4 PROJECT DESCRIPTION

This Chapter provides an overview of the proposed Solaire Direct Graspan Photovoltaic (PV) Power Facility. Project activities and requirements for the construction, operation and decommissioning of the PV power facility are discussed in this section, as well as the motivation for the project and the alternatives considered.

4.1 MOTIVATION

Global dependence on fossil fuels, rising fossil fuel prices and concern regarding the impacts of climate change has resulted in increasing international pressure on countries around the world to increase their share of energy derived from renewable sources. Targets for the promotion of renewable energy now exist in more than 58 countries around the world and solar energy is emerging as an important component of the energy market in a number of countries.

The South African government has developed a policy framework (the White Paper on Renewable Energy) and set a target of sourcing 10,000 GWh from renewable energy projects by 2013. This amounts to approximately 4 percent of South Africa's total estimated energy demand by 2013. At the Copenhagen Conference in December 2009, South Africa's president also set a target for the reduction of CO_2 emissions, as laid out in the Integrated Resource Plan (IRP 2010), which sets a target reduction of CO_2 emissions by 34 percent by 2020. The utilisation of renewable energy will play a major role in achieving this goal. South Africa's commitment to achieving this goal was reiterated by Minister Edna Molewa at the December 2010 Climate Change Conference in Cancun, Mexico. At present, South Africa generates approximately 77 percent of the power consumed from coal and as a country, South Africa is among the largest emitters of CO_2 globally.

The potential for the Northern Cape to become a key area for the generation of electricity through solar energy is recognized by the Northern Cape Provincial Government. The Premier of the Northern Cape, Ms H. Jenkins, has stated to delegates of the Northern Cape Climate Change and Green Jobs Summit in Upington on 14 April 2011,'*The Northern Cape has been identified as one of the provinces best suited and strategically poised for a number of solar and wind renewable energy projects. These projects will be responsible for creating a number of green jobs in the province and will also be contributing to the clean energy that will be put on to the electricity grid. These projects will also contribute in reducing South Africa's green house gas emissions at a national level.*'

In addition, PV power facilities are more effective where there is a high level of solar radiation. South Africa and more specifically the Northern Cape Province experiences some of the highest levels of solar radiation in the world.

As such, the development of renewable energy projects such as this presents an opportunity for contributing to sustainable development and growth of the province and the country at large.

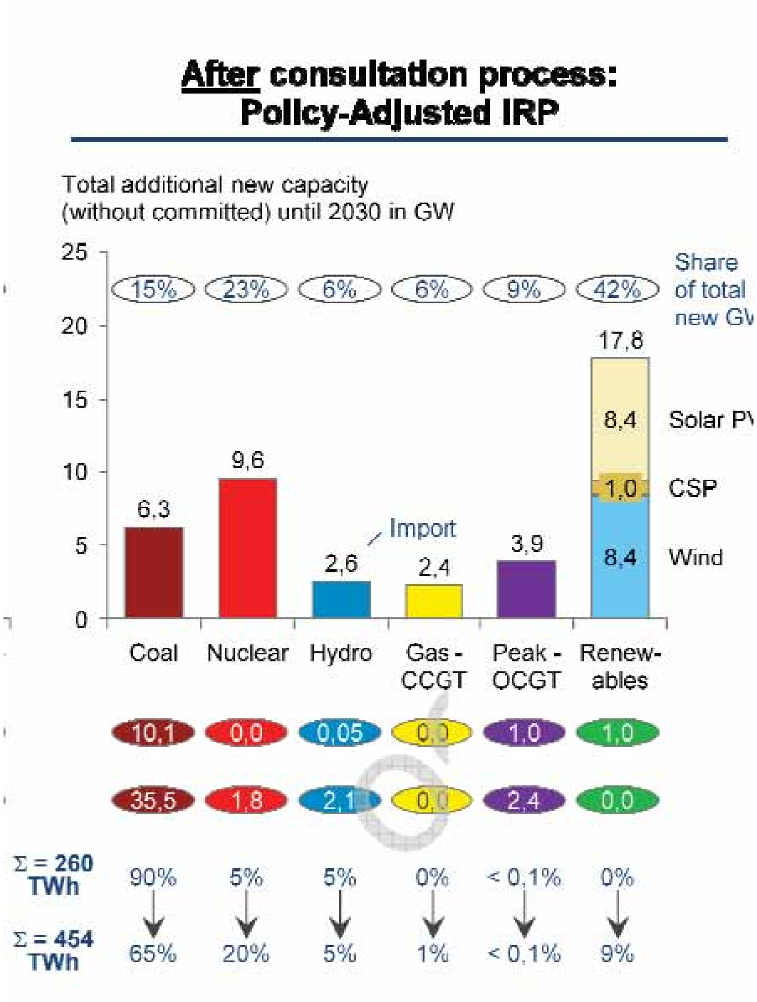
The intentions of Solaire Direct in establishing a PV power facility include reducing South Africa's dependence on non-renewable fossil fuel resources, contributing towards the targets and goals the South African government has set out, and contributing to climate change mitigation.

The Renewable Energy Independent Power Procurement Programme (IPP Procurement Programme) has been designed for the following reasons:

- To allow the private sector to contribute to the generation of renewable energy (and the target set by government);
- To contribute towards socio-economic and environmentally sustainable growth; and
- To enhance the renewable energy sector in South Africa.

Applicants are allowed to submit a proposal for the finance, construction, operation and maintenance of renewable energy facilities. *Figure 4.1* illustrates the total new additional energy capacity needed by 2030, and the different sources of this additional energy.

Figure 4.1 Cabinet Approved Energy Contribution for South Africa from 2010 to 2030



Source: Department of Energy, March 2011.

The cumulative impact of this 90 MW development as well as the numerous other proposed solar power facilities in the area may prove significant.

Beyond the positive climate impact, however, solar energy is very well placed to rapidly be implemented and contribute to alleviating the power gap in South Africa. Emergency load shedding in South Africa during 2007 and 2008 highlighted the challenges facing South Africa in terms of electricity generation, transmission and distribution. The National Energy Response Plan (NERP), drafted at the time, acknowledged the role that independent power producers (IPPs) (including those harnessing renewable energy resources) can play in ensuring sustainable electricity generation, and sets a goal that 30 percent of all new power generation will be derived from IPPs.

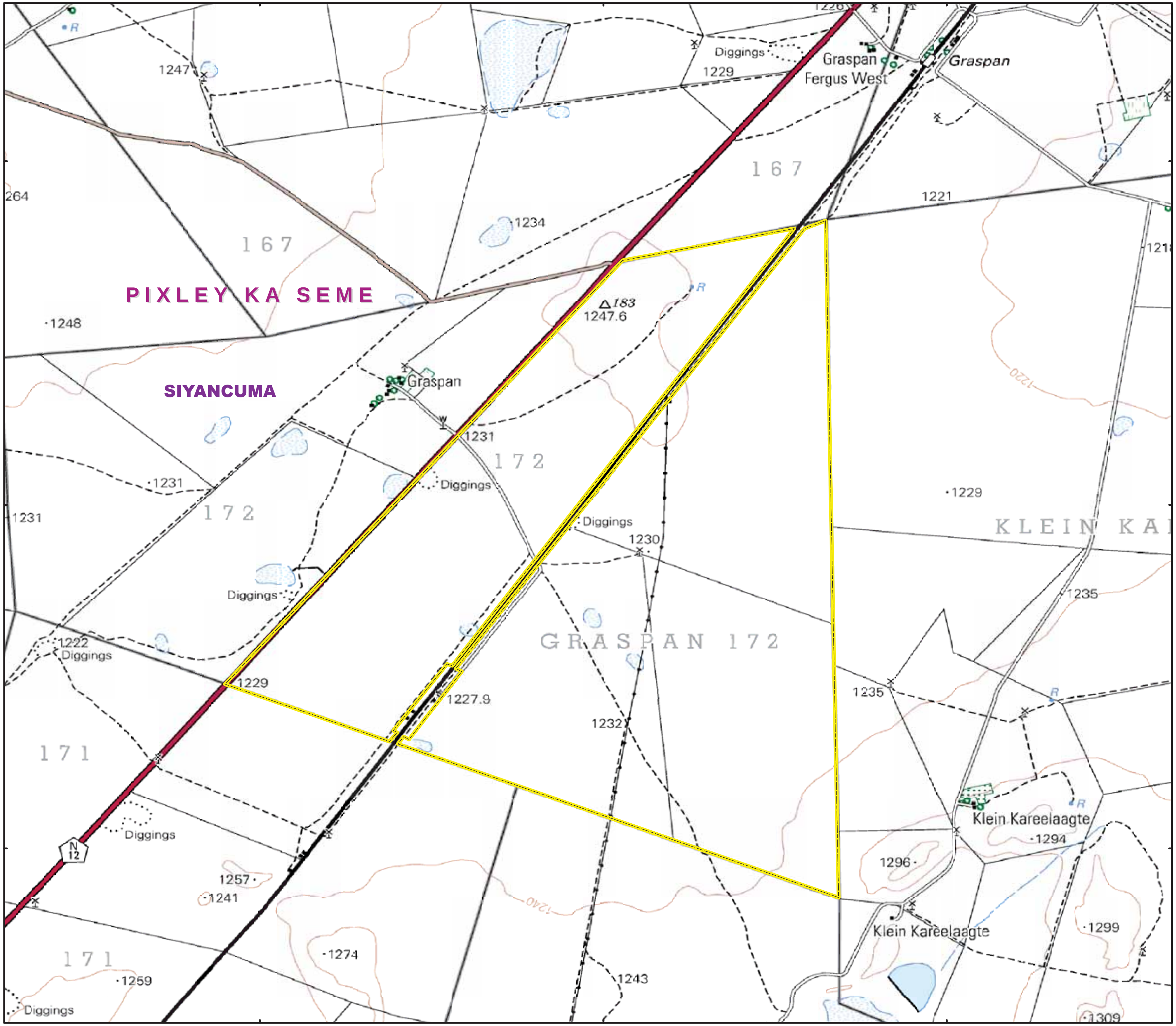
The development of solar energy in the Northern Cape offers the opportunity for a new industry in the province. Existing levels of employment are low within the province and wider site locality. Employment is considered to be the single biggest opportunity outside of the advantages expressed above, associated with the project. Training provided to employees will provide individuals with a skill set that will be highly desirable throughout the industry sector in South Africa as the renewable energy industry and specifically the solar energy sector rapidly develops, increasing potential opportunities available to such individuals.

4.2 PROJECT LOCATION AND EXISTING LAND USE

The proposed PV power facility is located on the remaining extent of Farm Graspan (No. 172), situated in the Siyancuma Local Municipality in the Northern Cape (see *Figure 4.2*). The site is located approximately 40 km north-east of Hopetown and is accessible from the N12 (tarred road).

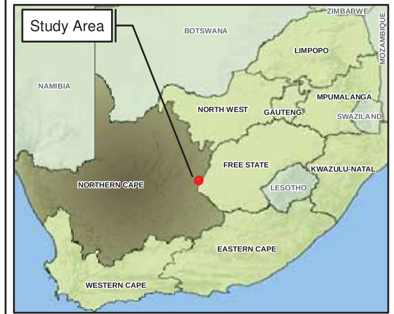
The site is designated for agricultural use, with current agricultural practices including sheep and cattle farming. Land use in the surrounding area includes further stock farming, cultivation approximately 15 km to the east and 30 km to the northeast of the site, and various salt works within a 15 km radius of the site.

There is an existing railway line traversing the site in a northeast-southwest direction. An existing gravel road network exists on the site, which crosses the railway line. The existing 132 kV Graspan Traction Substation is located within the northern section of the site, and an existing 132 kV power line traverses the site from the Graspan Traction Substation in a north-south direction, exiting the southern boundary of the site.



Legend

- Graspan Photovoltaic (PV) Power Facility
- Windpump
- Contours
- Rivers
- Cadastral Farms
- Power Line
- Main Roads
- Secondary Roads
- Other Roads
- Track and Hiking Trail
- Railway
- Water Bodies
- Non-Perrenial Water



SCALE: 0 500 1000 1500 Metres

N

TITLE:

Figure 4.2: Location of Graspan PV Power Facility on the Topographical Map

CLIENT: solairedirect Southern Africa The solar MWh company

DATE: July 2012	CHECKED: DA	PROJECT: 0156408
DRAWN: AB	APPROVED: SHC	SCALE: 1 : 30 000

DRAWING: Graspan EIR Topo Map.mxd

REV: 0

ERM
Block A, Silverwood House
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Steenberg Office Park, 7945
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Fax +27 (0)21 701 7900

Projection: Geographic: WGS84
Source: Chief Directorate National Geo-Spatial Information - 2924AD_2005_ED3_GEO.TIF
Inset Map: Esri Data & Maps

SIZE: A3

T:\Gis Projects\0156408_Solaire_Direct\Mapping\MXD\Graspan\EIR\Graspan EIR Topo Map.mxd

4.3 PV PLANTS AND POWER GENERATION

Solar energy systems produce energy by converting solar irradiation into electricity or heat. For the proposed PV power facility, Solaire Direct will utilise photovoltaic (PV) technology to generate electricity. PV technology consists of the following components:

- **PV cell;** a basic photovoltaic device, which generates electricity when exposed to solar radiation. The absorbed solar energy excites electrons inside the cells and produces electrical energy. The PV cells are commonly constructed from polycrystalline silicon. All photovoltaic cells produce direct current (DC).

- **PV module or panel;** the smallest complete assembly of interconnected photovoltaic cells. In the case of crystalline silicon cells, following testing and sorting to match the current and voltage, the cells are interconnected and encapsulated between a transparent front (usually glass) and a backing material. The module is then typically mounted in an aluminium frame.

- **PV array;** a mechanically integrated assembly of modules and panels together with support structures to form a direct current power producing unit. The proposed PV power facility will consist of antireflective modules arranged in numerous arrays. The feeding of electricity into the grid requires the transformation of DC from the PV array into alternating current (AC) by means of an inverter.

4.4 PROJECT COMPONENTS

It is anticipated that the project will feed a total of 90 MW into the national grid. The key components of the proposed PV power plant are discussed in detail below:

- PV solar panels/modules (arranged in arrays);
- PV module mountings;
- DC-AC current inverters and transformers;
- New grid connection substation;
- Underground cabling/ overhead power lines;
- On-site buildings (including an operational control centre, office, ablutions and a guard house);
- Access roads and internal road network; and
- Ancillary infrastructure.

4.4.1 PV Arrays and Mountings

The proposed development will include PV panels that will occupy approximately 150 ha (1.5 km^2) of the site area in total. The footprint of PV arrays will be approximately 127 ha. The PV panels will be 1975 mm in length, 990 mm in width and 50 mm in height with each producing an output of 300 W. Each PV panel will weigh approximately 26 kg. Within each PV panel there will be 60 polycrystalline cells (each 156 mm x 156 mm). These polycrystalline cells will be encapsulated in Ethylene Vinyle Acetate (EVA). The front substrate of the PV panel will be 3.2 mm of antireflection glass, while the back substrate will be Tedlar or APA composite sheeting. Each PV panel will be placed in a black or raw anodized aluminium frame 45 mm in width and equipped with drainage holes. PV panels will be connected in arrays to form units with a total power of 1 MW each (around 264000 PV panels will be installed on a 90 MW project). See *Annex F* for further technical specifications of the PV panels.

The PV panels will be mounted on aluminium fixed-frame structures approximately 3.33 m in height from the ground (see *Figure 4.3*). The aluminium structures will be mounted on steel screw piles or concrete foundations 1500 mm deep, depending on soil conditions. The distance or spacing between rows will be approximately 6.2 m. The PV arrays will face north in order to capture maximum sunlight. *Figure 4.4* shows a typical array of PV panels.

Figure 4.3 Typical Anodized Aluminium Frame

Source: Solaire Direct, 2012

Figure 4.4 Typical PV Array

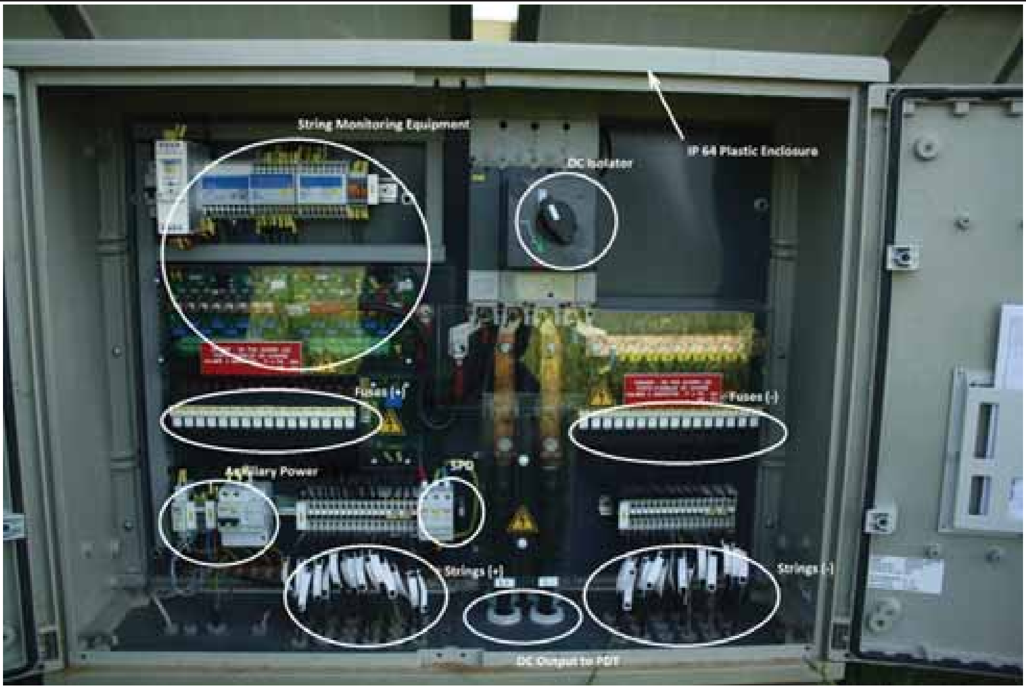
4.4.2 Electrical Connections and Controls

The PV panel arrays will be connected via underground cables (800 mm depth) to array enclosures (see *Figure 4.5* and *Figure 4.6*). Array enclosures combine the power generated by multiple PV panels and transmit that power via two underground DC cables (the array enclosures will be mounted underneath the PV module mounting structures and each array enclosure will occupy an area of approximately 1 m^2) to an inverter / transformer enclosure.

Figure 4.5 Typical Array Enclosure

Source: Solaire Direct, 2012

Figure 4.6 Array Enclosure Components



Source: Solaire Direct, 2012

The inverter / transformer enclosures convert the direct current (DC) produced by the PV panels to alternating current (AC) (see *Figure 4.7*). The inverter / transformer enclosures also contain transformers that transform low voltage AC (350 V) from the inverter to medium voltage AC (22 kV). The rated power of each central inverter is 630 kW at peak output. Two central inverters, along with an Low Voltage AC to Medium Voltage AC step-up transformer is placed inside a pre-fabricated concrete container. The container size is approximately 7m x 3m x 3.5m (length x width x height). Between 57 and 60 inverter / transformer enclosures will be required. The inverter / transformer enclosures will connect via underground cabling (depth 800 mm) to a new grid connection substation of approximately 400 m^2. The new grid connection substation will be a brick building containing medium voltage (22 kV) circuit breakers that will combine the power generated by each inverter / transformer enclosure. This combined power will then be transformed from Medium Voltage (22 kV) up to High Voltage (132 kV) for connection to the existing Eskom Graspan Traction Substation by power transformers. The power transformer units will be two 40 MW power transformers or three 25 MW power transformers. The power transformers and associated protection equipment (circuit breakers, etc) will be installed in the new grid connection substation yard, constructed to Eskom specifications (see *Figure 4.8* and *Figure 4.9*).

Figure 4.7 Typical Inverter/Transformer Enclosures

Source: Solaire Direct, 2012

Figure 4.8 Power Transformer

Source: Solaire Direct, 2012

Figure 4.9 ***Transformer in Grid Connection Substation Yard***

Source: Solaire Direct, 2012

4.4.3 Grid Connection

The 132 kV power from the new grid connection substation will be connected to the existing Eskom Graspan Traction Substation, located in the northern part of the site on the east side of the railway line, by two overhead power lines of approximately 800 m in length (see *Figure 4.10*). Both power lines will be installed on the same steel lattice structure, according to Eskom specifications.

Figure 4.10 Existing Graspan Traction Substation

4.4.4 Auxiliary Electrical Equipment

The following additional electrical equipment will be required for the project:

- A 200 kVA (10 MW) diesel generator will supply power to security and monitoring systems in the event of a grid failure;
- Security system, electrical fence and 24 hour on-site security access control;
- Fire detection system;
- Weather monitoring equipment (rainfall, wind speed / direction, solar irradiation, air moisture) will be located inside the guard house;
- PV power facility monitoring equipment and associated telecommunication links will be located inside the guard house; and
- Airconditioning equipment inside inverter / transformer enclosures which will regulate the operating temperature of the inverters.

4.4.5 Access Roads and Internal Paths

The site will be accessed from the N12 national road at the existing site entrance (29^{0}20'42.59" S 24^{0}24'51.66"E). An existing gravel road will be upgraded to approximately 6 m in width and used to cross the western portion of the site to the railway line. The railway line crossing will be upgraded to decrease the slope to between 26-45 degrees and 5 m width on either side of the railway line. The existing gravel road on the east side of the railway line running north will be used and upgraded to approximately 6 m in width in order to reach the PV power facility's direct footprint. Internal paths will be created to enable access within the PV power facility.

Within the PV arrays, a minimum spacing of 6.2 m is required between each row to avoid shadowing of the panels by adjacent rows. These spaces will not be gravelled or paved. PV power facility maintenance will consist mainly of PV panel replacement, PV panel cleaning and other minor mechanical and electrical infrastructure repairs. Access will be needed primarily for light service vehicles entering the site for maintenance, inspection and PV panel cleaning purposes. During the operational phase, traffic impacts will be reduced, with vehicles only required to transport infrastructure during routine maintenance and upgrading phases.

4.4.6 Additional Infrastructure

Additional infrastructure that will be required for the project includes the following:

- site perimeter fencing (electrical palisade fencing of approximately 2.8 m in height) including access gates;
- lighting at the main entrance only;
- temporary construction camp of approximately 4,800 m^2 (to house 35 personnel);
- an office for project supervision;
- a meeting room;
- an office for the caretaker of the site;
- two cloakrooms;
- two chemical toilets, as there is no water on the site; and
- a lay-down area for the temporary storage of materials during the construction activities of approximately 4,800 m^2.

At this stage it is unknown and unlikely if a borrow pit for rock or soil material will be required for the construction of project infrastructure. A temporary soil stockpile of approximately 6,000 m^2 will be required.

4.5 TRANSPORT, EQUIPMENT AND MACHINERY REQUIREMENTS

During the construction phase, it is expected that potential traffic impacts will be higher than normal as trucks will be required to transport materials and equipment (PV panels, frames, etc) to the site. Infrastructure required for the proposed PV power facility, including support structures, PV modules, frames, as well as machinery will be transported to and from the site from various locations in the region.

It is anticipated that the following number of trips would be required:

- Delivery of panels: 200 loads consisting of 18.9 tons each on 12 m long trailers.
- Delivery of electrical equipment and components: 28 loads of 20 tons each.
- Delivery of frames: 21 loads of 20 tons each.
- Earthworks: potentially 1400 loads of 10 m^3 each to the identified Local Authority Landfill Site.

During the operational phase, it is expected that potential traffic impacts will be reduced, with vehicles only required to transport infrastructure during routine maintenance and upgrading phases.

4.6 *WATER REQUIREMENTS*

During the construction phase the primary water use requirement will be for dust control. However, water may also be required to moisture condition the soils for proper compaction at roads and foundations. It is estimated that for dust control and compaction, approximately 4,800,000 litres of water will be required (an average of three truck loads per day for the first 60 days of construction and one truck load per day for the following 60 days of construction, with each truck carrying approximately 20,000 litres). Water will also be required for the concrete mixing for the foundations. It is estimated that 575,586 litres of water will be required for the concrete foundations (with a total of 209 litres / m^3 x 2,754 m^3). The estimated construction-related water requirement is 5.4 million litres with a daily usage of 60,000 kilolitres. Temporary ablution facilities will be required during construction. Water requirements for the construction phase of the PV power facility will be supplied by the Local Water Users' Association. Alternatively, additional water will be provided via a rainwater tank.

During the operational phase it is estimated that PV panel cleaning will require a total of approximately 100,000 litres / year (10,000 litres / MW / year). The PV panels will be cleaned manually with a window washer type device (covered with a specialized cloth material), soft brush, window squeegee or soft cloth. A composting toilet will be installed in the guard house requiring no water. During the operational phase drinking water and process water will also be supplied by existing boreholes and may require treatment for domestic use.

During the operational phase, it is the intention of Solaire Direct to source the required water from an existing reticulation system, either from the local municipality or the landowner. If this is not feasible, alternative options would be to tanker in the required water and / or amend the existing landowner's water use license to include the activity of the required water use.

During decommissioning and site restoration, dust control will be required, and it is anticipated that similar volumes of water as the construction phase will be required. Similar temporary ablution facilities as in the construction phase will be required during the decommissioning phase.

4.7 WASTE MANAGEMENT

All project generated wastes will need to be managed and disposed of in a manner to prevent potential impacts on the environment and risks to human health. A Waste Management Plan (WMP) for the proposed project will be developed. This will follow the principles of waste minimisation at source, segregation for reuse, recycling, treatment or disposal.

All wastes produced from the project activities on site will be temporarily stored in designated waste storage areas. Waste streams will be generated from logistical activities associated with project activities and accommodating personnel.

4.7.1 Waste Types and Quantities Generated

All wastes generated from the project will be categorised as either *non-hazardous* or *hazardous* following an assessment of the hazard potentials of the material in line with South African requirements. The main sources of waste will result from the temporary construction camp and construction and decommissioning activities. One of the main sources of non-hazardous wastes will be the domestic type solid waste from the approximately 35 personnel at the temporary construction camp. These wastes will be produced daily and comprise of the following:

- Domestic type waste, such as mixed waste from kitchens/canteen or living quarters;
    - residual packaging and food wastes
    - metal cans (from food and drinks)
    - plastics drinks bottles
    - glass jars and bottles
- Wooden pallets and cartons;
- Scrap metal;
- Concrete waste;
- Paper and cardboard;
- Grey water - from ablutions; and
- Food wastes.

The following hazardous wastes will also be produced from construction activities.

- Batteries (including large lead acid type);
- Medical / clinical wastes - from camp clinic;
- Oily rags and absorbents;
- Used oil and oil filters - from generators or vehicle maintenance;
- Contaminated water - slops and oily water from drip trays; and
- Sewage from toilets.

All wastes produced from project activities on site will be transferred to designated temporary storage areas and where possible into secure containers. Solid wastes will be segregated to facilitate reuse and recycling of specific materials. All wastes that cannot be reused or recycled will be collected by approved waste contractors and transferred to an appropriately licensed waste management facility for treatment and disposal.

4.7.2 Hazardous Materials and Hazardous Wastes

The construction and decommissioning phases will require the use of hazardous materials such as fuels and greases to fuel equipment and vehicles and maintain equipment. These substances will be stored on-site in temporary aboveground storage tanks. Fuels on site will be stored in a locked container within a fenced and secure temporary staging area. Trucks and construction vehicles will be serviced off-site. The use, storage, transport and disposal of hazardous materials used for the project will be carried out in accordance with all applicable South African regulations. Material Safety Data Sheets for all applicable materials present on site will be readily available to on-site personnel. It is proposed that the construction contracting company supply the required temporary ablution facilities and be responsible for the removal and treatment thereof. Solaire Direct will be responsible to ensure that the contracting company is accredited and has the necessary permits to remove the sewage. The sewage will be treated in accordance with the municipal sewage works policies and guidelines.

Operations and maintenance of the PV power plant is not expected to require hazardous materials to be present and used on site or to generate hazardous waste. PV panels, array enclosures and inverter / transformer enclosures will not produce waste during operation.

The composting toilet to be used in the guardhouse makes use of an aerobic process to treat human waste material. The composting toilet requires no water and produces compost-like, odourless, dehydrated material that could be either disposed of via municipal waste services or be used in the production of compost.

4.7.3 *Non-hazardous Wastes*

Construction waste will most likely consist of concrete (if concrete foundations are utilised to support mounting structures) and scrap metal. All concrete mixing be undertaken on impermeable plastic lining to prevent contamination of the soils and surrounding areas. Construction solid waste will be managed by a Construction Environmental Management Plan (EMP) and will incorporate reduction, recycling and re-use principles.

All waste that cannot be reused or recycled will be appropriately disposed of. All construction debris will be placed in appropriate on-site storage containers and periodically disposed of by a licensed waste contractor in accordance with applicable South African regulations. The construction contractor will remove refuse collected from the designated waste storage areas at the site at least once a week. All rubble generated during the construction phase will be removed from the site regularly to a licensed landfill site. It is estimated that approximately 222 m^3 of construction debris will be produced per month, while it is estimated that approximately 0.2 m^3 of solid waste will be generated during the operational phase.

4.8 SOCIO-ECONOMIC ASPECTS

The total investment cost of the project is estimated to be approximately R1,350 million.

During the construction phase, the following employment opportunities will be created:

- Site management: 25 employees
- Civil works: 54 employees
- Frames & foundations: 27 employees
- PV modules: 125 employees
- Electrical system & components: 60 employees

Of the PV power facility's employees during construction, approximately 174 employees are estimated to be skilled.

During the operation phase, the PV power facility is expected to create the following opportunities:

- General administration & maintenance: 30 employees
- Compliance related activities: 3 employees
- Performance monitoring of the PV power facility: 2 employees
- Security: 24 employees

Of the PV power facility's employees during operation, 21 employees are estimated to be skilled.

Certain aspects of the project will provide better opportunities for local employment and economic development than others. The conditions of contract between Solaire Direct and the subcontractor will include requirements for local Enterprise Development addressing the following identified opportunities:

- Electrical system: there will be a requirement for the electrical contractor to make use of local electrical companies for certain elements of the installation of the electrical system. The requirement will be for a minimum of 5 percent of the subcontract value to be spent on local enterprises.

- Security: there will be a contractual requirement for the security service contractor to subcontract the provision of local security staff to a local company. If such a company does not exist, then the requirement will be for the security service contractor to establish such a subcontractor. The requirement will be for a minimum of 25 percent of the subcontract value to be spent on local enterprises.

The labour contract between Solaire Direct and contractors who are appointed to provide services during the construction phase of the development will specify local labour employment criteria, e.g. percentage of total workforce.

Expected value of the employment opportunities during the construction phase is estimated to be 5 % of the total investment cost of the project, ie R 67.5 million, of which local labour is expected to receive 75 percent (approximately R 50 million). This estimate excludes the value of manufacturing labour costs.

Numerous local employment opportunities will be created in the manufacturing process of the PV panels, steel frames, etc. During the operation phase, the PV power plant is expected to generate approximately 24 security and 35 operation and maintenance employment opportunities (totalling an estimated R 59 million during the first 10 years (excluding construction). On-going reporting to the PSC regarding these specifics is required.

All financial returns will accrue to beneficiaries, including equity partners, according to Solaire Direct's company structure. Solaire Direct intends to contribute a portion of the gross profit (before tax and depending on the project stage) to a local community trust that has been set up specifically for this project. The value of this contribution will be determined on finalisation of the tariff as part of the Power Purchase Agreement (PPA).

4.9 *PROJECT STAGES AND ACTIVITIES*

The project life-cycle can be divided into three key stages as follows:

- site preparation and construction;

- operation (including maintenance and repair); and
- decommissioning.

Each of these stages is outlined in the sections below.

4.9.1 *Site Preparation and Construction*

Prior to construction of the PV power plant, the site would be prepared. The 150 ha site is generally flat. Site preparation would include the following activities:

- vegetation clearance – removal or cutting of any tall vegetation if present (bush cutting);
- levelling and grading of areas where the array will be sited, to remove steep slopes and undulations normally occurring, but this is not deemed necessary given the flat nature of the terrain on the site ;
- levelling of hard-standing areas, e.g. for temporary laydown and storage areas;
- erection of site fencing;
- construction of a temporary construction camp; and
- upgrading of farm tracks/ construction of on-site access roads.

Once the site has been prepared, prior to the installation of the PV components, the following construction activities will take place:

- the installation of fixed aluminium structures to support the PV modules;
- the construction of the new grid connection substation;
- the construction of electrical and control room;
- the construction of site office and storage facilities, including security and ablution facilities and associated septic tanks;
- the construction of array enclosure and inverter/transformer foundations and housing; and
- the installation of cables.

The PV, electrical and structure equipment will be procured in South Africa where available, or from an international manufacturer when sourcing from within the country is not possible. It is expected that these components will be delivered to site via road in small trucks. Once the PV components have arrived on site, technicians will supervise the assembly of the panels and test the facility. The PV panels will be installed on the fixed aluminium structures anchored to the ground through poles which will be screwed or piled into the ground.

Phased Approach to Construction

The development will be constructed in a phased approach. The exact size of each phase will be dependent on the various consents and authorisations to be obtained for the project, primarily the Power Purchase Agreement, as well as the interconnection technical constraints to be discussed and agreed with Eskom in the Interconnection Agreement. Installation of the full 90 MW could take up to 18 - 24 months or more to complete.

During the site preparation period, the workforce required for site security, manual labour, civil works, transportation of goods and other similar services will most likely be drawn from the local labour pool. During the first phase of construction, a highly-skilled team of solar energy technicians (the majority of which would likely be from outside South Africa as a workforce with the required skills is not currently available in the country) will train a number of the potential employees, preferably from the province, where available. Up to 291 personnel will be required to construct the full 90 MW PV power facility. However, any accurate employment number is dependent on how the phasing of the project is undertaken. For the purposes of the impact assessment, we have assumed that the development will take place in consecutive phases rather than all at once.

4.9.2 Operation

Once each phase of the facility is complete and operational, it is expected that it will have a lifespan of at least 20 years. Measuring the performance of the PV power plant will be done remotely, through the use of a monitoring system. Day to day facility operations will involve both regular on-site preventive and corrective maintenance tasks in order to keep the PV power plant in optimal working order throughout the operational period. Maintenance will consist mostly of panel replacement and other mechanical and electrical infrastructure repairs. Intermittent cleaning of the panels will be carried out as necessary, which is anticipated to be once or twice a year. Faulty components will be replaced as soon as problems are identified.

4.9.3 Decommissioning

The PV power facility will be decommissioned after 20 to 30 years. Alternatively, it will be upgraded or an application submitted to obtain a new license. Solaire Direct intend for the salvage value to cover the cost of decommissioning. Should the plant be decommissioned, the site will be rehabilitated to its original state.

Decommissioning activities will comprise:

- PV panels will be removed from the fixed aluminium frames.
- Fixed aluminium frame structures will be removed.
- PV panels will be transported to special recycling facilities (alternatively used at other operational sites).
- Electrical equipment (transformers) will either be re-used on other developments / projects or sold.
- Underground cable runs (where applicable) will be removed.
- Gravel / chipped stone on the access roads and on-site service roads, and guardhouse foundations, will be removed.
- Buildings such as the guardhouse can be taken over by the landowner for operational purposes. Alternately all the reusable material can be removed, the shells demolished and the rubble transported to a municipal waste site.
- Disturbed land areas will be rehabilitated, and replanted with indigenous vegetation if required.

4.10 CONSIDERATION OF ALTERNATIVES

In terms of the EIA Regulations, Section 28(1)(c) and NEMA, Section 24(4), feasible and reasonable alternatives are required to be considered in the EIA process. '*"Alternatives", in relation to a proposed activity, means different ways of meeting the general purposes and requirements of the activity, which may include alternatives to –*

(a) the property on which, or location where, it is proposed to undertake the activity;
(b) the type of activity to be undertaken;
(c) the design or layout of the activity;
(d) the technology to be used in the activity;
(e) the operational aspects of the activity; and
(f) the option of not implementing the activity (No Go)'.

This section outlines the alternatives considered for the Graspan PV power facility.

4.10.1 Site Location Alternatives

As part of the site selection process, a number of potential sites were investigated in the Northern Cape through a desk-top analysis and intrusive studies. The Graspan site was identified based on a number of criteria, including:

- **Solar resource:** Analysis of available data from existing weather stations suggests that the site has sufficient solar exposure to make a solar energy facility viable. The site is located in one of the most irradiated areas of the country.

- **Site extent:** An adequate portion of land was purchased to enable sufficient power supply and to allow for a minimum number of PV panels to make the project feasible.

- **Grid access:** Access to the grid and adequate transmission lines were key considerations for site location, i.e. proximity to Eskom's Graspan Traction Substation.

- **Land suitability:** Sites that facilitate easy construction conditions (relatively flat land with deep soft soil and few rock outcrops or waterbodies) were favoured during site selection.

- **Landowner consent:** The selection of sites where the land owners are supportive of the development of renewable energy is essential for ensuring the success of the project.

- **Environmental and socio-economic impacts:** Consideration was given to identifying a site with low agricultural potential, low level of biodiversity value and potentially low visual impacts during site selection.

- **Workforce:** The availability of a potential work force in surrounding area was taken into consideration.

4.10.2 Site Layout Alternatives

The PV power facility layout and project component design was subjected to a number of iterations, based on technical aspects of the project. These included aspects such as detailed site-specific solar data, construction conditions, as well as specialist input and sensitivity ratings for the site that were explored during the EIA process.

From a technical perspective, the final PV plant layout depends on a number of factors, including:

- Site-specific topographical conditions;

- Geotechnical features of the site;

- Drainage analysis;

- Final available interconnection capabilities to the Graspan Traction Substation;

- Final dimensions and sizing of structures to be done by specialized engineers to insure that all built equipment will be suitable for the local weather conditions; and

- Any additional inputs, obstacles, or constraints identified during the EIA and site survey process, as discussed below.

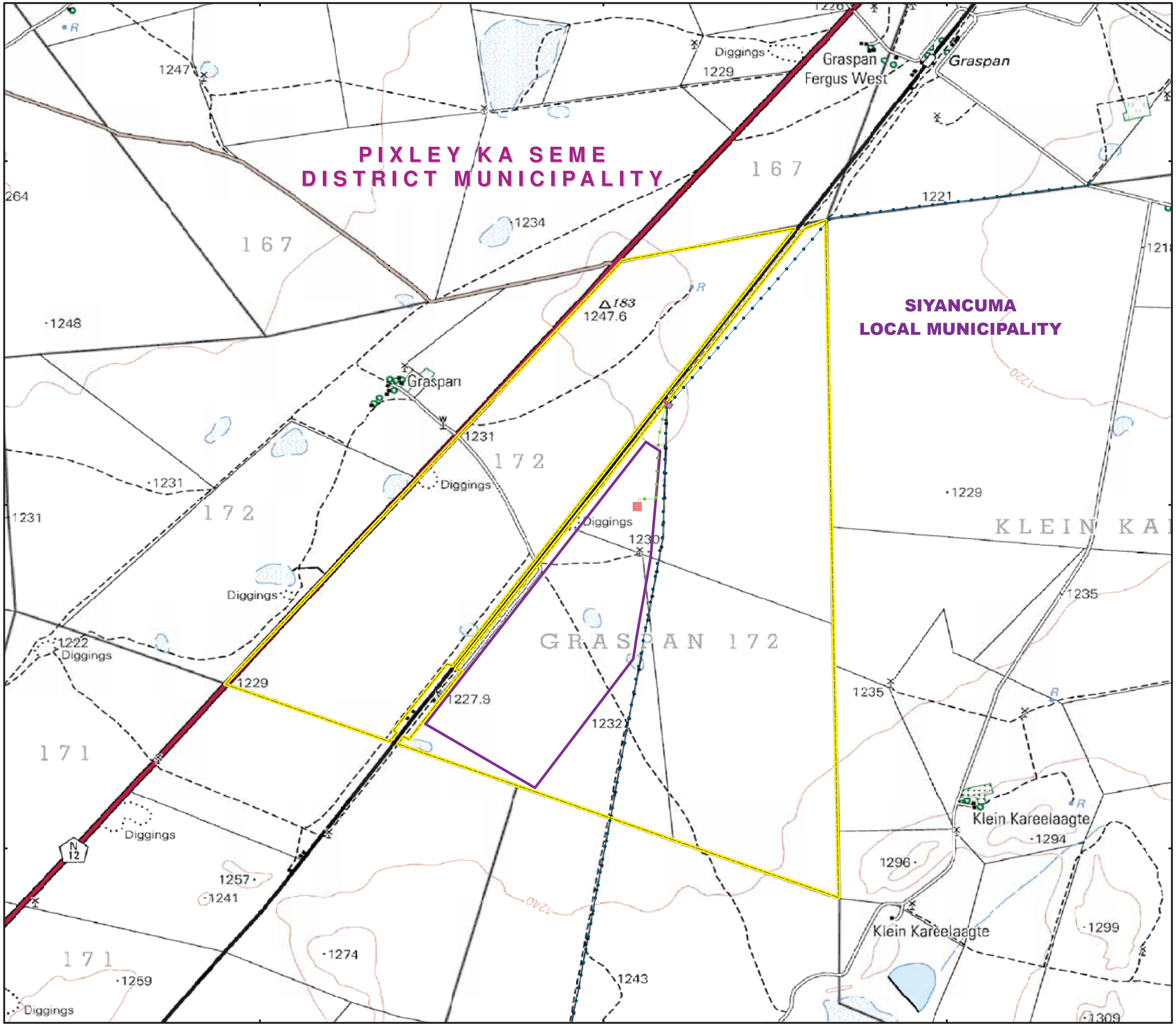
An original layout (Layout Alternative 1 shown in *Figure 4.11*) provided by Solaire Direct and based on limited data was used as the basis for the initial specialist assessment. After field surveys and workshops by the EIA team, particular areas posing additional environmental and social constraints or specific unsuitable locations were identified and fed back to the Solaire Direct technical team. Areas considered unsuitable by the environmental specialists were excluded where possible, based on potential impacts to vegetation, ecology, heritage and visual considerations. *Figure 4.12* indicates Layout Alternative 1 on the Constraints map. The technical team then generated a revised 'buildable areas map' based on these environmental and social constraints, as well as additional technical constraints, and from there developed a revised layout design, namely Layout Alternative 2 (*Figure 4.13*), taking these constraints into consideration.

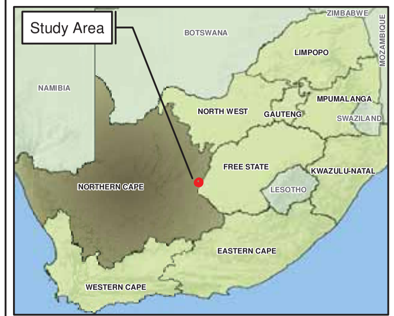
Technical criteria and buffer zones considered in deriving the final site layout (Layout Alternative 2) included:

- Where possible, avoiding areas which are very rocky or uneven, in order to minimise earthworks and thus real and potential environmental impact;
- Buffer around dry pans of 50 m;+
- National road buffer of 1 km;
- Local district road buffer of 100 m;
- Railway buffer of 100 m;
- External farm boundary buffer of 50 m; and
- Buffer along existing Eskom grid infrastructure of 500 m.

The aim of considering layout alternatives was to balance the technical and financial objectives of maximising the output of the proposed facility with the other critical environmental and social constraints, including visual, botanical, faunal, heritage, archaeology, and palaeontology.

It is reiterated that Layout Alternative 2 is the preferred and **final PV power facility layout** design applied for in this EIR.





Legend

- Windpump
- Contours
- Rivers
- Cadastral Farms
- National Roads
- Secondary Roads
- Other Roads
- Track and Hiking Trail
- Railway
- Existing Overhead Transmission Line ESKOM
- Transmission Line
- Water Bodies
- Non-Perrenial Water
- Proposed Substation
- Graspan Eskom Traction Substation
- Site Layout Alternative 1 (90MW)
- Graspan Photovoltaic (PV) Power Facility

SCALE:

0 500 1000 1500

Metres

N

TITLE:

Figure 4.11: Site Layout Alternative 1 showing Project Infrastructure (Topographical Map)

CLIENT:

solairedirect Southern Africa The solar MWh company

DATE: Oct 2012	CHECKED: DA	PROJECT: 0156408
DRAWN: AB	APPROVED: SHC	SCALE: 1 : 30 000

DRAWING: Graspan EIR Site Layout Alt1 proj infra-Topo.mxd

REV: 0

ERM
Block A, Silverwood House
Silverwood Close
Steenberg Office Park, 7945
Cape Town, SOUTH AFRICA
Tel: +27 (0)21 702 9100
Fax +27 (0)21 701 7900

Projection: Geographic: WGS84
Source: Chief Directorate National Geo-Spatial Information - 2924AD_2005_ED3_GEO.TIF
Inset Map: Esri Data & Maps

SIZE: A3

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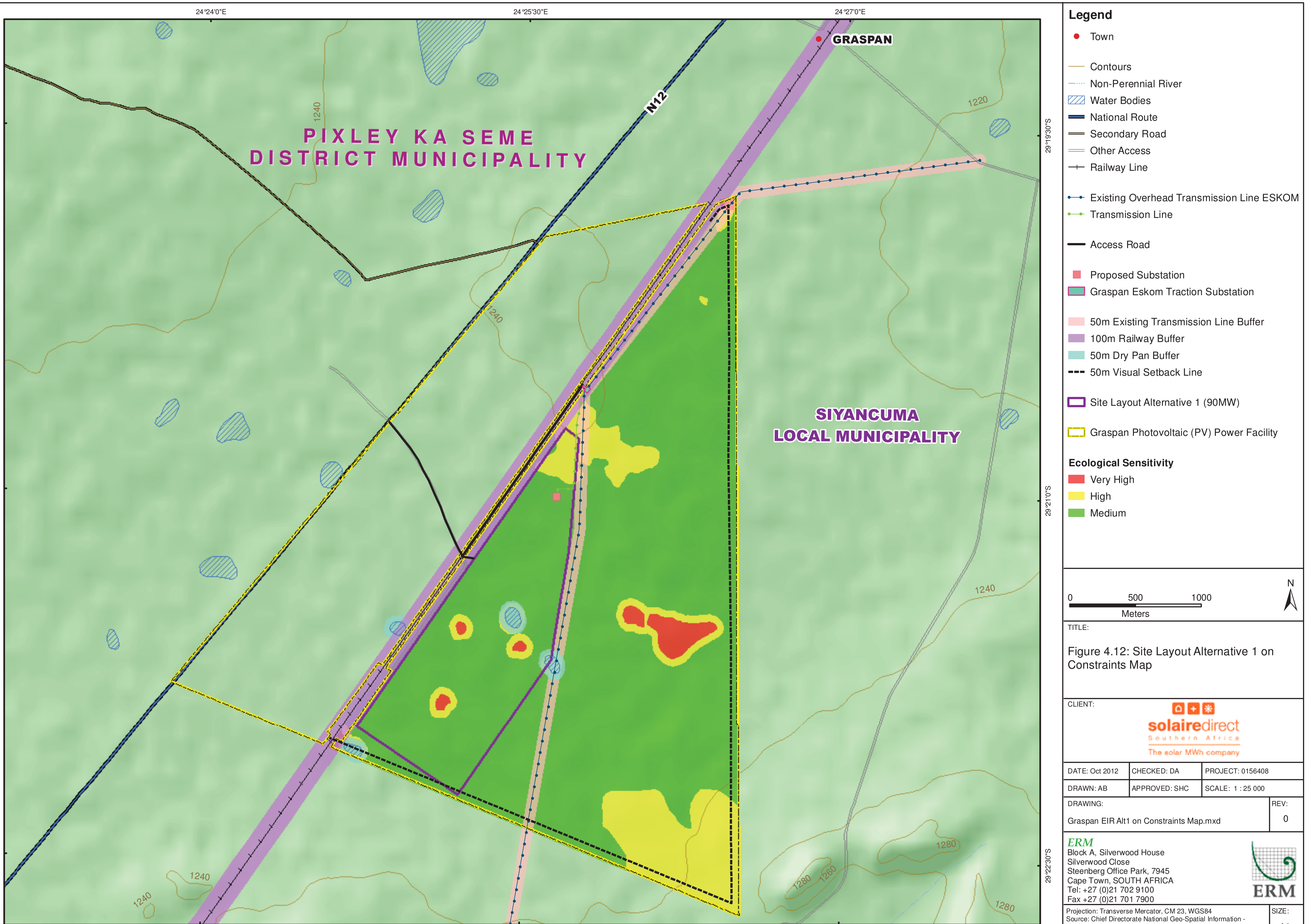

TITLE:

Figure 4.12: Site Layout Alternative 1 on Constraints Map

CLIENT: solairedirect Southern Africa — The solar MWh company

DATE: Oct 2012	CHECKED: DA	PROJECT: 0156408
DRAWN: AB	APPROVED: SHC	SCALE: 1 : 25 000

DRAWING: Graspan EIR Alt1 on Constraints Map.mxd

REV: 0

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Fax +27 (0)21 701 7900

Projection: Transverse Mercator, CM 23, WGS84
Source: Chief Directorate National Geo-Spatial Information - Base Data Simon Todd - Ecological Sensitivity
Inset Map: Esri Data & Maps

SIZE: A3

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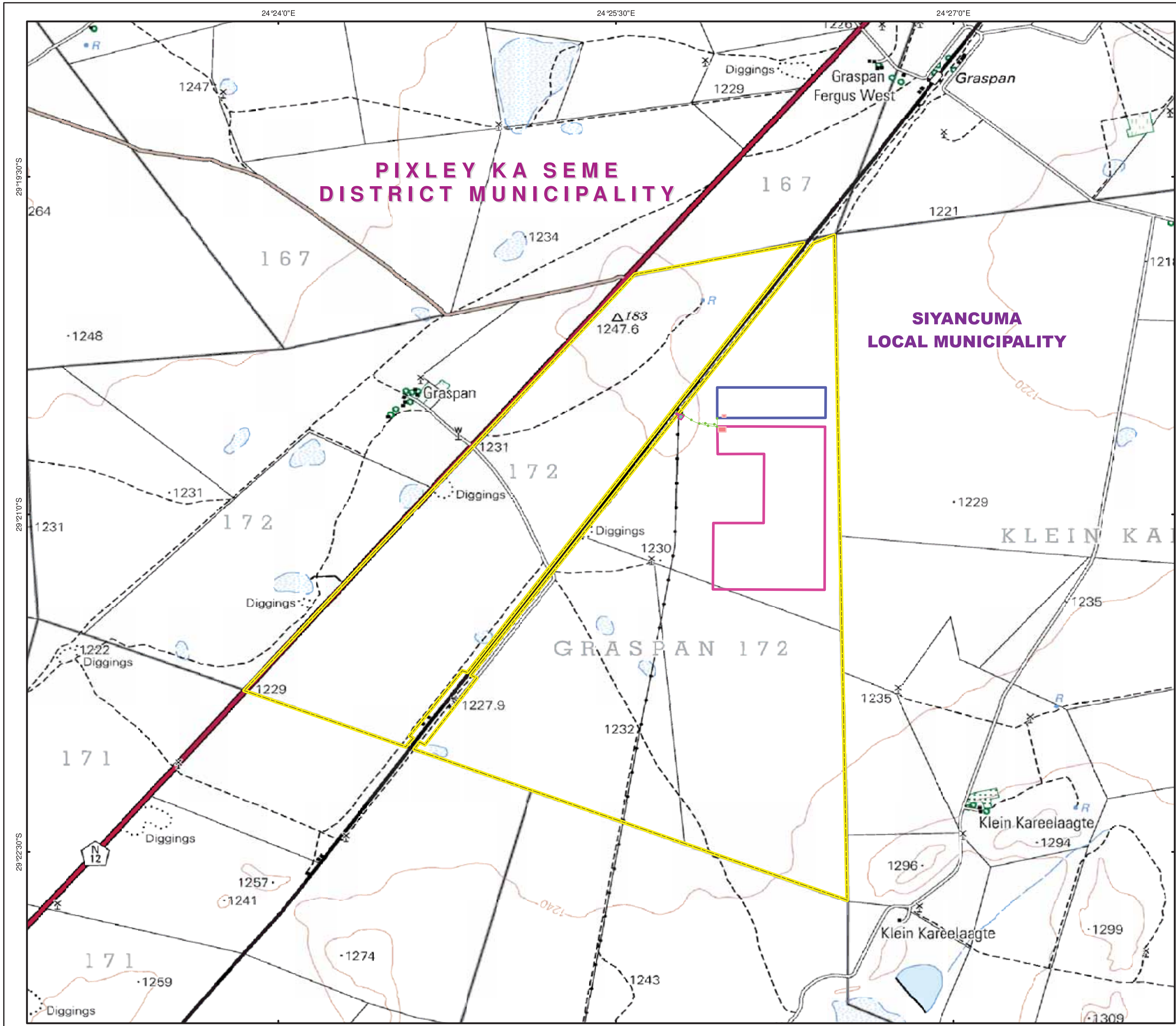

Legend

- Windpump
- Contours
- Rivers
- Cadastral Farms
- National Roads
- Secondary Roads
- Other Roads
- Track and Hiking Trail
- Railway
- Existing Overhead Transmission Line ESKOM
- Transmission Line
- Water Bodies
- Non-Perrenial Water
- Proposed Substation
- Graspan Eskom Traction Substation
- Site Layout Alternative 2 (10MW)
- Site Layout Alternative 2 (80MW)
- Graspan Photovoltaic (PV) Power Facility

SCALE: 0 500 1000 1500 Metres

N

TITLE:

Figure 4.13: Site Layout Alternative 2 showing Project Infrastructure (Topographical Map)

CLIENT: solairedirect Southern Africa — The solar MWh company

DATE: Oct 2012	CHECKED: DA	PROJECT: 0156408
DRAWN: AB	APPROVED: SHC	SCALE: 1 : 30 000

DRAWING: Graspan EIR Site Layout Alt2 proj infra-Topo.mxd

REV: 0

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Projection: Geographic: WGS84
Source: Chief Directorate National Geo-Spatial Information - 2924AD_2005_ED3_GEO.TIF
Inset Map: Esri Data & Maps

SIZE: A3

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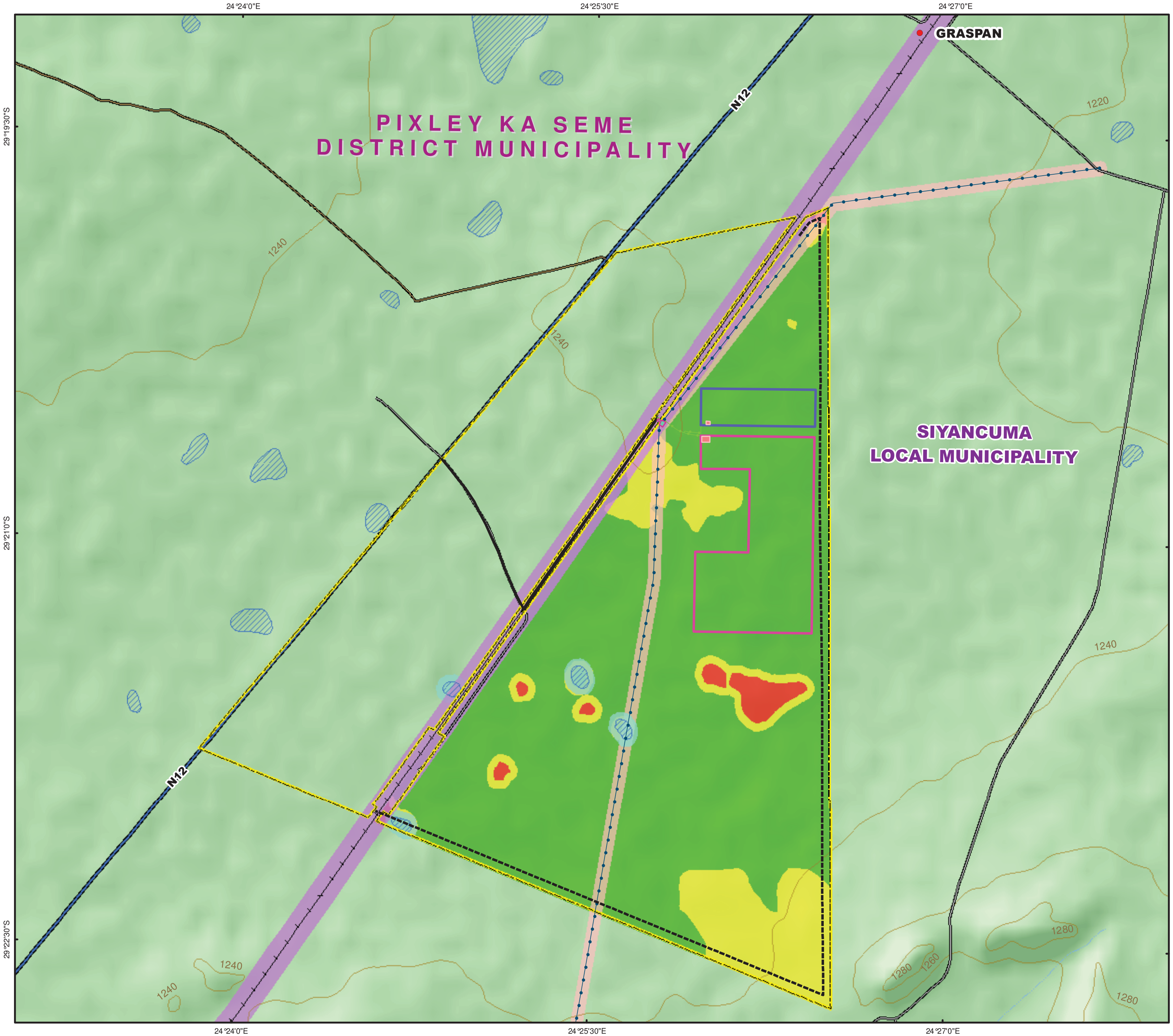

Legend

- Town
- Contours
- Non-Perennial River
- Water Bodies
- National Route
- Secondary Road
- Other Access
- Railway Line
- Existing Overhead Transmission Line ESKOM
- Transmission Line
- Access Road
- Proposed Substation
- Graspan Eskom Traction Substation
- 50m Existing Transmission Line Buffer
- 100m Railway Buffer
- 50m Dry Pan Buffer
- 50m Visual Setback Line
- Site Layout Alternative 2 (10MW)
- Site Layout Alternative 2 (80MW)
- Graspan Photovoltaic (PV) Power Facility

Ecological Sensitivity

- Very High
- High
- Medium

0 500 1000
Meters

N

TITLE:

Figure 4.14: Site Layout Alternative 2 on Constraints Map

CLIENT:

solairedirect
Southern Africa
The solar MWh company

DATE: Oct 2012	CHECKED: DA	PROJECT: 0156408
DRAWN: AB	APPROVED: SHC	SCALE: 1 : 25 000

DRAWING: Graspan EIR Alt2 on Constraints Map.mxd

REV: 0

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Tel: +27 (0)21 702 9100
Fax +27 (0)21 701 7900

Projection: Transverse Mercator, CM 23, WGS84
Source: Chief Directorate National Geo-Spatial Information - Base Data Simon Todd - Ecological Sensitivity
Inset Map: Esri Data & Maps

SIZE: A3

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4.10.3 *Technological Alternatives*

Solar energy is considered to be the most suitable renewable energy technology for this site, based on the site location, ambient conditions and energy resource availability. There are a number of different solar energy technologies that include:

- Fixed PV plants;
- Tracking PV plants (with solar panels that rotate to follow the sun's movement);
- Concentrated Solar Power (CSP) plants; and
- Concentrated PV Plants.

Financial, technical and environmental factors were taken into account when choosing the type of solar power technology for the site, including the local solar resource and its likely generation output, the economics of the proposed facility and availability of government feed-in tariffs and energy production licenses, and the requirement for other development inputs such as water resource requirements. PV is the most environmentally sensitive technology for the preferred site, as large volumes of water are not needed for power generation purposes compared to the CSP option. CSP requires large volumes of water for cooling purposes. PV is also preferred when compared to CSP technology because of the lower visual profile.

The remaining types of technologies were evaluated and the preferred configuration was selected based primarily on the operating environment. The suitability of different types of PV solar panels was assessed, including thin film and polycrystalline panels. Based on known performance in high temperature environments similar to those typical of the Northern Cape, thin film panels were selected as the preferred option. The Graspan PV power facility will install fixed structures rather than tracking systems as they require less repair work and maintenance during the operational life of the project. This decision is based on the benefits demonstrated by fixed structures with a longer track record in other markets, showing their high reliance over long periods of time. High capacity inverters (typically 1 MW) are considered more robust than smaller inverters and thus were selected as part of the preferred configuration.

Fixed Mounted PV System (Preferred Alternative)

In a fixed mounted PV system, PV panels are installed at a pre-determined angle from which they will not move during the lifetime of the plant's operation. The limitations imposed on this system due to its static placement are offset by the fact that the PV panels are able to absorb incident radiation reflected from surrounding objects. In addition, the misalignment of the angle of PV panels has been shown to only marginally affect the efficiency of energy collection. There are further advantages which are gained from fixed mounted systems, including;

- The maintenance and installation costs of a fixed mounted PV system are lower than that of a tracking system, which is mechanically more complex given that these PV mountings include moving parts.

- Fixed mounted PV systems are an established technology with a proven track record in terms of reliable functioning. In addition. replacement parts are able to be sourced more economically and with greater ease than with alternative systems.

- Fixed mounted systems are robustly designed and able to withstand greater exposure to winds than tracking systems.

Dual Axis Tracking System

In a dual axis tracking system, PV panels are fixed to mountings which track the sun's movement. There are various tracking systems. A 'single axis tracker' will track the sun from east to west, while a dual axis tracker will in addition be equipped to account for the seasonal waning of the sun. These systems utilise moving parts and complex technology, including solar irradiation sensors to optimise the exposure of PV panels to sunlight.

Tracking systems are a new technology and as such are less suitable to operations in South Africa. This is because:

- A high degree of maintenance is required due to the nature of the machinery used in the system, which consists of numerous components and moving parts. A qualified technician is required to carry out regular servicing of these parts, which places a question on the feasibility of this system given the remote location of the proposed project site.

- The costs of the system are necessarily higher than a fixed mounted system due to the maintenance required for its upkeep and its complex design.

- A larger project site is required for this system given that the separate mountings need to be placed a distance apart to allow for their tracking movement.

- A power source is needed to mechanically drive the tracking system and this would offset a certain portion of the net energy produced by the plant.

4.10.4 Grid Connection Alternatives

The options of connecting the PV power facility to Eskom's national grid are subject to on-going discussions between Solaire Direct and Eskom. The most efficient and practical option which is considered viable for the site is connection into the existing Eskom Graspan Traction Substation located in the northern section of the site. As the existing Graspan Traction Substation is located on the site, connection to this substation with an overhead powerline is considered the most efficient option as the length of the powerline will be relatively short (approximately 800 m). Two new grid connection substations will be built (one of 400 m^2 extent and the second of 2,500 m^2 extent) containing Medium Voltage (22 kV) circuit breakers that will combine the power generated by each inverter / transformer enclosure. This combined power will then be transformed from Medium Voltage (22 kV) up to High Voltage (132 kV) for connection to the existing Eskom Graspan Traction Substation by means of power transformers.

4.10.5 No-go Alternative

The no-go alternative is the option of not implementing the activity or executing the proposed development. Assuming that the solar power plant would not be developed at the proposed site, the site would remain in its current state. There would be no negative environmental and social impacts associated with the development of a solar power facility. The agricultural potential (although limited for this site) would not be lost due to the establishment of the facility on agricultural land. Similarly, there would be no positive impacts if the power plant is not executed; there will be no increase in electricity generation, no CO_2 offsets associated with the proposed development, no economic benefit to the landowners associated with the potential income generated through the operation of the facility and there would be no contribution to meeting South Africa's targets for renewable energy generation.

The direct benefits associated with both the construction and operational phases of the solar power plant such as increased employment opportunities and associated economic benefits would also not occur should the development not go ahead. It should be noted that requests for employment opportunities have been found to be the overwhelming theme from respondents to consultation opportunities provided to date.