7 IMPACTS ON SOILS, HYDROLOGY AND HYDROGEOLOGY

Note: *The Impact Assessment and the proposed mitigation measures outlined in this chapter are based on the original Layout Alternative 1, but the residual impacts after mitigation have been adjusted on the basis of the revised and preferred Final Layout (Alternative 2) as informed by the EIA process.*

This chapter identifies and assesses the potential impacts the proposed Olyven Kolk solar power plant may have on soils, surface- and groundwater. The construction and operation of the project may impact the soils, surface and groundwater in the area and these potential impacts are summarised in *Table 7.1*. It should be noted that there are no permanent surface water bodies on site. Although the site is flat, there are ill-defined, dendritic drainage paths which are discernible mostly by a change in vegetation type. Darker green, more bushy *Rhigozum* sp. tend to inhabit drainage paths areas with the size and density of cover increasing as the soil moisture and soil thickness increases towards the centers of the drainage lines and downstream (see *Chapter 5*). The railway line acts as a cut-off across the site concentrating any surface water flows through the culverts beneath the railway line. For the purpose of this assessment, surface water features refer to the shallow drainage lines found within the site.

Table 7.1 Impact characteristics: Impacts on soils, surface water and groundwater

Summary	Construction	Operation
Project Aspect/ activity	(i) Soil compaction, removal of topsoil and erosion associated with site clearance and preparation, construction of compacted gravel tracks, laydown area etc. (ii) Impact on surface water and groundwater resulting from fuel, oils or cement spills (iii) Increase in sediment load in drainage lines, change of drainage patterns and as a result of filling and presence of workers and erosion.	(i) Soil erosion around cleared areas, roads and at the foot of PV panels. (ii) Reduced wind erosion. (iii) Impact on surface water and groundwater resulting from fuel and oil spills. (iv) Increase of sediment load in drainage channels and surface water bodies as a result of erosion. (v) Reduction of groundwater recharge due to sealed surfaces and PV panels.
Impact Type	Direct	Direct

Summary	Construction	Operation
Receptors Affected	(i) Soils on site underlying construction areas, PV sites, roads etc. (ii) Surface and groundwater quality at or near the site.	(i) Soils in the vicinity of cleared areas or roads and PV sites. (ii) Surface and groundwater quality at or near the site.

7.1 LOSS OF TOPSOIL, SOIL COMPACTION AND EROSION

7.1.1 *Impact Description and Assessment*

Construction Phase Impacts

Preparation of the site for the establishment of PV arrays, underground cables, access road(s), temporary lay-down area and buildings (control and accommodation buildings) during the construction phase will require vegetation clearance, some site levelling and grading and soil compaction.

The area required for the PV array locations, buildings and access tracks linking infrastructure will be considerable. For Site Layout Alternative 1, the total footprint of solar panels is to be around 160 ha. A further 180 ha would be taken up by the necessary space between rows to avoid shadow effects from one row to the next one. Internal tracks that are developed around the perimeter of the site and within the site between components of the plant will be up to 5m wide with drainage trenches adjacent to the paths.

Construction on the site could lead to increased erosion by concentrating water flows and removing the natural erosion protection as well as increasing run-off off the site and thus reducing infiltration and groundwater recharge. The vegetation, surficial gravel layer and soil duricrust that is present on site all act as protection against erosion by water and wind. Removal of these by excavation, grading or clearing will encourage erosion. The vegetation cover is the most important physical factor influencing soil erosion. An intact cover reduces impact from rain-drops on the soil, slows down surface run-off, filters sediment and binds the soil together for more stability. The intensity of potential erosion is also influenced by precipitation which is generally low in this semi-arid region between 100 mm and 200 mm per annum.

Run-off within the site occurs over the entire site in the form of sheetwash and there are few short sections of narrow incised channels. Compaction of soils from increased levelling and grading of areas of the site will result in lower permeability and therefore decrease infiltration and increased runoff. Without appropriate measures, runoff from PV panels, compacted areas and hardstanding areas in addition to erosion by wind may increase erosion and increase the sediment load entering the drainage lines. Potential impacts to surface water are assessed further in *Section 7.2*.

In addition, the permanent removal of the topsoil horizon changes the soil profile which may inhibit rehabilitation which may, in turn, increase the erosion potential of the soil.

Soil may be impacted as a result of spills or leaks of fuels and oils and lubricants from construction vehicles. These impacts are dependent on the size of the spill and the speed with which it is addressed and cleaned up. The likelihood of a spill is also associated with the volume of product that may be stored onsite. Typically for a development of this nature, above ground storage tanks for diesel and varying amounts of hydraulic oils, transformer oil and used oils will be required onsite during the construction phase.

Box 7.1 Construction Impact: Loss of topsoil, soil compaction and soil erosion

Nature: The loss of topsoil, changes in the soil profile through compaction, potential soil erosion and contamination will have a **negative direct** impact on the soils of the site.

Impact Magnitude –Medium

- **Extent:** The extent of the impact is **local** since the impacts are predominantly limited to the boundaries of the site but may extend beyond the site where drainage lines pass.
- **Duration:** The duration would be **long-term** since although removal of topsoil and compaction in areas of the site will occur largely during the construction phase, the effect may continue through the project lifecycle.
- **Intensity:** The intensity is **medium** since although topsoil removal and soil compaction may be limited to specific areas of the site, potential erosion may affect a larger area.

Likelihood – It is **likely** that this impact will occur.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – MODERATE (-VE)

Degree of Confidence: The degree of confidence is **medium**.

Operational Phase Impacts

Soil erosion caused by stormwater or surface water runoff may occur during the operational phase as a result of additional impervious surfaces onsite such as the gravel compacted roads, car park and the lay down and storage areas used for the construction phase resulting in increased runoff. In addition, although the disturbance associated with the construction phase is over, unless measures are undertaken, loss of topsoil may continue during the operational phase of the project. No topsoil clearing is anticipated during routine operation and maintenance of the facility although effects of wind and could proliferate erosion where vegetation cover particularly where soil has been removed.

Layout Alternative 1 involves the installation of PV arrays and other solar components across the drainage lines both north and south of the railway that passes through the site. Obstructions such as poles supporting the solar structures, building foundations and compacted gravel tracks on site may direct flows and concentrate them to erode gullies or dongas, the depths of which will be dictated by the depth of soil cover present. Flows diverted along tracks and infilled trenches will also result in similar occurrences especially if not orientated along the contours.

Wind erosion is predominantly governed by wind speed and duration and winds are known to be strong in the study area. The PV panels are likely to have a positive impact on wind erosion as they act as wind breaks and therefore the wind will put soil in motion for a smaller distance which will result in less abrasion and less soil erosion.

Soil contamination associated with leaks and spills are reduced during the operation phase since limited on-site storage of fuels will take place and site activities will be reduced.

Box 7.2 *Operational Impact: Loss of topsoil, soil compaction and soil erosion*

Nature: Routine operational and maintenance activities may result in a **negative direct** impact on the soils of the site whereas PV panels acting as wind breaks result in a **positive direct** impact on soils of the site.

Impact Magnitude –Low

- **Extent:** The extent of the impact is **local;** the impacts are predominantly limited to the site boundaries but may extend to the immediate vicinity of the site.
- **Duration:** The duration would be **long-term** as the soils may be affected at least until the project stops.
- **Intensity:** The intensity is **low** since the impact will be limited to areas that are already disturbed or to areas in close proximity.

Likelihood – It is likely that these impacts will occur.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – MINOR (-VE)

Degree of Confidence: The degree of confidence is **medium**.

Decommissioning

As mentioned in *Chapter 4*, once the Olyven Kolk solar power plant has reached the end of its life (20 years) the solar panels may be refurbished or replaced to continue operating as a power generating facility, or the facility can be closed and decommissioned. If decommissioned, all the components of the solar power plant will be removed and the site would be rehabilitated.

Removal of site equipment including PV arrays, buildings, underground cables and access roads, will induce more disturbance to the site and have a potential for soil contamination as a result of spills or leaks of fuels, oils and lubricants from vehicles or storage tanks if managed inappropriately. This impact would be **negative direct** and the significance would be **minor**.

However, the concrete foundations of the PV array would be removed to below ground level and would be covered with topsoil and be replanted to allow a return to agricultural land use (cultivation and grazing) which will have a **positive direct** impact on the soils on site.

7.1.2 *Mitigating Loss of Topsoil, Soil Compaction and Erosion*

It is possible to mitigate the majority of the potential impacts outlined above in order to contribute to reducing the significance of the residual impacts associated with loss of topsoil, contamination of soil, soil compaction and erosion to an acceptable level.

Proposed mitigation measures are detailed below for each of the project phases and will be further detailed in the Environmental Management Plan (EMP) to ensure mitigation measures are followed.

Design Phase

- Keep open the main drainage lines or hydraulic corridors traversing the site especially immediately below the culvert outlets (at the railway). These need to be wide as the water flow depths are small and widths of the order of 100 m are indicated if the formation of gullies is to be avoided;
- Should the drainage lines not be avoided, maintain adequate breadth and width below panels and supports so as not to trap debris; and
- Where possible, avoid underground cables.

Construction Phase

- Protect disturbed surfaces against erosion;
- Build regular diversion humps in gravel compacted roads;
- Restrict removal of vegetation and soil cover to those areas necessary for the development;
- Implement soil conservation measures such as stockpiling top soil or gravel for remediation of disturbed areas;
- Stockpiles should be vegetated or appropriately covered to reduce soil loss as a result of wind or water to prevent erosion;
- Disturbed areas should be rehabilitated as soon as possible to prevent erosion;
- Work areas should be clearly defined and demarcated, where necessary, to avoid unnecessary disturbance or areas outside the development footprint;
- Fuel, oil and used oil storage areas should have appropriate secondary containment (i.e. bunds);
- Spill containment and clean up kits should be available onsite and clean-up from any spill should be appropriately contained and disposed of;
- Construction vehicles and equipment should be serviced regularly and provided with drip trays, if required; and
- Construction vehicles should remain on designated and prepared compacted gravel roads.

Operational Phase

The following mitigation measures should be implemented during the operational phase:

- Lay down or infrastructure assembly areas which should not be required during the operational phase of the solar power plant should be re-vegetated with indigenous vegetation to prevent erosion;
- Bi-annual monitoring of erosion in the vicinity of roads, PV arrays and other hard-standing surfaces should be conducted before and after the rainy season to ensure erosion sites can be identified early and remedied; and
- Establishing an Environmental Management System to monitor compliance, check quality controls and ensure the EMP is being followed.

Decommissioning Phase

The following mitigation measures should be implemented during the decommissioning phase:

- Work areas should be clearly defined and demarcated, where necessary, to avoid unnecessary disturbance or areas outside the development footprint;
- Fuel, oil and used oil storage areas should have appropriate secondary containment (i.e. bunds);
- Spill containment and clean up kits should be available onsite and clean-up from any spill should be appropriately contained and disposed of; and
- Construction vehicles and equipment should be serviced regularly and provided with drip trays, if required.

7.1.3 Residual Impact

As mentioned in *Chapter 4*, after field surveys, each specialist prepared site sensitivity maps identifying habitats or areas of various sensitivities for each receptor or resource. One of the key mitigation measures recommended by a number of specialists was to avoid disturbance to the drainage lines on site including keeping all solar components, roads, buildings, hard standing areas etc out of the drainage corridors. Based primarily on this constraint, Site Layout Alternative 2 was developed.

The revision of the site layout from Site Layout Alternative 1 to the preferred Final Layout (Alternative 2) and the implementation of the above mitigation will result in a reduction of the impacts to soil and erosion during the construction phase to minor as outlined in *Table 7.2.*

Table 7.2 Pre- and Post-Mitigation Significance: Loss of topsoil, soil compaction and erosion

Phase	**Significance (Pre-mitigation) Site Layout 1**	**Significance (Pre-mitigation) Site Layout 2**	**Residual Impact Significance (Post-mitigation) Layout 2**
Construction	**MODERATE (-VE)**	**MINOR(-VE)**	**MINOR(-VE)**
Operation	**MINOR (-VE)**	**MINOR (-VE)**	**MINOR (-VE)**
Decommissioning	**MINOR (-VE)**	**MINOR (-VE)**	**MINOR (-VE)**

7.2 IMPACT ON SURFACE WATER AND GROUNDWATER

7.2.1 *Impact Description and Assessment*

Construction Phase Impacts

As mentioned in *Section 7.1,* soil compaction and vegetation clearance may increase the intensity and volume of surface water runoff as a result of a decrease in water infiltration recharging the groundwater. This may impact the drainage lines within the site by exacerbating erosion features and increasing the sediment load of the water entering these channels when they are flowing. As the solar arrays are to be constructed across the drainage lines for Site Layout Alternative 1, damage and disturbance to the drainage lines would occur from installation machinery and workers. Solar arrays typically require levelled surfaces for their installation and to install the solar infrastructure across the drainage lines would likely require some filling of the drainage lines which would result in the change of the existing natural drainage pattern on site. In addition, increased run off from hard standing areas could result in blockage of drainage lines and damage to solar infrastructure and installation equipment by debris and flooding, deepening and sidewards erosion of channels, loss of infiltration and an increased risk of flooding downstream.

Groundwater may be impacted as a result of infiltration of contaminants associated with spills or leaks of fuels, oils and lubricants from construction vehicles or storage tanks. These impacts are dependent on the size of the spill and the speed with which it is addressed and cleaned up as well as the vulnerability and susceptibility of the aquifer (least vulnerability [(1)] and low susceptibility [(2)]). The likelihood of a spill is also associated with the volume of product that may be stored onsite which is likely to be minimal during the operational phase.

(1) Tendency or likelihood for contaminants to reach a specified position in the groundwater system after introduction at some location above the uppermost aquifer.
(2) Qualitative measure of the relative ease with which a groundwater body Can be potentially contaminated by anthropogenic activities and includes both aquifer vulnerability and the relative importance of the aquifer in terms of its classification.

Box 7.3 Construction Impact: Impact on Surface and Groundwater

Nature: Surface and groundwater impacts resulting from soil compaction, filling of drainage lines, increased sediment load or through leaks or spills would result in a **negative direct** impact.

Impact Magnitude – Medium

- **Extent:** The extent of the impact is **local** since the impacts are limited predominantly to the boundaries of the site or in the vicinity of the site.
- **Duration:** The duration for impacts to the drainage channels would be **permanent** since their natural pattern would be permanently altered. Impacts to water quality from spills would be **short- term** depending on the size or nature of the spill.
- **Intensity:** The intensity is **low** since runoff is expected to be low and the quantity of dangerous goods stored onsite will be relatively small, however the direct impact intensity to the drainage line from disturbance of the natural drainage patterns would be **medium**.

Likelihood – It is likely that this impact will occur.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – MODERATE (-VE)

Degree of Confidence: The degree of confidence is **medium**.

Operational Phase Impacts

Soil erosion caused by storm water or surface water runoff may occur during the operational phase and result in an increase in the sediment load of onsite drainage channels. In Site Layout Alternative 1, the solar arrays would be located across/ within the drainage channels. Heavy rainfall could have potentially detrimental effects on the solar infrastructure as it concentrates its flow within the drainage lines. Blocking of the drainage lines would alter natural drainage pattern on site. Obstructions such as foundations and roadways will direct flows and concentrate them to erode gullies or dongas, the depths of which will be dictated by the depth of soil cover present. Similarly, flows diverted along tracks and infilled trenches will also result in similar occurrences especially if not orientated along the contours. These impacts will last the duration of the operational phase.

Surface water and groundwater impacts associated with leaks and spills are reduced during the operation phase since no on-site storage of hydrocarbons will take place and site activities will be reduced.

Due to proposed hard standing areas (lay down areas, building foundations, compacted gravels roads), compacted soil (rows between arrays) and PV panels covering large parts of the site (approximately 435 ha) recharge to groundwater from rainfall is expected to be reduced on site.

Box 7.4 Operational Impact: Impact on Impact on Surface- and Groundwater

Nature: Increased sediment loads in drainage channels, spills and leaks during routine operational and maintenance activities and reduced groundwater recharge may result in a **negative direct** impact on surface- and groundwater.

Impact Magnitude –Low

- **Extent:** The extent of the impact is **local** since the impacts are limited predominantly to the boundaries of the site or in the vicinity of the site.
- **Duration:** The duration for contamination would be **short to long-term** depending on the size of the spill. The duration for increased sediment loads and reduced groundwater recharge would be **long-term**.
- **Intensity:** The intensity is **low** since the size of a spill is likely to be small given the limited volume of product to be stored onsite. Intensity for change in flow during the operation phase and increased sediment load will be **medium** and for reduced groundwater recharge **low** since the natural groundwater recharge from rainfall in the area is low.

Likelihood – It is likely that this impact will occur.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – MODERATE (-VE)

Degree of Confidence: The degree of confidence is **medium**.

Decommissioning

Removal of site equipment including PV arrays, buildings, underground cables and access roads, will have a potential for groundwater contamination related to infiltration of contaminants as a result of spills or leaks of fuels, oils and lubricants from construction vehicles or storage tanks if managed inappropriately. This impact would be **negative direct** and the significance would be **minor**.

However, the rehabilitation of the entire site will reduce erosion and therefore decrease sediment loads in surface water courses on site. Groundwater recharge will increase as a result of reduction of sealed surfaces and rehabilitated soils. In general, decommissioning will have a positive direct impact on surface- and groundwater if managed appropriately.

7.2.2 Mitigating impacts on surface and groundwater

Design Phase

- Keep open the main drainage lines or hydraulic corridors traversing the site especially immediately below the culvert outlets (at the railway). These need to be wide as the water flow depths are small and widths of the order of 100 m are indicated if the formation of gullies is to be avoided;
- Should the drainage lines not be avoided, maintain adequate breadth and width below panels and supports so as not to trap debris; and
- Where possible, avoid underground cables.

Construction Phase

- Protect disturbed surfaces against erosion;
- Soil stockpiles should be protected from wind or water erosion through placement, vegetation or appropriate covering;
- Proper drainage controls such as culverts, cut-off trenches should be used to ensure proper management of surface water runoff to prevent erosion;
- Cleared or disturbed areas should be rehabilitated as soon as possible to prevent erosion;
- Fuel, oil and used oil storage areas should have appropriate secondary containment (i.e. bunds);
- Spill containment and clean up kits should be available onsite and clean-up from any spill should be appropriately contained and disposed of; and
- Construction vehicles and equipment should be serviced regularly and provided with drip trays, if required.

Operational Phase

The following mitigation measures will be implemented during the operational phase:

- Fuel, oil and used oil storage areas should have appropriate secondary containment (i.e. bunds); and
- Areas disturbed during construction should be re-vegetated with indigenous vegetation to prevent erosion.

Decommissioning Phase

The following mitigation measures should be implemented during the decommissioning phase:

- Work areas should be clearly defined and demarcated, where necessary, to avoid unnecessary disturbance or areas outside the development footprint; Fuel, oil and used oil storage areas should have appropriate secondary containment (i.e. bunds);
- Spill containment and clean up kits should be available onsite and clean-up from any spill should be appropriately contained and disposed of; and
- Construction vehicles and equipment should be serviced regularly and provided with drip trays, if required.

7.2.3 *Residual Impact*

The drainage lines on site would be strongly impacted by the design layout, Site Layout Alternative 1. The most significant consequence of the revised layout is that it avoids transgressing these drainage lines and allows for a buffer around these drainage lines (see *Figure 4.7*). This will ensure that the drainage lines will not be impacted by construction, operational and decommissioning activities as far as possible. Consequently, flow regime will not be impacted. Taking into consideration the proposed mitigation outlined above the impacts on surface water and waterbodies will be reduced to impacts of minor significance (*Table 7.3*).

Table 7.3 Pre- and Post-Mitigation Significance: Impacts on surface and groundwater

Phase	**Significance (Pre-mitigation) Site Layout 1**	**Significance (Pre-mitigation) Site Layout 2**	**Residual Impact Significance (Post-mitigation) Layout 2)**
Construction	**MODERATE (-VE)**	**MINOR(-VE)**	**MINOR(-VE)**
Operation	**MODERATE (-VE)**	**MINOR (-VE)**	**MINOR (-VE)**
Decommissioning	**MINOR (-VE)**	**MINOR (-VE)**	**MINOR (-VE)**