SOIL REPORT FOR THE PROPOSED SAN SOLAR ENERGY FACILITY NEAR KATHU, NORTHERN CAPE PROVINCE, SOUTH AFRICA

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List of abbreviations

AMSL:	Above mean sea level
ECO:	Environmental Control Officer
EIA:	Environmental Impact Assessment
EMP:	Environmental Management Programme
ER:	Engineer's representative
Ma:	Million years
MW:	Megawatt
NEMA:	National Environmental Management Act 107 of 1998
NGL:	Natural ground level
PV:	Photovoltaic

1. INTRODUCTION

1.1. Background information

San Solar Energy Facility (Pty) Ltd is proposing the establishment of a commercial solar energy facility and associated infrastructure on a site located approximately 16 km south-east of Kathu in the Northern Cape Province of South Africa. The proposed activity will involve the construction of photovoltaic (PV) panels with a generating capacity of 75MW, an on-site inverter, a small substation to facilitate the connection to the Eskom electricity grid, underground and overhead electrical lines, internal access roads, a workshop, storeroom and a control building. The facility has a finite lifespan of approximately 20 years and the following activity is envisaged during the various stages:

Construction Phase

The construction phase is estimated to take approximately two years and construction vehicles would travel to the site via regional roads (R380) and on-site farm roads. On-site vehicles will remain on purpose-built access roads. Construction goods and materials would be stored in a temporary construction camp. Staff will be transported to site every day.

The following activities will be undertaken:

1. Site clearing and grubbing (with exception of protected vegetation);
2. Construction of site infrastructure, roads, electrical reticulation trenches;
3. Construction of foundations;
4. Panel construction and transport to pedestal;
5. Erection of panels onto pedestals;
6. Electrical connection;
7. Construction of substation and control centre.

The proposed technology typically makes use of a light-weight frame upon which the PV panels are attached. The frame is usually anchored to the ground by means of steel poles which are emplaced into pre-drilled holes or screwed into the ground (screwpiles). Alternatively, shallow concrete pads are cast to secure the top structure. In any case, minimal earthworks are involved in the foundations and the frames can be erected on moderate slopes without resorting to significant earthworks.

Operation Phase

Typical activities during the operational phase will include:

1. Cleaning panels;
2. Site maintenance;
3. Engines lubrication;
4. Preventive inspections.

Decommissioning Phase

Typical activities during the operational phase will include:

1. Disassembling facilities;
2. Removing equipment and infrastructure from site;
3. Rehabilitating soil, vegetation and surrounds.

1.2. Legislation

In terms of the Environmental Impact Assessment (EIA) regulations published in terms of Section 24(5) of the National Environmental Management Act (NEMA, Act No. 107 of 1998), the applicant requires authorisation from the National Department of Environmental Affairs (DEA) in consultation with the relevant Provincial Department for the undertaking of the proposed project.

This specialist study is undertaken in accordance with Regulation 17 of the NEMA.

1.3. Terms of reference

Savannah Environmental has been appointed by San Solar Energy Facility (Pty) Ltd to carry out the required environmental impact assessment for the proposed activities. Savannah Environmental has appointed Outeniqua Geotechnical Services to conduct a soil study and assess any associated potential impacts as a result of the proposed development.

The following scope of work has been given:

- Investigate the physical aspects of the site (geology, soil types, topography, vegetation, etc.), surface processes (weathering, erosion and surface hydrology), land use and agricultural potential.
- Describe the physical aspects of the site, the present land use and the agricultural potential.
- Identify and quantify the potential environmental impacts on the soil cover that may be associated with the proposed activity.
- Provide mitigating measures for inclusion in the Environmental Management Programme (EMP).

1.4. Information available and limitations

Information provided in this specialist report is based on information provided by San Solar Energy Facility (Pty) Ltd, Savannah Environmental (Pty) Ltd, published scientific literature and maps. Information on the soils of the area was obtained from old soil reports and land type information on the Kuruman 1:250 000 land type map. Geological information was obtained from the 1:250 000 Geological Series sheet 2722 Kuruman. Aerial imagery was obtained from Google Earth. Land contour data was obtained from the Directorate of Surveys and Mapping.

Experience gained on other projects in the nearby vicinity was heavily relied upon as the site was not visited and no detailed soil survey or mapping was conducted. The information provided in this report is deemed adequate for the EIA process.

1.5. Author's credentials & declaration of independence

The authors of this report are independent consultants with no financial or vested interest in the proposed development, other than remuneration for work performed in the compilation of this report.

Iain Paton is a professional engineering geologist registered with the South African Council for Natural and Scientific Professions (Pr Sci Nat # 400236/07) with 14 years experience in the built environment, including 3 years experience specifically relating to soil studies for renewable energy projects. Iain Paton is a member of the South African Institute of Engineering and Environmental Geologists (SAIEG) and the Geotechnical Division of the South African Institute of Civil Engineering (SAICE).

Theodore Robertson is an agricultural consultant and farmer with a National Diploma in Agriculture (Soil Science) and over 35 years experience in agricultural consulting.

2. SITE DESCRIPTION

2.1. Location

The San Solar Energy Facility is proposed on the remaining extent of the Farm Wincanton 472 which falls within the Gamagara Local Municipality. The proposed site is preferred by virtue of climatic conditions (primarily as the economic viability of a solar energy facility is directly dependent on the annual direct solar irradiation values for a particular area), orographic conditions, relief and aspect, and the availability of a grid connection (i.e. the point of connection to the national grid).

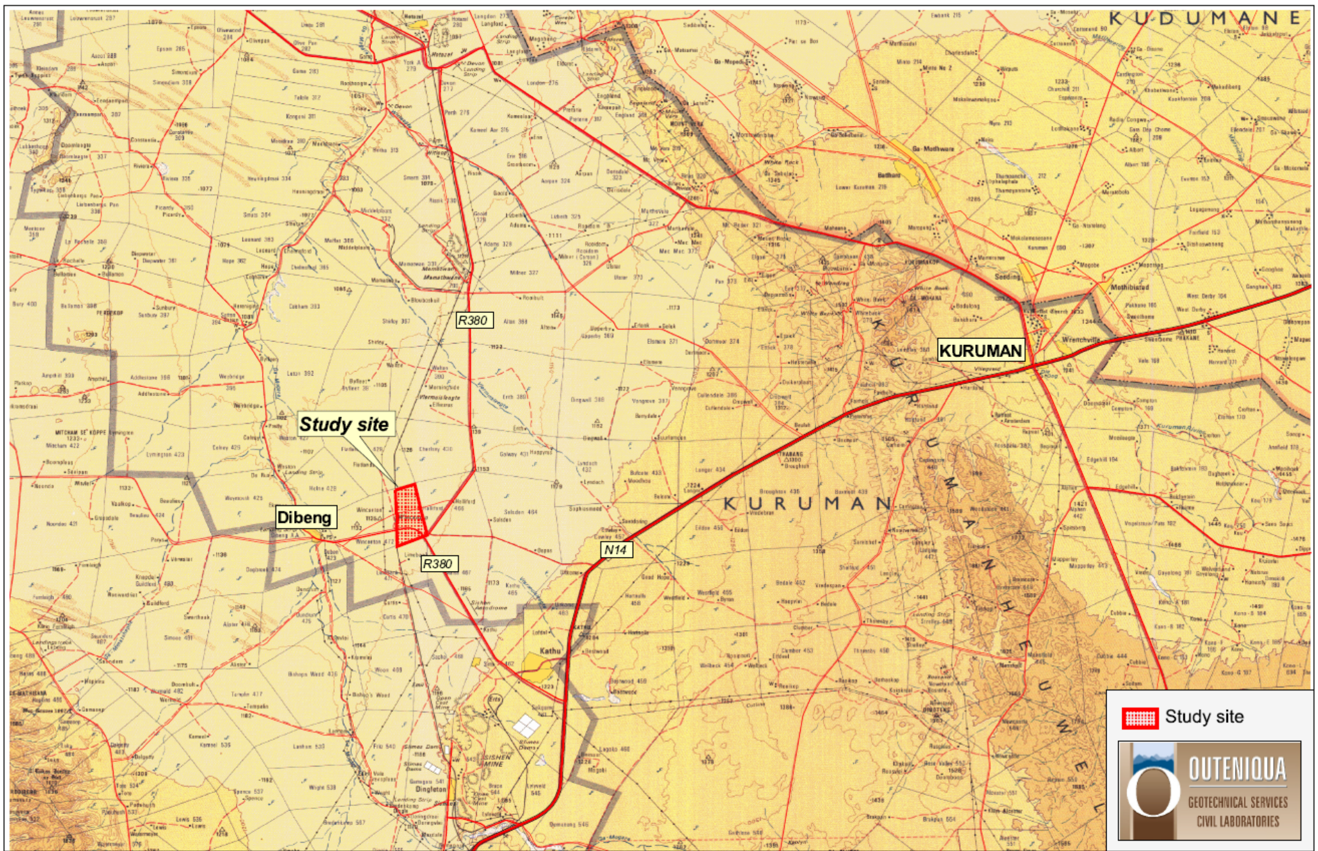

Figure 1: Locality map

10 0 10 20 30 40 Kilometers

2.2. Topography, climate, & vegetation cover

The proposed site is situated on very gently sloping terrain with a slope of less than 2% which drains to the north-west into the Ga-Mogara River (a seasonally dry river bed that very occasionally flows in a south to north direction through Dibeng). The altitude range across the site is approximately 1145-1135m AMSL.

The climate can be described as arid with precipitation occurring during the hot summer months. The mean annual precipitation for the Kathu area is 300-400 mm with the mean annual evaporation (S-Pan) of 2200-2600mm[3]. Summer temperatures are very hot with only occasional frost occurring in winter. The Weinert Climatic N-number[6] for the area, which is between 40 and 50, indicates that the climate is extremely arid and mechanical weathering processes are dominant.

The study area falls within the Karoo Biome and the vegetation type is Kathu Bushveld[7] with a shrub layer of Black Thorn Acacia, Star Apple and Karee Thorn dominant. Grasses occur below and between the shrubs. Grasses such as *Eragrostis lehmanniana*, *Stipogrostis* types and *Centropodia glauce* (Kalahari-Gha) are dominant in this vegetation type. Camel Thorn (*Acacia erioloba*) and Shepherds trees (*Boscia albitrunca*) also occur within the area. Mesquite (*Prosopis glandulosa*) is one of the alien plants occurring in the area and has the potential to invade disturbed sites.

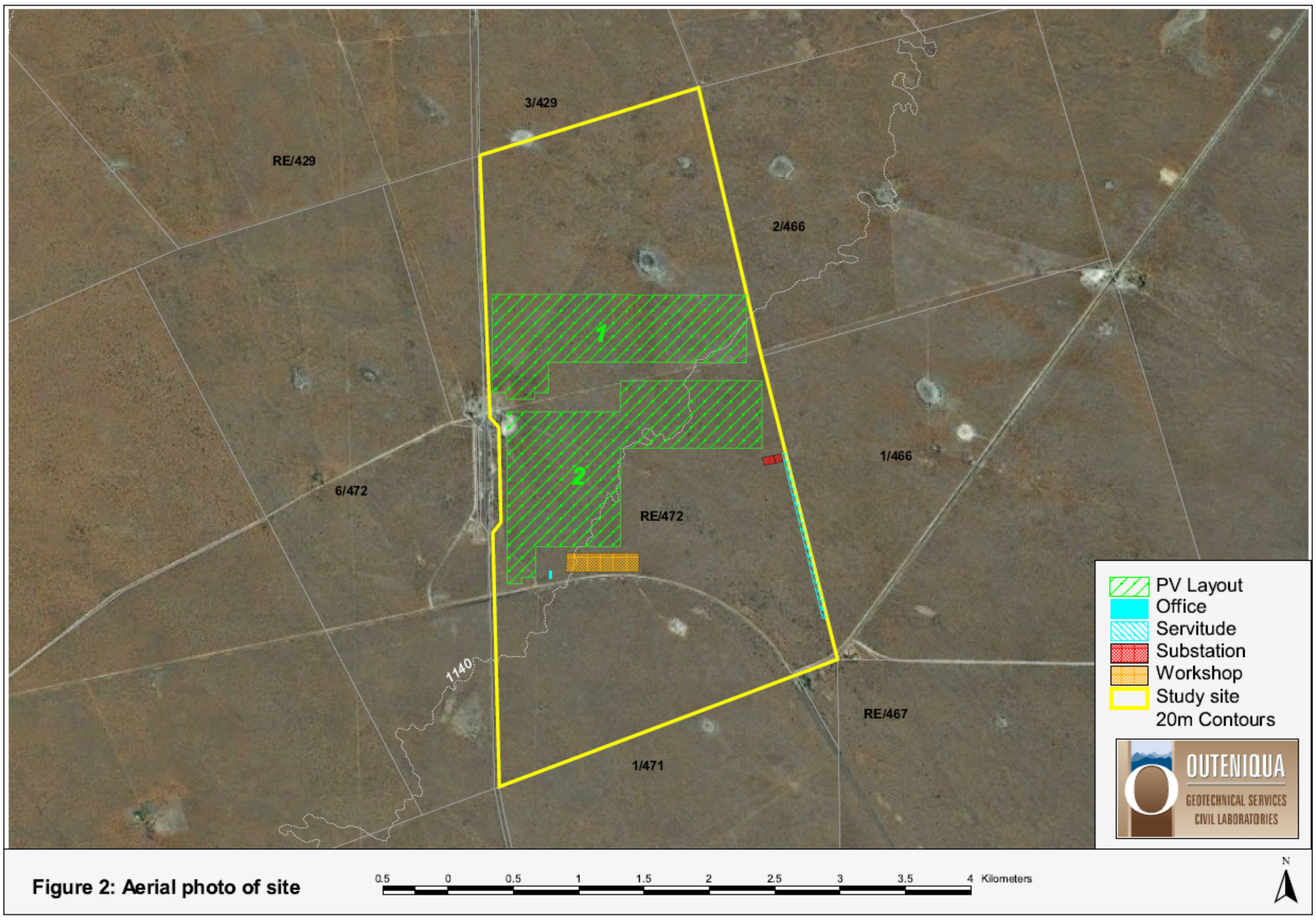

Figure 2: Aerial photo of site

2.3. Geology and soil cover

The study area is underlain by surficial deposits of unconsolidated aeolian sand (Quaternary) which is underlain by calcrete of Tertiary age. These relatively young deposits overlie much older sedimentary rocks of the Griqualand West Sequence which do not outcrop in the study area. The thickness of the younger sediments is unknown. Sporadic deposits of river terrace gravel may occur on the study area. These gravel deposits consist of a variable mixture of unconsolidated red silty sand, sub-rounded to sub-angular fragments of banded iron formation quartzite (re-worked Griqualand West Sequence).

The Griqualand West Sequence comprises a sequence of shale, dolomite, banded ironstone, jaspilite, quartzite, conglomerate which was deposited in a deep and extensive basin from waters rich in silica and carbonates some 2300 Ma ago. The sequence includes soluble carbonate rocks (dolomites) which can lead to the formation of sinkholes and dolines (compaction subsidence structures). A 50m deep sinkhole appeared in November 1967 on the farm Volgelstruisbult, a few kilometers southwest of Kuruman[5]. There are a few small but noticeable pans or depressions in the topography on the site which appear to have similar characteristics to the dolines that occur on karst terrain elsewhere in South Africa. These dolines are very old remnants of slowly subsided ground typically due to the dissolution of surficial calcrete capping. The pans are brackish and very little vegetation grows in them.

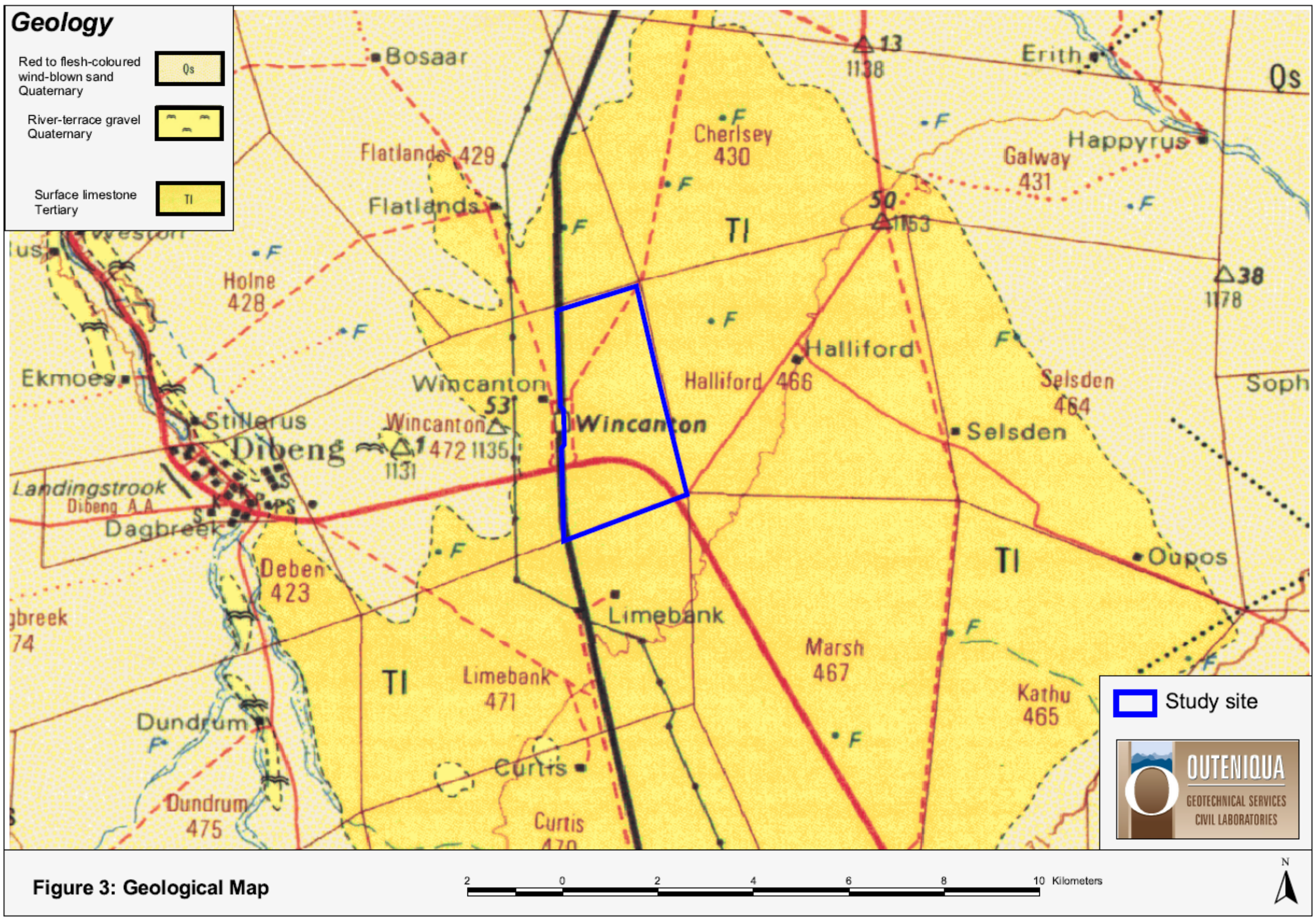

Figure 3: Geological Map

2.4. Hydrology and water erosion potential

The farm is located within the D14J Quaternary Catchment of the Lower Vaal Water Management Area (WMA). The mean annual precipitation is 300-400mm and the mean annual evaporation (S-Pan) is 2200-2600mm.[3]

Water erosion potential is directly related to the hydrogeology of the site. Topography and soil permeability is the major control over run-off which is the primary trigger of erosion. The sandy soil cover over the study area is typically thin and underlain by relatively impermeable calcrete which may restrict infiltration and promote run-off. However, due to the permeable nature of the soil cover and the very low rainfall, run-off seldom occurs and owing to the flat topography the energy of the run-off is low and unlikely to pose a problem in terms of erosion. In unusual cases of heavy, prolonged rainfall moderate levels of erosion can occur.

2.5 Land use, land capability and agricultural potential

The whole study area is regarded as natural veld (Kathu Bushveld) which is used for livestock grazing (cattle, sheep, goats and game) and there is no sign of any crop cultivation or irrigation systems. Drinking water for livestock is obtained from boreholes and the grazing capacities ranges from 30 to 50 hectares per large stock unit.

Agricultural potential is primarily determined by the suitability of the soil profile to support crop production. The soil needs to be adequately thick to support root development and the drainage characteristics need to be good to prevent chemical crusting on surface. The dominant soil type is fine sand Plooysburg form with depths ranging between 300 and 750mm. Minor soil types occurring is Askham form as well as Kimberley and Hutton forms. They are all very sandy and prone to wind erosion. Limestone/calcrete outcrops occur within the area with Coega form soils dominant.

In addition to the soil characteristics, climatic factors are also important because the annual rainfall needs to be adequate to sustain a viable crop production. The combined low rainfall and high evaporation rates result in a serious limitation to agricultural potential of the site. In summary, the agricultural potential is considered low and limited to 25 to 40 large stock units on the 800ha property.

3. IMPACT ASSESSMENT

The impact assessment aims to identify potential impacts that the proposed activity may have on the soil and assess the significance of the various impacts. In addition to this, possible mitigating measures are explored which could limit the effect of negative impacts.

The proposed activity could carry potentially negative direct impacts in terms of soil degradation (erosion, soil removal, loosening, compaction, contamination/pollution, etc.) and agricultural potential. The activity may also lead to indirect impacts such as dust pollution and siltation away from the site. The severity or significance of the various impacts is a factor of the nature and extent of the activity. Negative impacts on soil would mainly occur during the construction phase. During the post construction and decommissioning phases the potential impacts are likely to be insignificant.

Potential positive impacts could potentially include a *reduction* in soil erosion in areas where new engineering solutions are put in place to rectify certain existing problems, such as improved drainage along poorly constructed and maintained roads. Other positive impacts relating to the geological environment on a regional/national scale could include a reduction in the demand for non-renewable energy sources (such as coal or uranium).

3.1. Soil degradation

Soil degradation is the negative alteration of the natural soil profile, usually directly or indirectly related to human activity. Soil degradation negatively affects soil formation, natural weathering processes, moisture levels and soil stability. This could, in time, have a significant effect on agricultural potential and biodiversity. Soil degradation is a term which encompasses erosion (i.e. due to water and wind), soil removal, mixing, wetting, compaction, pollution, salinisation, crusting, and acidification.

Soil erosion is a natural process whereby the ground level is lowered by wind or water action and may occur as a result of *inter alia* chemical processes and/or physical transport on the land surface.[1] Soil erosion induced or increased by human activity is termed *accelerated erosion* and is an integral element of global soil degradation. Accelerated soil erosion is generally considered the most important impact in any development due to its potential impact on a local and regional scale (i.e. on and off site) and as a potential threat to global biodiversity. Soil erodability – the susceptibility of soil to erosion – is a complex variable, not only because it depends on soil chemistry, texture, and characteristics, but because it varies with time and other variables[8], such as mode of transport (i.e. wind or water).

Erosion of soil due to water run-off is generally considered as being more important due to the magnitude of the potential impact over a relatively short period of time which can be very difficult to control or reverse. Erosion by water occurs when the force exerted on the soil by flowing water exceeds the internal shear strength of the soil and the soil fails and becomes mobilised into suspension. Erosion potential is typically increased in areas where soil is loosened and vegetation cover is stripped (such is the case on most construction sites). Removal of vegetation (ground cover) may increase the risk of soil erosion, making the soil less fertile, and less able to support the regeneration of vegetation in future.

Erosion sensitivity can be broadly mapped according to the potential severity of erosion if land disturbing activities occur and this is generally affected by the geology, soil types and topography. Generally speaking, thick deposits of unconsolidated or partly consolidated fine-grained soils of low plasticity occurring along drainage lines, on moderate to steep slopes or at the base of steep slopes are most vulnerable to severe levels of erosion due to water run-off. Areas where these factors occur simultaneously are typically called “highly sensitive” areas.

The entire site is considered to have a medium erosion sensitivity as described in **Table 1**. During peak rainfall events, run-off may result in some erosion along small drainage lines and in areas that are cleared of vegetation, although in the case of the proposed development, full vegetation clearing is not envisaged across the entire site (vegetation will be shortened/maintained to prevent spread of fire and shadows on the panels).

Table 1: Water erosion sensitivity

Sensitivity Level	Topography/Geology	Comments/Recommendations
High	Natural drainage lines/watercourses, steep slopes (high relief areas), and areas with thick deposits of unconsolidated soil	No-go areas without special mitigating measures. Erosion presently taking place.
Medium	Moderately to gently undulating hills and plains (low relief areas) where some unconsolidated sediment occurs	Moderate levels of erosion will occur if land-disturbing activities take place (construction). Mitigating measures to be applied to minimise impact.
Low	Areas with very little or no soil cover	Minor erosion will naturally occur. Normal mitigating measures apply.

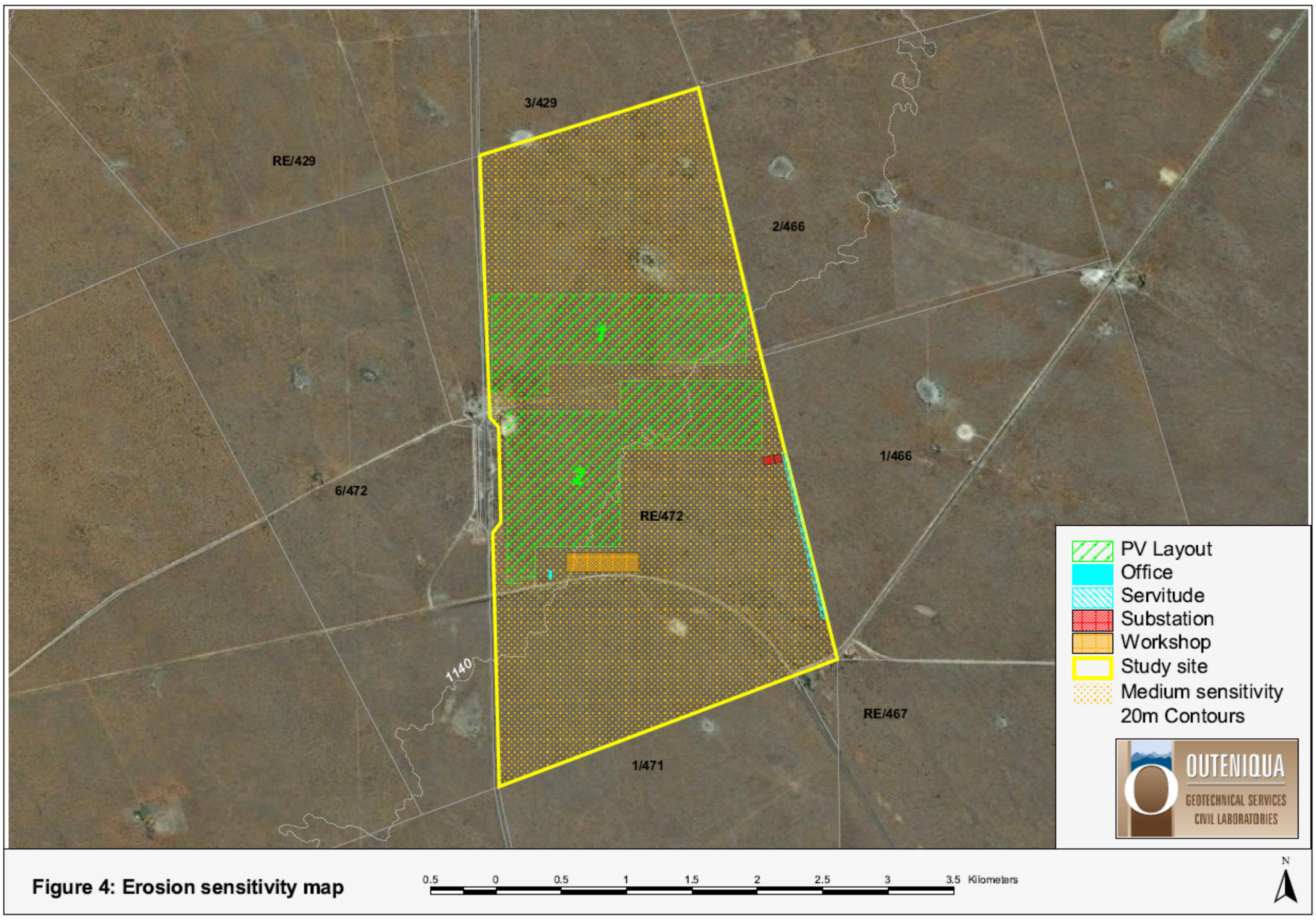

Figure 4: Erosion sensitivity map

3.2. Reduction in agricultural potential

The potential impact on the existing and future land use and the agricultural potential is the loss of 500 hectares of the total of 800 hectares of grazing land. This will reduce the carrying capacity by approximately 60%. This means a reduction from 40 to 16 large stock units. This may render the already uneconomical agricultural unit to be in a poorer position than before if no other land is available elsewhere.

3.3. Assessment of impacts

The environmental assessment aims to evaluate the impacts that the proposed activity will have on the environment and attempts to provide mitigating measures to minimise negative impacts.

3.3.1. Methodology of assessment

Direct, indirect, and cumulative negative impacts are assessed in terms of the following criteria:

- The nature of the impact - what causes the impact, what will be impacted and how it will be impacted;
- The extent of the impact - whether it is local (limited to the immediate area or site of the development) or regional (on a scale of 1 to 5).
- The duration of the impact – whether it will be very short (less than 1 year), short (1-5 years), medium (5-15 years), long (>15 years) or permanent (on a scale of 1 to 5, respectively).
- The magnitude, quantified on a scale of 0-10, where 0 is small and will have no impact on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will have a slight impact on processes, 6 is moderate and will result in processes continuing, but in a modified way, 8 is high and processes are altered 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 describes the likelihood of the impact actually occurring (on a scale of 1 to 5 – very improbable to definite).
- The significance, which is determined through a synthesis of the characteristics described above and is assessed as low, medium or high.
- The status, which is described as positive, negative or neutral.
- The degree to which the impact can be reversed.
- The degree to which the impact may cause the irreplaceable loss of resources.
- The degree to which the impact can be mitigated.
- The possibility of significant cumulative impacts of a number of individual areas of activity.
- The possibility of residual impacts existing after mitigating measures have been put in place

The significance is calculated by combining the criteria in the following formula:
S = (E+D+M) P

Where:
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: **Moderate** (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 will influence the decision to develop in the area).

3.3.2. Potential impacts on the proposed site

There are no site alternatives under consideration. The do-nothing alternative will have no negative impact on the local soil or agricultural potential but will continue to have an increasing cumulative negative impact on the national demand for non-renewable resources (e.g. coal).

An assessment of the individual potential direct impacts on the soil and agricultural potential of the site is tabulated in **Table 2**.

Table 2: Potential direct impacts

Nature: Soil degradation (soil removal, mixing, compaction, etc) due to the construction of foundations for structures (PV panels, buildings, substations, power lines).		
	Without mitigation	***With mitigation***
Extent	Local (1)	Local (1)
Duration	Short term (2)	Very Short term (1)
Magnitude	Minor (2)	Minor (2)
Probability	Definite (5)	Definite (5)
Significance	**Low (25)**	**Low (20)**
Status	Negative	Negative
Reversibility	Reversible	Reversible
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes.	
Mitigation:	» Rehabilitate topsoil & vegetation around site and between panels after construction.	
Cumulative impacts:	» The cumulative impact of earthworks in the area is considered low at this stage due to the low density of development in the immediate vicinity. Further development of the area may have increasing impact on the natural soil.	
Residual impacts:	» Minor loss of soil under buildings	

Nature: Soil degradation (soil removal, mixing, compaction, etc) due to the construction of access roads.		
	Without mitigation	***With mitigation***
Extent	Local (1)	Local (1)
Duration	Long term (4)	Long term (4)
Magnitude	Low (4)	Minor (2)
Probability	Definite (5)	Definite (5)
Significance	**Medium(45)**	**Medium(35)**
Status	Negative	Negative
Reversibility	Reversible	Reversible
Irreplaceable loss of resources?	No	No

Can impacts be mitigated?	Yes.
Mitigation:	» Use existing roads if possible/practical. » Minimise the length and width of new access roads (preferably just gravel tracks). » Maintain access roads in good condition, preventing detours due to bad road conditions
Cumulative impacts:	» The cumulative impact of earthworks in the area is considered low at this stage due to the low density of development in the immediate vicinity. Further development of the area may have an increasing impact on the natural soil.
Residual impacts:	» Minor loss of soil under roads.

Nature: Soil degradation due to pollution of soil by contaminants used on site during construction (e.g. fuel, oil, chemicals, cement).		
	Without mitigation	***With mitigation***
Extent	Local (1)	Local (1)
Duration	Medium term (3)	Short term (2)
Magnitude	Minor (2)	Minor (2)
Probability	Probable (3)	Probable (3)
Significance	**Low (18)**	**Low (15)**
Status	Negative	Negative
Reversibility	Reversible	Reversible
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	
Mitigation:	» Control use and disposal of potential contaminants or hazardous materials. » Remove contaminants and contaminated topsoil and replace topsoil in affected areas.	
Cumulative impacts:	» The cumulative impact of soil pollution is considered low at present due to the undeveloped nature of the area but further development may have an increasing impact.	
Residual impacts:	» Slow regeneration of topsoil	

Nature: Soil degradation due to increased soil erosion by wind and/or water on construction areas.		
	Without mitigation	***With mitigation***
Extent	Local (1)	Local (1)
Duration	Long term (4)	Short term (1)
Magnitude	Low (4)	Minor (2)
Probability	Probable (3)	Probable (3)
Significance	**Low (27)**	**Low (12)**
Status	Negative	Negative
Reversibility	Practically irreversible	Practically irreversible
Irreplaceable loss of resources?	Practically irreplaceable	Practically irreplaceable
Can impacts be mitigated?	Yes.	

Mitigation:	» Minimise size of the construction footprint/camp. » Restrict activity outside of construction camp areas. » Implement effective erosion control measures around site. » Carry out earthworks in phases across site to reduce the area of exposed ground at any one time. » Protect and maintain denuded areas and material stockpiles to minimise erosion and instability
Cumulative impacts:	» The cumulative impact of soil erosion is considered low at present due to the undeveloped nature of the area but further development may have an increasing impact on soil erosion.
Residual impacts:	» Minor localised erosion.

Nature: Impact on existing land-use.		
	Without mitigation	
Extent	Local (1)	
Duration	Long term (4)	
Magnitude	Minor (2)	
Probability	Probable (4)	
Significance	**Low (28)**	
Status	Negative	
Reversibility	Reversible	
Irreplaceable loss of resources?	No	
Can impacts be mitigated?	No	
Mitigation:	None practical.	
Cumulative impacts:	» The cumulative impact on land use is considered low at present due to the low intensity land-use practised on the site.	
Residual impacts:	» Temporary loss of grazing land while facility is in use.	

Nature: Reduction in agricultural potential.		
	Without mitigation	
Extent	Local (1)	
Duration	Long term (4)	
Magnitude	Minor (2)	
Probability	Probable (4)	
Significance	**Low (28)**	
Status	Negative	
Reversibility	Reversible	
Irreplaceable loss of resources?	No	
Can impacts be mitigated?	No	
Mitigation:	None possible	
Cumulative impacts:	» The cumulative impact of a reduction in the agricultural potential is considered low at present due to the low potential of the area.	
Residual impacts:	» Minor loss of grazing land while facility is in use.	

An assessment of the potential <u>indirect</u> impacts associated with the proposed development is tabulated in **Table 3**.

Table 3: Potential indirect impacts

Nature: Degradation of waterways due to increased siltation downstream from site.		
	Without mitigation	***With mitigation***
Extent	Regional (3)	Local (1)
Duration	Long term (4)	Long term (4)
Magnitude	Minor (2)	Minor (2)
Probability	Probable (3)	Probable (3)
Significance	**Low (27)**	**Low (21)**
Status	Negative	Negative
Reversibility	Irreversible	Irreversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes	
Mitigation:	» Install anti-erosion measures such as silt fences, geosynthetic erosion protection, and/or flow attenuation along watercourses below construction sites. » Strictly control activity near water courses/natural drainage lines as sediment transport is higher in these areas. » Minimise increased run-off from hard surfaces (PV panels) by channelising and capturing rainwater for re-use (rainwater harvesting)	
Cumulative impacts:	» The cumulative impact of siltation in the area is considered low at present but further development may have an increasing impact on siltation of waterways.	
Residual impacts:	» Minor localised movement of soil across site	

Nature: Increased dust pollution from construction sites affecting surroundings.		
	Without mitigation	***With mitigation***
Extent	Regional (2)	Local (1)
Duration	Short term (1)	Very short term (1)
Magnitude	Low (4)	Minor (2)
Probability	Highly probable (4)	Highly probable (4)
Significance	**Low (28)**	**Low (16)**
Status	Negative	Negative
Reversibility	Irreversible	Irreversible
Irreplaceable loss of resources?	Yes, minor	Yes, insignificant
Can impacts be mitigated?	Yes	
Mitigation:	» Apply dust control measures such as straw bales or dampen dusty denuded areas. » Clear vegetation in stages to minimise exposure at any one time.	
Cumulative impacts:	» The cumulative impact of dust in the area is considered low.	
Residual impacts:	» Minor localised dust pollution	

Nature: Reduction in demand for non-renewable energy sources.		
	Without mitigation	***With mitigation***
Extent	National (3)	n/a
Duration	Long term (4)	n/a
Magnitude	Moderate (6)	n/a
Probability	Very probable (4)	n/a
Significance	**Medium (52)**	n/a
Status	Positive	
Reversibility		
Irreplaceable loss of resources?		
Can impacts be mitigated?		
Mitigation:		
Cumulative impacts:	» The cumulative positive impact on a national scale is considered very high.	
Residual impacts:		

3.4. Impact Statement

The most significant potential negative impacts are that of soil degradation. However, if mitigation measures are successfully implemented, the negative impacts will have a low significance. It is likely that the negative impacts will be out-weighed by the cumulative positive impact of a reduction in the rate of demand (and extraction) of non-renewable energy sources (such as coal) on a national scale.

3.5. Environmental Management Programme (EMP) guidelines for earthworks

Negative impacts can be mitigated to a large degree by the implementation of an appropriate and effective EMP. The following generic guidelines relate specifically to the earthworks contract:

3.5.1. Earthworks

1. Prior to earthworks (including site clearance) starting on the site, a plant search and rescue operation should be undertaken as per the requirements set out in the EMP.
2. All earthworks shall be undertaken in such a manner to minimise the extent of any impacts caused by such activities.
3. Defined access routes to and from the area of operations as well as around the area of operation shall be adhered to.
4. No equipment associated with the activity shall be allowed outside of these areas unless expressly permitted by the Environmental Control Officer (ECO).
5. Mechanical methods of rock breaking, including Montabert-type breakers and jackhammers, have noise and dust impacts, and must be addressed in the EMP.
6. Residents shall be notified at least one week prior to these activities commencing, and their concerns addressed.
7. Chemical breaking shall require a method statement approved by the Engineer's Representative (ER).

3.5.2. Topsoil

1. Prior to construction, the topsoil areas to be disturbed should be stripped to a depth to be confirmed by the ER and set aside for spreading to all areas to be reinstated after the construction. Temporary topsoil stock piles must be covered with net, shade cloth or straw bales to protect them.
2. Once all grades have been finalised and prepared, topsoil should be spread evenly to all affected areas to be re-vegetated.

3.5.3. Erosion and Sedimentation Control

1. During construction the contractor shall protect areas susceptible to erosion by installing necessary temporary and permanent drainage works as soon as possible and by taking other measures necessary to prevent the surface water from being concentrated in streams and from scouring the slopes, banks or other areas.
2. A method statement shall be developed and submitted to the ER to deal with erosion issues prior to bulk earthworks operations commencing.
3. Any erosion channels developed during the construction period or during the vegetation establishment period shall be backfilled and compacted and the areas restored to a proper condition.
4. Stabilisation of cleared areas to prevent and control erosion shall be actively managed. The method of stabilisation shall determine in consultation with the ECO. Consideration and provision shall be made for the following methods (or combination):
   a) Brush cut packing
   b) Mulch or chip cover
   c) Straw stabilising
   d) Watering
   e) Planting/sodding
   f) Hand seed-sowing
   g) Hydroseeding
   h) Soil binders and anti erosion compounds
   i) Gabion bolsters & mattresses for flow attenuation
   j) Geofabric
   k) Hessian cover
   l) Log/ pole fencing
5. Traffic and movement over stabilised areas shall be restricted and controlled and damage to stabilised areas shall be repaired and maintained to the satisfaction of the ECO.
6. Anti-erosion compounds shall consist of all organic or inorganic material to bind soil particles together and shall be a proven product able to suppress dust and erosion. The application rate shall conform to the manufacturer's recommendations. The material used shall be approved by the ECO.

3.5.4. Drilling and Jack-Hammering

1. The contractor shall submit a method statement detailing his proposals to prevent pollution during drilling operations. This shall be approved by the site manager prior to the onset of any drilling operations.

2. The contractor shall take all reasonable measures to limit dust generation as a result of drilling operations.
3. Noise and dust nuisances shall comply with the applicable standards according to the Occupational Health and safety (Act No. 85 of 1993).
4. The Contractor shall ensure that no pollution results from drilling operations, either as a result of oil and fuel drips, or from drilling fluid.
5. All affected parties shall be informed at least one week prior to the onset of the proposed drilling/jackhammering operations, and their concerns addressed.
6. Drill coring with water or coolant lubricants shall require a method statement approved by the Site Manager.
7. Any areas or structures damaged by the drilling and associated activities shall be rehabilitated by the contractor to the satisfaction of the site manager.

3.5.5. Trenching

1. Trenching shall be kept to a minimum using single trenches for multiple service provision.
2. The planning and selection of trench routes shall be undertaken in liaison with the ER and cognisance shall be given to minimising the potential for soil erosion.
3. Trench routes with permitted working areas shall be clearly defined and marked with painted stakes prior to excavation.
4. The stripping and separation of topsoil shall occur as stipulated by the ER. Soil shall be stockpiled for use as backfilling as directed by the ER.
5. Trench lengths shall be kept as short as practically possible before backfilling and compacting.
6. Trenches shall be backfilled to the same level as (or slightly higher to allow for settlement) the surrounding land surface to minimise erosion. Excess soil shall be stockpiled in an area approved by the engineer.
7. Immediately after backfilling, trenches and associated disturbed working areas shall be planted with a suitable plant species and regularly watered. Where there is a particularly high erosion risk, a fabric such as Geojute (biodegradable) shall be used in addition to planting.

3.5.6. Dust

1. The contractor shall be solely responsible for the control of dust arising from the contractor's operations and for any costs against the employer for damages resulting from dust.
2. The contractor shall take all reasonable measures to minimise the generation of dust as a result of construction activities to the satisfaction of the site manager.
3. Removal of vegetation shall be avoided until such time as soil stripping is required and similarly exposed surfaces shall be re-vegetated or stabilised as soon as is practically possible.
4. Excavation, handling and transport of erodible materials shall be avoided under high wind conditions or when a visible dust plume is present.
5. During high wind conditions the site manager will evaluate the situation and make recommendations as to whether dust damping measures are adequate, or whether working will cease altogether until the wind speed drops to an acceptable level.

6. Where possible, soil stockpiles shall be located in sheltered areas where they are not exposed to the erosive effects of the wind. Where erosion of stockpiles becomes a problem, erosion control measures shall be implemented at the discretion of the site manager.
7. Vehicle speeds shall not exceed 40km/h along dust roads or 20km/h when traversing unconsolidated and non-vegetated areas.
8. Appropriate dust suppression measures shall be used when dust generation as unavoidable, e.g. dampening with water, particularly during prolonged periods of dry weather in summer. Such measures shall also include the use of temporary stabilising measures (e.g. chemical soil binders, straw, brush packs, clipping etc.)
9. Straw stabilisation shall be applied at a rate of one bale/ 10m^2 and harrowed into the top 100mm of top material for all completed earthworks.

3.5.7. Imported Materials and Stockpiles

1. Imported materials shall be free of weeds, litter and contaminants.
2. Sources of imported material shall be listed and approved by the ER on site.
3. The contractor shall provide samples to the ER for approval.
4. Stockpile areas shall be approved by the ER before any stockpiling commences.

3.5.8. Summary of objectives and performance monitoring

A summary of the project components, potential impacts, mitigating measures and performance monitoring is outlined below.

OBJECTIVE: Minimise negative impact on soil degradation and agricultural potential

» Soil degradation including erosion (by wind and water) and subsequent deposition elsewhere is of a concern in areas which are underlain by fine grained soil which can be mobilised when disturbed, even on relatively low slope gradients (accelerated erosion).
» Uncontrolled run-off relating to the construction activity (excessive wetting, uncontrolled discharge, etc) will also lead to accelerated erosion and possible sedimentation along natural drainage lines or catchment areas.
» Degradation of the natural soil profile due to excavation, removal or topsoil, stockpiling, wetting, compaction, pollution and other construction activities may affect soil forming processes and associated agricultural potential.

Project Component/s	• PV arrays and foundations to support them. • Substation. • Access roads. • Underground cabling. • Storage and maintenance facilities and foundations to support them. • Overhead power lines and substation linking the facility to the electricity grid.
Potential Impact	• Soil degradation including erosion, dust and siltation. • Reduction in agricultural potential
Activity/Risk Source	• Earthworks & activity on site. • Rainfall and concentrated discharge causing water erosion of disturbed areas. • Wind - erosion of disturbed areas.

Mitigation: Target / Objective	• Minimise soil degradation (removal, excavation, mixing, wetting, compaction, pollution, etc.). • Minimise erosion. • Minimise sediment transport downstream (siltation). • Minimise dust pollution.

Mitigation: Action / Control	**Responsibility**	**Timeframe**
Identify areas of high erosion risk (drainage lines/watercourses, existing problem areas). Only special works to be undertaken in these areas to be authorised by ECO and Engineer's representative (ER)	ECO/ER	At design stage.
Identify construction areas for general construction work and restrict construction activity to these areas.	ECO/ER/Contractor	At design stage and during construction
Prevent unnecessary destructive activity within construction areas (prevent over-excavations and double handling)	ECO/ER/Contractor	During construction
Access roads to be carefully planned and constructed to minimise the impacted area and prevent unnecessary degradation of soil. Special attention to be given to roads that cross drainage lines and roads on steep slopes (to prevent unnecessary cutting and filling operations).	ECO/ER/Contractor	At design stage and during construction
Dust control on construction site through wetting or covering of cleared areas.	Contractor	Daily during construction
Minimise removal of vegetation which aids soil stability.	ECO/Contractor	Continuously during construction
Rehabilitate disturbance areas as soon as an area is vacated.	Contractor	Continuously during and after construction
Soil conservation - stockpile topsoil for re-use in rehabilitation phase. Protect stockpile from erosion.	Contractor	Continuously during construction
Erosion control measures- run-off control and attenuation on slopes (sand bags, logs), silt fences, stormwater channels and catch-pits, shade nets, soil binding, geofabrics, hydroseeding or mulching over cleared areas.	Contractor/ECO	Erection: Before construction Maintenance: Duration of contract
Where access roads cross natural drainage lines, culverts must be designed to allow free flow. Regular maintenance must be carried out	ECO/ER/Contractor	Before construction and maintenance over duration of contract
Control depth of excavations and stability of cut faces/sidewalls	ECO/ER/Contractor	Before construction and maintenance over duration of contract

Performance Indicator	» Only authorised activity outside construction areas » No activity in no-go areas. » Acceptable level of activity within construction areas, as determined by ECO. » Acceptable level of soil erosion around site, as determined by ECO. » Acceptable level of sedimentation along drainage lines, as determined by ECO. » Acceptable level of soil degradation, as determined by ECO.

	» Acceptable state of excavations, as determined by ER & ECO.
Monitoring	» Monthly inspections of the site by the ECO. » Monthly inspections of sediment control devices by the ECO. » Monthly inspections of surroundings, including drainage lines by the ECO. » Immediate reporting of ineffective sediment control systems by the ECO. » An incident reporting system will record non-conformances.

4. CONCLUSIONS

If suitable mitigating measures are applied, the proposed activity will generally have a low negative impact on soil and agricultural potential. However, the proposed development can potentially make a significant indirect positive impact on the geological environment in terms of a reduction in demand (and exploitation) for non-renewable energy sources on a national scale.

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