DISSELFONTEIN

KEREN ENERGY HOLDINGS

BIODIVERSITY ASSESSMENT & BOTANICAL SCAN

A preliminary Biodiversity Assessment (with botanical input) taking into consideration the findings of the National Spatial Biodiversity Assessment of South Africa.

March 28, 2012

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SUMMARY - MAIN CONCLUSIONS

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MAIN VEGETATION TYPES	**Vaalbos Rocky Shrubland** occurs on slopes and elevated hills and ridges within plains of mainly Kimberley Thornveld but also in the vicinity of Northern Upper Karoo. It is described as evergreen shrub communities dominated by *Tarchonanthus camphoratus*, *Olea europaea* subsp. *africana*, *Euclea crispa*, *Diospyros lycioides*, *Rhus burchelli* and *Buddleja saligna*. **Least Threatened:** Although more than 98% of this vegetation type remains, very little is formally conserved.
LAND USE AND COVER	The study area is situated on agricultural farmland mainly used for stock grazing. An Eskom substation is also located on the same property.
RED DATA PLANT SPECIES	None encountered or expected Protected Trees: A number of *Boscia albitrunca* trees were observed located along the south-western fence of the proposed site location. It is recommended that the lay-out of the final proposed site is altered slightly in order to avoid having to remove or damage any of these trees.
IMPACT ASSESSMENT	Development without mitigation: Significance = 36% Development with mitigation Significance = 7% Where values of ≤15% indicate an insignificant environmental impact and values >15% constitute ever increasing environmental impact.

RECOMMENDATION

From the information available and the site visit, it is clear that the proposed final Disselfontein site location was fairly well chosen from a biodiversity viewpoint. With mitigation no irreversible species loss, habitat loss, connectivity or associated impact can be foreseen from locating and operating the solar facility on the final proposed solar site. However, there is a significant difference between development **without** and development **with** mitigation. As a result it is recommended that all mitigating measures must be implemented in order to minimise the impact of the construction and operation of the facility. Although solar energy is presently not seen as a viable stand-alone technology for electricity production it will lighten the pressure on the fossil burning facilities of Eskom and in so doing will add to a more sustainable way of electricity production.

With the available information at the author's disposal it is recommended that the project be approved, but that all mitigation measures described in this document is implemented and that a botanist or suitably qualified ECO be appointed during the initial layout of the structures in order to minimise/negate the impact on significant biodiversity features (e.g. watercourses) and the protected tree species.

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INTRODUCTION

Renewable energy takes many forms, including biomass, geothermal, hydropower, wind and solar. Of these, solar may be the most promising: it can be used to generate electricity or to heat water, has little visual impact, and scales well from residential to industrial levels. Solar is the fastest growing energy source in the world. It offers a limitless supply of clean, safe, renewable energy for heat and power. And it's becoming ever more affordable, more efficient, and more reliable.

According to various experts (www.thesolarfuture.co.za), building solar plants is in many ways more financially viable and sustainable than erecting coal fired power stations. When a coal power plant has reached its life span, usually after 40 years depending on the technology, it must be demolished and rebuild (at a huge price tag). When panels of a solar plant reach their lifespan, you only need to replace the panels. Replacing panels is becoming cheaper and better in what they do as the technology is continuously improving. South Africa has abundant coal reserves, but its reserves of solar power are even greater, and unlike coal, solar power is inflation-proof and doesn't lead to large scale destruction of landscapes or the pollution of precious water. In addition South Africa is the world's best solar energy location after the Sahara and Australia.

The advantages of Solar and other renewable power sources are clear: greater independence from imported fossil fuels, a cleaner environment, diversity of power sources, relief from the volatility of energy prices, more jobs and greater domestic economic development. All over the world, solar energy systems have reduced the need to build more carbon-spewing fossil-fuelled power plants. They are critical weapons in the battle against global warming. As the cost of solar technologies has come down, solar is moving into the mainstream and growing worldwide at 40-50% annually (www.wikepedia.org).

In 2011, the International Energy Agency said that "the development of affordable, inexhaustible and clean solar energy technologies will have huge longer-term benefits. It will increase countries' energy security through reliance on an indigenous, inexhaustible and mostly import-independent resource, enhance sustainability, reduce pollution, lower the costs of mitigating climate change, and keep fossil fuel prices lower than otherwise. These advantages are global.

Keren Energy Holdings is proposing the establishment of a 10 MW concentrated photovoltaic solar energy facility on the remainder of the Farm Disselfontein No. 77, Hopetown (Northern Cape Province, Thembelihle Local Municipality). The facility will be established on an area of approximately 20 ha, on a portion of Farm 77, located approximately 26 km north-north-west of Hopetown just. The purpose of the proposed facility is to sell electricity to Eskom as part of the Renewable Energy Independent Power Producers Procurement Programme. This programme has been introduced by the Department of Energy to promote the development of renewable power generation facilities.

TERMS OF REFERENCE

EnviroAfrica (Pty) Ltd was appointed by Keren Energy Holdings as the independent Environmental Assessment Practitioner (EAP) to undertake the Scoping/Environmental Impact Assessment (EIA) Process for the proposed development. PB Consult was appointed by EnviroAfrica to conduct a Biodiversity Assessment of the proposed development area.

PB Consult was appointed within the following terms of reference:

- Evaluate the general location of the proposed site and make recommendations on a specific location for the 20
- The study must consider short- to long-term implications of impacts on biodiversity and highlight irreversible impacts or irreplaceable loss of species.

INDEPENDENCE & CONDITIONS

PB Consult is an independent consultant to Keren Energy Holdings and has no interest in the activity other than fair remuneration for services rendered. Remunerations for services are not linked to approval by decision making authorities and PB Consult have no interest in secondary or downstream development as a result of the authorization of this proposed project. There are no circumstances that compromise the objectivity of this report. The findings, results, observations and recommendations given in this report are based on the author's best scientific and professional knowledge and available information. PB Consult reserve the right to modify aspects of this report, including the recommendations if new information become available which may have a significant impact on the findings of this report.

DEFINITIONS & ABBREVIATIONS

DEFINITIONS

Environmental Aspect: Any element of any activity, product or services that can interact with the environment.

Environmental Impact: Any change to the environment, whether adverse or beneficial, wholly or partially resulting from any activity, product or services.

No-Go Area(s): Means an area of such (environmental/aesthetical) importance that no person or activity is allowed within a designated boundary surrounding this area.

ABBREVIATIONS

BGIS	Biodiversity Geographical Information System
DEA	Department of Environmental Affairs
DENC	Department of Environment and Nature Conservation (Northern Cape Province)
EAP	Environmental assessment practitioner
EIA	Environmental impact assessment
EMP	Environmental management plan

NEMA	National Environmental Management Act, Act 107 of 1998
NEM: BA	National Environmental Management Biodiversity Act, Act 10 of 2004
NSBA	National Spatial Biodiversity Assessment
SANBI	South African National Biodiversity Institute
SKEP	Succulent Karoo Ecosystem Project
WWTW	Wastewater Treatment Works

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PROJECT DESCRIBTION

Keren Energy Holdings is proposing the establishment of a 10 MW concentrated photovoltaic solar energy facility on the remainder of the Farm Disselfontein, No. 77, Hopetown (Northern Cape Province, Thembelihle Local Municipality). The facility will be established on an area of approximately 20 ha, on a portion of Farm Disselfontein no. 77, located approximately 26 km north-north-west of Hopetown.

The proposed facility will utilise Concentrated Photovoltaic (CPV) technology, which aims to concentrate the light from the sun, using Fresnel lenses, onto individual PV cells. This method increases the efficiency of the PV panels as compared to conventional PV technology. An inverter is then used to convert the direct current electricity produced into alternating current for connection into the Eskom grid. A single solar generator produces approximately 66kV. In order to produce 10 MW, the proposed facility will require a number of generators arranged in multiples/arrays. The CPV panels will be elevated (2 m above ground) by a support structure, and will be able to track the path of the sun during the day for maximum efficiency. Approximately 1.8 ha is required per installed MW. A 10 MW capacity facility will thus require a development footprint of approximately 20 ha (including associated infrastructure – ancillary infrastructure). Each panel will be approximately 22 m wide by 12.5 m high. When the panels are tracking vertically the structure will have a maximum height of approximately 15 m.

The site can be accessed from an existing secondary leading north-north-west from Hopetown following the Orange River which eventually connects to the R357. However, additional temporary access roads will have to be established on site. Site preparation will include clearance of vegetation at the footprint of the following infrastructure:

- Support structures (approximately 148 units are proposed) (excavations of 1 m^2 by 5 m deep)
- Switchgear
- Inverters
- Workshops
- Trenches for the underground cabling

The activities may require the stripping of topsoil, which will need to be stockpiled, backfilled and/or spread on site. All in all, the proposed facility can be likened to light agriculture, with the exception that natural vegetation will be allowed to remain on all the non-disturbed areas. All surfaces not used for the facility and associated infrastructure will remain natural.

DESCRIPTION OF ENVIRONMENT

The aim of this description is to put the study area in perspective with regards to all probable significant biodiversity features which might be encountered within the study area. The study area has been taken as the proposed site and its immediate surroundings. During the desktop study any significant biodiversity features associated with the larger surroundings was identified, and were taken into account. The desktop portion of the study also informs as to the biodiversity status of such features as classified in the National Spatial Biodiversity Assessment (2004) as well as in the recent National list of ecosystems that are threatened and in need of protection (GN 1002, December 2011), promulgated in terms of the National Environmental Management Biodiversity Act (NEM: BA), Act 10 of 2004.

LOCATION & LAYOUT

The proposed Disselfontein Solar Site is located in the Northern Cape Province (Thembelihle Local Municipality), on the Remainder of the Farm Disselfontein, No. 77, Hopetown. The facility will be established on an area of approximately 20 ha, on a portion of Farm 77, located approximately 26 km north-north-west of Hopetown (Refer to Figure 1).

Figure 1: The general location of the proposed Disselfontein Keren Energy Solar Facility

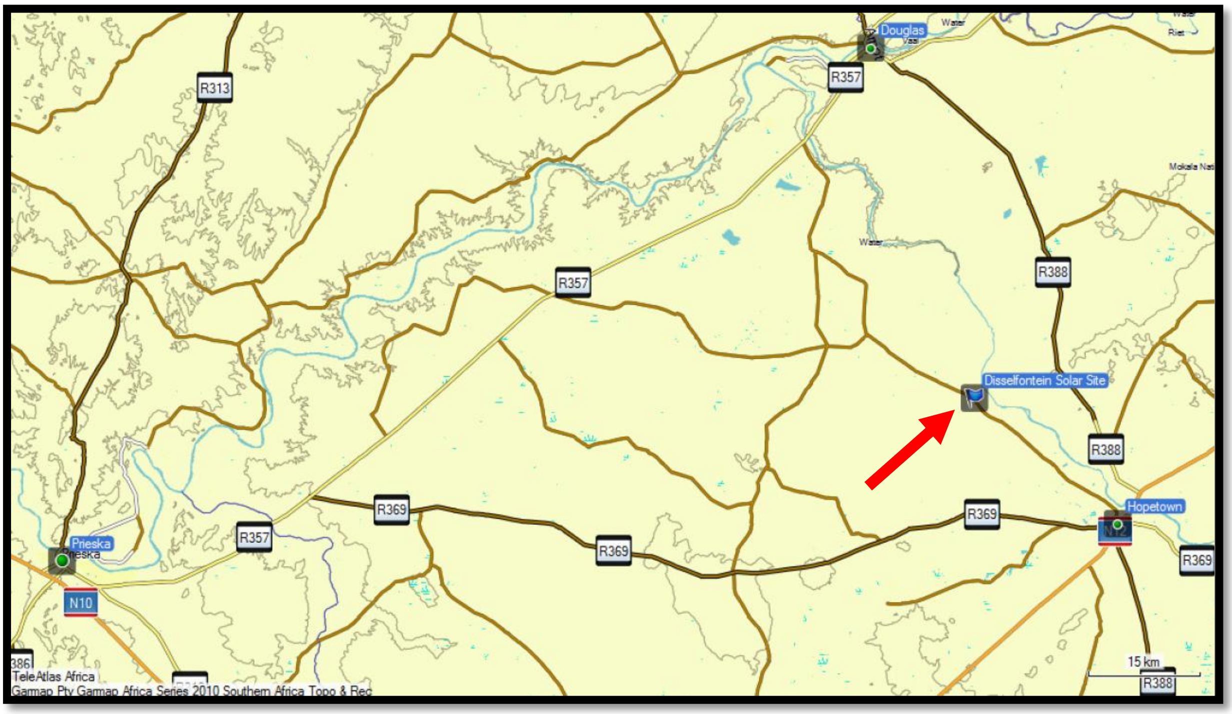


Figure 2 gives an artist view of what the solar site might look like (please note that the layout does not conform to the final proposed layout) which is shown in Figure 3 indicates the proposed final site location.

Figure 2: Proposed final site location (showing an overlay of the proposed solar units)

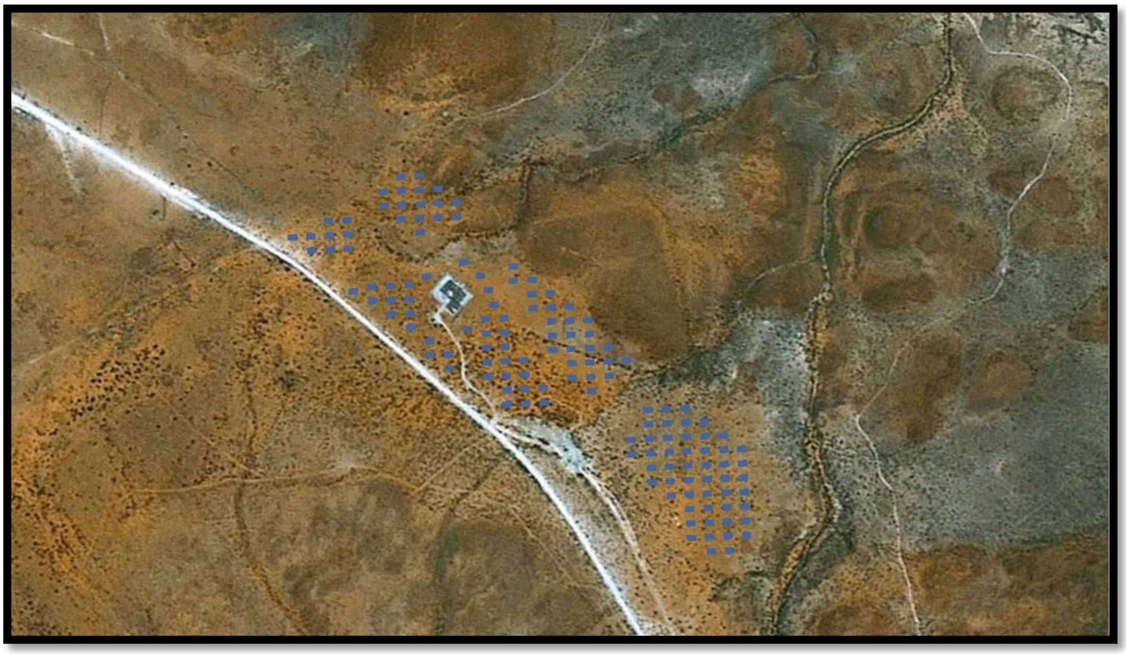


Figure 3: Final solar site location (approximately 20 ha)

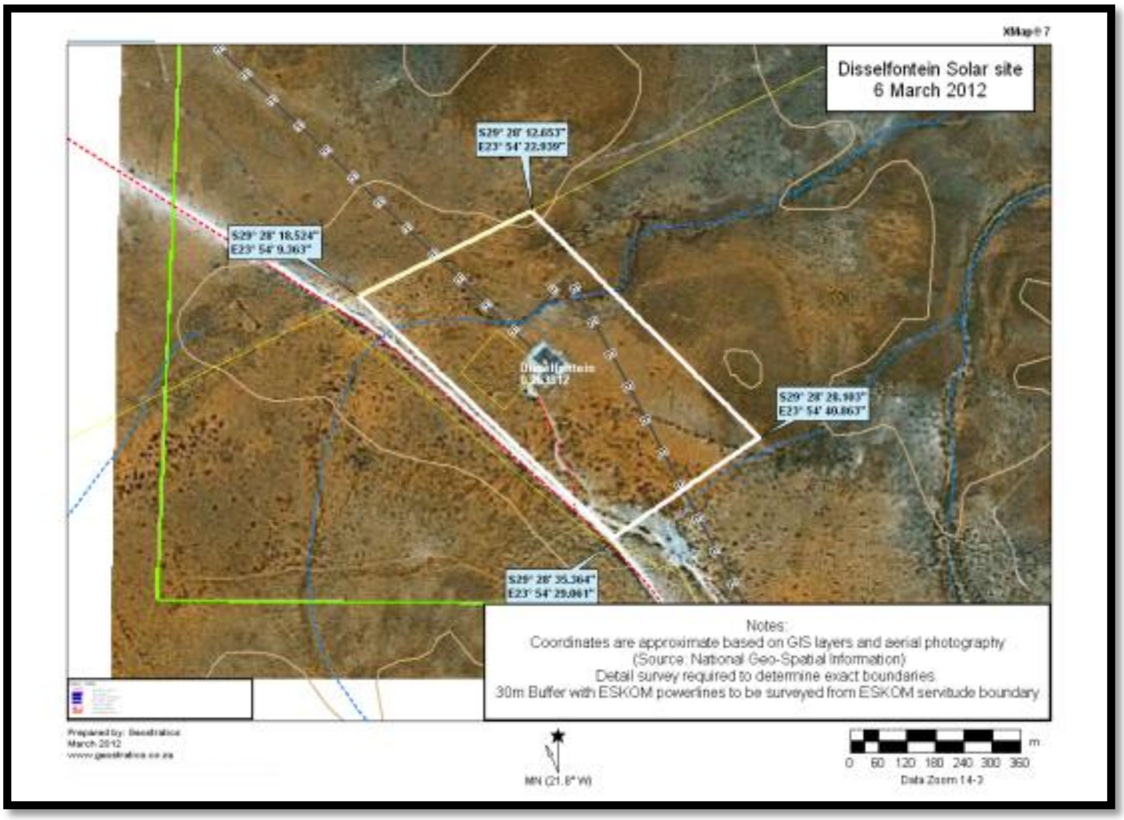


Table 1: GPS coordinates describing the boundaries of the final proposed solar site location (WGS 84 format)

DESCRIPTION	LATITUDE AND LONGITUDE	ALTITUDE
North-west corner	S29 28 18.5 E23 54 09.4	1083 m
North-east corner	S29 28 12.7 E23 54 22.9	1081 m
South-east corner	S29 28 28.1 E23 54 40.9	1071 m
South-west corner	S29 28 35.4 E23 54 29.1	1082 m

METHODS

Various desktop studies were conducted, coupled by a physical site visit at the end of January 2012 and further desktop studies. The timing of the site visit was reasonable in that essentially all perennial plants were identifiable and although the possibility remains that a few species may have been missed, the author is confident that a fairly good understanding of the biodiversity status in the area was obtained.

The survey was conducted by walking through the site (Refer to Figure 4) and examining, marking and photographing any area of interest. Confidence in the findings is high. During the site visit the author endeavoured to identify and locate all significant biodiversity features, including rivers, streams or wetlands, special plant species and or specific soil conditions which might indicate special botanical features (e.g. rocky outcrops or silcrete patches).

Figure 4: A Google image showing the route (white line) that was walked as well as special features encountered

* *B. albitrunca* = *Boscia albitrunca* (Sheppard's tree, Witgatboom)

TOPOGRAPHY

The solar site is located on an almost level area on a slightly undulating landscape, just west of the Orange River (north-north-west of Hopetown). Elevation data in Table 1 and Figure 5, shows that the site slopes very slightly from the north-east towards the south-west (towards the Orange River). Elevation varies from 1083 m (north-west corner) towards the south-east at 1071 m with an average slope of 1.0% and an elevation loss of approximately 9.8 m.

Two minor dry watercourses or drainage lines was observed on the property, one running west to east in the north-east corner of the site and one running south-south-east in the southern part of the proposed location.

Figure 5: Google image showing the difference in elevation from the NE towards the SW corner of the proposed location

CLIMATE

All regions with a rainfall of less than 400 mm per year are regarded as arid. Hopetown normally receives about 199 mm of rain per year, with most rainfall occurring during autumn. It receives the lowest rainfall (0 mm) in July and the highest (48 mm) in March. The monthly distribution of average daily maximum temperatures shows that the average midday temperatures for Hopetown range from 17.7°C in June to 32°C in January. The region is the coldest during July when the mercury drops to 1°C on average during the night (www.saexplorer.co.za). The graphs underneath indicate the average climate data for Kuruman (giving an average for the Northern Cape region) (Figure 6 to Figure 9).

Figure 6: Kuruman average minimum and maximum temperatures (www.weather-and-climate.com)

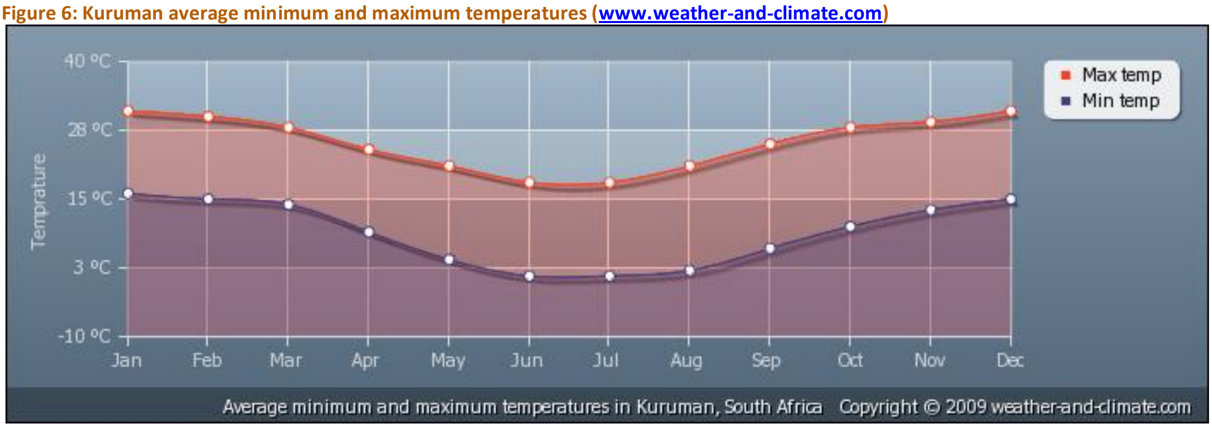


Figure 7: Kuruman average monthly precipitation over the year (www.weather-and-climate.com)

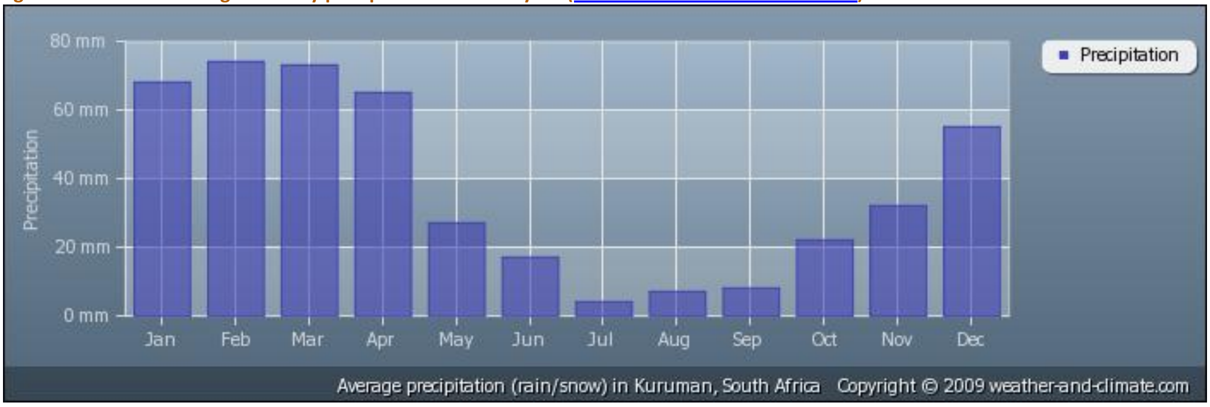


Figure 8: Kuruman average monthly hours of sunshine over the year (www.weather-and-climate.com)

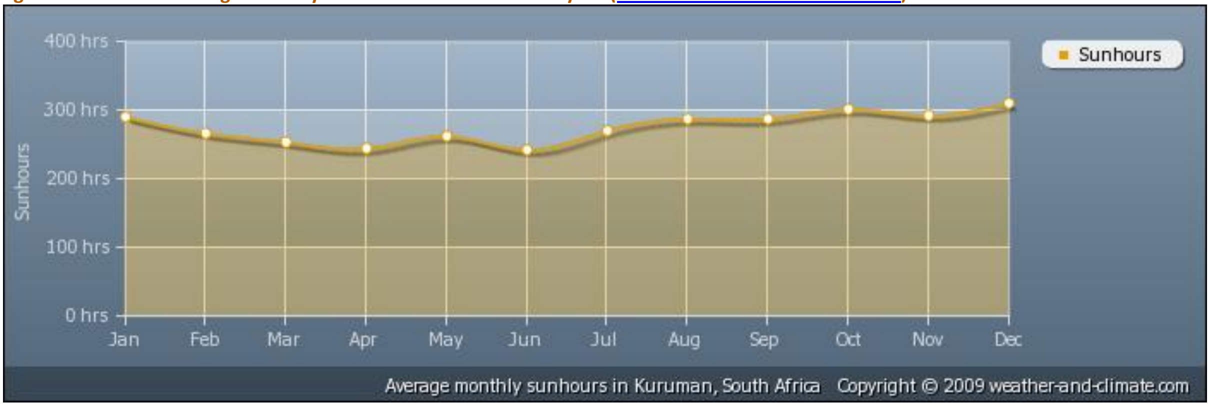
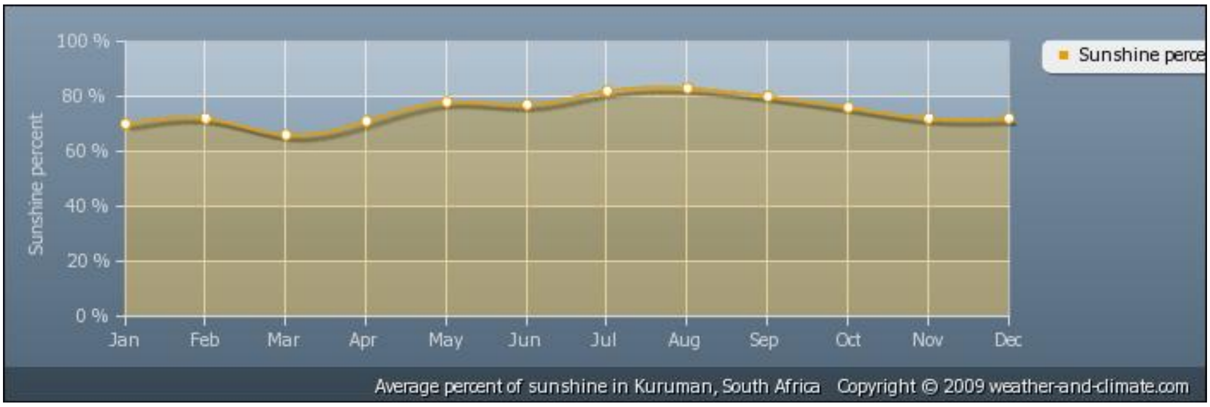


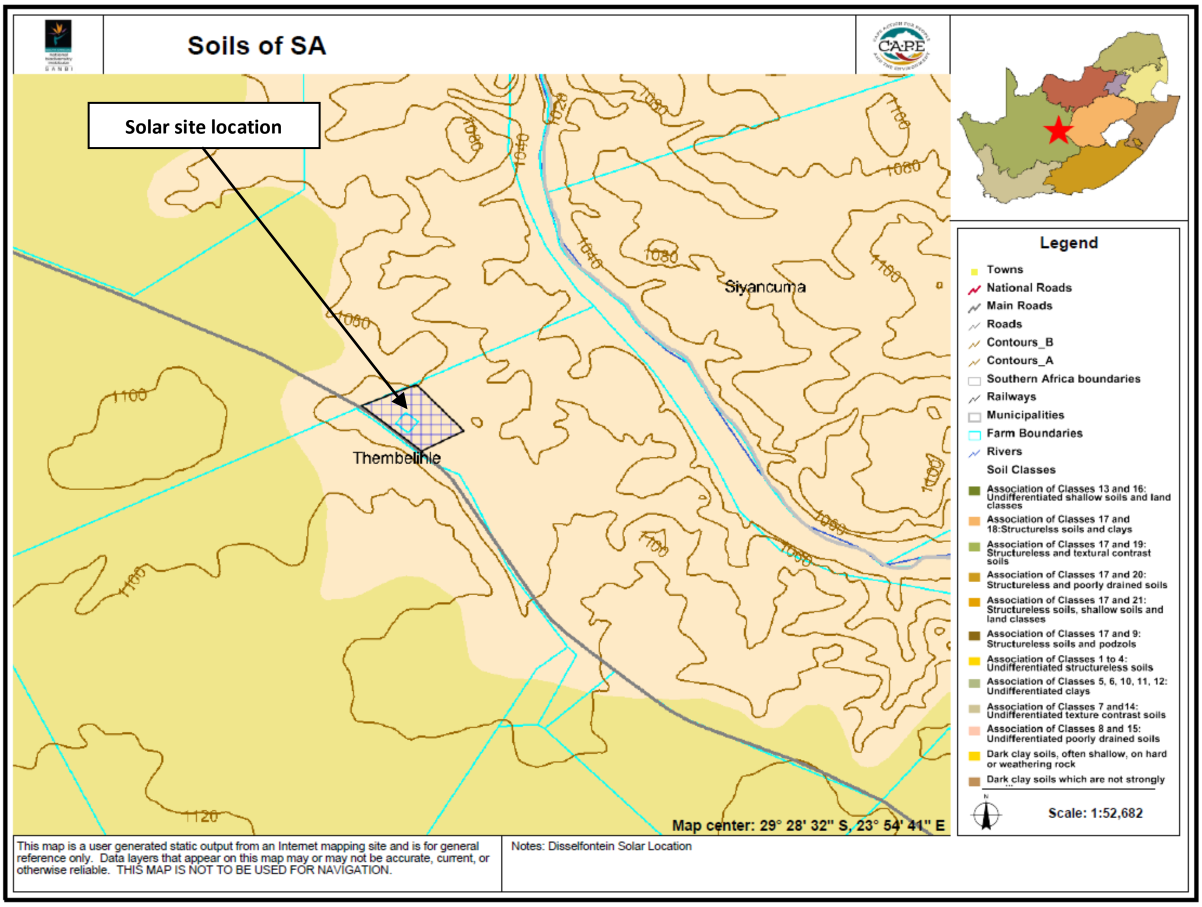
Figure 9: Kuruman average percent of sunshine over the year (mean % of sun hours during the day) (www.weather-and-climate.com)



GEOLOGY & SOILS

According to Mucina and Rutherford (2006) and the SANBI Biodiversity Geographical Information System, the geology is described as a highly fragmented area on Ecca and Dwyka Group sediments and Karoo dolerites as well as on Ventersdorp Supergroup lavas (Allanridge Formation). Extensive dolerite sills which form ridges, and plateaus and slopes of koppies and small escarpments mark the erosion terraces. These dolerite sills cover alternating layers of mudstone and sandstone of sedimentary origin. The Ib land type is typical of these rock- and boulder-covered slopes. Prominent soil forms are stony Mispah and gravel-rich Glenrosa forms derived from the Jurassic dolerite, while calcrete-rich soils cover the lowlands. The soils (Refer to Figure 10) show minimal development, usually shallow on hard weathered rock with or without intermittent diverse soils, with lime generally present (Mucina & Rutherford, 2006).

Figure 10: General soil map for the area of the proposed solar site location (SANBI BGIS)



No special soils or geology features (e.g. quartz patches or broken veld), which could support special botanical features, were observed during the site visit (or are expected).

LANDUSE AND COVER

The study area is situated on an almost level area in a slightly undulating landscape on the farm Disselfontein, adjacent and to the west of the Orange River or (north-north-west of Kuruman). The property zoned as agriculture and used for stock grazing. Smaller game species is still expected in the larger area (refer to Figure 11).

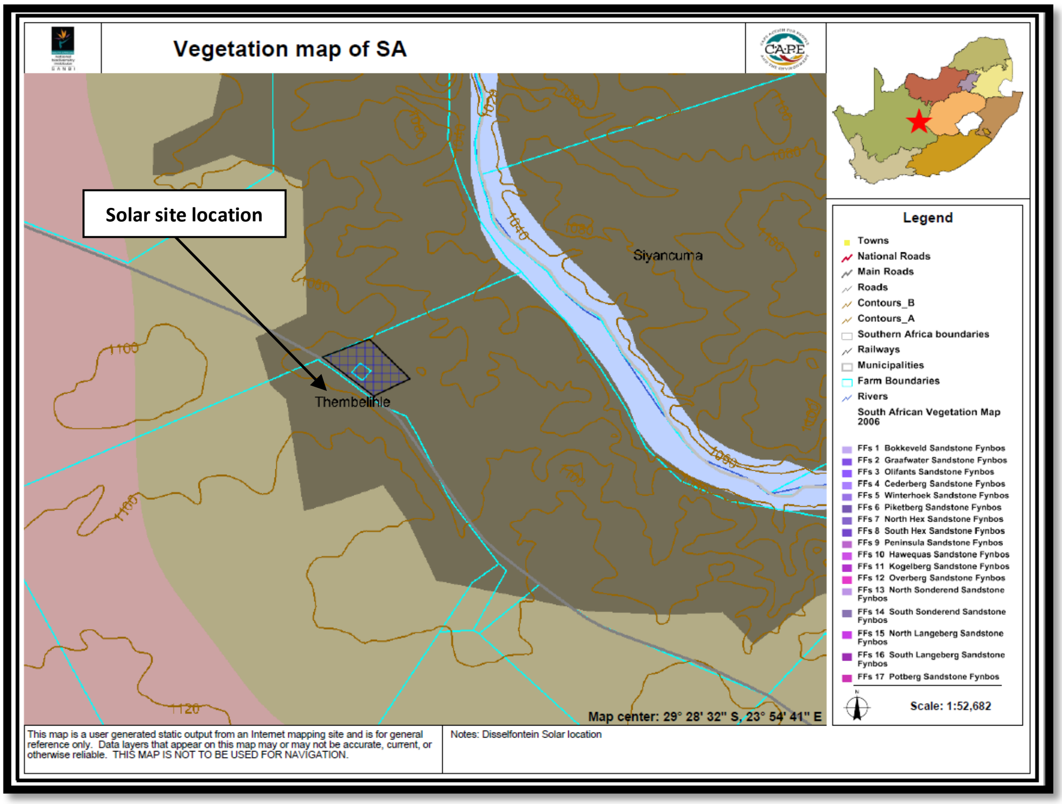
Natural vegetation forms an open shrub layer (up to 2 m in height) over a shorter grassy/shrub layer (up to 0.5 m) over the entire property. The vegetation showed signs of regular grazing. Small areas show pockets encroached by dense stands of *Acacia mellifera* while the watercourses are usually associated with denser woody vegetation. *Tarchonanthus camphoratus*, *Ziziphus mucronata*, *Grewia flava* and *Acacia karroo* are also prominent. During the site visit the main biodiversity feature of significance observed, was the remaining natural veld, the presence of a number of the protected tree *Boscia albitrunca*, as well as dry watercourses or drainage situated within the proposed solar site location.

Figure 11: A Google image giving an indication of the land use on the proposed solar site

VEGETATION TYPES

In accordance with the 2006 Vegetation map of South Africa, Lesotho and Swaziland (Mucina & Rutherford, 2006) only one broad vegetation type is expected in the proposed area and its immediate vicinity, namely Vaalbos Rocky Shrubland (Darker brown in Figure 12). The site visit confirmed that only Vaalbos Rocky Shrubland is present in the larger study area.

Figure 12: Vegetation map of SA, Lesotho and Swaziland (2006)



Vaalbos Rocky Shrubland was classified as "Least Threatened" during the 2004 National Spatial Biodiversity Assessment (NSBA). More than 98% of this vegetation still remains in its natural state, but only 1.7% of this vegetation type is formally protected throughout South Africa. Recently the *National list of ecosystems that are threatened and in need of protection* (GN 1002, December 2011), was promulgated in terms of the National Environmental Management Biodiversity Act (NEM: BA), Act 10 of 2004. According to this National list, **Vaalbos Rocky Shrubland, remains classified as Least Threatened**.

Mucina & Rutherford (2006) noted that Vaalbos Rocky Shrubland is found in the Northern Cape and Free State Provinces along solitary hills and scattered ridges east of the confluence of the Orange and the Vaal Rivers, mainly in the Kimberley and Herbert District and west of a line bounded by the western Free State towns of Luckhoff, Petrusburg, Dealesville, Bultfontein and Hertzogville at altitudes varying from 1 000 -1 400 m.

VAALBOS ROCKY SHRUBLAND

Vaalbos Rocky Shrubland is described as occurring on slopes and elevated hills and ridges within plains of mainly Kimberley Thornveld, but also in the vicinity of Northern Upper Karoo (Mucina & Rutherford, 2006). It is described as evergreen shrub communities dominated by *Tarchonanthus camphoratus*, *Olea europaea* subsp. *africana*, *Euclea crispa*, *Diospyros lycioides*, *Rhus burchelli* and *Buddleja saligna*. On the foot slopes of dolerite hills, where calcium rich soils occur, shrub and small trees of *Acacia tortilis* and *Ziziphus mucronata* can be dominant. Photo 1 gives an indication of the vegetation found on site.

Photo 1: Natural veld in the study area, note *Acacia mellifera* in the foreground and the rocky soils

Acocks (1953) described this vegetation as Kalahari Thornveld invaded by Karoo or as False Orange River Broken Veld while Low & Rebelo (1996) described this vegetation as Kimberley Thorn Bushveld or Orange River Nama Karoo.

According to Mucina & Rutherford (2006) important taxa for this vegetation type includes the following:

Small trees: *Boscia albitrunca, Cussonia paniculata* and *Searsia lancea.*

Tall shrubs: *Euclea crispa*, *Olea europaea*, *Tarchonanthus camphoratus, Ziziphus mucronata, Buddleja saligna, Cadaba aphylla, Diospyros austro-africana, D. lycioides, Ehretia rigida, Gymnosporia polyacantha, Rhigozum obovatum* and *Searsia burchelli.*

Low shrubs: *Asparagus suaveolens, Hermannia comosa, Lantana rugosa, Lycium pilifolium, Pentzia globosa* and *Searsia ciliata.*

Succulent shrubs*: Cotyledon arbiculata, Crassula nudicaulis, Kalanchoe paniculata* and *Lycium cinereum.*

Graminoides: *Aristida adscensionis, A. congesta*, *Digitaria eriantha, Elionurus muticus, Enneapogon scoparius*, *Eragrostis lehmanniana*, *E. obtusa, Eustachys paspaloides, Fingerhuthia africana, Heteropogon contortus, Hyparrhenia hirta, Stipagrostis uniplumis* and *Themeda triandra*.

Herbs: *Chascanum pinnatifidum, Hibiscus pusillus* and *Harpagophytum procumbens*.

Geophytic Herbs: *Albuca setose, Cheilanthes eckloniana, Haemanthus humilis* and *Pallaea calomelanos*.

Succulent Herbs: *Aloe grandidentata* and *Stapelia grandiflora.*

VEGETATION ENCOUNTERED

The vegetation encountered conforms to that of Vaalbos Rocky Shrubland and supported an open shrubland with two layers normally present, namely a lower shrub layer up to 0.5 m and a sparse woody shrub/small tree top layer (varying between 1-2 m in height) with open patches in between (Photo 2). A third layer (reaching up to 4 m) in the form of *Boscia albitrunca* or *Acacia tortilis* was also occasionally encountered.

Photo 2: Typical vegetation found on the rockier soils (*Acacia mellifera* very prominent)

Where the soils are rockier, grasses are almost absent and the two vegetation layers consisted mainly of a shrub bottom layer with a woody/shrub top layer (Photo 2). In the sandier areas (seemingly slightly deeper red soils) grasses were more common and *Boscia albitrunca* was also sometimes present (Photo 3). Note that

Boscia albitrunca was only observed along the western boundary of the site (associated with the slightly deeper less rocky soils), west of the Eskom substation (Refer to Figure 11). The differences in soil/soil depth led to variations in vegetation composition. Vegetation cover in general was between 50-65%.

Photo 3: The vegetation encountered on slightly deeper soils (note *Boscia albitrunca* in the background)

The shrub top layer was usually dominated by *Acacia mellifera* with *Acacia karroo*, *Ziziphus mucronata*, *Rhigozum trichotomum*, *Grewia* cf *flava*, *Lycium cinereum*, *Asparagus retrofractus*, *Asparagus burchelli, Tarchonanthus camphoratus* and *Euphorbia* spp. also present. In slightly deeper sandy soils, *Acacia tortilis* (Photo 4) and *Boscia albitrunca* was also encountered.

Photo 4: *Acacia tortilis* located within the proposed solar location

The bottom layer was usually dominated by hardy shrubs like, *Aptosimum spinescens*, *Aptosimum* spp., *Argemone ochroleuca*, *Dianthus* spp., *Eberlanzia ferox*, *Felicia hirsuta*, *Galenia sarcophylla*, *Geigeria filifolia*, *Ifloga glomerata*, *Lycium hirsutum*, *Lycium prunus-spinosa*, *Monechma incanum*, *Pentzia* cf. *spinescens*, *Polygala asbestina*, *Tetragonia* spp., *Zygophyllum* cf. *lichtensteinianum*. Grass species like, Schmidtia spp., Fingerhuthia spp., *Aristida* spp., *Enneapogon* spp., and *Eragrostis* spp. amongst others was also found on sandier areas.

ENDEMIC OR PROTECTED PLANT SPECIES

According to Mucina & Rutherford (2006), there is no endemic taxon associated with this vegetation type. However, the following protected tree species in terms of the National Forest Act of 1998 (Act 84 of 1998) have a geographical distribution that may overlap with the broader study area (Refer to Table 2).

Table 2: Protected tree species with a geographical distribution that may overlap the broader study area

SPECIES NAME	COMMON NAME	TREE NO.	DISTRIBUTION
Acacia erioloba	Camel Thorn Kameeldoring	168	In dry woodlands next to water courses, in arid areas with underground water and on deep Kalahari sand
Acacia haematoxylon	Grey Camel Thorn Vaalkameeldoring	169	In bushveld, usually on deep Kalahari sand between dunes or along dry watercourses.
Boscia albitrunca	Shepherds-tree Witgat/Matopie	130	Occurs in semi-desert and bushveld, often on termitaria, but is common on sandy to loamy soils and calcrete soils.

Photo 5: *Boscia albitrunca* tree on site (*A. mellifera* to the left)

During the site visit, a number of *Boscia albitrunca* were encountered (mostly associated with the slightly deeper sandy soils to the west of the proposed site location). All trees encountered were marked with GPS coordinates (Table 3, underneath) and plotted on a map (Refer to Figure 13), which, also gives a good indication of the distribution of these trees in relation to the larger site.

Please note that the Sheppard's trees are only found on a fairly small portion of the solar site, clumped together towards the western side of the boundary. It should make sense to shift the solar site slightly towards the east or south in order to avoid having to remove or damage any of these trees. Also note that this area is also the area in which slightly deeper soils were encountered, which mean that this area will always be able to support slightly larger trees (which might interfere with the workings of the solar site in the long run). It might thus make practical sense to consider not placing any solar panels in this specific area. A variation of the distribution of the solar panels as shown in the lay-out Figure 2, but avoiding the green area shown in Figure 13, might even be considered.

Figure 13: Google image showing the location (green area) of the protected trees encountered on the site

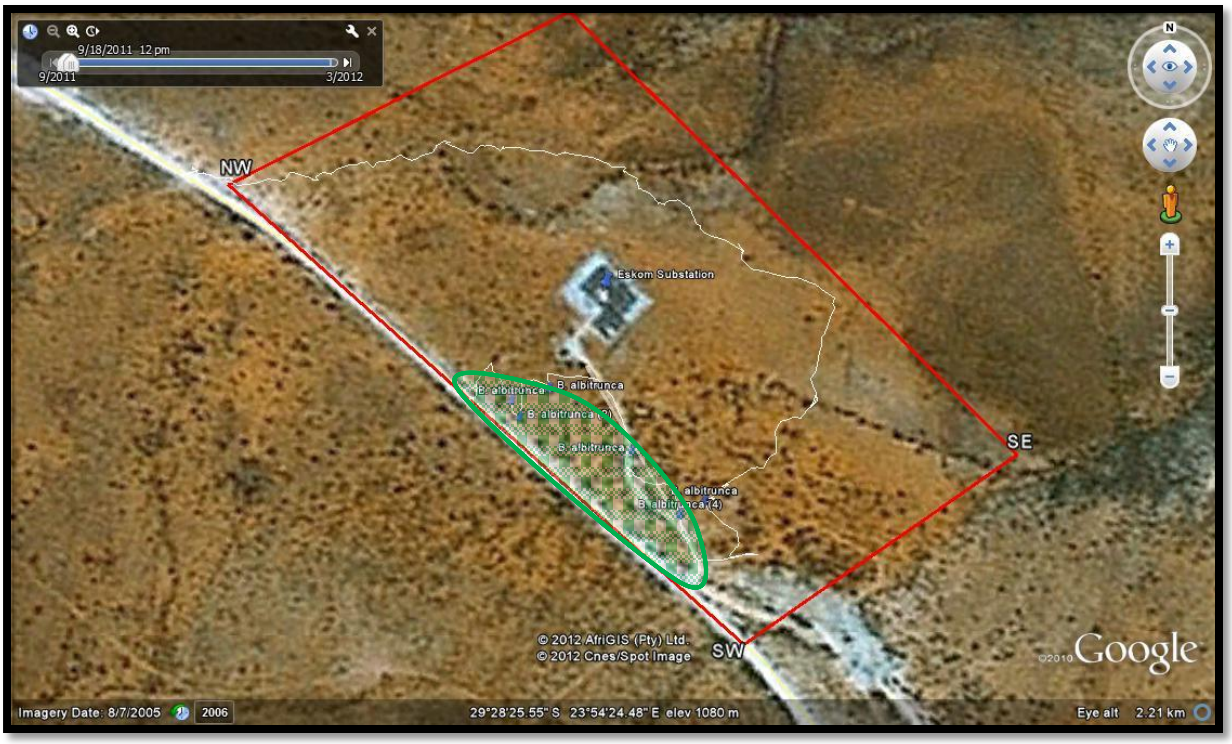


Table 3, underneath, gives a list of the protected trees encountered on the property with their GPS location as well as the number of trees associated with each marked location.

Table 3: A list of protected trees encountered during the site visit and their GPS co-ordinates

NO	SPECIES NAME	COMMON NAME	NUMBER OF TREES	LOCATION
1.	*Boscia albitrunca*	Sheppard's tree	1 mature	S29 28 30.2 E23 54 28.1
2.	*Boscia albitrunca*	Sheppard's tree	1 mature + 3 young	S29 28 30.6 E23 54 27.1
3.	*Boscia albitrunca*	Sheppard's tree	1mature	S29 28 28.4 E23 54 25.2
4.	*Boscia albitrunca*	Sheppard's tree	1 young	S29 28 26.2 E23 54 21.9
5.	*Boscia albitrunca*	Sheppard's tree	2 mature	S29 28 26.2 E23 54 21.9
6.	*Boscia albitrunca*	Sheppard's tree	1 young	S29 28 26.7 E23 54 20.4

MAMMAL AND BIRD SPECIES

The farm is zoned agriculture and used for livestock grazing. However, it is expected that the property still supports a number of game species, birds and other fauna. It was noted that the area in which the final proposed site is to be located seems to have been grazed over a long period of time. However, viewed in the larger context of the farm, the 20 ha solar facility will not pose a significant loss of grazing and the proposed solar site facility is not expected to have a major impact on regional biodiversity and with mitigating and good environmental control during construction the impact could be minimised.

According to the Sanparks website (www.sanparks.org.za/parks/mokala), the nearby Mokala National Park is host to a varied spectrum of birds which adapted to the transition zone between Kalahari and Karoo biomes. Birds that can be spotted are the Kalahari species, black-chested prinia and its Karoo equivalent rufous-eared warbler as well as melodious lark. In rocky hillocks attract species such as freckled nightjar (vocal at night), short-toed rock thrush and cinnamon-breasted bunting. There are also a number of birds making use of the artificial man-made habitat around accommodations, such as mousebirds, martins, robin-chats, thrushes, canaries and flycatchers. Animal species such as Black Rhino, White Rhino, Buffalo, Tsessebe, Roan Antelope, Mountain Reedbuck, Giraffe, Gemsbok, Eland, Zebra, Red Hartebeest, Blue Wildebeest, Black Wildebeest, Kudu, Ostrich, Steenbok, Duiker and Springbok are also present in the Mokala National Park. The trees associated with the riverbeds provide locally rare nesting and roosting habitat to birds.

RIVERS AND WETLANDS

Rivers maintain unique biotic resources and provide critical water supplies to people. South Africa's limited supplies of fresh water and irreplaceable biodiversity are very vulnerable to human mismanagement. Multiple environmental stressors, such as agricultural runoff, pollution and invasive species, threaten rivers that serve the world's population. River corridors are important channels for plant and animal species movement, because they link different valleys and mountain ranges. They are also important as a source of water for human use. Vegetation on riverbanks needs to be maintained in order for rivers themselves to remain healthy, thus the focus is not just on rivers themselves but on riverine corridors.

Figure 14: A Google overview of the proposed site location, indicating the drainage lines encountered on site

Two dry watercourses or upper drainage lines were observed on the property (Refer to Figure 14), one draining from west to east in the north-western portion of the proposed solar location (Photo 6) and one draining from the middle of the proposed solar location towards the south-south-west (Photo 7). Although they are not considered major watercourses they are well established and support denser woody riparian vegetation (defining the watercourse). Both of these drainage lines drain towards the Orange River, east of the proposed site location.

The woody riparian vegetation in both instances is dominated by *Acacia mellifera*, with *Acacia karroo*, and *Ziziphus mucronata* also sometimes present.

Photo 6: A photo of the drainage line to north-east of the site location (note the denser riparian vegetation)

Photo 7: A photo of the watercourse to the south-east of the property

INVASIVE ALIEN INFESTATION

Most probably because of the aridity of the area, invasive alien rates are generally very low for most of this area and no problem plants were observed within the study area (apart from some bush encroachment by the indigenous *Acacia mellifera*).

SIGNIFICANT BIODIVERSITY FEATURES ENCOUNTERED

The table underneath gives a summary of biodiversity features encountered during the site visit and a short discussion of their possible significance in terms of regional biodiversity targets.

Table 4: Summary of biodiversity features encountered on Erf 1654, Disselfontein and their possible significance

BIODIVERSITY ASPECT	SHORT DESCRIPTION	SIGNIFICANCE RATING
Geology & soils	The soils are mostly similar throughout the study area, although varying in depth.	No special features have been encountered on the final solar location (e.g. true quartz patches or broken veld).
Land use and cover	Agricultural land	Agricultural land used for grazing.
Vegetation types	Vaalbos Rocky Shrubland.	Vaalbos Rocky Shrubland is considered "Least threatened". However, the remaining natural veld shows good connectivity with the surrounding areas.
Endemic or protected plant species	No endemic species was observed, but a number of protected tree species was observed (Refer to Table 3).	A number of *Boscia albitrunca* trees were observed located along the south-western fence of the proposed site location. It is recommended that the lay-out of the final proposed site is altered slightly in order to avoid having to remove or damage these trees.
Mammal or bird species	The farm is used for agricultural grazing, although small game species are still expected.	The size and location of the solar facility is not expected to have a significant impact on total grazing or the movement of game species found on the larger area.
Rivers & wetlands	Two watercourses or upper drainage lines were encountered on the site.	It is recommended that the lay-out and final placement of the solar infrastructure take the location of these watercourses into consideration, with the intent of minimising impacts on these features (e.g. staying at least 32 m away from the edge of the watercourse wherever possible or at least protecting the integrity of the watercourse and riparian vegetation).
Invasive alien infestation	No alien invasive trees were observed.	No impact.

In summary, all areas with remaining natural vegetation, especially when these features show good connectivity with the surrounding natural veld (e.g. corridors) should be considered as significant. However, the placement of a 20 ha solar site in this location is not expected to have significant impact on any biodiversity feature or put pressure on regional conservation targets. The impact on populations of individual species is regarded as low (so long as *Boscia albitrunca* could be conserved), the impact on sensitive habitats is regarded as medium-low (mitigation with regards to watercourses will reduce the impact), the impact on ecosystem function is regarded as very low, cumulative impact on ecology is regarded as medium-low (rivers and protected trees) and finally the impact on economic use of the vegetation is regarded as low.

BIODIVERSITY ASSESSMENT

Biological diversity, or biodiversity, refers to the variety of life on Earth. As defined by the United Nations Convention on Biological Diversity, it includes diversity of ecosystems, species and genes, and the ecological processes that supp ort them. Natural diversity in ecosystems provides essential economic benefits and services to human society—such as food, clothing, shelter, fuel and medicines—as well as ecological, recreational, cultural and aesthetic values, and thus plays an important role in sustainable development. Biodiversity is under threat in many areas of the world. Concern about global biodiversity loss has emerged as a prominent and widespread public issue.

The objective of this study was to evaluate the biological diversity associated with the study area in order to identify significant environmental features which should be avoided during development activities and or to evaluate short and long term impact and possible mitigation actions in context of the proposed development.

As such the report aim to evaluate the biological diversity of the area using the Ecosystem Guidelines for Environmental Assessment (De Villiers *et. al*., 2005), with emphasis on:

- Significant ecosystems
  - Threatened or protected ecosystems
  - Special habitats
  - Corridors and or conservancy networks
- Significant species
  - Threatened or endangered species
  - Protected species

METHOD USED

During May 2001, Van Schoor published a formula for prioritizing and quantifying potential environmental impacts. This formula has been successfully used in various applications for determining the significance of environmental aspects and their possible impacts, especially in environmental management systems (e.g. ISO 14001 EMS’s). By adapting this formula slightly it can also be used successfully to compare/evaluate various environmental scenario's/options with each other using a scoring system of 0-100%, where any value of 15% or less indicate an insignificant environmental impact while any value above 15% constitute ever increasing environmental impact.

Using Van Schoor’s formula (adapted for construction with specific regards to environmental constraints and sensitivity) and the information gathered during the site evaluation the possible negative environmental impact of the activity was evaluated.

Underneath follows a short description of Van Schoor's formula. In the formula the following entities and values are used in order to quantify environmental impact.

***S* = [(*fd* + *int* + *sev* + *ext* + *loc*) x (*leg* + *gcp* + *pol* +*ia* + *str*) x *P*]** (as adapted for construction activities)

Where

S = Significance value

fd = frequency and duration of the impact

int = intensity of the impact

sev = severity of the impact

ext = extent of the impact

loc = sensitivity of locality

leg = compliance with legal requirements

gcp = conformance to good environmental practices

pol = covered by company policy/method statement

ia = impact on interested and affected parties

str = strategy to solve issue

P = probability of occurrence of impact

CRITERIA

The following numerical criteria for the above-mentioned parameters are used in the formula.

fd = frequency and duration of the impact					
low frequency ; low duration	1	medium frequency; low duration	1.5	high frequency ; low duration	2
low frequency; medium duration	1.5	medium frequency ; medium duration	2	high frequency ; medium duration	2.5
low frequency ; high duration	2	medium frequency ; high duration	2.5	high frequency ; high duration	3

int = intensity of the impact					
low probability of species loss; low physical disturbance	1	medium probability of species loss; low physical disturbance	1.5	high probability of species loss; low physical disturbance	2
low probability of species loss; medium physical disturbance	1.5	medium probability of species loss; medium physical disturbance	2	high probability of species loss; medium physical disturbance	2.5
low probability of species loss; high physical disturbance	2	medium probability of species loss; high physical disturbance	2.5	high probability of species loss; high physical disturbance	3

sev = severity of the impact	
changes immediately reversible	1
changes medium/long-term reversible	2
changes not reversible	3

ext = extent of the impact	
locally (on-site)	1
regionally (or natural/critical habitat affected)	2
globally (e.g. critical habitat or species loss)	3

loc = sensitivity of location	
not sensitive	1
moderate (e.g. natural habitat)	2
sensitive (e.g. critical habitat or species)	3

leg = compliance with legal requirements	
compliance	0
non-compliance	1

gcp = good conservation practices	
conformance	0
non-conformance	1

pol = covered by company policy	
covered in policy	0
not covered/no policy	1

ia = impact on interested and affected parties	
not affected	1
partially affected	2
totally affected	3

str = strategy to solve issue	
strategy in place	0
strategy to address issue partially	0.5
no strategy present	1

P = probability of occurrence of impact	
not possible (0% chance))	0
not likely, but possible (1 - 25% chance)	0.25
likely (26 - 50% chance)	0.50
very likely (51 - 75% chance)	0.75
certain (75 - 100% chance)	0.95

EVALUATION OF SIGNIFICANT ECOSYSTEMS

The main drivers in this vegetation type would be soil type and depth and grazing pressure (herbivore), and could largely determine plant community composition and occurrence of rare species. Grazing may be an important factor in regulating competitive interaction between plants (*Acacia mellifera* encroachment is often a sign of overgrazing or bad veld management). Certain species can act as important "nursery" plants for smaller species and are also important for successional development after disturbance. Tortoises and mammals can be important seed dispersal agents. Although upper drainage lines was observed on the property no other, wetlands, upland- down land gradients or vegetation boundaries were observed during the site visit (associated with the final proposed solar site location). It was also not evident to what extent the fire regime has been altered in order to improve grazing (if at all).

THREATENED OR PROTECTED ECOSYSTEMS

The site visit confirmed that the vegetation conforms to Vaalbos Rocky Shrubland (Refer to Figure 12). This vegetation type was classified as "Least Threatened" during the 2004 National Spatial Biodiversity Assessment (NSBA). More than 98% of this vegetation still remains in its natural state, but at present none of this vegetation type is formally protected throughout South Africa. Recently the *National list of ecosystems that are threatened and in need of protection* (GN 1002, December 2011), was promulgated in terms of the National Environmental Management Biodiversity Act (NEM: BA), Act 10 of 2004. According to this National list, **<u>Vaalbos Rocky Shrubland, remains classified as Least Threatened</u>**.

The <u>impact on threatened or protected ecosystems is regarded as being low</u>.

Mitigation:

- Good environmental control during the construction phase will ensure further mitigation.

SPECIAL HABITATS

The vegetation itself is not considered to belong to a threatened or protected ecosystem. Apart from the two watercourses or upper drainage lines, no special habitats were encountered on site (e.g. quartz patches or broken veld), which could sustain significant smaller ecosystems. It is recommended that the lay-out and final placement of the solar infrastructure take the position of these watercourses into consideration, with the intent of minimising impacts on these features (e.g. staying at least 32 m away from the edge of the watercourse wherever possible or at least protecting the integrity of the watercourse and riparian vegetation). If this could be achieved the impact will be much reduced.

Overall the development of the 20 ha Keren Energy solar facility at Disselfontein is not expected to a have a significant impact on any special habitat apart from the river systems. If the watercourses could be protected (e.g. staying at least 32 m away from the edge of the watercourse wherever possible, or at least protecting the integrity of the watercourse and riparian vegetation), impact on special habitats can be rated as low, however, without mitigation the impact would be rated as medium-low.

Mitigation:

- Stay at least 32 m away from the edge of any watercourse or at least protect the integrity of the watercourse and riparian vegetation.

CORRIDORS AND OR CONSERVANCY NETWORKS

Looking at the larger site and its surroundings it shows excellent connectivity with remaining natural veld in almost all directions. Corridors and natural veld networks are still relative unscathed (apart from road networks), also take note of the minor riparian corridors along the watercourses (which must be protected wherever possible).

Since large areas with good connectivity remains, the 20 ha Disselfontein Keren Energy solar facility development is not expected to a have a significant impact on connectivity with regards to surrounding natural veld (especially if mitigation with regards to the riparian vegetation can be implemented). The impact is rated as low to medium-low.

Mitigation:

- Stay at least 32 m away from the edge of any watercourse or at least protect the integrity of the watercourse and riparian vegetation.

EVALUATION OF SIGNIFICANT SPECIES

The site visit was performed at the end of February (2012). At the time of the study the veld in the Disselfontein area was generally in very good condition and most of the species was visible/identifiable. The author is of the opinion that in the larger context almost all significant species were observed and mapped.

THREATENED OR ENDANGERED SPECIES

No threatened or endangered species were recorded during the site visit, however, this does not rule out their presence as they may be subject to seasonable rainfall and may not have been observable during the time of the site visit. The composition of the herbaceous layer fluctuates with seasonal rainfall (Van Rooyen *et. all*, 1984, *vide* Mucina & Rutherford, 2006). It must be noted that the vegetation type is considered "Least Threatened" (Mucina & Rutherford, 2006) and that this classification is based on plant species diversity and turnover as well as habitat transformation. The number of species per broad geographical levels for the savannah biome is relative low (Van Rooyen, 1988, *vide* Mucina & Rutherford, 2006). It is therefore very unlikely that any red data species will be confined to this site alone.

During the site visit no such species were observed and in the regional context the author is of the opinion that the development of the 20 ha solar facility will not lead to irreversible species loss.

The possibility of such an impact occurring is rated as very low.

Mitigation:

- With good environmental control (e.g. topsoil removal, storage and re-distribution) and rehabilitation after construction (leaving the remaining area as natural as possible) the possibility of such an impact occurring will become insignificant.

PROTECTED SPECIES

Three protected tree species have a distribution which could overlap with the general site location of the solar facility namely: *Acacia erioloba* (Camel thorn) *Boscia albitrunca* (Witgat) and *Acacia haematoxylon* (Grey camel thorn). Of these 3 species only *Boscia albitrunca* (Witgat) was observed on the proposed site. (All of the trees observed were referenced by GPS and are indicated on Figure 4 and in Table 3).

The current final solar site location as shown in Figure 3, will impact on a number of mature *Boscia albitrunca* trees. However, since these trees are all located along the south-west boundary of the proposed final location (clumped together) a slight alteration of the layout (e.g. shifting the solar infrastructure slightly east in that specific area) could totally negate the impact. Still it is important that if this development is approved good environmental control should be exercised and that a botanist or an ECO with suitable experience should be appointed during the initial lay-out of the site. With good environmental control and careful placement of the solar pylons and the maintenance roads any further possible impact to such trees within the final site location can be greatly reduced or minimised.

With mitigation implemented the impact can be negated, without mitigation the severity of the impact is rated as medium to medium-low.

Mitigation:

- Consider moving the final layout of the proposed solar site, e.g. shifting the solar infrastructure slightly east in the specific area populated by *Boscia albitrunca* trees to avoid these trees.

- A botanist or suitably experienced ECO must be appointed to oversee the initial layout of the construction site, with the aim to identify and minimise the impact on any protected trees. The placement of roads and solar structures should endeavour to avoid any of these tree species.
- If any of these trees must be removed, permit approval must be obtained beforehand.
- It is also proposed that at least two plants of the same species be replanted for every single tree removed.

PLACEMENT AND CONSTRUCTION METHOD

A single solar generator produces approximately 66kV. In order to produce 10 MW, the proposed facility will require a number of generators arranged in multiples/arrays. The CPV panels will be elevated (2 m above ground) by a support structure, and will be able to track the path of the sun during the day for maximum efficiency (Refer to Photo 8). Approximately 1.8 ha is required per installed MW. A 10 MW capacity facility will thus require a development footprint of approximately 20 ha (including associated infrastructure – ancillary infrastructure). Each panel will be approximately 22 m wide by 12.5 m high. When the panels are tracking vertically the structure will have a maximum height of approximately 15 m. The excavation needed for each support structures (approximately 148 units are proposed) will be 1 m^2 by 5 m deep. It means that apart from the associated structures, approximately 148 holes of 1 m^2 by 5 m deep will be excavated. Each hole must be at least 22 m from the next.

Photo 8: Typical layout of such a solar site (Image courtesy of Amonix, a leading designer of CPV technology)

The activities will require the stripping of topsoil (for the pylon holes and access roads only, leaving the remainder as natural as possible), which will need to be stockpiled, backfilled and/or spread on site. All in all the proposed facility can be likened to light agriculture, with the exception that natural vegetation can be allowed to remain on all the non-disturbed areas. All surfaces not used for the facility and associated infrastructure can remain natural.

DIRECT IMPACTS

As the name suggest, direct impacts refers to those impacts with a direct impact on biodiversity features and in this case were considered for the potentially most significant associated impacts (some of which have already been discussed above).

Direct loss of vegetation type and associated habitat due to construction and operational activities.

- Loss of ecological processes (e.g. migration patterns, pollinators, river function etc.) due to construction and operational activities. (Refer to page 23).
- Loss of local biodiversity and threatened plant species (Refer to page 23)
- Loss of ecosystem connectivity (Refer to page 24)

LOSS OF VEGETATION AND ASSOCIATED HABITAT

One broad vegetation type is expected in the study area, namely Vaalbos Rocky Shrubland (Refer to Vegetation encountered on page 13). Vaalbos Rocky Shrubland was classified as "Least Threatened" during the 2004 National Spatial Biodiversity Assessment. Within the more recent "*National list of ecosystems that are threatened and in need of protection"* (GN 1002, December 2011), promulgated in terms of the National Environmental Management Biodiversity Act (NEM: BA), Act 10 of 2004, the status of Vaalbos Rocky Shrubland are still regarded as least threatened. More than 98% of this vegetation type is still found in a relative natural state. Thus the vegetation itself is not considered to belong to a threatened or protected ecosystem. No special habitats were encountered on site (e.g. quartz patches or broken veld), which could sustain significant smaller ecosystems.

Even if all of the 20 ha is transformed (such as for intensive cultivation), the impact on the specific vegetation type would most probably only be <u>medium-low</u> as a result of the status of the vegetation and the location of the final proposed solar location. However, with mitigation the impact can be much reduced.

<u>Mitigation</u>: The following is some mitigation which will minimise the impact of the solar plant location and operation.

- Also include the mitigation actions under the heading: Protected species (page 25).
- Only existing access roads should be used for access to the terrain (solar site).
- The internal network of service roads (if needed) must be carefully planned to minimise the impact on the remaining natural veld on the site. The number of roads should be kept to the minimum and should be only two-track/twee spoor roads (if possible). The construction of hard surfaces should be minimised or avoided.
- Access roads and the internal road system must be clearly demarcated and access must be tightly controlled (deviations may not be allowed).

- Indiscriminate clearing of areas must be avoided, only pylon sites and sites where associated infrastructure needs to be placed must be cleared (all remaining areas to remain as natural as possible).
- All topsoil (at all excavation sites) must be removed and stored separately for re-use for rehabilitation purposes. The topsoil and vegetation should be replaced over the disturbed soil to provide a source of seed and a seed bed to encourage re-growth of the species removed during construction.
- Once the construction is completed all further movement must be confined to the access tracks to allow the vegetation to re-establish over the excavated areas.

INDIRECT IMPACTS

Indirect impacts are impacts that are not a direct result of the main activity (construction of the solar facility), but are impacts still associated or resulting from the main activity. Very few indirect impacts are associated with the establishment of the solar facility (e.g. no water will be used, no waste material or pollution will be produced through the operation of the facility).

The only indirect impact resulting from the construction and use of the facility is a loss of movement from small game and other mammals, since the property will be fenced. However, it is not considered to result in any major or significant impact on the area as a whole.

CUMULATIVE IMPACTS

In order to comprehend the cumulative impact, one has to understand to what extent the proposed activity will contribute to the cumulative loss of this vegetation type and other biodiversity features on a regional basis. Vaalbos Rocky Shrubland was classified as "Least Threatened", during the 2004 National Spatial Biodiversity Assessment. Within the more recent "*National list of ecosystems that are threatened and in need of protection"* (GN 1002, December 2011), promulgated in terms of the National Environmental Management Biodiversity Act (NEM: BA), Act 10 of 2004, the status of Vaalbos Rocky Shrubland is still regarded as least threatened. More than 98% of this vegetation type is still found in a relatively natural state. Thus the vegetation itself is not considered to belong to a threatened or protected ecosystem. No special habitats were encountered on site (e.g. quartz patches or broken veld), which could sustain significant smaller ecosystems.

Even if all of the 20 ha is transformed (such as for intensive cultivation), the impact on the regional status of this vegetation type and associated <u>biodiversity features would likely still be only medium-low</u>. No irreversible species-loss, habitat-loss, connectivity or associated impact can be foreseen from locating and operating the solar facility on the final proposed solar site. <u>However, all mitigation measures should still be implemented in order to further minimise the impact of the construction and operation of the facility</u>.

THE NO-GO OPTION

During the impact assessment only the final proposed site (as described in Figure 3 and Table 1 is discussed. From the above, the "No-Go alternative" does not signify significant biodiversity gain or loss especially on a regional basis. However, minor watercourses or upper drainage lines and a number of protected tree species will remain undisturbed.

The site visit and desktop studies described and evaluated in this document led to the conclusion that the "No-Go" alternative will not result in significant gain in regional conservation targets, the conservation of rare & endangered species or gain in connectivity, however, a number of protected tree species will be conserved (which, with mitigation, could be achieved even if the development is approved). On the other hand the pressure on Eskom facilities, most of which are currently still dependant on fossil fuel electricity generation, will remain. Solar power is seemingly a much cleaner, biodiversity friendly, and more sustainable long term option for electricity production.

QUANTIFICATION OF ENVIRONMENTAL IMPACTS

Taking all of the above discussions into account and using Van Schoor's formula for impact quantification, impacts of the following can be quantified as follows:

NO DEVELOPMENT

The no development scenario can only take regional biodiversity into account. In this instance national biodiversity (and even possibly global diversity) may, however, show significant gain over time, if for instance fossil burning electricity generation could be reduced and or replaced by cleaner energy production methods. Although solar energy is presently not seen as a viable stand-alone technology for electricity production it will lighten the pressure on the fossil burning facilities of Eskom and in so doing will add to a more sustainable way of electricity production.

DEVELOPMENT WITHOUT MITIGATION

The purpose of this scenario is to illustrate, using Van Schoor's formula, the loss should development be allowed <u>without any mitigation measures</u>. It is assumed that the 20 ha will be totally developed into hard surfaces, but still in context of the regional importance of the biodiversity associated with the area.

***S* = [(*fd* + *int* + *sev* + *ext* + *loc*) x (*leg* + *gcp* + *pol* +*ia* + *str*) x *P*]** (as adapted)

S = [(1.5 + 1.5 + 2 + 1 + 1.5) x (1 + 1 +1 + 1 +1) x 0.95] = 36 %

In the above any value of 15% or less indicates an insignificant environmental impact, while any value above 15% constitutes ever increasing environmental impact.

DEVELOPMENT WITH MITIGATION

The purpose of this scenario is to illustrate, using Van Schoor's formula, the environmental gain should development be allowed <u>with all proposed mitigation measures implemented</u>. It is assumed that the 20 ha will be developed, but that all areas not directly impacted by infrastructure placement will remain as natural as possible.

***S* = [(*fd* + *int* + *sev* + *ext* + *loc*) x (*leg* + *gcp* + *pol* +*ia* + *str*) x *P*]** (as adapted)

S = [(1.5 + 1.5 + 2 + 1 + 1.5) x (0 + 1 +0 + 1 +0) x 0.95] = 7 %

In the above any value of 15% or less indicates an insignificant environmental impact, while any value above 15% constitutes ever increasing environmental impact.

RECOMMENDATIONS & IMPACT MINIMIZATION

From the information discussed in this document it is clear to see that the Disselfontein final location was relatively well chosen from a biodiversity viewpoint. Even if all of the 20 ha is transformed (such as for intensive cultivation), the impact on the regional status of this vegetation type and associated biodiversity features (e.g. watercourses and drainage lines) would likely still be only medium. With mitigation, no irreversible species-loss, habitat-loss, connectivity or associated impact can be foreseen from locating and operating the solar facility on the final proposed solar site.

Photo 9: *Polygala asbestina* encountered on site

The site visit and desktop studies described and evaluated in this document led to the conclusion that the "No-Go Alternative" alternative will not result in significant gain in regional conservation targets, the conservation of rare & endangered species or gain in connectivity, however, a number of protected tree species will be conserved (please note that this could also be achieved with mitigation as proposed in this document). On the other hand the pressure on Eskom facilities, most of which is currently still dependant on fossil fuel electricity generation, will remain. Solar power is seemingly a much cleaner and more sustainable option for electricity production.

In this instance national biodiversity (and even possibly global diversity) may show significant gain over time, if for instance fossil burning electricity generation could be reduced and or replaced by cleaner energy production methods. Although solar energy is presently not seen as a viable stand-alone technology for electricity production it will lighten the pressure on the fossil burning facilities (and the need for building more) of Eskom and in so doing will add to a more sustainable way of electricity production.

Finally, when quantifying the development options, the Van Schoor's formula for impact quantification still shows a significant difference between development **without** and development **with** mitigation. As a result it is recommended that all mitigating measures must be implemented in order to further minimise the impact of the construction and operation of the facility.

With the available information at the author's disposal it is recommended that the project be approved, but that all mitigation measures described in this document is implemented and that a botanist or suitably qualified ECO be appointed during the initial layout of the structures in order to minimise/negate the impact on significant biodiversity features (e.g. watercourses) and the protected tree species.

IMPACT MINIMIZATION

GENERAL

- All construction must be done in accordance with an approved construction and operational phase Environmental Management Plan (EMP), which must be developed by a suitably experienced Environmental Assessment Practitioner.
- A suitably qualified Environmental Control Officer must be appointed to monitor the construction phase of the solar plant in terms of the EMP and the Biodiversity study recommendations as well as any other conditions which might be required by the Department of Environmental Affairs.
- An integrated waste management system must be implemented during the construction phase.
- All rubble and rubbish (if applicable) must be collected and removed from the site to a suitable registered waste disposal site.
- All alien vegetation should be removed from the larger property.
- Adequate measures must be implemented to ensure against erosion.

SITE SPECIFIC

- Consider altering the final layout of the proposed solar site, through shifting the solar infrastructure slightly east in the specific area populated by *Boscia albitrunca* trees to avoid these trees (Refer to Figure 15).
- A botanist or suitably experienced ECO must be appointed to oversee the initial layout of the construction site, with the aim to identify and minimise the impact on any protected trees. The placement of roads and solar structures should endeavour to avoid any of these tree species.
- If any of these trees must be removed, permit approval must be obtained beforehand. It is also proposed that at least two plants of the same species be replanted for every single tree removed.
- Stay at least 32 m away from the edge of any watercourse or at the very least the integrity of all watercourses and its associated riparian vegetation must be protected (since it can be regarded as minor watercourses) (Refer to Figure 15).
- Only existing access roads should be used for access to the terrain (solar site).
- The internal network of service roads (if needed) must be carefully planned to minimise the impact on the remaining natural veld on the site. The number of roads should be kept to the minimum and should be only two-track/ twee-spoor roads (if possible). If possible the construction of any hard surfaces should be minimised or avoided.
- During construction access roads and the internal road system must be clearly demarcated and access must be tightly controlled (deviations must not be allowed).
- Indiscriminate clearing of areas must be avoided, only pylon sites and sites where associated infrastructure needs to be placed may be cleared (all remaining areas to remain as natural as possible).

- All topsoil (the top 15-20 cm at all excavation sites), must be removed and stored separately for re-use for rehabilitation purposes. The topsoil and vegetation should be replaced over the disturbed soil to provide a source of seed and a seed bed to encourage re-growth of the species removed during construction.
- Once the construction is completed all further movement must be confined to the approved access and maintenance tracks to allow the vegetation to re-establish over the excavated areas.

Figure 15: A visual summary of the proposed mitigation areas, showing areas to be avoided in yellow