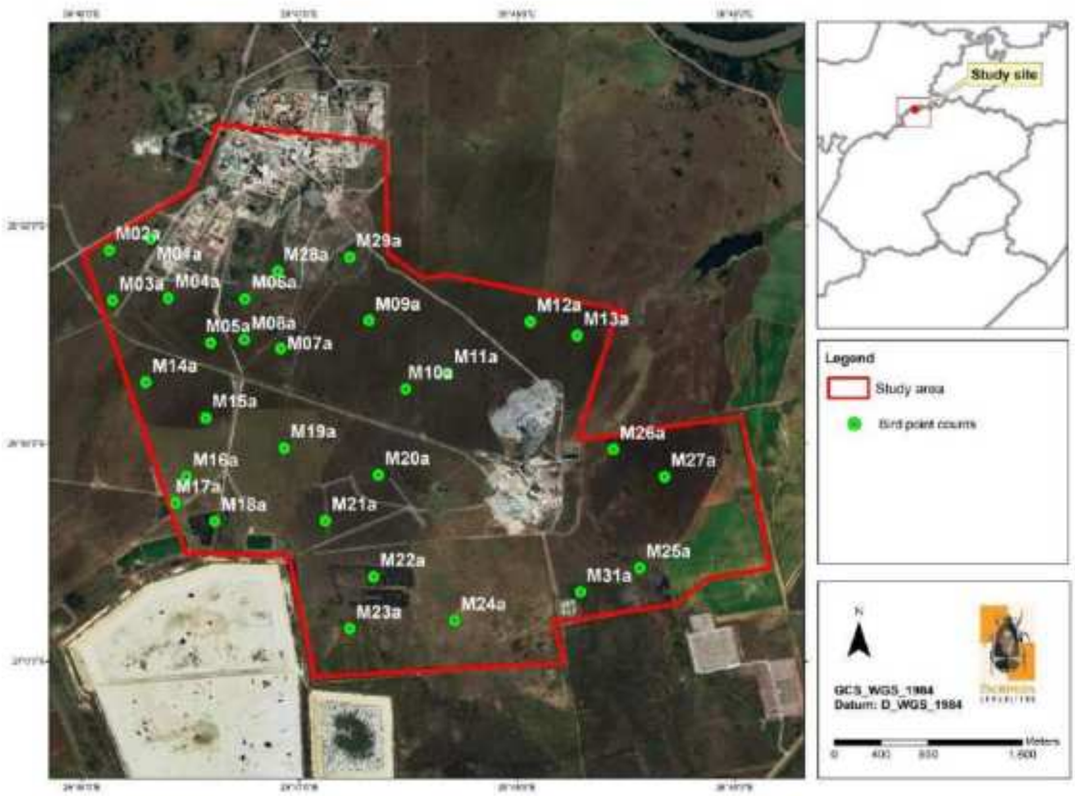


Figure 5: A map illustrating the spatial position of 30 bird point counts located within the study area.

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 (two sampling surveys) was followed representing the end of the austral wet season and during the peak austral dry season. The austral dry season is not the 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 represent 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 Moab mining operations located and approximately 10km North of the town of Vierfontein, Free State Province (Figure 1).

3.2 Regional Vegetation Description

The study site corresponds to the Grassland Biome and more particularly to the Dry Highveld Grassland Bioregion as defined by Mucina & Rutherford (2006). It comprehends two ecological types known as (1) Vaal Reefs Dolomite Sinkhole Woodland and (2) Vaal-Vet Sandy Grassland (Mucina & Rutherford, 2006) (Figure 6).

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 particular 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.

1. Vaal Reefs Dolomite Sinkhole Woodland

Vaal Reefs Dolomite Sinkhole Woodland is confined to a small area associated with dolomite sinkholes in the Stilfontein and Orkney areas corresponding to the North West and Free State Provinces. It is located on the northern and central parts of the study site, where it occurs on slightly undulating landscapes dissected by prominent chert ridges, thereby supporting a grassland-woodland floristic mosaic. A prominent floristic structure of this vegetation type is woodland formations in the form of bush clumps around sinkholes and dolomite outcrops.

The Vaal Reefs Dolomite Sinkhole Woodland is a threatened (**Vulnerable**) ecosystem with only a small patch conserved in the statutorily conservation are of the Sterkfontein Caves (part of the Cradle of Humankind World Heritage Site). In addition, the proposed "Highveld National Park" is supposed to conserve a large section of this vegetation type, which is considered to be one of the most aesthetically pleasing and scenic landscapes in the western Grassland Biome. Approximately 25% of this vegetation type has been transformed due to mining activities and cultivation, and it corresponds to an area with the highest concentration of mines when compared to other vegetation types. In addition, the Vaal Reefs Dolomite Sinkhole Woodland is a Threatened 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).

2. Vaal-Vet Sandy Grassland

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. It is confined to the southern part of the study site. The floristic structure of the Vaal-Vet Sandy Grassland is 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.

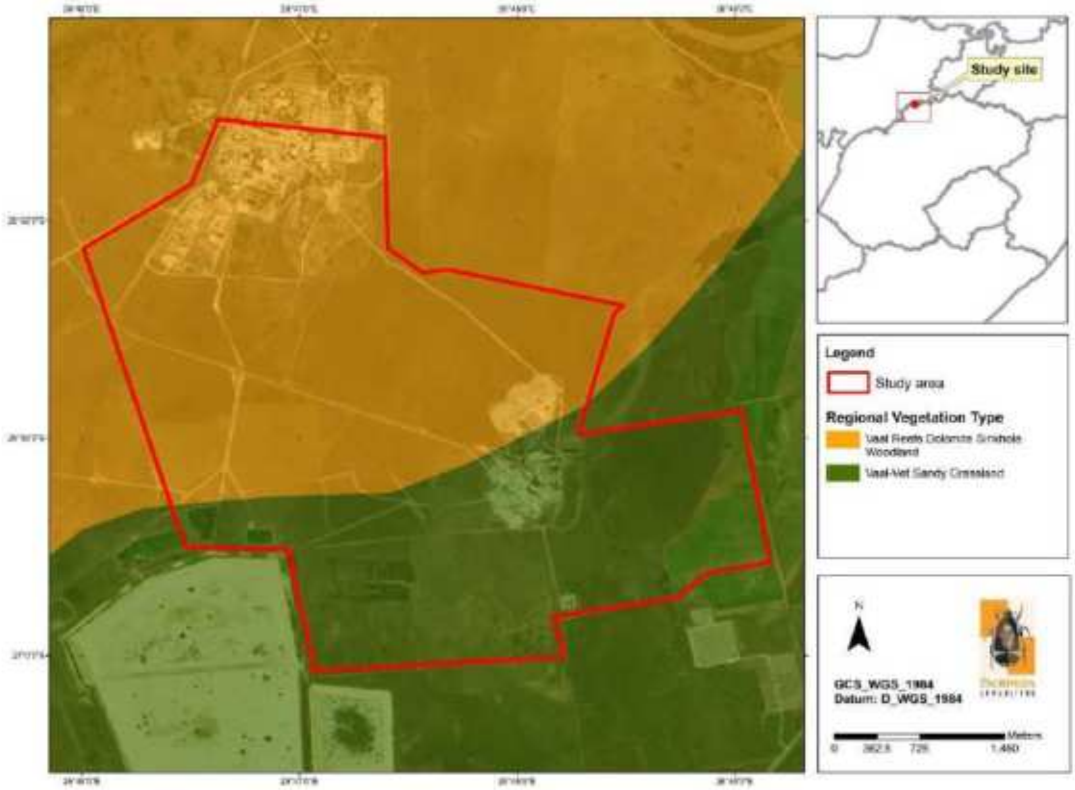


Figure 6: A satellite image illustrating the regional vegetation type corresponding to the study area. Vegetation type categories were defined by Mucina & Rutherford (2006).

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 7):

Natural areas:

- Mainly Grassland;
- Low shrubland; and
- Wetlands.

Transformed areas:

- Mine infrastructure and build-up land;
- Eucalyptus plantations; and
- Cultivation.

From the land cover dataset it is evident that most of the is occupied by natural grassland with scattered bush clumps (especially in the south), wish a natural seep area located on the eastern part of the study site. Existing infrastructure includes the two Harmony Moab (on the central part) and Noligwa (in the north) gold plants. Other transformed land cover classes include commercial agricultural land in the east, a few pollution control dams in the south as well as scattered *Eucalyptus* plantations in the south.

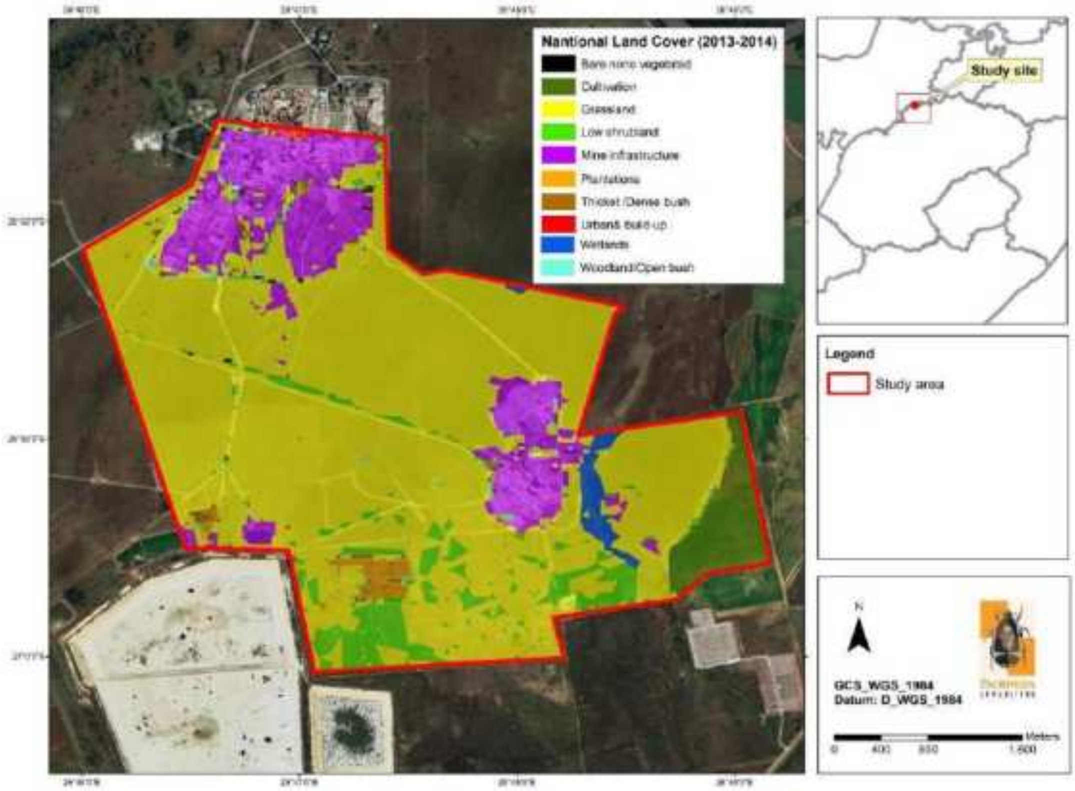


Figure 7: A map illustrating the land cover classes (Geoterrainimage, 2015) corresponding to the proposed study area.

3.4 Conservation Areas, Protected Areas and Important Bird Areas

There are no formal/legal protected or conservation areas or any Important Bird and Biodiversity Areas in close proximity to the study area. However, the southern section of the study area overlaps with the Mispah Game Farm (see figure 1), which is already partly transformed by a slimes dam.

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 holds a **medium** sensitivity with respect to the relative animal species protocol (Figure 8) (report generated 25/04/2022):

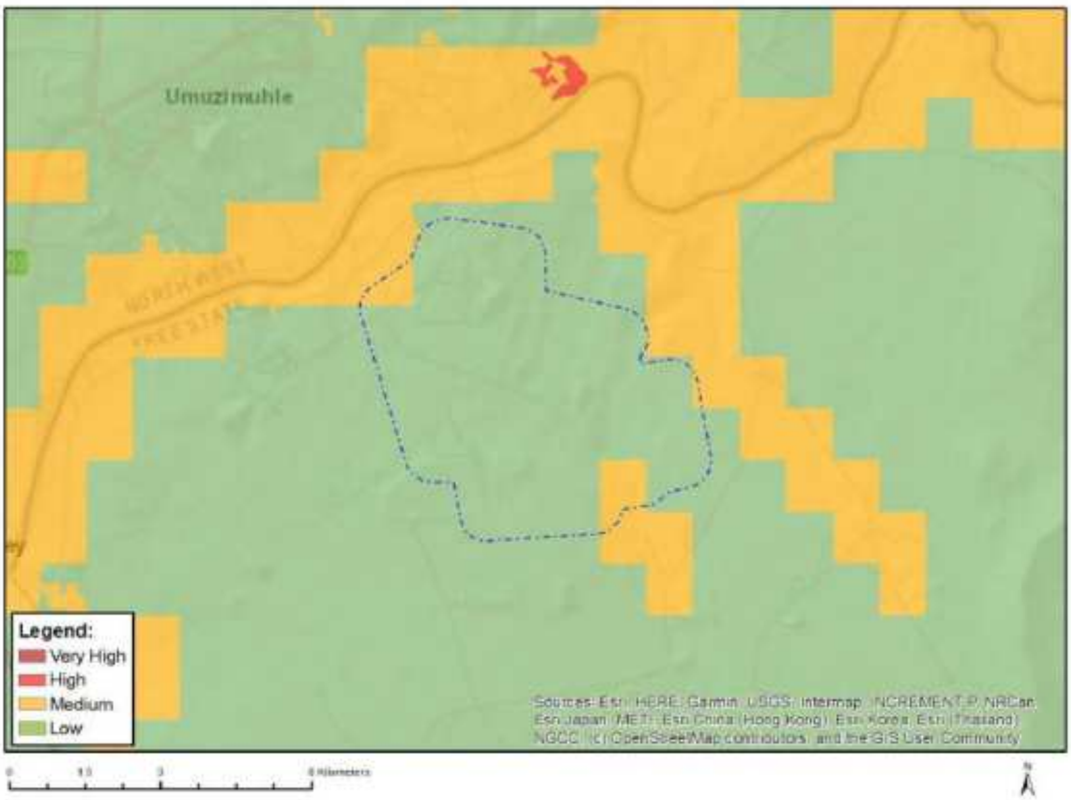


Figure 8: The animal species sensitivity of the study area (including a 500m buffer) according to the Screening Tool.

Sensitive features include the following:

Sensitivity	Feature(s)
Low	Subject to confirmation
Medium	Aves - *Circus ranivorus*
Medium	Mammalia-*Hydrictis maculicollis*

It is evident from the results of the Screening Tool report that the south-eastern and northern parts of the study area contains habitat of medium sensitivity for one threatened bird species, which includes the endangered African Marsh Harrier (*Circus ranivorus*).

The study site holds a **low** sensitivity with respect to the relative avian theme (Figure 9) (report generated 25/04/2022):

Figure 9: The relative avian sensitivity of the study area (including a 500m buffer) according to the Screening Tool.

It is evident from the results of the Screening Tool report that the study area is potentially not an important area for bird species with a high probability to interact with the solar infrastructure and that the site does not potentially overlap with important avian flyways.

However, the study site holds a **very high** sensitivity with respect to the relative terrestrial biodiversity theme (Figure 10) (report generated 25/04/2022):

Figure 10: The relative terrestrial biodiversity sensitivity of the study area (including a 500m buffer) according to the Screening Tool.

Sensitive features include the following:

Sensitivity	Feature(s)
Very High	Critical Biodiversity Area 1
Very High	Critical Biodiversity Area 12
Very High	Ecological Support Area 1
Very High	Ecological Support Area 2
Very High	Endangered Ecosystem
Very High	Mispah Game Farm

It is evident from the results of the Screening Tool report that the entire study area coincides with a Critical Biodiversity Area 1 and 2 (CBA 1 & 2) and an Ecological Support Are 1 and 2 (ESA 1 & 2) as per the Free State Biodiversity Plan (DESTEA, 2015). It also corresponds to an endangered ecosystem which relates to the Vaal-Vet Sandy Grassland. In addition, the southern section of study site is located on the Mispah Game Farm.

4. RESULTS AND DISCUSSION

4.1 Avifaunal habitat types

The study area consists of four discrete broad-scale habitat units that are of **untransformed** nature and important to bird species (Figure 11 and Figure 12):

1. *Open dolomite grassland with scattered bush clumps:* This unit is prominent on the study site and covers nearly the entire surface area of the study site. It is represented by two discrete floristic variations which also provide habitat for two discrete avifaunal associations. The first floristic variation consists of open untransformed to slightly grazed dolomite grassland. The grassland variation is represented by untransformed and semi-transformed Vaal Reefs Sinkhole Dolomite Woodland in the north, and depending on grazing intensity, the graminoid layers is dominated "late-successional" graminoids such a *Cymbopogon caesius, C. pospischilii, Trachypogon spicatus, Triraphis andropogonoides* and *Eragrostis chloromelas.* The latter was prominent where grazing by livestock was eminent. On dolomite outcrops the graminoid layer was significantly taller and dominated by *Setaria sphacelata, Schizachyrium sanguineum* and *Tristachya rehmannii.* In the south the grassland composition occurred on predominantly sandy soils with high affinities towards the Vaal-Vet Sandy Grassland, of which the compositions consists of a large part of secondary graminoid taxa such as *Aristida congesta* and *Pogonarthria squarrosa*. The bird composition is composed of typical grassland taxa dominated by insectivorous and granivore passerine bird species such as Desert Cisticola, (*Cisticola aridulus*), Cloud Cisticola (*C. textrix*), Melodious Lark (*Mirafra cheniana*), Rufous-naped Lark (*Mirafra africana*), Eastern Clapper Lark (*Mirafra fasciolata*), African Pipit (*Anthus cinnamomeus*) and during the peak dry season also Plain-backed Pipit (*Anthus leucophrys*) and Capped Wheatear (*Oenanthe pileata*). Prominent non-passerine species include Orange River Francolin (*Scleroptila gutturalis*), Swainson's Spurfowl (*Pternistis swainsonii*), Northern Black Korhaan (*Afrotis afraoides*) and, Crowned Lapwing (*Vanellus coronatus*).

   The bush clumps form a prominent mosaic characterised by the dominance of a woody layer of *Searsia lancea, Vachellia karoo* and *Asparagus laricinus*. In some areas localised disturbances, was responsible for the proliferation of agrestal weeds and secondary graminoids such as *Bidens cf. biternata, Tagetes minuta, Eragrostis curvula* and *Hyparrhenia hirta*. The occurrence of bush clumps were more prominent on the northern parts of the study site and invariably corresponds to dolomite outcrops. The eminent increase in vertical heterogeneity provided by the woody layer is responsible for 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*), Fiscal Flycatcher (*Melaenornis silens*), African Red-eyed Bulbul (*Pycnonotus nigricans*) as well as granivores such as Yellow Canary (*Crithagra flaviventris*), Southern Masked Weaver (*Ploceus velatus*) and Black-faced Waxbill (*Brunhilda erythronotos*). 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*).

2. *Depressions:* This unit is highly localised on the southern section of the study site. It is represented by discrete depressions which become inundated during precipitation events. It is represented by *Cynodon dactylon* and *Verbena bonariense*. This habitat provides habitat for a unique bird composition represented by many smaller wetland-associated passerine species, although larger non-passerines such as waterfowl were uncommon since the presence of open water and lentic conditions were mostly absent, which will discourage waterfowl and shorebirds from utilising this particular habitat. Typical bird species include Zitting Cisticola (*C. juncidis*), Levaillant's Cisticola (*C. tinniens*), Common Waxbill (*Estrilda astrild*) and Lesser Swamp Warbler (*Acrocephalus gracilirostris)*.

3. *Imperata cylindrica seep zones*: This unit is also highly localised on the southern part of the study site and characterised by a seasonal wet conditions which were colonised by tall *Imperata cylindrica* grassland with Seriphium plumosum along the edges. It provides habitat for a unique bird composition represented by many smaller wetland-associated passerine species such as Zitting Cisticola (*Cisticola juncidis*), Levaillant's Cisticola (*C. tinniens*) and African Stonechat (*Saxicola torquata*). It also provides foraging habitat for non-passerine species such as the Blacksmith Lapwing (*Vanellus armatus*) and Hadeda Ibis (*Bostrychia hagedash*), while it holds at least one to two pairs of Marsh Owl (*Asio capensis*).

4. *Valley-bottom seep/stream*: A small perennial valley-bottom seep/stream is located on the south-eastern part of the study site. The upper reaches are permanently inundated and characterised by obligatory wetland-associated vegetation such as *Phragmites australis, Typha capensis, Cyperus* spp., *Nasturtium officinale* which were interspersed by patches of *Imperata cylindrica*. The lower reached are often colonised by dense patches of *Panicum schinzii*. Some parts along the system has formed open ponds which provide foraging and roosting habitat for waterbirds such as Yellow-billed Duck (*Anas undulata*), Egyptian Goose (*Alopochen aegyptiaca*) and South African Shelduck (*Tadorna cana*). The upper reaches also provide ephemeral foraging habitat for the endangered African Marsh Harrier (*Circus ranivorus*).

The study area also consists of four discrete broad-scale habitat units that are of **transformed** nature (Figure 11 and Figure 13):

5. *Agricultural land*: These are represented commercial cultivated land which is used for the production of maize. The bird composition is often of low richness and composed of generalist taxa such as Speckled Pigeon (*Columba guinea*), Ring-necked Dove (*Streptopelia capicola*) and Cape Sparrow (*Passer melanurus*).

6. *Eucalyptus plantations*: These areas are represented exotic plantations consisting of *Eucalyptus* spp. In general this habitat provides habitat for a poor richness of bird species, although on the study site the vertical heterogeneity was responsible for a diverse assemblage of bird species which included Swallow-tailed Bee-eater (*Merops hirundineus*), Orange River White-eye (*Zosterops pallidus*), Southern Masked Weaver (*Ploceus velatus*), Red-eyed Dove (*Streptopelia semitorquata*), Neddicky (*Cisticola fulvicapilla*), Cape Robin-chat (*Cossypha capensis*), Red-billed Firefinch (*Lagonosticta senegala*) and Cardinal Woodpecker (*Dendropicos fuscescens*).

7. *Rehabilitated grassland and pastures*: These areas are represented by rehabilitated land consisting of monotonous stands of *Chloris cf. gayana* and *Cynodon dactylon* pastures. These often provide habitat for widespread Highveld bird species with dominants such as Desert Cisticola (*Cisticola aridulus*), Ant-eating Chat (*Myrmecocichla formicivora*) and Quailfinch (*Ortygospiza atricollis*).

8. *Pollution control dams*: These areas are confined to the extreme southern part of the study site and are represented by a series of small ponds. These, although of artificial origin, attract a variety of waterbird species which include amongst others species such as Yellow-billed duck (*Anas undulata*), Red-billed Teal (*A. erythrorhyncha*), Egyptian Goose (*Alopochen aegyptiacus*), Red-knobbed Coot (*Fulica cristata*), Common Moorhen (*Gallinula chloropus*), Little Grebe (*Tachybaptus ruficollis*) and Reed Cormorant (*Microcarbo africanus*).

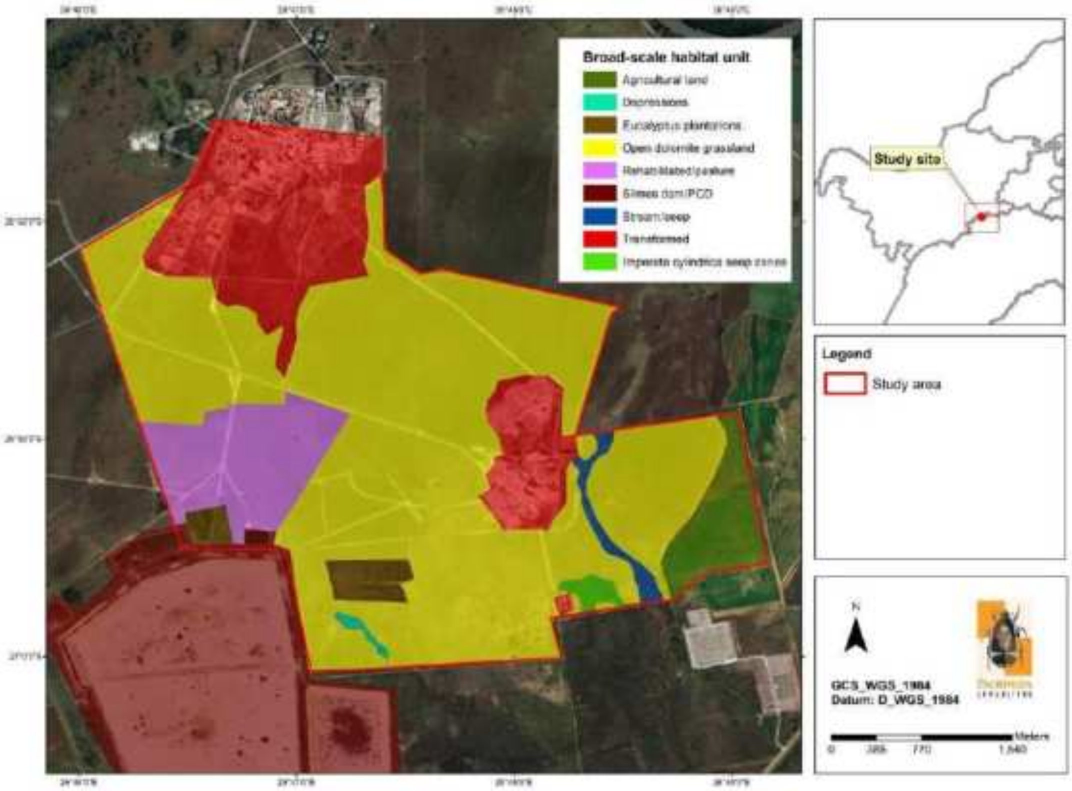
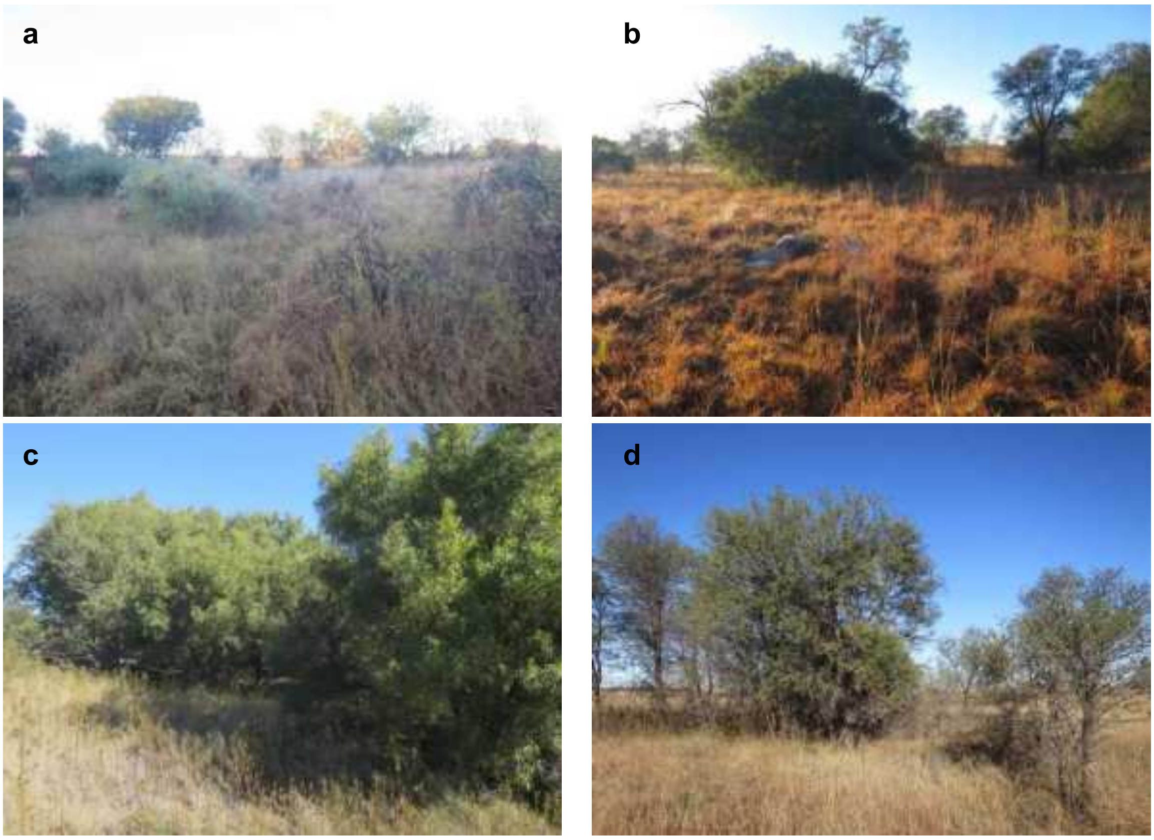


Figure 11: A map illustrating the avifaunal habitat types on the study and development areas.



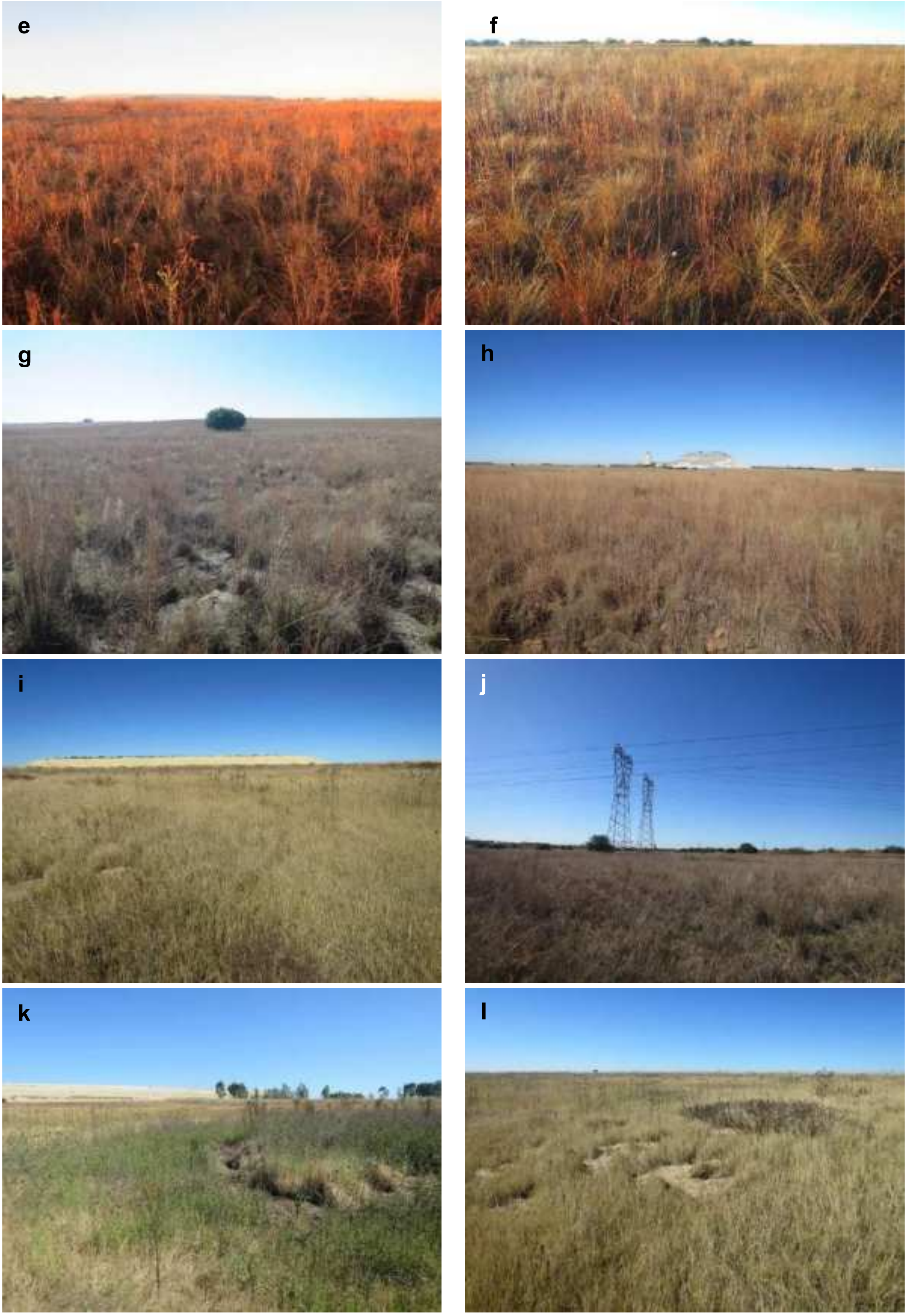

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Figure 12: A collage of images illustrating examples of avifaunal habitat types confined to untransformed broad-scale habitat units: (a - j) open dolomite grassland and bush clumps (k - l) depressions, (m - p) *Imperata cylindrica*-dominated seeps and (q - v) valley-bottom seep/stream.

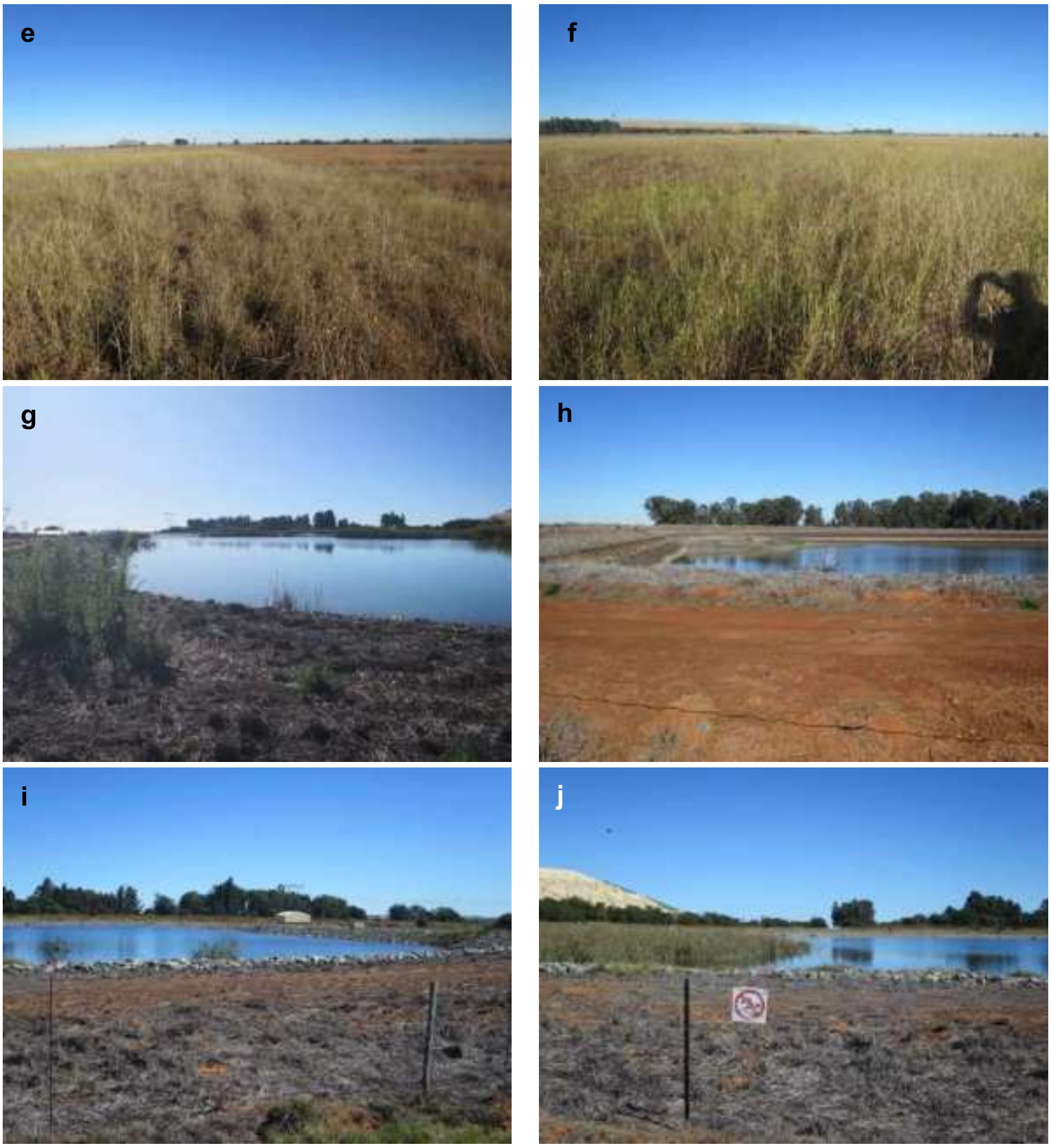

Figure 13: A collage of images illustrating examples of avifaunal habitat types confined to transformed broad-scale habitat units: (a - d) *Eucalyptus* plantations (e - f) rehabilitated grassland and pastures and (g - j) pollution control dams.

4.2 Species Richness and Summary statistics

Approximately 222 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. The expected richness is also strongly correlated with favourable environmental conditions (e.g. during good rains) and seasonality (e.g. when migratory species are present). This equates to 22 % of the approximate 987[2] species listed for the southern African subregion[3] (and approximately 25 % of the 871 species recorded within South Africa[4]). However, the species richness obtained from the pentad grid 2655_2645 corresponding to the study area[5] is lower than the expected number of species with an average of 57.3 species recorded for each full protocol card submitted (for observation of two hours or more; range = 33 - 94 species). The lower richness is explained due to the spatial scale of the pentad grid and habitat variability, whereby the study site is much smaller in surface area and will encompass less habitat variability (as opposed to a larger surface area, e.g. the 2655_2645 also incorporate habitat unit which consists of the Vaal River and tributaries, urban gardens and parks, wetlands and extensive *Vachellia* woodland).

According to field observations (May and July 2022), the total number of species observed on the study area is *ca.* 109 species (see Appendix 1). It shows that the surveys on the study area produced a higher tally when compared to the average richness recorded for the corresponding pentad grid and were regarded as sufficient. On a national scale, the species richness per pentad on the study area is considered to be high (refer to Figure 14).

According to Table 1, the study area is poorly represented by biome-restricted[6] (see Table 2) and local endemic bird species. However, the observed ratio of regional endemic species and near-endemic species is high when compared to the expected number of species, which suggests that most of the endemic species that could occur on the study site was observed during the surveys. Approximately 13 threatened or near threatened species is known to be present in the wider study area with only four recorded within the pentad grid corresponding to the study site (threatened or near threatened species were absent during the surveys). Furthermore, 16 southern African endemics and 11 near-endemic species were confirmed on the study site and the immediate surroundings (Table 3). Waterbird

[1] The expected richness statistic was derived from the pentad grid 2655_2645 totalling 226 bird species and modified according to habitat suitability, personal observations and probability of occurrence (based on 64 submitted cards, 54 being full protocol cards and 10 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 Including observations made during the May 2022 and July 2022 surveys.

[6] A species with a breeding distribution confined to one biome. Many biome-restricted species are also endemic to southern Africa.

species were present on the pollution control dams and along the valley-bottom seep/streams (mainly Yellow-billed duck *Anas undulata*, Red-knobbed Coot *Fulica cristata*, Common Moorhen *Gallinula chloropus* and Little Grebe *Tachybaptus ruficollis*), along with regular fly-overs of South African Shelduck (*Tadorna cana*) and Egyptian Goose (*Alopochen aegyptiacus*).

The 2022 surveys also detected three bird species that are novel (new) species, which were observed for the first time within pentad grid 2655_2645. These species were previously overlooked. These include:

- Southern Boubou (*Laniarius ferruginea*) - observed from (and highly vocal) *Eucalyptus* plantations.
- Cape Grassbird (*Sphenoeacus afer*) - observed from moist rank grassland bordering a slimes dam; and
- Fiery-necked Nightjar (*Caprimulgus pectoralis*) - an adult male flushed observed (flushed) within a *Eucalyptus* plantation.

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*	222 (25 %)	109 (49 %)
Number of Red Listed species**	13 (9 %)#	0 (0 %)
Number of biome-restricted species – Zambezian and Kalahari-Highveld Biomes*	3 (21%)	3 (100 %)
Number of local endemics (BirdLife SA, 2022)*	2 (5 %)	2 (100 %)
Number of local near-endemics (BirdLife SA, 2022)*	8 (27 %)	7 (88 %)
Number of regional endemics (Hockey *et al.,* 2005)**	18 (17 %)	16 (89 %)
Number of regional near-endemics (Hockey *et al.,* 2005)**	17 (28 %)	11 (65 %)

* 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.

Includes taxa recorded from pentad grids adjacent to 2655_2645.

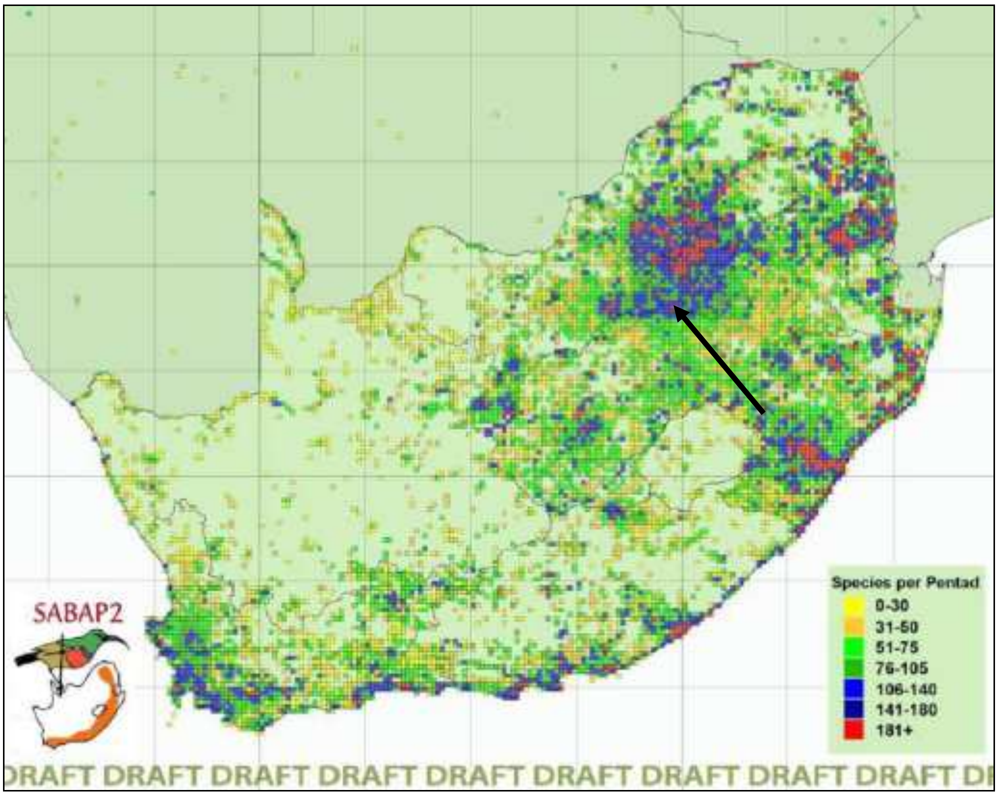

Figure 14: The bird species richness per pentad grid in comparison to the broader study area (see arrow) (map courtesy of SABAP2 and the Animal Demography Unit). According to the SABAP2 database, the study area hosts over 181 bird species.

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		Common (restricted to bush clumps)
White-throated Robin-chat (*Cossypha humeralis*))		X	Fairly common (restricted to dense/large bush clumps)
White-bellied Sunbird (*Cinnyris talatala*)		X	Uncommon

Table 3: Important bird species 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 (May & Jul. 2022)	Collision with power lines	Collision with PV panels	Displacement (disturbance & loss of habitat)
Martial Eagle	*Polemaetus*	EN	EN		1		

Common Name	Scientific name	Regional Status	Global Status	Observed (May & Jul. 2022)	Collision with power lines	Collision with PV panels	Displacement (disturbance & loss of habitat)
	bellicosus						
Curlew Sandpiper	*Calidris ferruginea*		NT			1	
South African Shelduck	*Tadorna cana*	End		1	1	1	
Cape Shoveller	*Anas smithii*	End			1	1	
Northern Black Korhaan	*Afrotis afraoides*	End		1	1		1
White-backed Mousebird	*Colius colius*	End		1			1
Melodious Lark	*Mirafra cheniana*	End		1			1
Karoo Thrush	*Turdus smithi*	End					1
Ant-eating Chat	*Myrmecocichla formicivora*	End		1			1
White-throated Robin-chat	*Cossypha humeralis*	End		1			1
Fiscal Flycatcher	*Melaenornis silens*	End		1			1
Fairy Flycatcher	*Stenostira scita*	End		1			1
Cape Grassbird	*Sphenoeacus afer*	End		1			1
Cape Longclaw	*Macronyx capensis*	End		1			1
Southern Boubou	*Laniarius ferrugineus*	End		1			1
Cape White-eye	*Zosterops virens*	End		1			1
Cape Weaver	*Ploceus capnesis*	End		1			1
Orange River White-eye	*Zosterops pallidus*	End		1			1
South African Cliff Swallow	*Petrochelidon spilodera*	End		1			1
Orange River Francolin	*Scleroptila gutturalis*	N-end		1	1		1
Natal Spurfowl	*Pternistis natalensis*	N-end			1		1
Acacia Pied Barbet	*Tricholaema leucomelas*	N-end		1			1
Eastern Clapper Lark	*Mirafra fasciolata*	N-end		1			1
Pink-billed Lark	*Spizocorys conirostris*	N-end					1
Ashy Tit	*Parus cinerascens*	N-end					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
Bokmakierie	*Telophorus zeylonus*	N-end					1
Cape Sparrow	*Passer melanurus*	N-end		1			1
Scaly-feathered Weaver	*Sporopipes squamifrons*	N-end		1			1
Shaft-tailed Whydah	*Vidua regia*	N-end					1
Yellow Canary	*Crithagra flaviventris*	N-end		1			1

Common Name	Scientific name	Regional Status	Global Status	Observed (May & Jul. 2022)	Collision with power lines	Collision with PV panels	Displacement (disturbance & loss of habitat)
Cloud Cisticola	*Cisticola textrix*	N-end		1			1
Caspian Tern	*Hydroprogne caspia*	VU				1	
Yellow-billed Stork	*Mycteria ibis*	EN			1		
	Totals:	**36**	**2**	**25**	**7**	**4**	**31**

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 between 80-90 % 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 20 point counts (Figure 15). The sampling captured approximately 67.88% of the number of species predicted by the Michaelis-Menten model at 16 point counts. Approximately 84% of the species was captured by 60 counts. Sampling effort was considered sufficient and recorded most of the species present on the study area during the respective survey sessions.

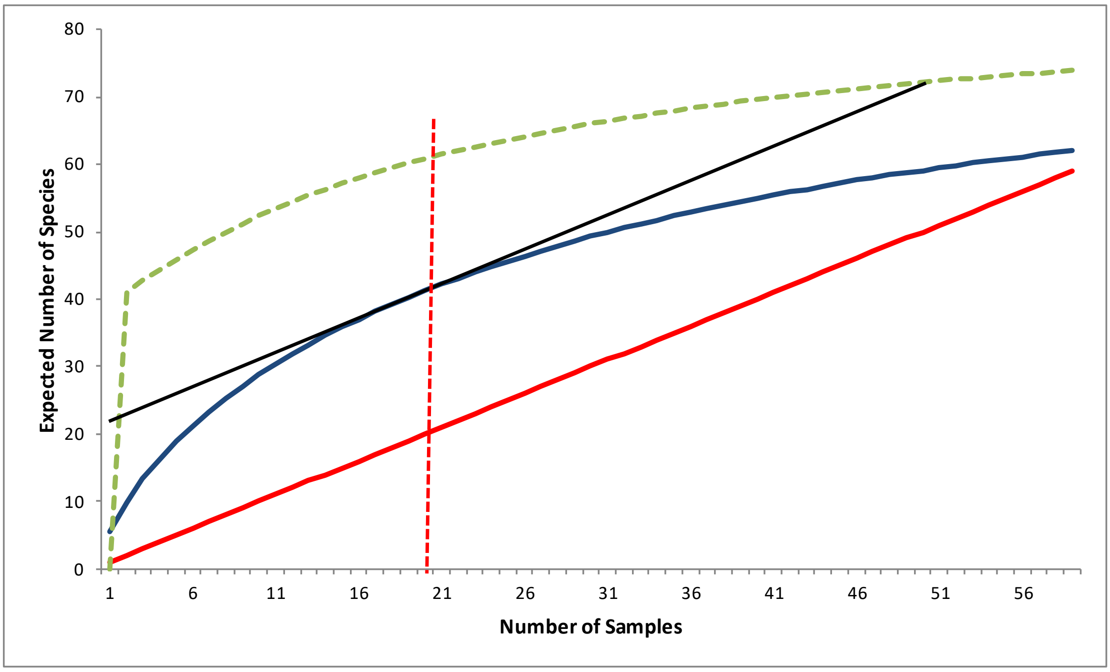

Figure 15: The species accumulation curve (SAC) (red line) for bird points sampled during the May 2022 and July 2022 survey sessions. The blue line represents an accumulation of one species for every additional point count. The black line is parallel to the blue one and is tangent to the SAC approximately after 20 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 13 species have been recorded in the wider study area (sensu SABAP2) which include four globally threatened species, three globally near threatened species, four regionally threatened bird species and two regionally near threatened species. In addition, only four of these species have been recorded within the study site (sensu pentad grid scale) which include the globally endangered Martial Eagle (*Polemaetus bellicosus*), globally near threatened Curlew Sandpiper (*Calidris ferruginea*), the regionally vulnerable Caspian Tern (*Hydroprogne caspia*) and the regionally endangered Yellow-billed Stork (*Mycteria ibis*).

It is evident from Table 4 that these most of the species have reporting rates less than 2 % which suggests that these species are highly irregular visitors to the development area due to the absence of suitable habitat on the study site. However, suitable habitat, depending on water levels and the environmental conditions (e.g. salinity, presence of resources) dictate that most of the waterbird taxa could occur along the impoundment that is located approximately 700m east of the study site (as opposed to occurring on the study site). This is the only habitat feature in the study region that is likely to have high probability to sustain bird waterbird and wading bird species with a high probability to occur within the study region.

Nevertheless, species with reporting rates over 1-2% could potentially occur on the study area, which include the occasional occurrence of the regionally vulnerable Lanner Falcon (*Falco biarmicus*) and the regionally near threatened Abdim's Stork (*Ciconia abdimii*). From the SABAP2 data it is also evident that high reporting rates occur for the occurrence of the vulnerable Caspian Tern (*Hydroprogne caspia*). However, most of the observations in the study area stem from the nearby Vaal River which comprises of dispersing/foraging individuals which disperse between Bloemhof Dam and the Vaal Dam (this species has previously bred at both sites), although the probability that this species could occur on the study site is low.

In addition, the valley-bottom seep/stream on the eastern part of the study site provides suitable foraging habitat for the regionally endangered African Marsh Harrier (*Circus ranivorus*), although this species was not observed during the respective surveys. Although it was only observed from the northern study region (Figure 16), all potential habitat should be conserved (as a precautionary principle) which include the seep zone as delineated on the eastern part of the study site.

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**	Mean Reporting rate: SABAP2: Nine pentad grids	Mean Reporting rate: SABAP2: 2655_2645	Preferred Habitat	Potential Likelihood of Occurrence
Ciconia abdimii (Abdim's Stork)	-	Near threatened	1.11 (eight observations)	-	Open stunted grassland, fallow land and agricultural fields.	An uncommon summer foraging visitor to areas consisting of secondary grassland or arable land.
Falco biarmicus (Lanner Falcon)	-	Vulnerable	2.8 (23 observations)	-	Varied, but prefers to breed in mountainous areas.	An occasional foraging visitor to the study site. Currently only known from habitat adjacent to the study site.
Calidris ferruginea (Curlew	Near-threatened	-	0.41 (three observations)	1.85 (single observation)	Restricted to permanent wetlands with	Highly uncommon to irregular summer foraging

Species	Global Conservation Status*	National Conservation Status**	Mean Reporting rate: SABAP2: Nine pentad grids	Mean Reporting rate: SABAP2: 2655_2645	Preferred Habitat	Potential Likelihood of Occurrence
Sandpiper)					extensive reedbeds.	visitor. Probably absent due to the absence of suitable habitat on the physical study site. It could occur along the shoreline of the dam located to the east of the study site on Farm Doornkom-Oost 447 (approx. 700m east of site boundary).
Circus ranivorus (African Marsh Harrier)	-	Endangered	0.14 (single observation)	-	Restricted to permanent wetlands with extensive reedbeds.	Probably absent from the study site, ephemeral foraging habitat observed along the valley-bottom wetland on the eastern part of the study site. Only known from a single observation during 2017 in the wider study region. (sensu SABAP2).
Glareola nordmanni (Black-winged Pratincole)	Near threatened	Near threatened	0.14 (singe observation)	-	Varied, but forages over open short grassland, pastures and agricultural lands (especially when being tilled)	A highly irregular foraging summer visitor to the to the study site. Only known from a single observation during 2010 in the wider study region. (sensu SABAP2).
Phoenicopterus roseus (Greater Flamingo)	-	Near-threatened	0.56 (five observations)	-	Restricted to large saline pans and other inland water bodies.	A highly irregular foraging visitor to the to the study site. Probably absent on the physical study site due to the absence of

Species	Global Conservation Status*	National Conservation Status**	Mean Reporting rate: SABAP2: Nine pentad grids	Mean Reporting rate: SABAP2: 2655_2645	Preferred Habitat	Potential Likelihood of Occurrence
						suitable habitat. It could occur on the dam (depending water levels and resource conditions) located to the east of the study site on Farm Doornkom-Oost 447 (approx. 700m east of site boundary).
Phoeniconaias minor (Lesser Flamingo)	Near-threatened	Near-threatened	0.14 (two observations)	1.85	Restricted to large saline pans and other inland water bodies containing cyanobacteria.	A highly irregular foraging visitor to the to the study site. Probably absent on the physical study site due to the absence of suitable habitat. It could occur on the dam (depending water levels and resource conditions) located to the east of the study site on Farm Doornkom-Oost 447 (approx. 700m east of site boundary).
Polemaetus bellicosus (Martial Eagle)	Endangered	Endangered	0.14 (single observation)	1.85	Varied, from open karroid shrub to lowland savanna.	A highly irregular foraging visitor to the study area. Only known from a single observation during 2010 (sensu SABAP2).
Mycteria ibis (Yellow-billed Stork)	-	Endangered	0.30 (two observations)	1.85 (single observation)	Wetlands, pans and flooded grassland.	An irregular foraging visitor to the to the study site. Suitable habitat is present along the shoreline of the dam (depending water levels and

Species	Global Conservation Status*	National Conservation Status**	Mean Reporting rate: SABAP2: Nine pentad grids	Mean Reporting rate: SABAP2: 2655_2645	Preferred Habitat	Potential Likelihood of Occurrence
						resource conditions) located to the east of the study site on Farm Doornkom-Oost 447 (approx. 700m east of site boundary).
Hydroprogne caspia (Caspian Tern)	-	Vulnerable	2.81 (21 observations)	22.22 (12 observations)	Large impoundments and large pans, also estuaries.	An irregular foraging visitor to the to the study site, probably due to the absence of suitable habitat. Suitable habitat is present along the shoreline of the dam (depending water levels and resource conditions) located to the east of the study site on Farm Doornkom-Oost 447 (approx. 700m east of site boundary). **This species has a high reporting rate for the study area, which is owing to birds observed dispersing along the nearby Vaal River (a major flyway for this species between Bloemhof Dam and the Vaal Dam; it regularly breeds at these sites).**
Gyps africanus (White-backed Vulture)	Critically Endangered	Critically Endangered	0.14 (two observations)	-	Breed on tall, flat-topped trees. Mainly restricted to large rural or game farming areas.	An irregular foraging/scavenging visitor to the study area pending the presence of food/carcasses. Mainly observed overhead.

Species	Global Conservation Status*	National Conservation Status**	Mean Reporting rate: SABAP2: Nine pentad grids	Mean Reporting rate: SABAP2: 2655_2645	Preferred Habitat	Potential Likelihood of Occurrence
Oxyura maccoa (Maccoa Duck)	Endangered	Vulnerable	0.28 (two observations)	-	Large saline pans and shallow impoundments.	Regarded as highly irregular foraging visitor to the study site. It could occur on the dam (depending water levels and resource conditions) located to the east of the study site on Farm Doornkom-Oost 447 (approx. 700m east of site boundary).
Sagittarius serpentarius (Secretarybird)	Endangered	Endangered	0.13 (single observation)	-	Prefers open grassland or lightly wooded habitat.	A highly irregular foraging visitor and probably historically displaced due to anthropogenic activities. It has not been recently observed on the study area (it was last recorded during 2016; *sensu* SABAP2).

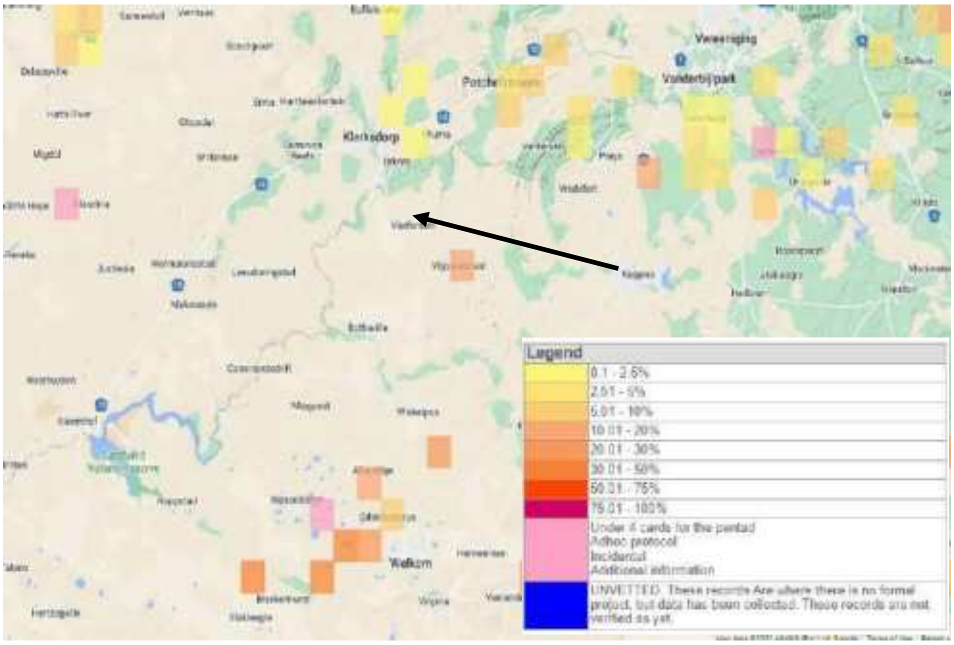

Figure 16: The extant (current) occurrence of African Marsh Harrier (*Circus ranivorus*) on the study area according to SABAP2 reporting rates (the arrow indicates the position of the study site). Note the presence of observations (c. low reporting rates) to the north (Klerksdorp area) and south of the study area (map courtesy and copyright of SABAP2 and Animal Demography Unit).

4.4 Bird Assemblage Structure and Composition

4.4.1 Summary of point counts

A total of 62 bird species and an average abundance of 362 individuals were recorded from 30 bird points (representing two replicative counts) located on the study area. 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 7.63 species and 12.06 individuals were recorded per point count. The average mean number of bird species and the average number of individuals was relatively low when compared to areas with similar habitat units (e.g. dolomite grassland with bush clump habitat) where the mean bird richness and mean number of individuals are receptively >10 and >15. The highest number of species and individuals recorded from a point count was 20 species (manly from tall grassland on undulating topography and from *Eucalyptus* plantations) and between 41 and 47 individuals (manly from tall grassland on undulating topography and from *Eucalyptus* plantations). The lowest number of species and individuals was respectively one species and one individual (highly moribund dolomite grassland). One of the point counts (M28a, on transformed grassland) produced zero birds (for at least 20-30 minutes).

The mean frequency of occurrence of a bird species in the study area was 12.31 % and the median was 6.67%, while the most common value (mode) was 3.33%. The latter represents those species that were encountered in only one point count. Only three species occurred 50% or more of the point counts (c. Desert Cisticola *Cisticola aridulus*, Black-chested Prinia *Prinia flavicans* and Ring-necked Dove *Streptopelia capicola*), while another two species occurred in 30% or more of the counts (Table 5),

Table 5: Bird species with a frequency of occurrence greater than 30% observed on the study area (according to 30 counts).

Species	Frequency (%)	Species	Frequency (%)
Desert Cisticola (*Cisticola aridulus*)	63.33	African Red-eyed Dove (*Pycnonotus nigricans*)	43.33
Black-chested Prinia (*Prinia flavicans*)	60.00	Chestnut-vented Warbler (*Curruca subcaerulea*)	36.67
Ring-necked Dove (*Streptopelia capicola*)	50.00		

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 17 and Figure 18 it is evident that the highest bird numbers were observed from transformed habitat units which comprises of *Eucalyptus* plantations and bush clumps. In addition, the presence of tall canopy tree cover and wetland habitat were also responsible for moderate to high numbers of bird species (Figure 17). Nevertheless, it appeared that bird richness and abundance values on open dolomite and sandy grasslands were relatively low. Therefore, the potential displacement of birds due to the loss of habitat during construction is likely to occur at natural habitat which features the presence of wetland habitat (c. depressions, valley-bottom seeps and *Imperata cylindrica* seep zones) and large natural bush clumps.

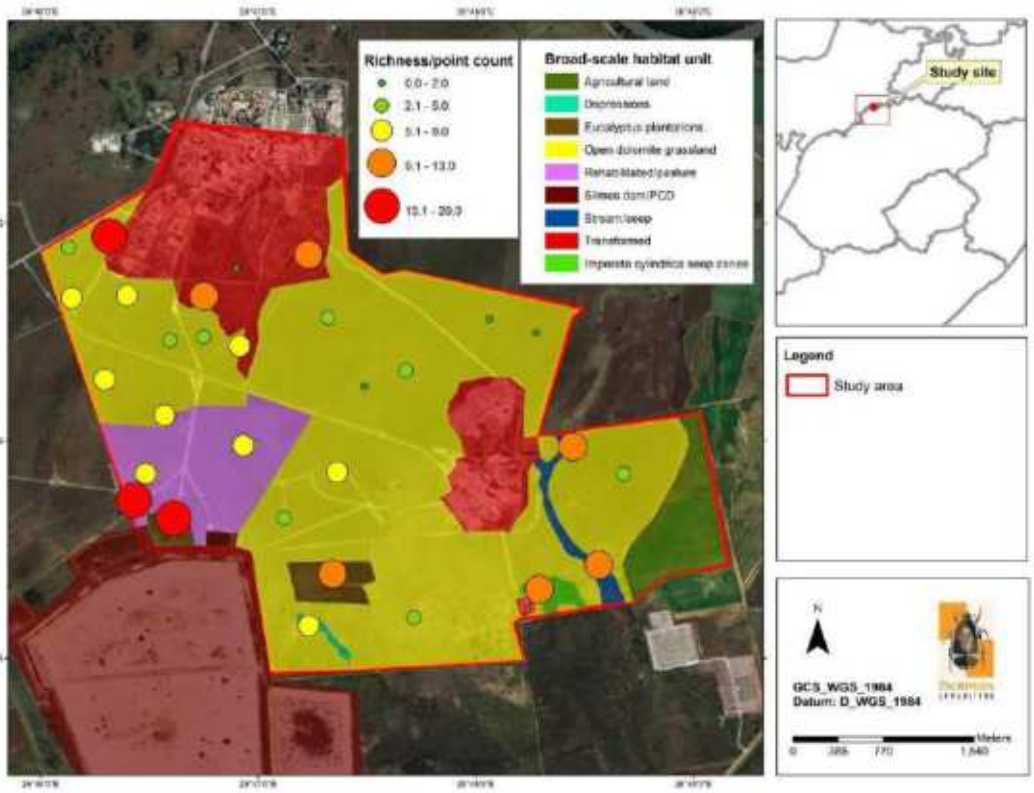

Figure 17: A map of the study area illustrating the spatial distribution of bird richness values (number of species) obtained for each point count.

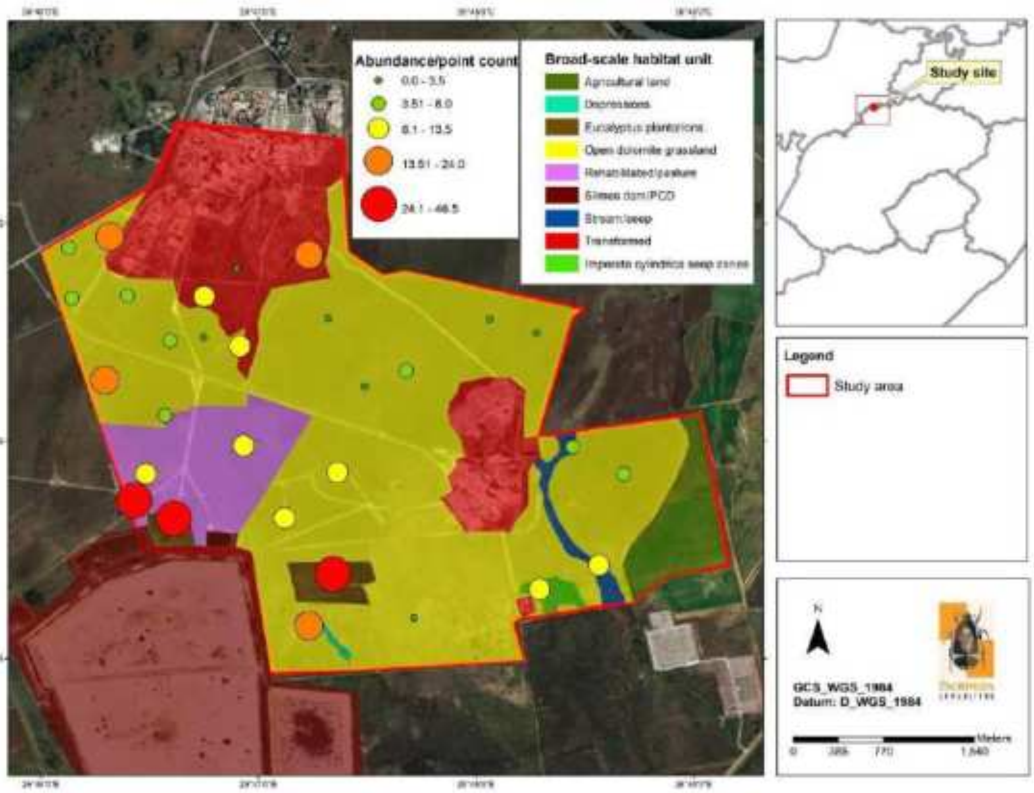

Figure 18: A map of the study area illustrating the distribution of bird abundance values (average number of individuals) obtained for each point count.

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 Desert Cisticola (*Cisticola aridulus*), Black-chested Prinia (*Prinia flavicans*) and Ring-necked Dove (*Streptopelia capicola)*). These species are considered widespread species in the broader study area and occur in most of the habitat types that area present. 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). The Black-chested Prinia (*Prinia flavicans*) and Southern Masked Weaver (Ploceus velatus) are also the two most dominant species (numerically abundant) on the study site.

Table 6: Typical (high frequency of occurrence) bird species on the study area.

Species	Av.Abundance	Consistency (Sim/SD)	Contribution (%)	Primary Trophic Guild
Desert Cisticola (*Cisticola aridulus*)	0.76	0.73	33.14	Insectivore: upper canopy foliage gleaner

Black-chested Prinia (*Prinia flavicans*)	1.17	0.69	19.55	Insectivore: upper canopy foliage gleaner
Ring-necked Dove (*Streptopelia capicola*)	0.72	0.54	11.40	Granivore: ground gleaner
African Red-eyed Bulbul (*Pycnonotus nigricans*)	0.59	0.46	7.69	Frugivore/Insectivore: upper canopy gleaner
Chestnut-vented Warbler (*Curruca subcoerulea*)	0.57	0.37	5.22	Insectivore: upper canopy foliage gleaner
Eastern Clapper Lark (*Mirafra fasciolata*)	0.17	0.26	4.43	Granivore/Insectivore: ground gleaner
Levaillant's Cisticola (*Cisticola tinniens*)	0.36	0.24	2.68	Insectivore: upper canopy foliage gleaner
Southern Masked Weaver (*Ploceus velatus*)	0.91	0.23	1.68	Granivore: lower to ground gleaner

4.4.4 Composition and diversity

Multidimensional scaling and hierarchical agglomerative clustering ordination of bird abundance values obtained from 30 point counts on the study area differentiate between three discrete bird associations (Global R= 0.56, p=0.001; Figure 21), with statistically significant differences between open grassland, *Eucalyptus* plantations/ bush clump mosaics and the wetland-associated habitat (depression/Imperata grassland and valley bottom seeps). The bird composition on the rehabilitated grassland was statistically similar to the natural open grassland units, while the composition on the *Eucalyptus* plantations was similar to that of the bush clump mosaics.

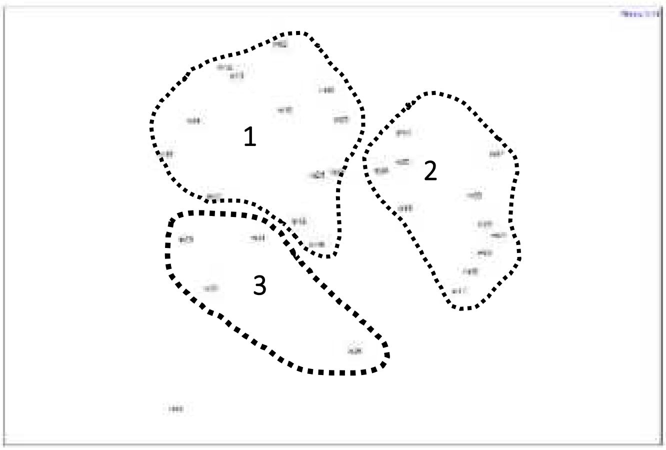

Figure 19: A two-dimensional non-metric multidimensional scaling ordination (stress=0.16) of the relative abundances of bird species based on Bray-Curtis similarities obtained from 30 point counts on the project area. It differentiates between three major bird associations: (1) an association on open grassland habitat,

(2) an association on bush clump mosaics and *Eucalyptus* plantations and (3) an association confined to wetland-associated habitat.

The following bird associations are relevant to the study site and immediate surroundings:

1. Association on open grassland (in the absence of any woody cover)

Dominant species: Desert Cisticola (*Cisticola aridulus*), Eastern clapper Lark (*Mirafra fasciolata*), Black-chested Prinia (*Prinia flavicans*), Ring-necked Dove (*Streptopelia capicola*) and Quailfinch (*Ortygospiza atricollis*).

Indicator species[7]: Ant-eating Chat (*Myrmecocichla formicivora*), Crowned Lapwing (*Vanellus coronatus*) and Quailfinch (*Ortygospiza atricollis*).

2. Association on bush clump mosaics and Eucalyptus plantations

Dominant species: Black-chested Prinia (*Prinia flavicans*), Chestnut-vented Warbler (*Curruca subcoerulea*), Ring-necked Dove (*Streptopelia capicola*), African Red-eyed Dove (*Pycnonotus nigricans*), Southern Masked Weaver (*Ploceus velatus*), Orange river White-eye (*Zosterops pallidus*), Neddicky (*Cisticola fulvicapilla*) and Laughing Dove (*Spilopelia senegalensis*).

Indicator species: Chestnut-vented Warbler (*Curruca subcoerulea*), Neddicky (*Cisticola fulvicapilla*), Orange river White-eye (*Zosterops pallidus*), White-throated Robin-chat (*Cossypha humeralis*), Brown-crowned Tchagra (*Tchagra australis*), Jameson's Firefinch (*Lagonosticta rhodopareia*) and Red-billed Firefinch (*Lagonosticta senegala*).

3. Association on wetland-associated habitat (Valley-bottom seeps, Imperata cylindrica grassland and depressions)

Dominant species: Levaillant's Cisticola (*Cisticola tinniens*), Zitting Cisticola (*C. juncidis*) and African Stonechat (*Saxicola torquatus*).

Indicator species: Marsh Owl (*Asio capensis*), Blacksmith Lapwing (*Vanellus armatus*) and Lesser Swamp Warbler (*Acrocephalus gracilirostris*).

The highest number of bird species on the study area was observed from pans and areas with surface water, followed by the bird association on tall Kathu Bushveld (Table 7). The lowest number of bird species was recorded from dense short Kathus Bushveld.

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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)
Bush Clump Mosaics (incl. *Eucalyptus* plantations)	44	21.5	3.11
Wetland-associated habitat	25	13.25	2.87
Open grassland	24	5.17	2.76

4.5 Passerine bird densities

Forty-six passerine bird species were recorded from 30 point counts on the study area. The study area accommodates approximately 7.69 species.ha^{-1} (Appendix 2). The average density per hectare is 12.26 birds.ha^{-1} and ranges between 1.28 birds.ha^{-1} to 47.44 birds.ha^{-1}.

4.6 Movements/dispersal of Collision-prone birds

The only **regular** movements observed for waterbird species were the South African Shelduck (*Tadorna cana*) and Egyptian Goose (*Alopochen aegyptiacus*) which could potentially collide with the PV infrastructure when visiting nearby water features in the area (Figure 22). Both species were regularly observed (especially in the early mornings) flying across the study site with many individuals also observed perching on the existing pylon structures. Most of these individuals tend to take advantage of the wet conditions created by the foot slopes of the tailing facilities and the control dams. In addition, other waterbird species such as the White-breasted Cormorant (*Phalacrocorax lucidus*) and the Yellow-billed Duck (*Anas undulata*) were also observed flying over the study site, while the latter species was observed roosting on open water pertaining to the valley-bottom seep. A roosting/breeding pair of Marsh Owls (*Asio capensis*) and Gabar Goshawk (*Micronisus capensis*) was also observed on the study site.

The home ranges of approximately three pairs of Northern Black Korhaan (*Afrotis afraoides*) correspond to the study area (Figure 21). These individuals have a high probability to become displaced from the study area due to the loss of habitat to accommodate the PV arrays.

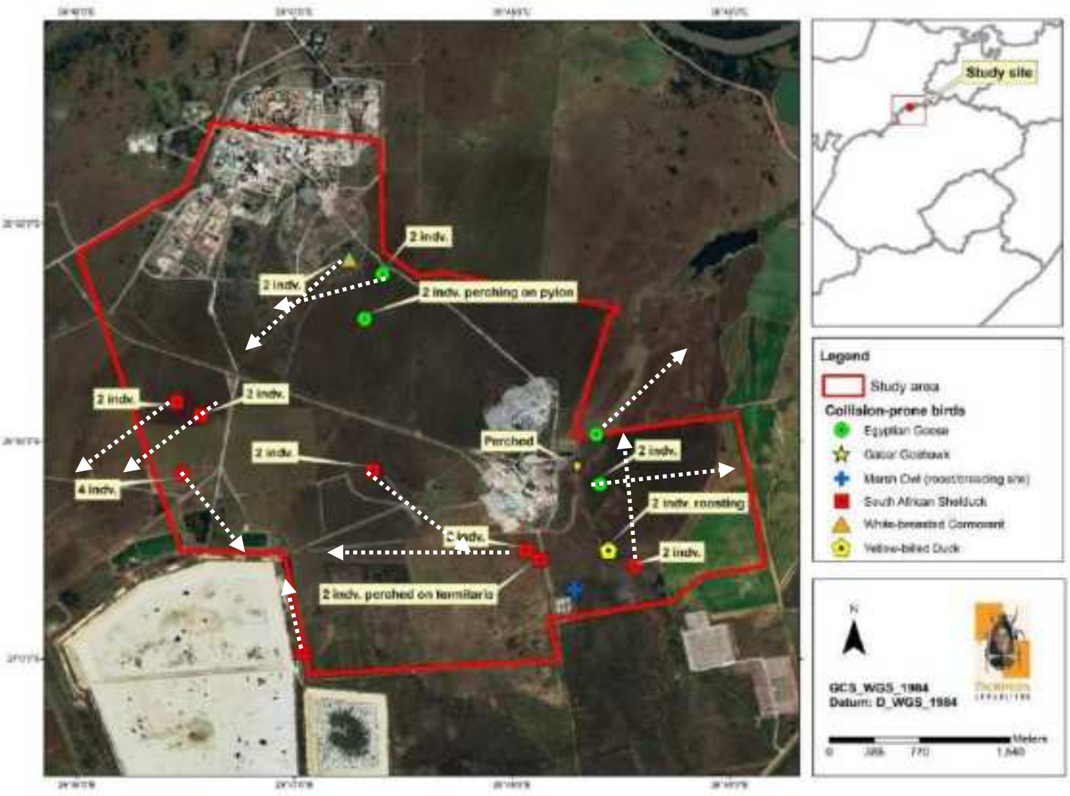

Figure 20: A map of the study site illustrating the occurrence and movements of collision-prone birds.

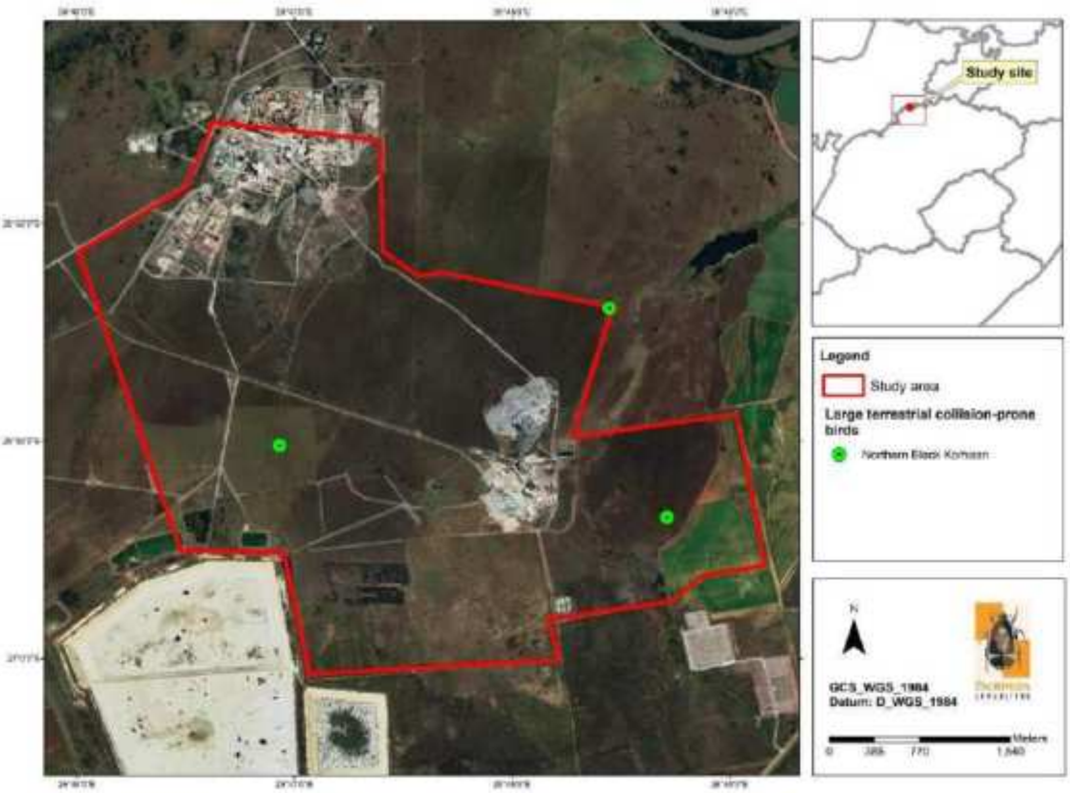

Figure 21: A map of the study area illustrating the occurrence of collision prone terrestrial bird species.

4.7 Avifaunal sensitivity

A sensitivity map was compiled, illustrating habitat units comprising of potential sensitive elements based on the following arguments (Figure 22):

Areas of high sensitivity

The wetland-associated habitat units (c. depressions, pollution control dams, Imperata cylindrica seeps and the valley-bottom seeps) and their respective buffers are of high sensitivity. These features provide habitat for a variety of collision-prone bird species which include waterbird and shorebird taxa. 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

It includes the open grassland and bush clump mosaics which are prominent in the wider study region and provides potential suitable foraging habitat for some collision-prone bird species, including the Northern Black Korhaan (*Afrotis afraoides*) with the potential to interact (e.g. collide) with the proposed electrical infrastructure. In addition, reporting rates for threatened and near threatened bird species are anticipated to be relatively low for these units, thereby suggesting a medium sensitivity rating instead of a high sensitivity even though the majority of the habitat is natural.

Areas of low sensitivity

These habitat units are represented by transformed habitat, mine infrastructure, agricultural and rehabilitated land and the *Eucalyptus* plantations. These habitat types are of artificial origin and although the bird richness was often high on certain parts of these units (e.g. areas with tree cover) most of the bird species are either generalists or have widespread distribution ranges.

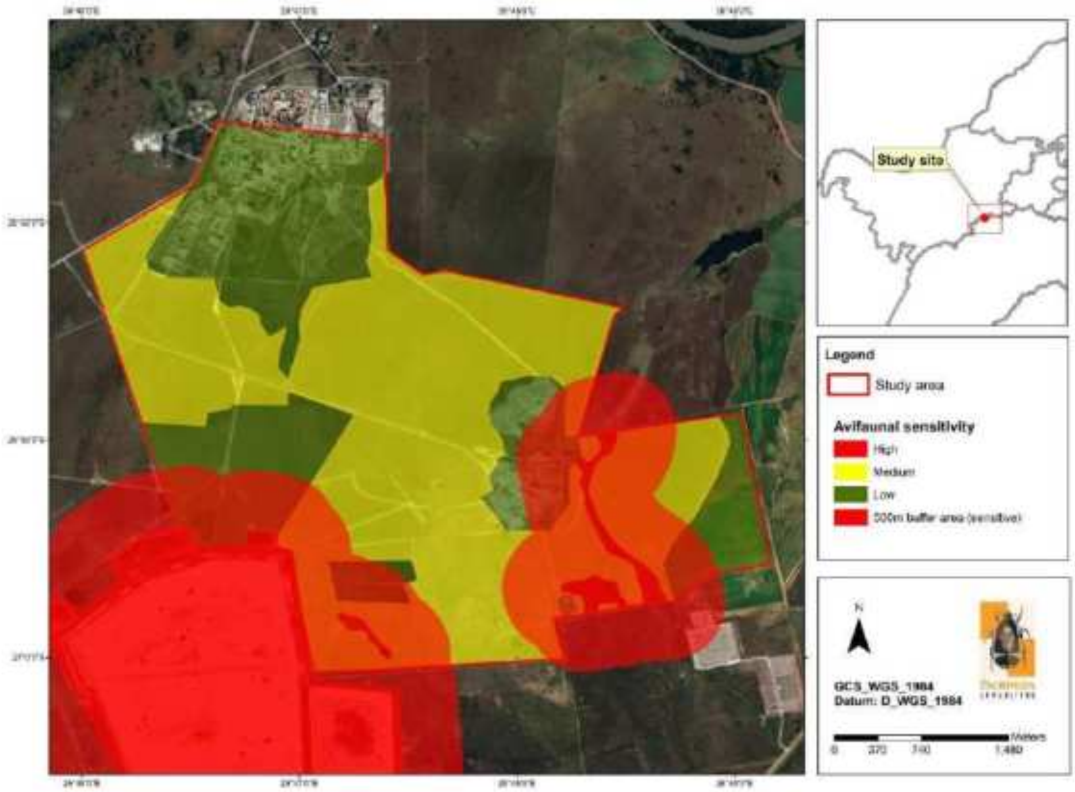

Figure 22: A map illustrating the avifaunal sensitivity of the study area based on habitat types supporting bird taxa of conservation concern and important ecological function.

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 Moab Khotsong Solar Energy Facilities

Table 8 provides a summary of the impacts anticipated and quantification thereof.

4.9.1 Loss of habitat and displacement of birds

Approximately 280 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 7.69 species.ha^{-1} and 12.26 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 open dolomite grassland and bush clump mosaics of medium avifaunal sensitivity, although at least three pairs of Northern Black Korhaan could become displaced.

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*);
- Orange River Francolin (*Scleroptila gutturalis*);
- Melodious Lark (*Mirafra cheniana*);
- White-throated Robin-chat (*Cossypha humeralis*); and potentially also
- Cape Grassbird (*Sphenoeacus afer* - only recently "discovered" on the study site.

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*);
- Speckled Pigeon (*Columba guinea*); and potentially also
- Egyptian Goose (*Alopochen aegyptiacus*).

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 same applies to the locally abundant

Egyptian Goose (*Alopochen aegyptiacus*) which may roost on the infrastructure. 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 wetland-associated habitat units and nearby bodies of surface water (e.g pollution control dams) could increase 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 avoid areas of high sensitivity as illustrated by Figure 22. Appropriate bird deterrent devices should be installed at strategic localities, and these should include a combination of rotating flashers/reflectors to increase the visibility of the infrastructure. In addition, post construction monitoring to quantify mortalities will be important during to early operational phase in order to determine "hotspot" areas (areas where high mortalities are prevalent) which may require additional mitigation measures. Waterbirds with a high frequency of occurrence which could interact with the PV panels are the Egyptian Goose (*Alopochen aegyptiaca*), South African Shelduck (*Tadorna cana*), Yellow-billed Duck (*Anas undulata*) and potentially also White-breasted Cormorant (*Phalacrocorax lucidus*) and Reed Cormorant (*Microcarbo africanus)*).

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*);
- Yellow-billed Duck (*Anas undulata*);
- Red-billed Teal (*Anas erythrorhynchus*);
- Reed Cormorant (*Microcarbo capensis*);
- White-breasted Cormorant (*Phalacrocorax lucidus*);
- African Sacred Ibis (*Threskiornis aethiopicus*) and potentially also
- Little Grebe (*Tachybaptus ruficollis*);
- Red-knobbed Coot (*Fulica cristata*);
- Common Moorhen (*Gallinago chloropus*);
- Black-headed Heron (*Ardea melanocephala*);
- Cape Shoveller (*Anas smithii*);
- African Spoonbill (*Platalea alba*); and
- Black-winged Stilt (*Himantopus himantopus*).

4.9.4 Interaction with overhead powerlines and reticulation

The three proposed solar PV facilities will tie-in to the Vaalreefs 11, Southvaal Plant, and Southvaal (6.6/132 kV) substations via three separate overhead connection lines with a capacity of up to 132kV. However, a number of existing overhead powerlines occur on the study site (see Figure 1) and it is recommended that the proposed overhead corridors be placed alongside these existing powerlines 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 overhead 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	High (8)	Moderate (6)
Probability	Definite (5)	Highly Probable (4)
Significance	**High (70)**	**Medium (48)**
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 medium and low sensitivity. The best practicable mitigation will be to consolidate infrastructure (e.g. proposed powerlines) to areas where existing impacts occur (e.g. placing the proposed powerline alongside existing powerlines) and to avoid areas of high sensitivity.		
Residual: Decreased bird species richness, low evenness values and subsequent loss of avian diversity on a local scale. The impact will also result in sterilisation of local landscapes and 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 completive 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	Site and immediate surroundings (4)	Site and immediate surroundings (3)
Duration	Long-term (4)	Long-term (4)
Magnitude	High (8)	Moderate (6)
Probability	Highly Probable (4)	Probable (3)
Significance	**High (64)**	**Medium (39)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes, potential loss of waterfowl and certain shorebird taxa species.	Yes, potential loss of waterfowl and certain shorebird taxa 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 especially be placed at panels nearest to wetland features, pollution control dams and slimes dams. Security/CCTV cameras may be installed to quantify mortalities (cameras are also installed along the perimeter fence for security measures and may also proved effective to quantify mortalities). Buffer wetland features, slimes dams and pollution control dams by at least 500m. If post-construction monitoring predicts and/or confirms 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.		
Overhead powerline corridors	**Without mitigation**	**With mitigation**
Extent	Local (2)	Local (2)
Duration	Long-term (4)	Long-term (4)
Magnitude	Moderate (6)	Minor (2)
Probability	Highly Probable (4)	Probable (3)
Significance	**Medium (48)**	**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 terrestrial bird and waterbird species.	Yes (to some extent), owing to the potential loss of terrestrial bird and waterbird species.
Can impacts be mitigated?	Yes	Yes
Mitigation: Apply bird deterrent devices to the power lines and make use of "bird-friendly" pylon structures. It is highly to		

retrofit existing powerlines with bird deterrent devices. 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 proposed corridors are 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.

Overhead powerline corridors	**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 terrestrial bird and waterbird species.	Yes (to some extent), owing to the potential loss of terrestrial bird and waterbird species.
Can impacts be mitigated?	Yes, to some extent	Yes, to some extent

Mitigation:
Avoid the placement of overhead electrical infrastructure in close proximity to wetland features and pollution control dams. Make use of bird-friendly pylons and bird guards as recommended by EWT.

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 76 collision-prone bird species have been recorded in the wider study area, of which 13 species are birds of prey and 54 are waterbirds/shorebird taxa (Table 9). Collision-prone species with the highest probability to occur along the power-line servitude includes the Helmeted Guineafowl (*Numida meleagris*), Speckled Pigeon (*Columba guinea*), Pied Crow (*Corvus albus*), Northern Black Korhaan (*Afrotis afraoides*), South African Shelduck (*Tadorna cana*), Egyptian Goose (*Alopochen aegyptiacus*), Yellow-billed Duck (*Anas undulata*) and White-breasted Cormorant (*Phalacrocorax lucidus*). According to Table 9, it is evident that the number of potential collision-prone waterbird and shorebird taxa in the wider study area is high (c. 71% 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). Species highlighted in red refers to threatened of near threatened species (sensu Taylor et al, 2015; IUCN, 2022).

Common Name	Scientific Name	SABAP2 Reporting Rate	
		Full Protocol (%)	Ad hoc Protocol (%)
African Black Duck	*Anas sparsa*	3.70	0.00
African Crake	*Crecopsis egregia*	1.85	0.00
African Darter	*Anhinga rufa*	51.85	10.00
African Fish Eagle	*Haliaeetus vocifer*	31.48	0.00
African Rail	*Rallus caerulescens*	1.85	0.00
African Sacred Ibis	*Threskiornis aethiopicus*	5.56	0.00
African Snipe	*Gallinago nigripennis*	3.70	0.00
African Spoonbill	*Platalea alba*	5.56	0.00
African Swamphen	*Porphyrio madagascariensis*	14.81	0.00
Amur Falcon	*Falco amurensis*	9.26	0.00
Black Crake	*Zapornia flavirostra*	20.37	0.00
Black Heron	*Egretta ardesiaca*	9.26	0.00
Black-headed Heron	*Ardea melanocephala*	20.37	10.00
Black-necked Grebe	*Podiceps nigricollis*	1.85	0.00
Black-winged Kite	*Elanus caeruleus*	38.89	20.00
Black-winged Stilt	*Himantopus himantopus*	11.11	0.00
Blue-billed Teal	*Spatula hottentota*	5.56	0.00
Cape Shoveler	*Spatula smithii*	9.26	10.00
Caspian Tern	*Hydroprogne caspia*	22.22	0.00
Common (Steppe) Buzzard	*Buteo buteo vulpinus*	12.96	0.00
Common Greenshank	*Tringa nebularia*	1.85	0.00
Common Moorhen	*Gallinula chloropus*	44.44	0.00
Common Myna	*Acridotheres tristis*	72.22	0.00
Common Sandpiper	*Actitis hypoleucos*	9.26	0.00
Curlew Sandpiper	*Calidris ferruginea*	1.85	0.00
Egyptian Goose	*Alopochen aegyptiaca*	68.52	20.00
Gabar Goshawk	*Micronisus gabar*	5.56	0.00
Giant Kingfisher	*Megaceryle maxima*	7.41	0.00
Glossy Ibis	*Plegadis falcinellus*	7.41	10.00
Goliath Heron	*Ardea goliath*	1.85	0.00
Great Crested Grebe	*Podiceps cristatus*	1.85	0.00
Great Egret	*Ardea alba*	3.70	0.00
Greater Kestrel	*Falco rupicoloides*	3.70	20.00
Grey Heron	*Ardea cinerea*	40.74	10.00
Grey-headed Gull	*Chroicocephalus cirrocephalus*	5.56	0.00
Hadada Ibis	*Bostrychia hagedash*	72.22	10.00
Hamerkop	*Scopus umbretta*	7.41	0.00

Helmeted Guineafowl	*Numida meleagris*	68.52	10.00
Intermediate Egret	*Ardea intermedia*	0.00	10.00
Lesser Kestrel	*Falco naumanni*	1.85	0.00
Little Bittern	*Ixobrychus minutus*	3.70	0.00
Little Egret	*Egretta garzetta*	9.26	0.00
Little Grebe	*Tachybaptus ruficollis*	38.89	0.00
Little Stint	*Calidris minuta*	9.26	0.00
Long-crested Eagle	*Lophaetus occipitalis*	1.85	0.00
Marsh Owl	*Asio capensis*	3.70	10.00
Marsh Sandpiper	*Tringa stagnatilis*	3.70	0.00
Martial Eagle	*Polemaetus bellicosus*	1.85	0.00
Natal Spurfowl	*Pternistis natalensis*	29.63	0.00
Northern Black Korhaan	*Afrotis afraoides*	42.59	0.00
Orange River Francolin	*Scleroptila gutturalis*	3.70	0.00
Peregrine Falcon	*Falco peregrinus*	1.85	0.00
Pied Avocet	*Recurvirostra avosetta*	1.85	0.00
Pied Crow	*Corvus albus*	66.67	10.00
Pied Kingfisher	*Ceryle rudis*	20.37	0.00
Purple Heron	*Ardea purpurea*	12.96	0.00
Red-billed Teal	*Anas erythrorhyncha*	22.22	0.00
Red-knobbed Coot	*Fulica cristata*	40.74	20.00
Reed Cormorant	*Microcarbo africanus*	61.11	10.00
Ruff	*Calidris pugnax*	5.56	0.00
South African Shelduck	*Tadorna cana*	24.07	0.00
Southern Pochard	*Netta erythrophthalma*	1.85	0.00
Spotted Eagle-Owl	*Bubo africanus*	3.70	10.00
Spur-winged Goose	*Plectropterus gambensis*	38.89	30.00
Squacco Heron	*Ardeola ralloides*	7.41	0.00
Swainson's Spurfowl	*Pternistis swainsonii*	48.15	10.00
Western Barn Owl	*Tyto alba*	1.85	0.00
Western Cattle Egret	*Bubulcus ibis*	50.00	10.00
Whiskered Tern	*Chlidonias hybrida*	7.41	0.00
White-breasted Cormorant	*Phalacrocorax lucidus*	31.48	0.00
White-browed Sparrow-Weaver	*Plocepasser mahali*	64.81	20.00
White-faced Whistling Duck	*Dendrocygna viduata*	11.11	10.00
White-winged Tern	*Chlidonias leucopterus*	1.85	0.00
Wood Sandpiper	*Tringa glareola*	11.11	0.00
Yellow-billed Duck	*Anas undulata*	79.63	20.00
Yellow-billed Stork	*Mycteria ibis*	1.85	0.00

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.

According to the National Screening Report (generated 25/04/2022), there is currently eight solar PV facilities with an approved environmental authorisation under consideration within 30km of the proposed Harmony Moab Khotsong PV facility (Table 10). Four of these are within 2.3 km of the study site.

Table 10: Solar developments with an approved Environmental Authorisation or applications under consideration within 30 km of the proposed area (sensu the results of the National Screening Tool).

No	EIA Reference No	Classification	Status of application	Distance from proposed area (km)
1	12/12/20/2513/3	Solar PV	Approved	2.3
2	14/12/16/3/3/2/777	Solar PV	Approved	6.5
3	12/12/20/2513/1	Solar PV	Approved	2.3
4	12/12/20/2513/2	Solar PV	Approved	5.2
5	14/12/16/3/3/2/954	Solar PV	Approved	20.7
6	12/12/20/2513/1/AM3	Solar PV	Approved	2.3
7	12/12/20/2513/4	Solar PV	Approved	2.3
8	14/12/16/3/3/2/778	Solar PV	Approved	8.4

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 11.

Table 11: 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	Moderate (6)	Moderate (6)
Probability	Highly Probable (4)	Highly Probable (4)
Significance	**Medium (48)**	**Medium (52)**

Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Loss of resources?	Yes	Yes
Can impacts be mitigated?	To some extent	To some extent
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 (e.g. proposed powerline) to areas where existing impacts occur (e.g. placing the proposed powerline alongside existing powerlines) and to concentrate infrastructure on land with a low biodiversity conservation value.		
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	Site and immediate surroundings (3)	Local and immediate surroundings (3)
Duration	Long-term (4)	Long-term (4)
Magnitude	Moderate (6)	High (8)
Probability	Probable (3)	Highly Probable (4)
Significance	**Medium (39)**	**Medium (60)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes, potential loss of waterfowl and certain shorebird taxa species.	Yes, potential loss of waterfowl and certain shorebird taxa species.
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. Apply appropriate buffer zones to water features and wetlands.		
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 (36)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes, potential loss of waterfowl and certain shorebird taxa species.	Yes, potential loss of waterfowl and certain shorebird taxa species.
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**.**		
	Without mitigation	**With mitigation**
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)**	**Medium (36)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes, potential loss of waterfowl and certain shorebird taxa species.	Yes, potential loss of waterfowl and certain shorebird taxa species.
Can impacts be mitigated?	Yes, to some extent	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 overhead power lines 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) to discourage birds from colonising/colliding with the infrastructure. Bird deterrent devices should especially be placed at panels nearest to ("facing") wetland features, bodies of water and slimes dams 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. An option is to employ video cameras at selected areas to document bird mortalities.
- Buffer all wetland-associated habitat, pollution control dams as well as slimes dams by at least 500m.
- 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 23[8].

From Figure 23 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).

Figure 23: 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 24). The maximum distance between the diverters should not exceed 5 m. For dynamic devices (e.g. Viper live bird flapper), flappers should be

[8] Please note that these are examples of recommended pylon designs. These are taken from steel monopole pylons.

applied to earth wires while alternating between different colours (e.g. between black and yellow or black and red) and should be fitted to the middle 60 % of the span (corresponding to the lower part of the span). All flappers should be spaced at 5 m intervals from each other.

- It is recommended that existing powerlines be retrofitted with bird flight diverters, especially when a wetland/seep/stream/dam/pollution control dam is crossed. The actual crossover span as well as one span on either side of the wetland/seep/stream/dam/pollution control dam should be marked.

Figure 24: Examples of bird flight diverters to be used on the power lines: Double loop bird flight 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 additional monitoring be implemented to augment existing data:

- At least one additional pre-construction survey is recommended, consisting of a minimum of four 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 3 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 3 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 4 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 4 days.

	• Implement post-construction surveys during operation with a minimum of 3 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 Moab Khotsong Operations Pty (Ltd) to compile an avifauna impact assessment report for three separate solar facilities (referred to as the "Moab Khotsong PV facility") with a combined contracted capacity of up to 100MW located on a site approximately 10km north of the town of Vierfontein in the Free State Province.

Eight avifaunal habitat types were identified on the study site and surroundings, consisting of four untransformed types (ranging from open grassland with bush clump mosaics, depressions, Imperata cylindrica seep zones to a valley-bottom see/stream) and four transformed units (ranging from agricultural land, *Eucalyptus* plantations, rehabilitated grassland and pastures to pollution control dams). The study site was also surrounded by slimes dams and an impoundment to the east (c. 700m from the site), which provided additional habitat for waterbird and shorebird taxa (especially the latter). Approximately 222 bird species are expected to occur in the wider study area, of which 109 species were observed in the study area (during two independent surveys). The expected richness included five threatened or near threatened species, 18 southern African endemics and 17 near-endemic species. However, the occurrence of threatened and near threatened bird species was predicted to be low, although the natural broad-scale habitat units provided foraging habitat for the occasional occurrence of the vulnerable Lanner Falcon (*Falco biarmicus*) and the regionally near threatened Abdim's Stork (*Ciconia abdimii*). In addition, the valley-bottom seep/stream on the eastern part of the study site provides suitable foraging habitat for the regionally endangered African Marsh Harrier (*Circus ranivorus*), although this species was not observed during the respective surveys. Although the African Marsh Harrier was recorded on the study site during the survey period, it was recommended that all potential habitat be conserved (as a precautionary principle) which included the seep zone/stream on the eastern part of the study site. Sixteen 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 (mainly large-bodied waterfowl such as the South African Shelduck *Tadorna cana* and Egyptian Goose *Alopochen aegyptiacus*) colliding with the PV infrastructure remained eminent due to the presence of wetland-associated features and pollution control dams 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 2655_2645 (the eight surrounding grids were also consulted) and from personal observations. The reporting rates include submissions made during the May and July 2022 surveys.

#	Common Name	Scientific Name	Observed (May & July 2022	SABAP2 Reporting Rate			
				Full Protocol (%)	Number of cards	Ad hoc Protocol (%)	Number of cards
432	Acacia Pied Barbet	*Tricholaema leucomelas*	1	74.07	40	0.00	0
95	African Black Duck	*Anas sparsa*		3.70	2	0.00	0
380	African Black Swift	*Apus barbatus*		3.70	2	0.00	0
199	African Crake	*Crecopsis egregia*		1.85	1	0.00	0
52	African Darter	*Anhinga rufa*		51.85	28	10.00	1
833	African Firefinch	*Lagonosticta rubricata*		7.41	4	0.00	0
149	African Fish Eagle	*Haliaeetus vocifer*	1	31.48	17	0.00	0
418	African Hoopoe	*Upupa africana*	1	31.48	17	0.00	0
228	African Jacana	*Actophilornis africanus*		1.85	1	0.00	0
387	African Palm Swift	*Cypsiurus parvus*	1	33.33	18	0.00	0
682	African Paradise Flycatcher	*Terpsiphone viridis*		7.41	4	0.00	0
685	African Pied Wagtail	*Motacilla aguimp*		12.96	7	0.00	0
692	African Pipit	*Anthus cinnamomeus*	1	31.48	17	0.00	0
197	African Rail	*Rallus caerulescens*		1.85	1	0.00	0
544	African Red-eyed Bulbul	*Pycnonotus nigricans*	1	92.59	50	0.00	0
606	African Reed Warbler	*Acrocephalus baeticatus*		46.30	25	0.00	0
81	African Sacred Ibis	*Threskiornis aethiopicus*	1	5.56	3	0.00	0
250	African Snipe	*Gallinago nigripennis*		3.70	2	0.00	0

#	Common Name	Scientific Name	Observed (May & July 2022	SABAP2 Reporting Rate			
				Full Protocol (%)	Number of cards	Ad hoc Protocol (%)	Number of cards
85	African Spoonbill	*Platalea alba*		5.56	3	0.00	0
576	African Stonechat	*Saxicola torquatus*	1	79.63	43	20.00	2
208	African Swamphen	*Porphyrio madagascariensis*		14.81	8	0.00	0
247	African Wattled Lapwing	*Vanellus senegallus*		42.59	23	0.00	0
772	Amethyst Sunbird	*Chalcomitra amethystina*		1.85	1	0.00	0
119	Amur Falcon	*Falco amurensis*		9.26	5	0.00	0
575	Ant-eating Chat	*Myrmecocichla formicivora*	1	12.96	7	0.00	0
514	Ashy Tit	*Melaniparus cinerascens*		7.41	4	0.00	0
510	Banded Martin	*Riparia cincta*		1.85	1	0.00	0
493	Barn Swallow	*Hirundo rustica*	1	29.63	16	20.00	2
622	Bar-throated Apalis	*Apalis thoracica*		11.11	6	0.00	0
203	Black Crake	*Zapornia flavirostra*		20.37	11	0.00	0
64	Black Heron	*Egretta ardesiaca*		9.26	5	0.00	0
650	Black-chested Prinia	*Prinia flavicans*	1	98.15	53	20.00	2
431	Black-collared Barbet	*Lybius torquatus*	1	40.74	22	0.00	0
841	Black-faced Waxbill	*Brunhilda erythronotos*	1	9.26	5	0.00	0
55	Black-headed Heron	*Ardea melanocephala*	1	20.37	11	10.00	1
5	Black-necked Grebe	*Podiceps nigricollis*		1.85	1	0.00	0
245	Blacksmith Lapwing	*Vanellus armatus*	1	98.15	53	10.00	1
860	Black-throated Canary	*Crithagra atrogularis*	1	72.22	39	0.00	0
130	Black-winged Kite	*Elanus caeruleus*	1	38.89	21	20.00	2
270	Black-winged Stilt	*Himantopus himantopus*		11.11	6	0.00	0
839	Blue Waxbill	*Uraeginthus angolensis*	1	51.85	28	0.00	0
99	Blue-billed Teal	*Spatula hottentota*		5.56	3	0.00	0

#	Common Name	Scientific Name	Observed (May & July 2022	SABAP2 Reporting Rate			
				Full Protocol (%)	Number of cards	Ad hoc Protocol (%)	Number of cards
722	Bokmakierie	*Telophorus zeylonus*		11.11	6	0.00	0
823	Bronze Mannikin	*Spermestes cucullata*		1.85	1	0.00	0
443	Brown-backed Honeybird	*Prodotiscus regulus*		9.26	5	0.00	0
714	Brown-crowned Tchagra	*Tchagra australis*	1	53.70	29	0.00	0
402	Brown-hooded Kingfisher	*Halcyon albiventris*		24.07	13	0.00	0
509	Brown-throated Martin	*Riparia paludicola*	1	68.52	37	20.00	2
731	Brubru	*Nilaus afer*		7.41	4	0.00	0
695	Buffy Pipit	*Anthus vaalensis*	1	7.41	4	0.00	0
4131	Burchell's Coucal	*Centropus burchellii*		14.81	8	0.00	0
	Cape Grassbird	*Sphenoeacus afer*	1	n/a			
703	Cape Longclaw	*Macronyx capensis*	1	35.19	19	0.00	0
581	Cape Robin-Chat	*Cossypha caffra*	1	77.78	42	0.00	0
94	Cape Shoveler	*Spatula smithii*		9.26	5	10.00	1
786	Cape Sparrow	*Passer melanurus*	1	50.00	27	0.00	0
737	Cape Starling	*Lamprotornis nitens*	1	57.41	31	0.00	0
316	Ring-necked Dove	*Streptopelia capicola*	1	96.30	52	0.00	0
686	Cape Wagtail	*Motacilla capensis*	1	51.85	28	0.00	0
799	Cape Weaver	*Ploceus capensis*	1	1.85	1	0.00	0
1172	Cape White-eye	*Zosterops virens*	1	16.67	9	0.00	0
568	Capped Wheatear	*Oenanthe pileata*	1	3.70	2	0.00	0
450	Cardinal Woodpecker	*Dendropicos fuscescens*	1	24.07	13	0.00	0
290	Caspian Tern	*Hydroprogne caspia*		22.22	12	0.00	0
658	Chestnut-vented Warbler	*Curruca subcoerulea*	1	96.30	52	0.00	0
673	Chinspot Batis	*Batis molitor*	1	12.96	7	0.00	0

#	Common Name	Scientific Name	Observed (May & July 2022	SABAP2 Reporting Rate			
				Full Protocol (%)	Number of cards	Ad hoc Protocol (%)	Number of cards
872	Cinnamon-breasted Bunting	*Emberiza tahapisi*	1	12.96	7	0.00	0
631	Cloud Cisticola	*Cisticola textrix*	1	5.56	3	0.00	0
154	Common (Steppe) Buzzard	*Buteo buteo vulpinus*		12.96	7	0.00	0
263	Common Greenshank	*Tringa nebularia*		1.85	1	0.00	0
210	Common Moorhen	*Gallinula chloropus*	1	44.44	24	0.00	0
734	Common Myna	*Acridotheres tristis*	1	72.22	39	0.00	0
258	Common Sandpiper	*Actitis hypoleucos*		9.26	5	0.00	0
421	Common Scimitarbill	*Rhinopomastus cyanomelas*		9.26	5	0.00	0
843	Common Waxbill	*Estrilda astrild*	1	16.67	9	0.00	0
594	Common Whitethroat	*Curruca communis*		12.96	7	0.00	0
439	Crested Barbet	*Trachyphonus vaillantii*	1	75.93	41	0.00	0
711	Crimson-breasted Shrike	*Laniarius atrococcineus*		3.70	2	0.00	0
242	Crowned Lapwing	*Vanellus coronatus*	1	68.52	37	0.00	0
251	Curlew Sandpiper	*Calidris ferruginea*		1.85	1	0.00	0
630	Desert Cisticola	*Cisticola aridulus*	1	27.78	15	30.00	3
352	Diederik Cuckoo	*Chrysococcyx caprius*		46.30	25	0.00	0
849	Dusky Indigobird	*Vidua funerea*		1.85	1	0.00	0
1183	Eastern Clapper Lark	*Mirafra fasciolata*	1	9.26	5	0.00	0
89	Egyptian Goose	*Alopochen aegyptiaca*	1	68.52	37	20.00	2
404	European Bee-eater	*Merops apiaster*		29.63	16	20.00	2
678	Fairy Flycatcher	*Stenostira scita*	1	1.85	1	0.00	0
570	Familiar Chat	*Oenanthe familiaris*	1	5.56	3	0.00	0
665	Fiscal Flycatcher	*Melaenornis silens*	1	70.37	38	0.00	0
	Fiery-necked Nightjar	*Caprimulgus pectoralis*	1	n/a			

#	Common Name	Scientific Name	Observed (May & July 2022	SABAP2 Reporting Rate			
				Full Protocol (%)	Number of cards	Ad hoc Protocol (%)	Number of cards
162	Gabar Goshawk	*Micronisus gabar*	1	5.56	3	0.00	0
595	Garden Warbler	*Sylvia borin*		3.70	2	0.00	0
395	Giant Kingfisher	*Megaceryle maxima*		7.41	4	0.00	0
83	Glossy Ibis	*Plegadis falcinellus*		7.41	4	10.00	1
447	Golden-tailed Woodpecker	*Campethera abingoni*		14.81	8	0.00	0
56	Goliath Heron	*Ardea goliath*		1.85	1	0.00	0
4	Great Crested Grebe	*Podiceps cristatus*		1.85	1	0.00	0
58	Great Egret	*Ardea alba*		3.70	2	0.00	0
603	Great Reed Warbler	*Acrocephalus arundinaceus*		11.11	6	0.00	0
122	Greater Kestrel	*Falco rupicoloides*		3.70	2	20.00	2
502	Greater Striped Swallow	*Cecropis cucullata*	1	37.04	20	0.00	0
419	Green Wood Hoopoe	*Phoeniculus purpureus*	1	9.26	5	0.00	0
830	Green-winged Pytilia	*Pytilia melba*	1	20.37	11	0.00	0
54	Grey Heron	*Ardea cinerea*		40.74	22	10.00	1
288	Grey-headed Gull	*Chroicocephalus cirrocephalus*		5.56	3	0.00	0
84	Hadada Ibis	*Bostrychia hagedash*	1	72.22	39	10.00	1
72	Hamerkop	*Scopus umbretta*		7.41	4	0.00	0
192	Helmeted Guineafowl	*Numida meleagris*	1	68.52	37	10.00	1
784	House Sparrow	*Passer domesticus*	1	7.41	4	0.00	0
596	Icterine Warbler	*Hippolais icterina*		7.41	4	0.00	0
60	Intermediate Egret	*Ardea intermedia*		0.00	0	10.00	1
835	Jameson's Firefinch	*Lagonosticta rhodopareia*	1	22.22	12	0.00	0
586	Kalahari Scrub Robin	*Cercotrichas paena*	1	62.96	34	0.00	0
1104	Karoo Thrush	*Turdus smithi*		40.74	22	0.00	0

#	Common Name	Scientific Name	Observed (May & July 2022	SABAP2 Reporting Rate			
				Full Protocol (%)	Number of cards	Ad hoc Protocol (%)	Number of cards
317	Laughing Dove	*Spilopelia senegalensis*	1	90.74	49	20.00	2
706	Lesser Grey Shrike	*Lanius minor*		3.70	2	0.00	0
442	Lesser Honeyguide	*Indicator minor*		9.26	5	0.00	0
125	Lesser Kestrel	*Falco naumanni*		1.85	1	0.00	0
604	Lesser Swamp Warbler	*Acrocephalus gracilirostris*	1	81.48	44	0.00	0
646	Levaillant's Cisticola	*Cisticola tinniens*	1	87.04	47	30.00	3
410	Little Bee-eater	*Merops pusillus*		5.56	3	0.00	0
67	Little Bittern	*Ixobrychus minutus*		3.70	2	0.00	0
59	Little Egret	*Egretta garzetta*		9.26	5	0.00	0
6	Little Grebe	*Tachybaptus ruficollis*	1	38.89	21	0.00	0
609	Little Rush Warbler	*Bradypterus baboecala*	1	18.52	10	0.00	0
253	Little Stint	*Calidris minuta*		9.26	5	0.00	0
385	Little Swift	*Apus affinis*	1	50.00	27	0.00	0
621	Long-billed Crombec	*Sylvietta rufescens*		7.41	4	0.00	0
138	Long-crested Eagle	*Lophaetus occipitalis*		1.85	1	0.00	0
852	Long-tailed Paradise Whydah	*Vidua paradisaea*		3.70	2	0.00	0
818	Long-tailed Widowbird	*Euplectes progne*		16.67	9	0.00	0
397	Malachite Kingfisher	*Corythornis cristatus*		12.96	7	0.00	0
361	Marsh Owl	*Asio capensis*	1	3.70	2	10.00	1
262	Marsh Sandpiper	*Tringa stagnatilis*		3.70	2	0.00	0
607	Marsh Warbler	*Acrocephalus palustris*		14.81	8	0.00	0
142	Martial Eagle	*Polemaetus bellicosus*		1.85	1	0.00	0
456	Melodious Lark	*Mirafra cheniana*	1	3.70	2	0.00	0
564	Mountain Wheatear	*Myrmecocichla monticola*	1	7.41	4	0.00	0

#	Common Name	Scientific Name	Observed (May & July 2022	SABAP2 Reporting Rate			
				Full Protocol (%)	Number of cards	Ad hoc Protocol (%)	Number of cards
318	Namaqua Dove	*Oena capensis*		11.11	6	0.00	0
183	Natal Spurfowl	*Pternistis natalensis*		29.63	16	0.00	0
637	Neddicky	*Cisticola fulvicapilla*	1	77.78	42	0.00	0
1035	Northern Black Korhaan	*Afrotis afraoides*	1	42.59	23	0.00	0
179	Orange River Francolin	*Scleroptila gutturalis*	1	3.70	2	0.00	0
1171	Orange River White-eye	*Zosterops pallidus*	1	83.33	45	0.00	0
498	Pearl-breasted Swallow	*Hirundo dimidiata*		1.85	1	0.00	0
113	Peregrine Falcon	*Falco peregrinus*		1.85	1	0.00	0
269	Pied Avocet	*Recurvirostra avosetta*		1.85	1	0.00	0
522	Pied Crow	*Corvus albus*	1	66.67	36	10.00	1
394	Pied Kingfisher	*Ceryle rudis*		20.37	11	0.00	0
746	Pied Starling	*Lamprotornis bicolor*	1	25.93	14	0.00	0
490	Pink-billed Lark	*Spizocorys conirostris*		1.85	1	0.00	0
846	Pin-tailed Whydah	*Vidua macroura*		12.96	7	30.00	3
694	Plain-backed Pipit	*Anthus leucophrys*	1	1.85	1	0.00	0
674	Pririt Batis	*Batis pririt*		27.78	15	0.00	0
57	Purple Heron	*Ardea purpurea*		12.96	7	0.00	0
850	Purple Indigobird	*Vidua purpurascens*		3.70	2	0.00	0
844	Quailfinch	*Ortygospiza atricollis*	1	27.78	15	20.00	2
642	Rattling Cisticola	*Cisticola chiniana*	1	55.56	30	0.00	0
708	Red-backed Shrike	*Lanius collurio*		29.63	16	30.00	3
837	Red-billed Firefinch	*Lagonosticta senegala*	1	22.22	12	0.00	0
805	Red-billed Quelea	*Quelea quelea*	1	40.74	22	30.00	3
97	Red-billed Teal	*Anas erythrorhyncha*	1	22.22	12	0.00	0

#	Common Name	Scientific Name	Observed (May & July 2022	SABAP2 Reporting Rate			
				Full Protocol (%)	Number of cards	Ad hoc Protocol (%)	Number of cards
488	Red-capped Lark	*Calandrella cinerea*	1	1.85	1	0.00	0
343	Red-chested Cuckoo	*Cuculus solitarius*		18.52	10	0.00	0
813	Red-collared Widowbird	*Euplectes ardens*		27.78	15	0.00	0
314	Red-eyed Dove	*Streptopelia semitorquata*	1	96.30	52	30.00	3
392	Red-faced Mousebird	*Urocolius indicus*	1	77.78	42	10.00	1
212	Red-knobbed Coot	*Fulica cristata*	1	40.74	22	20.00	2
453	Red-throated Wryneck	*Jynx ruficollis*		1.85	1	0.00	0
50	Reed Cormorant	*Microcarbo africanus*	1	61.11	33	10.00	1
940	Rock Dove	*Columba livia*		3.70	2	0.00	0
506	Rock Martin	*Ptyonoprogne fuligula*	1	3.70	2	0.00	0
256	Ruff	*Calidris pugnax*		5.56	3	0.00	0
458	Rufous-naped Lark	*Mirafra africana*	1	37.04	20	0.00	0
460	Sabota Lark	*Calendulauda sabota*		3.70	2	0.00	0
789	Scaly-feathered Weaver	*Sporopipes squamifrons*	1	40.74	22	0.00	0
847	Shaft-tailed Whydah	*Vidua regia*		1.85	1	0.00	0
504	South African Cliff Swallow	*Petrochelidon spilodera*	1	11.11	6	0.00	0
90	South African Shelduck	*Tadorna cana*	1	24.07	13	0.00	0
707	Southern Fiscal	*Lanius collaris*	1	51.85	28	10.00	1
4142	Southern Grey-headed Sparrow	*Passer diffusus*	1	55.56	30	0.00	0
803	Southern Masked Weaver	*Ploceus velatus*	1	98.15	53	0.00	0
102	Southern Pochard	*Netta erythrophthalma*		1.85	1	0.00	0
808	Southern Red Bishop	*Euplectes orix*	1	66.67	36	50.00	5
390	Speckled Mousebird	*Colius striatus*		35.19	19	0.00	0
311	Speckled Pigeon	*Columba guinea*	1	74.07	40	0.00	0

#	Common Name	Scientific Name	Observed (May & July 2022	SABAP2 Reporting Rate			
				Full Protocol (%)	Number of cards	Ad hoc Protocol (%)	Number of cards
474	Spike-heeled Lark	*Chersomanes albofasciata*	1	1.85	1	0.00	0
368	Spotted Eagle-Owl	*Bubo africanus*	1	3.70	2	10.00	1
654	Spotted Flycatcher	*Muscicapa striata*		22.22	12	0.00	0
275	Spotted Thick-knee	*Burhinus capensis*	1	3.70	2	0.00	0
88	Spur-winged Goose	*Plectropterus gambensis*		38.89	21	30.00	3
62	Squacco Heron	*Ardeola ralloides*		7.41	4	0.00	0
185	Swainson's Spurfowl	*Pternistis swainsonii*	1	48.15	26	10.00	1
411	Swallow-tailed Bee-eater	*Merops hirundineus*	1	3.70	2	0.00	0
649	Tawny-flanked Prinia	*Prinia subflava*		3.70	2	0.00	0
804	Thick-billed Weaver	*Amblyospiza albifrons*		20.37	11	0.00	0
238	Three-banded Plover	*Charadrius tricollaris*	1	35.19	19	0.00	0
851	Village Indigobird	*Vidua chalybeata*		7.41	4	0.00	0
735	Wattled Starling	*Creatophora cinerea*	1	42.59	23	0.00	0
359	Western Barn Owl	*Tyto alba*		1.85	1	0.00	0
61	Western Cattle Egret	*Bubulcus ibis*	1	50.00	27	10.00	1
305	Whiskered Tern	*Chlidonias hybrida*		7.41	4	0.00	0
391	White-backed Mousebird	*Colius colius*	1	59.26	32	0.00	0
763	White-bellied Sunbird	*Cinnyris talatala*	1	16.67	9	0.00	0
47	White-breasted Cormorant	*Phalacrocorax lucidus*	1	31.48	17	0.00	0
780	White-browed Sparrow-Weaver	*Plocepasser mahali*	1	64.81	35	20.00	2
100	White-faced Whistling Duck	*Dendrocygna viduata*		11.11	6	10.00	1
409	White-fronted Bee-eater	*Merops bullockoides*		22.22	12	30.00	3
383	White-rumped Swift	*Apus caffer*		14.81	8	0.00	0
582	White-throated Robin-Chat	*Cossypha humeralis*	1	7.41	4	0.00	0

#	Common Name	Scientific Name	Observed (May & July 2022	SABAP2 Reporting Rate			
				Full Protocol (%)	Number of cards	Ad hoc Protocol (%)	Number of cards
495	White-throated Swallow	*Hirundo albigularis*		42.59	23	0.00	0
304	White-winged Tern	*Chlidonias leucopterus*		1.85	1	0.00	0
814	White-winged Widowbird	*Euplectes albonotatus*		22.22	12	0.00	0
599	Willow Warbler	*Phylloscopus trochilus*		14.81	8	0.00	0
264	Wood Sandpiper	*Tringa glareola*		11.11	6	0.00	0
866	Yellow Canary	*Crithagra flaviventris*	1	40.74	22	0.00	0
96	Yellow-billed Duck	*Anas undulata*	1	79.63	43	20.00	2
76	Yellow-billed Stork	*Mycteria ibis*		1.85	1	0.00	0
812	Yellow-crowned Bishop	*Euplectes afer*		14.81	8	0.00	0
859	Yellow-fronted Canary	*Crithagra mozambica*		1.85	1	0.00	0
788	Yellow-throated Bush Sparrow	*Gymnoris superciliaris*		7.41	4	0.00	0
629	Zitting Cisticola	*Cisticola juncidis*	1	12.96	7	20.00	2

Appendix 2: Preliminary density estimates of birds recorded from the study area during two independent surveys conducted during May 2022 and July 2022.

Species	m01	m02	m03	m04	m05	m06	m07	m08	m09	m10	m11	m12	m13	m14	m15
Ant-eating Chat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5
African Pipit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
African Red-eyed Bulbul	1.5	0	0.5	1	1	2	1.5	0	0	0	0	0	0	1	0
Black-chested Prinia	2	0	1	2	2	2	2	2	0	0	2	0	0	2	1
Black-faced Waxbill	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brown-crowned Tchagra	0	0	0	0	0	0	0.5	0	0	0	0	0	0	0	0
Blue Waxbill	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capped Wheatear	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Cloud Cisticola	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0.5	0
Cape Grassbird	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cape Longclaw	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Cape Robin-chat	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Chinspot Batis	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Cape Sparrow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cape Starling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chestnut-vented Warbler	2	0	0	1	0	2	2	0	0	0	0.5	0	0	1	0
Cape Wagtail	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Waxbill	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cape White-eye	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Desert Cisticola	0	1.5	1.5	0.5	1	0	0	1	0	1	0	1	1	1.5	1
Eastern Clapper Lark	0	1.5	0.5	0.5	0.5	0	0	0	0	0	0	0	0.5	0	0
Fairy Flycatcher	0	0	0	0	0	0.5	0	0	0	0	0	0	0	0	0

Species	m01	m02	m03	m04	m05	m06	m07	m08	m09	m10	m11	m12	m13	m14	m15
Jameson's Firefinch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kalahari Scrub-robin	1	0	0	0	0	1	0.5	0	0	0	0	0	0	0	0
Levaillant's Cisticola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Lesser Swamp Warbler	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mountain Wheatear	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Neddicky	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Orange River White-eye	1	0	0	0	0	2	3.5	0	0	0	0	0	0	0	0
Plain-backed Pipit	0	0	0.5	0	0	0	0	0	0.5	0	1	0	0	0	0
Pied Starling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Quailfinch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Rattling Cisticola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Red-billed Firefinch	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Red-capped Lark	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	0
Rufous-naped Lark	0	0.5	0	0	0	0	0	0.5	0	0	0	0	0	1	0
Southern Fiscal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Southern Grey-headed Sparrow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spike-heeled Lark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Southern Masked Weaver	2.5	0	0	0.5	0	0.5	0	0	0	0	0	0	0	0	0
African Stonechat	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0
Wattled Starling	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0
White-bellied Sunbird	0.5	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0
White-browed Sparrow-weaver	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
White-throated Robin-chat	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zitting Cisticola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of individuals	16.5	4.5	4.5	5.5	4.5	12	11	3.5	1.5	1	3.5	1	1.5	22.5	6.5

Species	m01	m02	m03	m04	m05	m06	m07	m08	m09	m10	m11	m12	m13	m14	m15
Number of species	12	5	6	6	4	9	7	3	2	1	3	1	2	8	6
Number of birds/ha	**21.15**	**5.77**	**5.77**	**7.05**	**5.77**	**15.38**	**14.10**	**4.49**	**1.92**	**1.28**	**4.49**	**1.28**	**1.92**	**28.85**	**8.33**
Number of species/ha	**15.38**	**6.41**	**7.69**	**7.69**	**5.13**	**11.54**	**8.97**	**3.85**	**2.56**	**1.28**	**3.85**	**1.28**	**2.56**	**10.26**	**7.69**
Average number of birds/ha	**12.26**														
Average number of species/ha	**7.69**														

Species	m16	m17	m18	m19	m20	m21	m22	m23	m24	m25	m26	m27	m29	m28	m31	Mean birds/ha
Ant-eating Chat	1	0	0	2	0	3.5	0	0	0	0	1	0	0	0	0	**0.011**
African Pipit	0	0	0	0.5	0	0	0	0	0	0	1	0	0	0	0.5	**0.003**
African Red-eyed Bulbul	0	1.5	2	0	0	1	2	0	0	1	0	0	1	0	0	**0.024**
Black-chested Prinia	1	1	4	0	2	2	2	0	0	0	0	0	2	0	2	**0.048**
Black-faced Waxbill	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0.003**
Brown-crowned Tchagra	0	0	0.5	0	1	0	0.5	0	0	0	0	0	0	0	0	**0.004**
Blue Waxbill	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0.001**
Capped Wheatear	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0.001**
Cloud Cisticola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0.001**
Cape Grassbird	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	**0.001**
Cape Longclaw	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	**0.004**
Cape Robin-chat	0	1	2	0	0	0	0	0	0	0	0	0	0.5	0	0	**0.006**
Chinspot Batis	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	**0.004**
Cape Sparrow	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	**0.001**
Cape Starling	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0.001**
Chestnut-vented Warbler	0	2	2	0	1	0	1	0	0	0	0	0	2	0	0	**0.024**
Cape Wagtail	0	0	0.5	0	0	0	0	0	0	0	0.5	0	0	0	0	**0.001**
Common Waxbill	0	2	0	0	0	0	0	9.5	0	0	0	0	0	0	0	**0.016**

Species	m16	m17	m18	m19	m20	m21	m22	m23	m24	m25	m26	m27	m29	m28	m31	Mean birds/ha
Cape White-eye	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	**0.004**
Desert Cisticola	1	0	0	1.5	1	1	0	2	0.5	0	1	1.5	0	0	1.5	**0.031**
Eastern Clapper Lark	0	0	0	0.5	0	0	0	0	0.5	0	0	0	0	0	0.5	**0.007**
Fairy Flycatcher	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	**0.002**
Jameson's Firefinch	0	0	0	0	1.5	0	0	0	0	0	0	0	0	0	0	**0.002**
Kalahari Scrub-robin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0.004**
Levaillant's Cisticola	0	0.5	0.5	0	0	0	0	1.5	0	2	1	1	0	0	2	**0.015**
Lesser Swamp Warbler	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	**0.001**
Mountain Wheatear	0	0	0	0	0	0	0	0	0	0	0.5	0	0	0	0	**0.001**
Neddicky	0	1	3	0	0.5	0	2.5	0	0	0	0	0	1	0	0	**0.013**
Orange River White-eye	0	1	5	0	0	0	3	0	0	0	0	0	0	0	0	**0.022**
Plain-backed Pipit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0.003**
Pied Starling	4.5	3.5	0	0	0	0	0	0	0	0	0	0	0	0	0	**0.011**
Quailfinch	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	**0.006**
Rattling Cisticola	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	**0.001**
Red-billed Firefinch	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	**0.006**
Red-capped Lark	0	0	0	0	0	0	0	0	0	0	0.5	0	0	0	0	**0.001**
Rufous-naped Lark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0.003**
Southern Fiscal	1	0.5	0	0	0	0	0	0	0	1.5	0.5	0	0	0	0.5	**0.006**
Southern Grey-headed Sparrow	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	**0.001**
Spike-heeled Lark	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	**0.004**
Southern Masked Weaver	0	3	4	0	0	0	14	0	0	0	0	0	2	0	0	**0.038**
African Stonechat	0	0	0	0	0	2	0	1.5	0	0	0	1	0	0	2	**0.010**
Wattled Starling	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	**0.046**
White-bellied Sunbird	0	0	0	0	0	0	0	0	0	0	0	0	1.5	0	0	**0.004**
White-browed Sparrow-weaver	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0.001**

Species	m16	m17	m18	m19	m20	m21	m22	m23	m24	m25	m26	m27	m29	m28	m31	Mean birds/ha
White-throated Robin-chat	0	0.5	0	0	0	0	0	0	0	0	0	0	1	0	0	**0.004**
Zitting Cisticola	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	**0.004**
Number of individuals	10.5	37	27.5	8.5	7	9.5	28	18.5	1	5.5	7	4.5	13	0	10	**0.409**
Number of species	7	16	13	6	6	5	8	7	2	4	9	4	10	0	8	**0.256**
Number of birds/ha	**13.46**	**47.44**	**35.26**	**10.90**	**8.97**	**12.18**	**35.90**	**23.72**	**1.28**	**7.05**	**8.97**	**5.77**	**16.67**	**0.00**	**12.82**	
Number of species/ha	**8.97**	**20.51**	**16.67**	**7.69**	**7.69**	**6.41**	**10.26**	**8.97**	**2.56**	**5.13**	**11.54**	**5.13**	**12.82**	**0.00**	**10.26**	
Average number of birds/ha	**12.26**															
Average number of species/ha	**7.69**															