2.4 Hydrology and Catchment Areas

The proposed solar farm development falls within the Lower Orange Water Management Area (14. LOWMA). The LOWMA's natural environment is generally characterised by an arid climate with minimal rainfall and frequent drought conditions, with occasional severe flooding. The Development falls in the Quaternary Catchment D33A and D33B and the area has a similar climate, typical of a semi-desert and an arid savannah area.

All drainage in the area is directed eventually into the Gariep (Orange) River, the largest water course in the area, before its confluence with the Vaal River. The generally flat to undulating terrain often produces long and meandering water courses. A seasonal wetland is present in the western corner of the site, within 500m of Kloofsig development boundary, and a number of non-perennial streams are present in the northern area surrounding the site. The water courses around the site are mostly dry, apart from small pools after rainfall, which will occur at the many small earth dams built across the larger drainage lines. Small open pans exist on the western boundary and at the northernmost point, but are predominantly dry.

2.5 Site Stability

No signs of ground instability or flood damage, such as slip scars, landslides, major erosion ditches, rockfalls and small collapses are evident on site. This indicates that the natural flat topography, even with its sparse vegetation cover and loose sandy soils, is sufficient to slacken the normal over-land storm water run-off velocities, to prevent or reduce erosion.

It is not foreseen that embankment slopes on cut or fill faces, during the construction excavations, will be designed steeper than 1:5 and no risk of erosion or collapsing will be present. This will have the positive effect of reducing the footprint of excavated or affected areas.

2.6 Vegetation and Flora

The biodiversity of the area is Nama Karoo, consisting of the very homogeneous Northern Upper Karoo vegetation. The development site is dominated by small karroid shrubs, mostly below 50 cm high, with signs that sparse grass cover, fills the bare areas inbetween, after sufficient rain.

The vegetation on the site can be divided into three sub-units, namely :

1) Southern Plains Karoo on calcareous soil;
2) Southern Bottomland Karoo; and
3) Southern Highland Karoo on red soil;

all of which are classified as medium to low sensitivity. Key characteristics of each vegetation sub-unit are briefly described in the below.

2.6.1 Southern Highland Karoo on red soil

This vegetation type is limited to the north-western corner and a section of powerline to the south of the site for Kloofsig 1. The soil is deep red sand, with less calcrete visible on the soil surface (see Photo 1 and 2 below).The vegetation is open bossieveld karoo with many bare patches. The grass layer is poorly developed, very shortly grazed, with new growth commencing after rains. Most of the general karroid dwarf shrubs and grass species occur in this area.

This vegetation type is widespread and not considered to be rare, threatened or protected. Sensitivity is considered to be medium-low.


Photo 1 and 2 : Southern Highland Karoo on red soil

2.6.2 Southern Plains Karoo on Calcareous Soil

This vegetation occurs widely on the plains throughout the development site. The soil is shallow, light brown sandy loam over calcrete and much more calcrete is visible on the soil surface. The vegetation is very typical short bossieveld, entirely dominated by karroid dwarf shrubs - see Photo 3. Vegetation is grazed by sheep, and very little grass is visible, though new grass growth commencing after rains.

This vegetation type is very widespread and not rare. The species richness is high, though none of these species are considered to be rare, threatened or protected. Sensitivity is considered to be low.

Photo 3 : Southern Plains Karoo on calcareous soil

2.6.3 *Southern Bottomland Karoo*

This vegetation occurs in the somewhat lower-lying south-central parts of the development site and forms part of the flat over-land drainage system of this area. The southern non-perennial water holes are mostly located within this vegetation. The soil is reddish-brown with calcrete often abundant on the soil surface. This area seemed to be moister than the adjacent, higher-lying plant communities. The vegetation is very similar to that of the Southern Plains Karoo described above, but seems to be more overgrazed by domestic livestock – see Photo 4. Dwarf karroid shrubs are dominant and grass species are very short, just appearing after recent rains.

Although this plant community occurs widespread, it is restricted to the bottomland, within a slightly undulating landscape. These areas are also often more grazed than the upland areas. The species richness is high, though none of these species is considered to be rare, threatened or protected. Sensitivity is considered to be low.

Photo 4 : Trampled Southern Bottomland Karoo

3 STORMWATER MANAGEMENT

3.1 Generic Stormwater Management Principles

Storm water planning is essential to prevent erosion of natural, agricultural or grazing landscapes and flooding of disturbed areas and new infrastructure. New developments and impacted footprints shall be designed, constructed and maintained using best Storm Water Management practices to prevent flooding and, protect natural water quality. The focus will also be to reduce soil erosion and to maintain and improve the natural wildlife habitat thereby contributing to the aesthetic values of the development area.

The concept and principles to protect any identified sensitive hydrological features should be contained the Environmental Management Plan (EMP) and the Environmental Method Statement

(EMS), which should both form part of the conditions of the Environmental Approval. This should be made available to the Contractor at tender stage as compulsory requirements. This is to ensure that these proposals be incorporated in their planning and costing exercises, prior to commencement of construction.

The primary design criteria of the hard surfaces for the internal roads and PV panels will be to minimise unnecessary disturbance of natural vegetation during excavation stage, and also to control the storm water run-off velocities and to minimise storm water runoff concentration.

3.2 Site Specific Storm Water Management Principles

The description of the Site Topography, Geology and Climate in the previous paragraphs, **indicates the medium to low sensitive characteristics of the area**. Careful planning has already been exercised to position all the PV Solar panel arrays, away from the natural non-perennial dry water courses. This will ensure that higher storm water run-off velocities at the new hard surfaces of the site, and potential local flooding at the development site will be greatly limited and possibly negated in total.

The overland run-off storm water will be the biggest threat to the environment and challenge to manage effectively during the construction stage, as well as the operational stage. Rainfall is usually in short thunderstorm events, which will contribute to the increased storm water run-off velocity, in short periods, over the newly hard compacted gravel surfaces.

3.2.1 Concept Planning : Roadways

Road construction projects will have an impact on the environment, both during the road construction stage, as well as thereafter during the long-term operational stage. It is important that the possible adverse impacts on the environment be understood and adequately considered in the planning and design process, in order to minimise the negative environmental consequences of the roadway and related storm water infrastructure development. This will ensure environmentally friendly, responsible and sustainable development and will preserve the environment for future generations.

New road construction works will permanently affect the environment along the road footprint, as all vegetation, grass and top-soil will be removed prior to the road construction. It is therefore important to plan the road geometric criteria and alignments carefully, to minimise the cut and fill volumes and **limit unnecessary large embankments or steep slopes, which will be prone to erosion**. All roads will have gravel surfaces and will in general be constructed with a single cross fall of 2% against the natural slope. This will allow the opportunity to control surface run-off storm water and to direct water to road low points. Due to the flat topography, no road gradients will be steeper than 5% (1:20), however is **it recommendable to construct local cross-cut berms in the road side channels, to break the velocity of discharged storm water**.

Road embankments and road verges beyond the shoulder widths inside the road reserves, which were disturbed during the construction stage, must be shaped to conform to the natural ground levels and be environmentally rehabilitated. This can be done by a combination of advanced embankment stabilization methods, eg using geotextile materials, bio-degradable soil saving blankets, spreading top-soil, laying grass sods or hydro-seeding and / or planting of indigenous vegetation. This will minimise and control erosion and will improve the visual impact of the final roadway inside the affected reserve width.

During construction and later maintenance of the roadway, adverse side effects such as dust pollution, oil or diesel spillage, air pollution from exhaust fumes and safety hazards of traffic to the community should be investigated and minimised by monitoring and maintaining or repair the roadway on an ongoing basis.

3.2.2 *Borrow Pit Requirements*

Roadway construction will most likely demand the importation of natural gravel form borrow pits. This will often necessitates the establishment of new borrow pits or the expansion of existing borrow pits. **Excavations at borrow pits may have a major environmental and visual impact**. After completion of the roadway construction, the borrow-pit must be completely rehabilitated by trimming and sloping steep and exposed embankments, to limit the long term erosion potential. Embankments must be treated with top-soil, grass or indigenous vegetation to minimise the visual impacts.

3.2.3 *Concept Planning : Storm Water Infrastructure*

The natural over-land storm water run-off and stream-flow drainage patterns (non-perennial water courses), where such water courses cross the roadway, will be disturbed. **Careful planning must therefore be exerted to provide sufficient storm water drainage structures** : either a nominal concrete lined Low-Level Drift or Storm Water Culverts with a large enough capacity, to accommodate the designed run-off volumes for the designed recurrence peak flows, without the possibility to cause frequent flooding and damage.

Storm water structures which are too small or designed incorrectly, will cause siltation inside the conduit and upstream ponding and flooding, or will contribute to higher velocities due to storm water concentration, which will cause downstream erosion. Storm water pipes and culverts are prone to silt-up due to the transportation of the top layer fine materials during storm water run-off events. It is therefore recommended that the floor slope of these storm water infrastructure conduits be constructed steeper than 1:50 (2%) to limit sedimentation and encourage through-flow even during low rainfall events.

Storm water control infrastructure such as pipes and culverts, side channels and mitre drains must adequately protect the roadway, but must also protect the environment from soil erosion. The minimum diameter opening of any storm water conduit must be 600mm for ease of access into and cleaning of the sediment in these conduits, during routine road maintenance activities.

Steep sections along road side channels and local areas such as outlet aprons of storm water conduits, where the designed storm water discharge velocities may be too large for the natural soil and vegetation conditions to prevent erosion, should be lined with cemented stone pitching work, to prevent erosion and to protect the environment.

3.3 Impact on Drainage Area for Phase 1

The entire catchment area where the Kloofsig PV Solar development (all 3 Phases) will be constructed, is only exposed to over-land storm water run-off flow conditions, and no concentrated stream-flow run-off conditions exist. **This implies that storm water run-off velocities are generally low**, especially considering the very flat topography of the surrounding landscape (less than 1%) and the development of erosion trenches are limited.

During the construction of new terraces, platforms, hard surfaces, cut and fill embankments, ring (access) roads, electrical sub-stations and building footprints, the characteristic of the local area will be changed. The proposed area for the **Kloofsig Phase 1 development** will be approximately 243,8ha, with a **permanent direct disturbed footprint of less than 15% (approx. 36ha) of the development area**. Although this is still a relative large area, it is small (1,4%), compared to the total size of the entire farm property (approx. 2600ha). Compared to the vast open areas of all the surrounding farm, **the affected footprint of Phase 1 is minimal**, with a low storm water run-off and a low potential erosion impact on the environment.

Photo 5 : Typical Solar Farm Development.
Note the small areas permanently impacted, around the PV solar panels.

Photo 6: Typical Solar Farm Development.
Note the undisturbed natural landscape (or rehabilitated grassed areas) of the internal road ways in between the PV Solar panels

Natural storm water run-off from the Phase 1 development footprint, will flow over land (northwards) across the proposed future Phase 2 development – refer to Drw : R2004-RD-GA-01-PRE, bound in Annexure A. **The permanent new hard surfaces of the Phase 1 development (as stated above) will increase the flow volumes and velocities that will be flowing across the Phase 2 development.** However, due to the small area and specific impacts of the new proposed permanent hard surfaces, the impact on the downstream landscape will be small and can be mitigated, by implementing the storm water manage principles stated in paragraph 3 of this report.

It is therefore not foreseen that the lower laying non-perennial drainage areas (Phase 2) will be negatively affected by the development footprint of this Phase 1, providing that proper storm water management and maintenance principles be implemented during both the construction and operational stages.

3.4 Site Clearance and Stripping of Topsoil

The stripping of topsoil, the removing or disturbing rocks (as natural habitat to many small animal species) and the grubbing of any natural vegetation over large areas, together with the simultaneous compaction of same large areas, will greatly prevent any much needed storm water ingress into sub-soil during rainfall events, causing fewer opportunities for rainfall precipitation to re-charge underground aquifers.

The soils are predominantly sandy and are prone to wash-aways during high rainfall or flooding events. It can therefore be expected that large volumes of topsoil materials (eg. removed from the roadways and the solar panel platforms), will be transposed and be sedimented downstream, during thunder shower events over time.

Storm water run-off activities may cause over-land erosion trenches, especially along the exposed longitudinal sides of road infrastructure, if no topsoil rehabilitation work will be exercised. Roads must be regularly inspected and repaired by importation of quality material and be properly compacted. This will place a priority on regular maintenance of the PV Solar facility in general.

It is therefore recommended that the disturbance of topsoil and vegetation be limited to an absolute minimum. It should be aimed to only trim vegetation at open areas in-between PV Solar panels and not to strip all topsoil, hence allowing strips of natural undisturbed vegetation to remain intact, in between the arrays of PV panels.

It is further recommended that the large open areas for the PV Solar panels be constructed in terraces, with undisturbed strips of natural vegetation. This will contribute to dust control and will limit the volumes of dust compacting on top of the PV panels, which need to be cleaned regularly.

3.5 Storm Water Erosion Mitigation Measures

Measures recommended to mitigate storm water erosion and flooding should be incorporated in the final detail designs, and may include some or all of the following:

a) limitation of land disturbance (minimise clearing and grubbing of natural vegetated areas and topsoil removal) to suit the minimum requirements of the Development and potential fire breaks;

b) all vegetation clearing should occur in in a phased manner in accordance with the construction programme to minimise large bare open areas for long periods, before construction activities will commence. This will minimise the possibility of soil erosion. (Large tracts of bare soil will either cause dust pollution or quickly erode and then cause sedimentation wash aways into the lower portions of the local catchments.);

c) minimization of impervious surfaces – eg. avoid excessive open areas for road turning radii or service roads along the overhead cables routes. It is preferable to leave natural vegetation undisturbed and where possible only trimming shrubs, rather than to clear and grub vegetation;

d) maintaining vegetated buffers and natural vegetation strips;

e) the use of terraces, berms and / or contoured landscapes, to control natural overland storm water run-off;

f) the use of cut-off drains or berms at the top of cut embankments above roads and PV panel areas, to divert and control natural storm water flow;

g) limit the length of road side drains and divert and / or discharge storm water run-off as quickly as possible via mitre drains to natural water courses or low laying areas;