Stormwater Management Plan

KHAUTA NORTH SOLAR PV FACILITY RF
WELKOM, FREE STATE

CES
ENVIRONMENTAL AND SOCIAL ADVISORY SERVICES

ENVIRONMENTAL SERVICES:
Khauta North Solar PV Facility, Welkom, Free State

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CES - Environmental and Social Advisory Services

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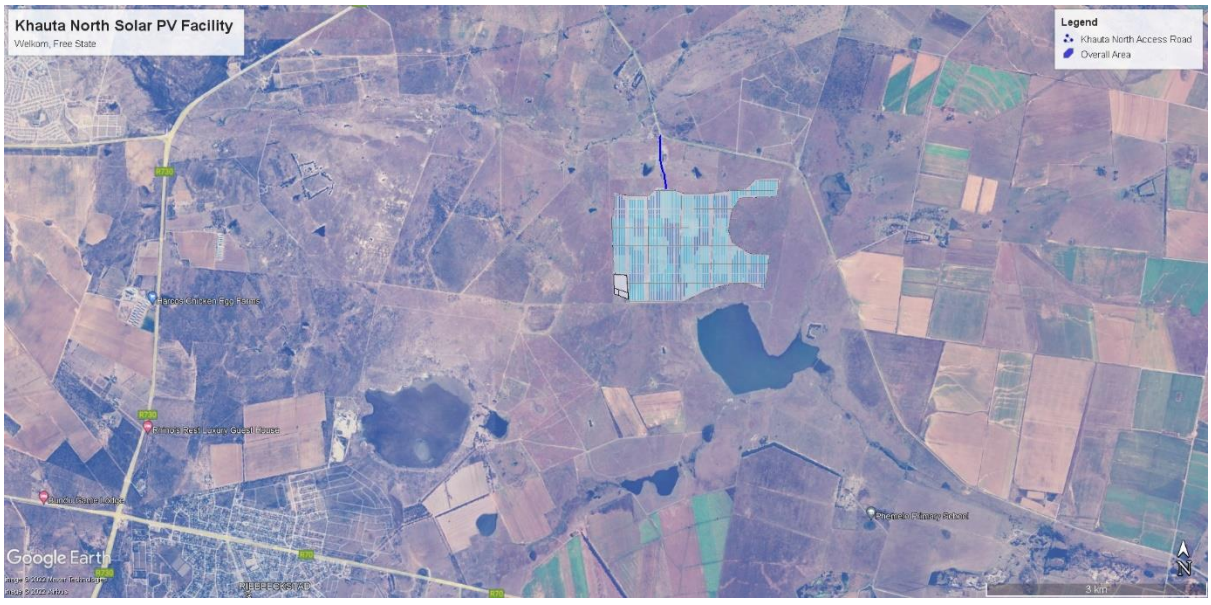
1 INTRODUCTION

PROJECT DESCRIPTION

WKN Windcurrent have engaged the services of Coastal and Environmental Services (Pty) Ltd (hereafter referred to as "CES") in order to compile a Stormwater Management Plan (SWMP) for the Khauta North Solar PV Facility located to the Northeast of Welkom in the Free State. The Khauta North Solar PV Facility (See Figure 1 below) is expected to generate up to a maximum 165MW during operation. The facility will comprise of the following infrastructure:

- SPV modules and mounting structures (monofacial or bifacial) with fixed, single, or double axis tracking mounting structures.
- Battery Energy Storage System (BESS).
- Site- and internal- access roads (up to six metres wide).
- Auxiliary buildings (offices, parking, etc.).
- Ablution facilities and associated infrastructure.
- Temporary laydown area during the construction phase (which will be a permanent laydown area for the BESS during the operational phase).
- On-site 33/132 kilovolt (kV) substation (facility substation) and associated 33/132 kV collector transmission line.
- Grid connection infrastructure including medium-voltage cabling between the proposed development and the facility substation (underground cabling will be used where practical).
- Perimeter fencing.
- Rainwater and/or groundwater storage tanks and associated water transfer infrastructure.
- Associated stormwater management infrastructure.

Figure 1: Project area



PURPOSE OF THIS REPORT

The SWMP is a stand-alone document to address the management of storm water falling on the Khauta Solar PV Facilities. The SWMP is compiled in line with the provisions of the Best Practice Guidelines (Best Practice Guideline G1) for Storm Water Management with the aim of addressing the following points:

Clean/Dirty Water

Clean water must be kept clean, by diverting it around areas that are considered dirty and routing it to a natural watercourse where possible, while dirty water must be collected and contained in a separate system from the clean water. The risk of spillage or seepage into clean water systems must be minimised.

Sustainable Life Cycle

The SWMP must be sustainable over the life cycle of the PV facility and over different hydrological cycles and the statutory requirements of the applicable legislation and regulatory agencies as well as interests of stakeholders must be considered and incorporated throughout the lifecycle of the operation. In order to achieve the objectives stated above the following Principles must be adhered to as described in the Best Practice Guidelines for Stormwater Management G1.

Clean Water

- Identify areas of clean storm water runoff and ensure this water is routed to natural watercourses ensuring it is not contaminated.
- Contamination of the clean water system must be avoided.
- Clean storm water runoff should only be contained if the volume of runoff poses a risk, if the water cannot be discharged to a watercourse by gravitation, for attenuation purposes, or the clean area is small and located within a dirty area.

Dirty Water

- Identify all potential sources of dirty water and implement appropriate collection and containment facilities.
- Minimise the areas that will generate contaminated runoff where possible, thus reducing the generation of contaminated storm water.
- Prevent seepage losses and overflows from storage facilities (e.g., pollution control dams (PCDs)).
- Ensure that dirty water is managed in accordance with the hierarchy of the PV Facilities water management – water reuse and reclamation.
- Ensure that less polluted water, or moderately polluted water is not further polluted, where waters of various levels of pollution should be kept separate improving the possibility for water reuse.

Sustainability

- Obtain management and staff commitment to the design and implementation of the SWMP.
- Determine the risks of failure of the SWMP, including extreme events and potential shortfalls of rain, and the consequences of such failures, in order to establish risk management measures.
- Consider changes or upgrades that may be necessary over the life of the project based on infrastructure changes or modifications.

Regulation

- Identify items of legislation relevant to the environment and water resources and ensure compliance with these.
- Include effective liaison with the relevant departments (Department of Human Settlements, Water and Sanitation) to ensure that statutory requirements are met, and any conditions stipulated by the DWS in the Water Use License (WUL) will be adhered to.
- Communicate and consult with Catchment Management Agencies (if these are established).

LIMITATIONS

This is a Desktop SWMP that has been compiled based on relevant Specialist Site assessments as well as consultation of the relevant National Legislation and best practice guidelines.

- This report does not intend to serve as a Storm Water Master Plan for the region, but merely focuses on the specific development sites and impacted footprints of the greater Khauta Solar PV Facilities.
- This report is limited to highlighting concepts related to storm water management and erosion control principles. No detailed designs will be included.
- This report does not present or discuss any detailed designed Storm Water infrastructure.
- The information provided by various specialists and/or historic reports is used, and detailed review of the information is not undertaken.
- The study is limited to the proposed site, and it is assumed that the existing downstream catchments and / or drainage systems can accommodate the storm water that is discharged from the site.
- No flood line data is provided at this stage
- Detailed design of the infrastructure has not been undertaken.
- This report presents the proposed storm water management infrastructure at this stage and should also be verified at the time of implementation so that it follows the final infrastructure design.

2 SITE DESCRIPTION

CLIMATE

The rainfall of the region peaks during the summer months and the Mean Annual Precipitation (MAP) of the area is approximately 577 mm (www.climate-data.org). The maximum average monthly temperature is approximately 23.3°C in the summer months while the minimum average monthly temperature is approximately 9.7°C during the winter. Maximum daily temperatures can reach up to 29.7°C in the summer months and dip to as low as 2.4°C during the winter.

GEOLOGY

According to Mucina & Rutherford (2006) the main geology of the landscape and associated vegetation type can be described as being covered by deep sandy to clayey alluvial soils developed over Quaternary alluvial sediments.

VEGETATION

According to SANBI (2006-2019), the proposed development area falls within the Highveld Alluvial Vegetation type (Aza 5). This vegetation type mainly consists of a flat topography supporting riparian thickets accompanied by seasonally flooded grasslands. This vegetation type is classified as Least Concerned (SANBI, 2006-2019). The specialist site investigation undertaken in support of the proposed project identified the entire proposed development area as forming part of a clayey terrestrial grassland landscape, based on vegetation structure, species composition and soil characteristics.

3 STORMWATER MANAGEMENT

Proper Stormwater planning is essential to prevent erosion of natural land and flooding of disturbed areas with the establishment of new infrastructure. Impacted footprints of new infrastructure must be designed, constructed, and maintained using best Storm Water Management practices to prevent flooding and to protect natural water quality. The overall focus will also be to reduce soil erosion (See Section 4) and to maintain and improve the natural wildlife habitat thereby contributing to the aesthetic values of the development.

The relevant National Legalisation sets out the overall objectives of the SWMP as follows:

- To categorise the site into clean and dirty water areas.
- Ensure that storm water originating from potentially dirty water areas is kept separate from the storm water runoff from the surrounding catchment.
- Where feasible to route all storm water falling on clean water areas to the natural environment without increasing the risk of a negative impact on safety and infrastructure.
- The determination of runoff and the sizing of storm water management infrastructure is to comply with the 1:50 year 24-hour rain event.

- Implement appropriate collection and containment facilities for the site that protects the environment and limits erosion of the surrounding environment and the storm water catchment system.
- Ensuring that upstream and downstream users are not adversely affected by the proposed SWMP.
- Establish maintenance and monitoring procedures for the storm water management and containment system.
- Consider changes and upgrades to the facility over its life.

The design principles of the hard surface infrastructure for the Khauta Solar PV Development (SPV Modules, access roads, laydown areas etc.) must be to focus on minimising unnecessary disturbance during excavation and to control the storm water run-off volume and velocities and minimise storm water run-off concentrations.

In order to achieve these principles, the following measures to mitigate stormwater damage and flooding should be incorporated into the design and management of the site.

Table 1: General Stormwater Management Measures

Stormwater Management Measures	
	Mitigation Measure
Land Clearance	Limit the disturbance of land (minimise clearing and grubbing of natural vegetated areas and topsoil removal) to suit the requirements of the Development and potential fire breaks.
	All vegetation clearing should occur in a phased manner in accordance with the construction programme, to minimise large bare open areas for extended periods, before construction activities will commence, to 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.
	Minimise the use of impermeable surfaces where possible to avoid excessive open areas. It is preferable to leave natural vegetation undisturbed - where possible only perform trimming of trees and bushes
Site Maintenance	Washing and cleaning of construction equipment should only be done at dedicated demarcated areas at the plant storage area. Berms or lined ponds should be constructed, to trap any cement, oils, and fuel spillages and to prevent excessive soil erosion at the washing areas.
Stormwater Designs	The use of cut-off drains, or berms should be incorporated at the top of cut embankments above roads and platforms.
	Limit the length of roadside drains and discharge storm water run-off as quickly as possible, via mitre drains to natural water courses or valleys.

	Reduce stormwater runoff energy through the use of vegetated open channels next to roads to convey and treat stormwater runoff. This also acts as a bio-filter allowing suspended sediment particles to settle, and to remove pollutants. This results in slower discharged velocities.
	Install breakers in roadside drains, e.g., grass or rock lined swales.
	Design and construct roads to avoid concentration of flow along and off the road. Where flow concentration is unavoidable, measures to incorporate the road into the pre-development stormwater flow should not exceed the capacity of the culvert.
	Design culvert inlet structures to ensure that the capacity of the culvert does not exceed the pre-development stormwater flow at that point. Provide detention storage on the road and/or upstream of the stormwater culvert.
	Design outlet culvert structures to dissipate flow energy. Any unlined downstream channel must be protected against soil erosion.
	Where the construction of a building causes a change in the vegetative cover of the site that might result in soil erosion, the risk of soil erosion by stormwater must be minimised by the provision of appropriate artificial soil stabilisation mechanisms or re-vegetation of the area. Any inlet to a piped system should be fitted with a screen or grating to prevent debris and refuse from entering the stormwater system.
	Preferably all drainage channels on the project area and contained within the larger area of the property should remain in the natural state so that the existing hydrology is not disturbed.
	Plan and construct stormwater management systems to remove contaminants before they pollute surface waters or groundwater resources.
	Prevent concentration of stormwater flow at any point where the ground is susceptible to erosion.
	Construction of gabions and other stabilisation features on steep slopes may be undertaken to prevent erosion, if deemed necessary.
	Ensure that all stormwater control works are constructed in a safe and aesthetic manner in keeping with the overall development
	Ensure that the development does not increase the rate of stormwater flow above that which the natural ground can safely accommodate at any point in the sub-catchments.
	Avoid situations where natural or artificial slopes may become saturated and unstable, both during and after the construction process.

MONITORING

To ensure that storm water management infrastructure is operating adequately and that the conditions of the facilities are in line with the design parameter, Khauta North Solar PV Facility must undertake monthly monitoring of the storm water management system. The clean water systems and the dirty water system must be inspected on a monthly basis to ensure the integrity of the system. Any vegetation or material build-up which could lead to a blockage of the system must be reported and the issue rectified within 24 hours. Records of the inspection findings must be kept on site and updated accordingly throughout the life of the operation.

4 EROSION CONTROL

If erosion control is not considered during the plannings stages this will result in the wash-away of fine material and will create unnatural storm water run-off paths, which will develop into erosion channels and may over time develop into land slip scars. If erosion occurs on gravel road surfaces, due to excessive storm water run-off with high velocities, regular grading maintenance will be required to repair minor surface erosion problems. If regular maintenance is neglected, road surface erosion will develop in rutting, corrugations and transverse channels which may negatively impact on the accessibility of transport roads. Erosion on exposed cut or fill gravel embankments, will soon lead to erosion channels. Storm water will opt to flow down the path of least resistance. Therefore, stormwater will discharge via erosion channels, at higher velocities and causing more and severe wash-aways. This may lead to embankment damage and road slippages, which may then have major cost implications if access roads become inaccessible during the construction of the PV facility.

The goals of erosion control during and after construction of the project area should be to:

- Protect the land surface from erosion.
- Intercept and safely direct run-off water from undisturbed upslope areas through the site without allowing it to cause erosion within the site or become contaminated with sediment.
- Progressively revegetate or stabilise disturbed areas.

These goals can be achieved by applying the management practices outlined in Table 2 Below.

Table 2 General Erosion Control Measures

Erosion Control Measures	
	Mitigation Measures
Design Requirements / Planning Phase	Reduce stormwater flows as far as possible by the effective use of attenuating devices (such as swales, berms, and silt fences). As construction progresses, the stormwater control measures are to be monitored and adjusted to ensure complete erosion and pollution control at all times.
	Silt traps must be used where there is a danger of topsoil or material stockpiles eroding and entering streams and other sensitive areas.
	Construction of gabions and other stabilisation features on steep slopes may be undertaken to prevent erosion, if deemed necessary.
	Minimise the area of exposed bare soils to minimise the erosive forces of wind, water, and all forms of traffic.
	Design outlet culvert structures to dissipate flow energy. Any unlined downstream channel must be protected against soil erosion.
	Where the construction of a building causes a change in the vegetative cover of the site that might result in soil erosion, the risk of soil erosion by stormwater must be minimised by the provision of appropriate artificial soil stabilisation mechanisms or

	re-vegetation of the area. Any inlet to a piped system should be fitted with a screen or grating to prevent debris and refuse from entering the stormwater system.
	Design culvert inlet structures to ensure that the capacity of the culvert does not exceed the pre-development stormwater flow at that point. Provide detention storage on the road and/or upstream of the stormwater culvert.
	Roads should be planned and constructed in a manner which minimises their erosion potential. Roads should therefore follow the natural contour as far as possible. Roads parallel to the slope direction should be avoided as far as possible.
Construction Requirements	Prevent concentration of stormwater flow at any point where the ground is susceptible to erosion
	Contain soil erosion, whether induced by wind or water forces, by constructing protective works to trap sediment at appropriate locations. This applies particularly during construction.
	Avoid situations where natural or artificial slopes may become saturated and unstable, both during and after the construction process.
	Soil loss is related to the length of time that soils are exposed prior to rehabilitation or stabilisation. Therefore, the gap between construction activities and rehabilitation should be minimised. Phased construction and progressive rehabilitation, where possible, are therefore essential elements of the erosion control strategy.
	Topsoil should be removed and stored in a designated area separately from subsoil and away from construction activities. Topsoil should be reapplied where appropriate as soon as possible in order to encourage and facilitate rapid regeneration of the natural vegetation in cleared areas.
Operational Requirements	Roads used for project-related activities and other disturbed areas should be regularly monitored for erosion. Any erosion problems recorded should be rectified as soon as possible and monitored thereafter to ensure that they do not re-occur.
	Runoff may have to be specifically channelled or storm water controlled to prevent localised gully erosion.
	Compacted areas should have adequate drainage systems to avoid pooling and surface flow. Heavy machinery should not compact those areas which are not intended to be compacted as this will result in compacted hydrophobic, water repellent soils which increase the erosion potential of the area. Where compaction does occur, the areas should be ripped.
	All bare areas should be revegetated with appropriate locally occurring species, to bind the soil and limit erosion potential.
	Silt fences should be used where there is a danger of topsoil or material stockpiles eroding and entering streams and other sensitive areas.

	Activity at the project area after large rainfall events when the soils are wet and erosion risk is increased should be reduced. No driving off of hardened roads should occur at any time, and particularly immediately following large rainfall events.
	Regular monitoring of the project area for erosion problems during construction (on-going) and operation (at least twice annually) is recommended, particularly after large summer thunderstorms have been experienced. The Environmental Control Officer (ECO) will determine the frequency of monitoring based on the severity of the impacts in the erosion prone areas

5 CONCLUSION

This SWMP which includes both stormwater management and erosion control measures provides guidance for the management of storm water at the Khauta Solar PV Facilities and forms an integral part of the supportive documentation required for adherence to the conditions of the Environmental Authorisation during the pre-construction, construction, and operational phases. An Environmental Management Plan (EMP) will be compiled, which should incorporate the recommendations of this report, serving as a guideline for the Developer to comply with the requirements of the National Legislation.